



ICPS

**10th International Carnivorous Plant Conference**

18 - 20th JULY 2014

CAIRNS • AUSTRALIA



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# Conference Program

| Friday 18 July 2014 |                            | Presenter                | Topic  |
|---------------------|----------------------------|--------------------------|--|
| 8.30am              | Registration Open          |                          |  |
| 9.00am              | Welcome                    | Marcel van den Broek Msc | Opening remarks by the president of the ICPS.  |
| 9.15am              | Presentation 1             | Greg Bourke              | A photographic journey through Australia's fragile habitats  |
| 10.00am             | Presentation 2             | Dr. Adam Cross           | Little left to lose: habitat loss and the global challenge of returning to a carnivorous landscape |
| 10.45am             | Morning Tea                |                          |  |
| 11.15am             | Presentation 3             | Dr. Katja Rembold        | Diversity and conservation of the genus <i>Nepenthes</i>   |
| 12.00pm             | Lunch                      |                          |  |
| 1.00pm              | Presentation 4             | Rob Cantley              | Conservation - The IUCN Carnivorous Plant Specialist Group   |
| 1.45pm              | Presentation 5             | Jan Schlauer             | Field Notes from Andalucía, Spain  |
| 2.30pm              | Afternoon Tea              |                          |  |
| 3.00pm              | Presentation 6             | Drew Martinez            | LED lighting for plant horticulture  |
| 3.45pm              | Book Launch                | Allen Lowrie             | Public Event   |
| 4.45pm              | Welcome Drinks and Canapés |                          |  |
| 5.30pm              | Day 1 Close                |                          |  |

| Saturday 19 July 2014 |  | Presenter                  | Topic   |
|-----------------------|--|----------------------------|---|
| 9.00am                | Housekeeping   |                            |   |
| 9.15am                | Presentation 7   | Jeremiah Harris            | Cultivating Finicky Carnivorous Plants  |
| 10.00am               | Presentation 8   | Ch'ien C. Lee              | Recent Discoveries in Nutrient Acquisition Strategies in <i>Nepenthes</i>   |
| 10.45am               | Morning Tea  |                            |   |
| 11.15am               | Presentation 9   | Allen Lowrie               | <i>Stylidium</i> (Triggerplants), are they carnivores?  |
| 12.00pm               | Lunch<br>Public Event – Introduction to Carnivorous Plants     |                            |   |
| 12.45pm               | Presentation 10  | Micheal G. Schoner         | The Bornean pitcher plant <i>Nepenthes hemsleyana</i> – its natural history and interaction with a bat mutualist  |
| 1.30pm                | Presentation 11  | Caroline R. Schoner        | Interactions between carnivorous plants and animals - what's in it for the plants?                                |
| 2.15pm                | Afternoon Tea  |                            |   |
| 2.45pm                | Presentation 12  | Dr Andrej Pavlovic         | Costs and benefits of electrical signaling in carnivorous plant Venus's flytrap ( <i>Dionaea muscipula</i> Ellis) |
| 3.30pm                | Presentation 13  | Naoki Tanabe<br>Koji Kondo | Introduction of Pinguiculas native to the Japanese habitats   |
| 4.15pm                | Day 2 Close – see following page for Conference Dinner details |                            |   |

| Sunday 20 July 2014 |                      | Presenter           | Topic  |
|---------------------|----------------------|---------------------|--|
| 9.00am              | Housekeeping         |                     |  |
| 9.15am              | Presentation 14      | Alastair Robinson   | Palawan: A Microcosm for <i>Nepenthes</i> Taxonomy         |
| 10.00am             | Presentation 15      | Andreas Fleischmann | Evolution of carnivory in the plant kingdom                |
| 11.00am             | Morning Tea          |                     |  |
| 11.30am             | Presentation 16      | Gary Wilson         | Studies of <i>Nepenthes</i> pitcher plants in Austro-Papua |
| 12.15pm             | Lunch                |                     |  |
| 1.15pm              | Presentation 17      | Mason McNair        | <i>Sarracenia</i> : A Nomenclature Nightmare               |
| 2.00pm              | Presentation 18      | Charles Clarke      | Why are there so many species of <i>Nepenthes</i> ?        |
| 2.45pm              | Wrap Up / Discussion |                     |  |
| 3.30pm              | Conference Close     |                     |  |

| Monday 21 July 2014 |                                      |
|---------------------|--------------------------------------|
| Field Trip 1        | <b>Day Trip - Mount Bartle Frere</b> |

| Tuesday 22 July – Monday 28 July |                  |
|----------------------------------|------------------|
| Field Trip 2                     | <b>Cape York</b> |

| Conference Dinner – Saturday 19 <sup>th</sup> July 2014 |   |
|---|---|
| 5.00pm  | <b>Cairns Sunset Cruises</b><br>The Reef Fleet Terminal<br>1 Spence St, Cairns QLD 4870<br><a href="http://www.cairnssunsetcruises.com.au">www.cairnssunsetcruises.com.au</a> |
| 7.30pm  | <b>Ochre Restaurant</b><br>43 Shields Street, Cairns QLD 4870<br><a href="http://www.ochrerestaurant.com.au">www.ochrerestaurant.com.au</a>                                   |

## Presenters

### Greg Bourke - Australia

*Acting Curator/Manager, The Blue Mountains Botanic Gardens, Mount Tomah*

Growing up in the southern suburbs of Sydney with the Royal National Park at his doorstep, Greg's first encounter with carnivorous plants was in the form of *Drosera spatulata* in sandstone seeps whilst bushwalking with his father. From there, his enthusiasm for carnivorous plants developed considerably and over the last 20 years he has explored many parts of Australia and South East Asia. With his passion for photography, Greg has travelled extensively to discover, study and document carnivorous plants in their natural habitats. His large, private collection of native and exotic species was buoyed by his acquisition of a carnivorous plant nursery, 'Captive Exotics' [www.captiveexotics.com.au](http://www.captiveexotics.com.au) in 2009 and he now supplies carnivorous plants to collectors and the public in order to reduce collection pressure on wild populations. Greg is a founding member of the Australasian Carnivorous Plant Society and has held the position of President and Editor for many years since its inception in 2003. Greg is currently the Acting Curator/Manager with the Royal Botanic Gardens and Domain Trust at the Blue Mountains Botanic Gardens, Mount Tomah. He is also a serving board member of the International Carnivorous Plant Society (ICPS) and holds the position of Director of Conservation and Research.

### Rob Cantley - Sri Lanka

Robert Cantley was educated as a physicist and then later as an electronics engineer, with his final "real" job being a police officer in Hong Kong. Along the way he became interested in *Nepenthes* when living in Brunei, where he ran a small nursery business from 1984 -1990 called 'Isra Exotics', whilst also pursuing his many other interests. In 1997 he resigned from the Royal Hong Kong Police to start 'Borneo Exotics' ([www.borneoexotics.com](http://www.borneoexotics.com)) in Sri Lanka.

Borneo Exotics was expected to be a small semi-retirement business but kept growing and now Robert and his partner Diana Williams find themselves running a venture employing over 80 people and exporting several hundred thousand *Nepenthes* plants per year. Robert's next ambition is to open a topless bar in a warm climate.

### Charles Clarke - Australia

Charles is an ecologist who is interested in the relationships between *Nepenthes* pitcher plants and animals, particularly those species that provide *Nepenthes* with the nutrients that are lacking in their substrates. Charles has been conducting ecological and taxonomic research on *Nepenthes* in Southeast Asia and Australia since 1988. From 2008-2013 Charles worked at Monash University's campus in Kuala Lumpur, Malaysia, where he conducted a variety of research projects on the ecology of *Nepenthes*. In 2013 Charles returned to Cairns, Australia, where he continues his research through associations with James Cook University, the Australian Tropical Herbarium and the Carnivorous Plant Specialist Group.

### Dr. Adam Cross - Australia

*1- School of Plant Biology, the University of Western Australia, Perth, Western Australia*

*2- Science Directorate, Kings Park and Botanic Garden, Perth, Western Australia*

Dr. Adam Cross is a Research Associate at the University of Western Australia, based at Kings Park and Botanic Garden, Perth. A childhood of discovering Western Australia's exceptional native biodiversity led Adam towards a career in botanical research and conservation, and kindled a love of adventure and a lifelong fascination with carnivorous plants. Plants have led Adam to explore some of the remotest areas of Australia, and to the spectacular highlands of South America, ancient Redwood forests and pitcher plant bogs of North America, and arctic northern Europe. He has published a book on his research into the globally endangered carnivorous waterwheel plant (*Aldrovanda vesiculosa*), and recently completed a PhD on the ecology and seasonal biology of wetland plants in northern Western Australia. Adam has a continuing research interest in wetland ecology, restoration ecology, ecophysiology, and the biology of carnivorous plants.

## **Andreas Fleischmann - Germany**

Andreas Fleischmann was born in Landsberg, southern Germany. From an early age, Andreas studied the flora of Bavaria and the Alps, and soon became especially fascinated by plants with an unusual way of gaining nutrients, mainly carnivorous and parasitic plants, which he also grows in his greenhouse and garden. Andreas studied biology in Munich, where he has been working at Munich University as a botanist since 2006. In February 2014, Andreas became the curator of vascular plants at the Botanische Staatssammlung München, which is the Munich herbarium. Andreas's main study interests are systematics, taxonomy and evolution of carnivorous plants (especially *Drosera* and *Lentibulariaceae*), as well as plant pollination biology.

## **Jeremiah Harris – United States**

Jeremiah Harris is founder and president of the Colorado Carnivorous Plant Society; he was a founding board member of the North American Sarracenia Conservancy. He has been growing carnivorous plants since 1992 and now grows over 700 different varieties of carnivorous plants of every genus. His collection specializes in *Nepenthes* and he has one of the most diverse species collections in the world with 132 different recognized species under his care. One of his highlights of last year was germinating pure *N. rajah* seed from cultivated plants.

## **Ch'ien C. Lee - Malaysia**

Ch'ien Lee holds a B.Sc. in Biology/Ecology from the University of California, Santa Cruz, where his fascination with *Nepenthes* began when he took a position caring for the carnivorous plant collection there. In 1996 he moved to Sarawak, Malaysia to initiate a *Nepenthes* propagation program at 'Malesiana Tropicals', and has since continued to travel widely across Southeast Asia to document the genus in its natural habitat. Ch'ien has undertaken a number of regional *Nepenthes* field studies and is currently a contributing member of IUCN's Carnivorous Plant Specialist Group.



## **Allen Lowrie - Australia**

Allen Lowrie, was born at Mount Hawthorn, Western Australia, in 1948. Beginning work at the age of 15, he forged a successful commercial career, turning his hand to advertising, steel fabrication, work as a geologist's assistant in the Pilbara, and eventually swimming pool construction. Allen's philosophy on life has been largely shaped by the unfortunate saga of the Vietnam War and a close-call with conscription. From an early age, it drove him to follow his great passion for botany, to be outgoing, to take risks, to profit from his own endeavours and to strive to succeed, but always having fun and adventures along the way.

During his commercial career, he invented a range of pool chlorinators and pH controllers; the success of these inventions and his business allowed him to leave the commercial world in 1987 to focus on his dearest plant passions, the carnivorous plants and triggerplants of Australia, full time. Though not formally trained in botany, Allen persevered in his research studies to become truly accomplished, working both solo and alongside mentors and colleagues in the plant sciences to make botanical pursuits his life's work.

Allen has previously written 3 books on the carnivorous plants of Australia, for which he is now a world authority in addition to his expertise with triggerplants. He has given numerous lectures to botanical students and wildflower enthusiasts, as well as written many scientific papers naming the many new species of plants that he has discovered. During his botanical career, to date, Allen has named 135 new plant species, undertaken botanical expeditions all over Australia, and conducted botanical surveys in some of the most remote places in Australia, including the Cape York Peninsula and the Kimberley. He has made expeditions to Borneo and Sumatra, as well as Malaysia, with the assistance of Robert Oliver and Steve Rose. He has also acted as botanical consultant to mining companies throughout Western Australia. An accomplished artist, Allen has also produced all of the botanical drawings and illustrations for his books and papers.

Beyond his botanical pursuits, Allen is also a keen musician, playing guitar, rhythm, lead and bass, the mandolin and keyboards. He writes music for pleasure and has composed and recorded no fewer than 30 songs.

Married for 43 years, Allen and his wife, Pauline, have two daughters, Trinity Renae and Filicity Raye, and three grandchildren, Lochlan, Evan and Yana.

## **Drew Martinez – United States**

Drew Martinez is a scientist, explorer and carnivorous plant enthusiast. He has been growing carnivorous plants for the past 18 years and currently operates 'Carnivero' ([www.carnivero.com](http://www.carnivero.com)), a company specializing in carnivorous plants and the technology to grow them. He has visited plant sites on five continents. Drew's fascination with nature inspired him to pursue B.S. degrees in Physics and Biological Sciences from Stanford University and an M.S. degree at the College of Optical Sciences at the University of Arizona. He is currently employed as a scientist at Google[x] laboratories and has had previous tenure at IBM, KLA-Tencor and Pacific Biosciences.

## **Mason McNair – United States**

*Horticulturalist, Camellia Forest Nursery*

*BS in Horticultural Science, Minor in Agricultural Business Management*

*NC State University*

*Co-founder, Carolina Carnivorous Plant Society*

Mason McNair is a recent graduate from North Carolina State University where he earned a BS in Horticultural Science and a minor in agricultural business management. He currently works at 'Camellia Forest Nursery' ([www.camforest.com](http://www.camforest.com)), a mail order nursery specialized in rare and unique woody plants. He co-founded the Carolina Carnivorous Plant Society (CCPS) and has traveled all across the Southeastern United States photographing Carnivorous Plants in-situ. He is currently writing a field guide to the carnivorous plants native to that area with all original photographs. He hopes in the near future to return to school to obtain his PhD in Botany with the goal of resolving the taxonomy of the genus *Sarracenia* through molecular systematics.

## **Dr Andrej Pavlovic - Slovakia**

*Department of Biophysics, Centre of the Region Haná for Biotechnological and Agricultural Research, Palacký University in Olomouc, Šlechtitelů 11, CZ-783 71, Olomouc, Czech Republic, andrej.pavlovic@upol.cz*

Dr. Andrej Pavlovič currently works at Palacký University in Olomouc (Czech Republic) and Comenius University in Bratislava (Slovakia). He received his Ph.D. degree in Plant Physiology (Comenius University in Bratislava) and his main scientific interest is studying the relationship between prey capture and physiological response in carnivorous plants. During his short scientific career he published 15 papers in impacted journals. He described the effect of electrical signals generated by touch on photosynthetic and respiration reactions in Venus's flytrap, increased photosynthetic efficiency in response to nutrient uptake from prey and currently his scientific group work on regulation of enzymatic activities by stimuli from captured prey.

## **Dr Katja Rembold - Germany**

Katja Rembold completed Biology studies with a master thesis on the ecology of *Nepenthes madagascariensis* at the University of Bonn (Germany). Afterwards Katja was responsible for the carnivorous plants working group at the Nees Institute for Biodiversity of Plants and for the carnivorous plant collection at the Botanical Gardens of Bonn for 2.5 years. While she is very glad that she was able to join several field trips and excursions related to carnivorous plants in the following years, the main focus of Katja's research shifted towards conservation biology. Katja finished her PhD on the conservation status of plants in East African rain forests at the University of Koblenz (Germany) in 2011 and got a position as project manager in an agroforestry project in Rwanda. Since 2012 Katja has held a postdoc position in an international collaboration project investigating the consequences of rainforest transformation into agricultural systems for plant diversity in Sumatra (Indonesia).

## **Alastair Robinson - Australia**

Raised in Malaysia, field botanist Alastair Robinson has undertaken research into *Nepenthes* across virtually their entire range. Alastair originally has a background in plant pathology and physiology, culminating in a Ph.D. from the University of Cambridge, U.K., for research into the molecular control mechanisms of cell division in plants. When not in the field, Alastair works as an editorial consultant with the natural history publisher, 'Redfern' ([www.redfernnaturalhistory.com](http://www.redfernnaturalhistory.com)), known for its carnivorous plant publications, as well as two journal publishing houses.

## **Jan Schlauer - Germany**

Jan Schlauer was born in 1966 in Prague (now Czech Republic) and is living in Germany since 1969. Since the age of 13 he has been fascinated with carnivorous plants and eager to learn as much as possible about their evolution, diversity and distribution. This explains his early disappointment with the way threatened species and habitats have been managed around Frankfurt/Main (where he spent his schooldays, and where pristine carnivorous plant habitats had existed until the early 20th century to be destroyed by misguided development) and elsewhere in Germany.

He studied biochemistry at the University of Tübingen, where he graduated as Dr. rer. nat. (Doctor of natural science) in 1996. After a postdoctoral fellowship with Prof. Dr. G. Bringmann at the University of Würzburg investigating secondary metabolites of *Nepenthes* he finished his habilitation in Tübingen to receive the Venia Legendi in biochemistry. Since 2003 he is working for an agrochemical company in southern Germany.

Since 1996 he is a co-editor of "Carnivorous Plant Newsletter", the official journal of the International Carnivorous Plant Society (ICPS) of which he is a serving board member. He has written or co-authored 40 scientific papers dealing with enzymology, secondary metabolism, chemotaxonomy, carnivorous plant classification and chorology.

His current research focuses on the floristics and phenology of European carnivorous plants, especially of Lentibulariaceae.

## **Caroline R Schoner - Germany**

Caroline studied Biology, Chemistry, German Literature and Philosophy at the University of Wurzburg/Germany. Since 2011 she is PhD candidate (Thesis: "Ultimate causes of the interactions between bats and pitcher plants (*Nepenthes*)") at the University of Greifswald/Germany. Caroline Schoner is mainly interested in the evolution of animal plant interactions and the costs and benefits of the involved partners. For this aim she applies methods like genetics, analyses on thermoregulation in mammals, experiments on growth and fluorescence rates, nitrogen and chlorophyll content in carnivorous plants or stable isotope analyses. Overall, Caroline Schoner aims to improve the knowledge about mutualisms and the requirements of mutualistic species to their environment

## **Michael G Schoner - Germany**

Michael is holding grades in German Literature, History, Biology and Philosophy. His broad research interests and methodological approaches can also be seen in his PhD thesis about the proximate mechanisms of the interactions between bats and pitcher plants which he started in 2012 (Greifswald University, Germany). By applying methods like non-invasive in-situ experiments, bioacoustics, radio-telemetry or morphological comparisons he aims to enhance knowledge on different interactions between animals and plants. Currently, he is mainly researching on mechanisms that enable mutualistic relations. Finally, Michael Schoner tries to contribute to a better protection of fragile mutualists and the habitats they live in.

## **Naoki Tanabe/Koji Kondo - Japan**

### **Naoki Tanabe**

*Chairperson of the Japanese Carnivorous Plant Society (JCPS).*

Naoki Tanabe was born in Tokyo in 1963. Since an encounter with carnivorous plants in the second year at a primary school, Naoki has been under a spell of carnivorous plants and affectionate with them for more than 40 years.

In 1996, Naoki established the Japanese Carnivorous Plant Society and has been deploying energetic activities such as regular assemblies, publishing journals, managing mail-order trading and show shops in botanical gardens, organizing field trips and lectures. Moreover, Naoki has been actively exploring overseas habitats in Australia, the US, Malaysia, Indonesia and so on. Naoki is also a tax accountant and professional magician

### **Koji Kondo**

Koji Kondo is a member of the JCPS and ICPS. He is currently a freelancer retired from an American company and then a Japanese pharmaceutical company. Koji used to be a CP hobbyist when he was a student in a high school and university. After a 25-year break Koji restarted growing CPs 10 years ago. Koji joined the ICPS Conference in 2008 as the only participant from Japan and attended the 2012 Conference with Naoki Tanabe. Naoki will assist Mr Tanabe's presentation through English translation in this conference.

## **Gary W Wilson – Australia**

Gary Wilson is a biologist, teacher and photographer living in North Queensland. He is an adjunct of the Australian Tropical Herbarium in Cairns. He travels and works in the Asia-Pacific region. His current research focuses on *Nepenthes* pitcher plants, while his wider interests include rain forest cycads, eco-tourism, natural history photography, red wine and black coffee.

## **Presentations**

### **Greg Bourke - A photographic journey through Australia's fragile habitats**

Australia is well known for its diversity, almost every landscape imaginable is found on the continent and carnivorous plants have evolved to inhabit almost all of these. The diverse range of ecosystems has led to an equally diverse range of carnivorous plants. Many of these plant species have extremely limited ranges and although many fall within protected areas, pressures from mining, climate change, introduced species and development still exist with many species likely to be impacted in the near future. This presentation serves to introduce the audience to some of Australia's vulnerable habitats, the spectacular species that occur within them, and to highlight some of the pressures that may affect them in the near future.

### **Rob Cantley - Conservation - The IUCN Carnivorous Plant Specialist Group**

More than a decade has passed since the last version of the IUCN Red List for Carnivorous Plants was compiled ([www.iucnredlist.org](http://www.iucnredlist.org)) and since that time, numerous new taxa have been described, previously Data Deficient taxa have been further studied in habitat and there appears to have been a radical shift in the conservation status of many taxa, thereby requiring reclassification of their conservation status according to the latest IUCN criteria. Furthermore, since the last version of the Red List was compiled, there has been a dramatic increase in unsubstantiated information about threats faced by carnivorous plants, due to rapid expansion in the use of Information Technology as a tool for communication among stakeholders with interests in carnivorous plants. Although the quality of much of this information is difficult to verify, this should make it easier to identify threatened taxa (and the specific nature of the threats they face) more effectively than was possible in the late 1990s.

In October 2012 the Carnivorous Plant Specialist Group (CPSG) was created as one of about 100 Specialist Groups that form the Species Survival Commission of the IUCN. The mandate of the CPSG is quite broad and is expected to involve conservation projects of all kinds and in some cases guide projects wishing to become IUCN approved. But the initial and most urgent goal of the CPSG is to re-assess all species of all genera of carnivorous plants for the IUCN Red List. Without correct classification, imperiled species cannot receive the appropriate attention to conserve them. Chaired by Robert Cantley and with Sir David Attenborough as Patron, the group is currently very small. Dr. Charles Clarke is Red List Focal Point and Ch'ien Lee is the first Specialist Member. So far, the CPSG has completed new Red List assessments for more than 15% of all *Nepenthes* species and has resulted in a significant reduction in the number of Data Deficient and therefore 'Not Evaluated' species.

It's now time to open the group to wider membership with interest in all genera of carnivorous plants and invite input from the wealth of expertise represented at the ICPS Conference and elsewhere. The talk will explain the meaning and purpose of the CPSG and you are invited to sign up at [www.iucn-cpsg.org](http://www.iucn-cpsg.org) to join, whether just to receive newsletters, or contribute your knowledge and time to the cause of aiding conservation efforts.

## **Charles Clarke - Why are there so many species of *Nepenthes*?**

Since the mid-1990s there has been a dramatic increase the number of newly described *Nepenthes* species. On the face of it, this indicates that diversity within the genus is much greater than scientists previously assumed. There are several explanations for this pattern. First, many regions in Southeast Asia that had not be explored for *Nepenthes* previously have now been surveyed, yielding many new taxa. Second, there has been a marked shift in the way that the species concept is applied to *Nepenthes*, with many recently described taxa being distinguished from congeners on the basis of very minor morphological variations. The lack of quantitative data and analysis of morphological traits in *Nepenthes* means that there is presently little scope for objective evaluation of the status of taxa within the genus.

Recent ecological research has demonstrated that diversity in *Nepenthes* is strongly influenced by geography, vicariance, climate and the availability of nutrients. The Malay Archipelago is one of the most fragmented and geologically complex regions on Earth. This, coupled with the frequent inception of spatial and temporal barriers that isolate populations of *Nepenthes*, has been (and continues to be) an important driver of diversification throughout the geographical range of the genus. In addition, diversification in the degrees of development of various trap components among *Nepenthes* taxa appears to be driven by a combination of climate (in particular, the distribution and quantity of rainfall) and the range of exploitable sources of nutrients available to the plants' in their habitats. These recent advances in our understanding of the ecology of *Nepenthes* can help us to better interpret the taxonomic importance of morphological diversification *Nepenthes*, hopefully laying the foundations for a more rigorous and objective approach to taxonomic studies of the genus in future.

## **Dr. Adam Cross - Little left to lose: habitat loss and the global challenge of returning to a carnivorous landscape**

Freshwater wetlands comprise less than 9% of global land area, but harbour ca. 6% of all described species (>100,000 taxa) and contribute over US \$13 trillion annually in global ecosystem services (40% of all ecosystems on the globe). They also represent one of the most endangered ecosystems in the world, with over 50% of wetland habitats worldwide lost in the last two centuries and a large proportion of remaining habitat becoming increasingly degraded. Wetlands and seasonally wet lowlands harbour the overwhelming majority of carnivorous plant taxa (at least 60% of the ca. 630 known species), one of the most increasingly threatened angiosperm groups on the planet. Although the conservation status of only ~15% of carnivorous plants has to date been assessed by the International Union for the Conservation of Nature, over half of these have been identified as Vulnerable to Critically Endangered. This study discusses the ecological challenges faced in the restoration of carnivorous plant habitats, with particular focus on the global biodiversity hotspot in the southwest of Western Australia. Many local ecosystem damages are considered irreversible, and wetland restoration initiatives globally are recognised as inadequate to offset continuing habitat decline and fragmentation. With a significant and continuing underrepresentation of carnivorous species in rehabilitation efforts, the future faced by many carnivorous taxa is becoming increasingly bleak. Threatened and at-risk carnivorous species must be urgently considered in both local and regional conservation and management initiatives, to ensure their adequate representation in the global conservation equation.

## Andreas Fleischmann - Evolution of carnivory in the plant kingdom

The carnivorous syndrome evolved at least seven times independently in flowering plants, distributed to five orders of the angiosperm phylogeny, leading to the 18 genera and ca. 800 species of carnivorous plants which currently we know. In the monocot lineage, carnivory evolved two times in parallel in the Bromeliaceae family (the only distantly related genera *Catopsis* and *Brocchinia*). In the dicot order Caryophyllales, carnivory evolved only once from a single common ancestor, leading to the sticky traps, snap traps, and pitcher traps of Droseraceae, Drosophyllaceae, Triphyophyllum, Dioncophyllaceae, and Nepenthaceae, respectively. Carnivory was lost again in some members of this lineage. In the rosids we find a single carnivorous member, *Cephalotus* of the order Oxalidales, while in asterids, carnivory evolved in Ericales (the pitfall traps of the three extant genera of Sarraceniaceae; and the resinous, enzyme-lacking traps of carnivorous Roridulaceae, the two species of *Roridula* which apply the smart and very effective way of digestive mutualism). Finally, in the asterids, Lamiales are remarkable in that carnivory evolved at least three times in parallel in that order, namely in the unrelated Byblidaceae, Lentibulariaceae and in *Philcoxia* of Plantaginaceae. This order also hosts a large trap diversity, covering active and passive sticky traps, eel traps and suction traps, and in all three lineages the carnivorous members seem to be derived from adhesive glandular leaves. The possible evolutionary pathways that lead to the extant carnivorous plants and their trap diversity are illustrated, and the evolution of the different trapping mechanisms is explained for each lineage. Representatives of all known carnivorous plant genera will be shown with photographs taken in the plants' natural habitat and in cultivation.

## Jeremiah Harris - Cultivating Finicky Carnivorous Plants

Carnivorous plants in some way or another captivate all of us, that is what brings us together from all corners of the globe. Most of us have grown more than our fair share of these fascinating plants and will go to great lengths to make sure they are happy. I have always been intrigued by the carnivorous plants that are considered the most difficult to cultivate. All carnivorous plants thrill me from the smallest of the pygmy *Drosera* to the waist high *Darlingtonia* but none more so than highland *Nepenthes*.

Highland *Nepenthes* are the most spectacular of all carnivorous plants. The pitchers range in size from few centimeters to well over 50cm. They come in every shape and color imaginable. Trouble is they can also be some of the most slow growing and difficult carnivorous plants to cultivate. Most require very high light coupled with cool days and even colder nights. Those conditions alone are very difficult to artificially replicate. After over 20 years of successful cultivation of notoriously difficult carnivorous plants using various methods I will discuss some of those methods that have worked well for me.

## Ch'ien C. Lee - Recent Discoveries in Nutrient Acquisition Strategies in *Nepenthes*

With over 150 currently recognized species, the carnivorous plant genus *Nepenthes* exhibits a great variety of infrageneric pitcher trap morphologies. Although once regarded as merely opportunistic insectivores, recent research has shown that specializations in pitcher structure of some species is correlated with either the targeting of specific prey types or the exploitation of other non-prey nutrient resources. It is possible that niche segregation among sympatric *Nepenthes* taxa may be a driving force behind these specializations. Trends away from carnivory have been indicated in several *Nepenthes* taxa including those which sequester nutrients from detritus (e.g. *N. ampullaria*) and animal droppings (e.g. *N. lowii*). In just the past six years, vertebrate mutualisms with *Nepenthes* have been studied and confirmed in four species (*N. lowii*, *N. rajah*, *N. macrophylla*, and *N. hemsleyana*), and further such associations are indicated in other *Nepenthes* taxa.

## **Allen Lowrie - *Stylidium* (Triggerplants), are they carnivores?**

A number of *Stylidium* species of Australia have been observed to capture small flying insects on the *Drosera*-like glandular trichomes present on their leaves, scapes, hypanthium, sepals and petals. The question that must be asked is - are some *Stylidium* species practicing carnivory?

## **Drew Martinez -LED Lighting for Plant Horticulture**

The talk will provide an overview of artificial lighting for horticultural applications. Key concepts underlying photosynthesis will be introduced followed by a description of how light is evaluated and measured for horticultural purposes. Current technologies available for indoor growing will be discussed and compared, including LED and fluorescent lighting. Demonstrations will be set up with measuring equipment and light sources. Finally, work will be presented regarding the optimization of LED illumination systems for carnivorous plant growing applications in the future.

## **Mason McNair - *Sarracenia*: A Nomenclature Nightmare**

The genus *Sarracenia* has had a tumultuous taxonomic past. Through extensive in field experience it is possible to gain a good understanding of the nomenclature of these beautiful and often times perplexing plants. Many a botanist has explored the many habitats that *Sarracenia* occupy and been perplexed as to what to call individual plants they find. During this lecture we will seek to provide not only a good understanding of all of the infraspecific taxa in the genus *Sarracenia*; we will also attempt to answer the question of when is a species a species, a subspecies, or a variety.

## **Dr Andrej Pavlovic - Costs and benefits of electrical signaling in carnivorous plant Venus's flytrap (*Dionaea muscipula* Ellis).**

The carnivorous plant Venus's flytrap (*Dionaea muscipula*) produces a rosette of leaves: each leaf is divided into a lower part called the lamina and an upper part, the trap, with sensory trigger hairs on the adaxial surface. The trap catches prey by very rapid closure, within a fraction of a second of the trigger hairs being touched twice. Generation of electrical signals (action potentials, AP) plays an important role in trap closure. We demonstrated for the first time that generation of AP during trap closure and prey retention has a significant inhibitory effect on photosynthetic reactions. On the contrary, the rate of respiration was transiently increased. Thus, we put forward the first experimental evidence for energetic demands and carbon costs during insect trapping and retention in carnivorous plants with active trapping mechanism, providing a new insight into the cost/benefit model of carnivory. However, carnivory should evolve only if benefits from electrical signaling exceed the cost of investment in this carnivorous adaptation. We investigated the effect of mechanical (coupled to generation of AP) and chemical stimulation on regulation of proteolytic activity catalysed by an enzyme, cysteine endopeptidase ("Dionain"). Digestive fluid released in response to mechanical stimulation has not the full power to digest protein and there must be some chemical substances released from prey to trigger full proteolytic activity. The regulatory role of plant hormones, which translate the stimuli from prey into physiological response, was also investigated. Finally, the nutrients taken up from digested prey increased photosynthetic efficiency, and thus the carbon costs associated with prey capture, retention and digestion are paid off.

## Dr Katja Rembold - Diversity and conservation of the genus *Nepenthes*

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The pitcher shaped leaves of the carnivorous plant genus *Nepenthes* have all times attracted and inspired a great variety of people. Due to their attractiveness, countless plants have been collected from wild populations and in combination with ongoing habitat loss, many *Nepenthes* species are nowadays highly endangered as a result. All *Nepenthes* species are listed in appendix I or II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), but the CITES regulations cannot protect the species from habitat loss or from private plant collectors. Sustainable *Nepenthes* conservation requires the protection of species within their natural habitats and therefore it is necessary to reveal and protect centers of diversity and endemism.

Based on the digitized distribution of 120 *Nepenthes* species, we present detailed maps of species richness and endemism. These maps not only confirm the islands of Borneo and Sumatra in their role as diversity centers, but also show that regions with many endemic and respectively range restricted *Nepenthes* species are underestimated in their diversity if analyzed only quantitatively by species number. Small-scale distribution areas such as mountain endemics tend to not intersect with each other.

Based on these maps it is now possible to locate centers of endemism which are suitable for small scale conservation areas and to detect *Nepenthes* species which do not occur in any protected area and therefore require special attention.

## Alastair Robinson - Palawan: A Microcosm for *Nepenthes* Taxonomy

The Philippine island of Palawan shares many common floristic elements with its southern neighbour, Borneo, including what is generally regarded as a common lineage of *Nepenthes* L. pitcher plants. The relationships between the different taxa on the island are broadly reflective of *Nepenthes* systematics across the broad range of this Old World genus, the collective species on Palawan representing a viable model for a future revision of *Nepenthes* taxonomy.

## Jan Schlauer - Field Notes from Andalucía, Spain

In late April 2013 Jürg Steiger, Heiko Rischer and Jan Schlauer performed a field trip to Andalusia (Andalucía), southern Spain in order to see and study some carnivorous plant species in situ. Jan's presentation will report on findings and conclusions from the trip.

Situated at the westernmost end of the Mediterranean Sea between 36 °N and 39 °N and spanning the altitudinal range from sea level to almost 3500 m (highest point in continental Spain), Andalusia is inhabited by a diverse flora composed of mediterranean (adapted to summer drought, usually in lowlands), high mountain (adapted to snow cover and freezing in the winter, limited to high mountain elevations), oceanic (depending on permanently humid, usually frost-free conditions, predominantly in the westernmost parts of Andalusia that are strongly influenced by westerly winds from the Atlantic ocean) and a few xero-tropical (adapted to prolonged drought) elements.

The southernmost corner around Gibraltar and the southernmost cape of the Iberian Peninsula around Tarifa marks the western end of the Baetic System that extends from there to the easternmost border of Andalusia and contains most of the region's highland areas, including the Sierra Nevada near Granada as its highest peak. This series of mountain ranges separates the basin of the Guadalquivir river to the north from the Mediterranean basin to the south. It is essentially this montane area that serves as a migration route for plants that are less well adapted to drought than those of the Mediterranean element, and it consequently hosts the majority of Andalusia's carnivorous plants, most of which are derived from the temperate (*Pinguicula nevadensis*, *P. grandiflora*, *P. dertosensis*, *P. mundi*, *P. vallisneriifolia*) and/or the oceanic (*Drosophyllum lusitanicum*, *P. lusitanica*) elements.



## **Caroline R Schoner - Interactions between carnivorous plants and animals - what's in it for the plants?**

Caroline R. Schöner<sup>1</sup>, Michael G. Schöner<sup>1</sup>, Gerald Kerth<sup>1</sup>, Charles Clarke<sup>2</sup>, Anissa Junaidi<sup>3</sup> and T. Ulmar Grafe<sup>3</sup>  
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**Deadly Trap or Habitat?** The traps of carnivorous plants are an unlikely habitat for animals, but nevertheless many species of animals make use of them for part or all of their lives. Borneo's pitcher plants (*Nepenthes*) provide shelters for numerous animals including insects, amphibians and even mammals, such as the tiny bat species *Kerivoula hardwickii*.

**Parasitism or Mutualism?** Interactions between several species are generally complex: Depending on the partner organism the same species can act as a mutualist, commensalist, or parasite. This is also true for the bat *K. hardwickii* which regularly roosts in pitchers of several different *Nepenthes* species. Only *N. hemsleyana* gains benefits from its mammalian inhabitants (34% of its nitrogen) and thus has to compete with roosting pitchers involuntarily offered by *N. bicalcarata* or *N. ampullaria*. Here we show that *N. hemsleyana* succeeds by offering a higher roosting quality (indicated by a more stable microclimate and a lower risk of parasite infestation for the bats) compared to *N. bicalcarata*, resulting in a higher body condition of the bats.

**Insectivory or Coprophagy?** Like all pitcher plants, *N. hemsleyana* has developed a double strategy to take up nutrients – firstly by roots, secondly by their fluid-filled pitchers which act as insect traps but additionally gain nutrients from bat faeces. However, the degree to which the plants benefit from the bats, in addition to the nitrogen intake, is still unknown. Here we present preliminary results of a feeding experiment with *N. hemsleyana* to investigate its qualitative and quantitative benefits by taking up digested bat faeces. Experiments were conducted both in the field in Brunei's peat swamp forests and under controlled conditions in the greenhouse. This will clarify how strongly *N. hemsleyana* depends on its mammalian partner.

## **Michael G Schoner - The Bornean pitcher plant *Nepenthes hemsleyana* – its natural history and interaction with a bat mutualist**

Michael G. Schöner<sup>1</sup>, Caroline R. Schöner<sup>1</sup>, T. Ulmar Grafe<sup>2</sup>, Charles Clarke<sup>3</sup>, Ralph Simon<sup>4</sup>, Sébastien Puechmaille<sup>1</sup>, Liaw Lin Ji<sup>2</sup>, and Gerald Kerth<sup>1</sup>  
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*Nepenthes hemsleyana* is a lowland species that occurs in peat swamp and heath forests in north-western Borneo. It is very similar in appearance to *N. rafflesiana*, a species that is widespread in the Sunda region, but differs by its elongated pitcher form and the presence of an epicuticular wax zone in the aerial pitchers. Moreover, *N. hemsleyana* more or less completely lacks typical traits for prey attraction: nectar, effective UV light patterns and volatiles. Due to this, *N. hemsleyana*'s insect capture rate is up to seven times lower than that of *N. rafflesiana*. For a long time it remained an enigma how *N. hemsleyana* copes with such a small predation success. Individuals of the small woolly bat species *Kerivoula hardwickii*, however, are known to regularly roost inside the pitchers of *N. hemsleyana*. These bats defecate into the pitchers while roosting in them. Using stable isotope analyses, it has been shown that the bats' droppings and urine contribute on average 34% to the pitcher plant's nitrogen income. This enables the plants to compensate for the lack of captured insects and nutrients.

A major problem for the bats and the pitcher plants is to find each other within their dense and cluttered habitat of Borneo's peat swamp forests. This situation is aggravated by several factors: 1) the bats and *N. hemsleyana* pitchers are rare, 2) only the bats can actively search for their hosts, and 3) the main orientation sense of bats is echolocation, which is complicated in such cluttered habitats. We provide evidence for the use of ultrasound reflective structures in *N. hemsleyana* that aid its localization by the bats. This is the first example of a plant using echo-acoustic features to gain nutrients from an animal.

## **Naoki Tanabe/Koji Kondo - Introduction of *Pinguiculas* native to the Japanese Habitats"**

This presentation is to deliver the information on the Japanese natural habitats of genus *Pinguicula*.

The first part will introduce habitats of *P. macroceras* on/in Mt. Shibutsu, Ayamedaira Moor, Happo-one Ridge, Mt. Akagi, Hayadekyo Valley, Sugikawa Valley, Mt. Tanigawadake, Hitoegane and Neo. Although *P. macroceras* is taxonomically one species, there are diversities in shape and color of flowers and growing conditions (e.g., soil, moisture, insolation condition, altitude) by location.

The second part will introduce 2 habitats of *P. ramosa*, which is endemic to Japan on Mt. Nantai and in the Unryu Valley. The habitat on Mt. Nantai, however, has been lost due to a mud and rock slide probably caused by the Great East Japan Earthquake (2011).

In the habitat in Unryu Valley, roughly 100 plants of *P. ramosa* grow on a narrow area of a mere 1 square meter or so. This could mean that this habitat will be lost if a landslip occurs. *P. ramosa* usually has two-pronged inflorescences, but three-pronged inflorescences can be found in this habitat.

## **Gary W Wilson - Studies of *Nepenthes* pitcher plants in Austro-Papua**

The Australian Tropical Herbarium (CNS) is located in Cairns, north Queensland and has curation, research and teaching roles. Activities focus on the flora of the Asia-Pacific. Gary Wilson will report on studies at CNS of *Nepenthes* in Austro-Papua. The study is to determine the phylogenetics, biogeography and ecology of the three species and the entity known as *N. 'mini-tenax'* that occur in Queensland. It is also to determine the number and status of species of *Nepenthes* in the Trans-Fly bioregion in PNG and Papua, Indonesia. In addition, he will comment on the conservation of *Nepenthes* in Queensland.

