LINNEAN SOCIETY OF NEW SOUTH WALES

LINN S'O'C' NEWS

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IN THIS ISSUE

NEW MEMBERS: We welcome

Mr Daniel R Sloane of Macquarie University. Fields of interest: biology, botany, environmental science and management, natural sciences and ecology.

AUSTRALIAN NATURAL HISTORY MEDALLION AWARDED TO MAX MOULDS.

Congratulations to Max Moulds who has been awarded the Australian Natural History Medallion for 2016. The Field Naturalists Club of Victoria awards the Australian Natural History Medallion to the person judged to have made the most meritorious contribution to the understanding of Australian Natural History. Max is a foremost authority on cicadas and has published many books and papers. He is a member of the Linnean Society and was once on the council

OCTOBER LECTURE BY A/Prof JES SAMMUT

Details about Prof Sammut's lecture were not available in the last newsletter. See Page 7 for the abstract on his talk about fish farming in New Guinea, to be given on 19th October.

LINNEAN MACLEAY FELLOWSHIP

Applications are invited for the Linnean Macleay Fellowship for the year 2017. Applicants must be Members of the Society, reside in New South Wales, and have a degree in Science or Agricultural Science from the University of Sydney. Applicants are required to outline the proposed research and where it will be carried out. The Fellowship pays $3,200 per annum, and the Fellow must engage in full time research on the project. The regulations governing the Fellowship are available on request from the Secretary or the Society's web site. These regulations were stipulated in Sir William Macleay's will and the Society is obliged to adhere to them.

Applications close 15 November, 2016

REPORTS FROM THE RECIPIENTS OF RESEARCH GRANTS

It is a condition of an award that the recipient reports the results to the Society. Some have had their work published and others are preparing papers for publication.

Mr Kyle **ADAMS** (University of Wollongong) studied site fidelity and habitat preference of the banjo shark (*Trygonorrhina fasiatata).* This species is a by-catch in commercial fishing and with low fecundity, late maturity and slow growth rate, it is at risk of overfishing. Recent work focuses on the management of the commercial by-catch: this project aims to assess the impact of recreational fishing. The abundance of this species in a no-take zone increased by up to 90 % down to a depth of 10 m when compared with a fished zone, and there were many more juveniles and larger individuals. The increase varied with depth, but it was always positive. Most individuals stayed within a relatively small area.

Mr Peter **BOND** (University of Queensland) investigated the inshore environments
ruined with marine debris. The broken-down fragments of plastic are of particular concern because they can be ingested by marine life. The diet and feeding habits of the hardyhead was studied to assess the impact of plastic pollution. The hardyhead is commonly found in bays and estuaries in calm shallow waters and are preyed upon by many commercially important fish species and water birds. The gut contents contained microplastics that appear to have come from their prey – a diversity of zooplankton.

Miss Kiralee Jane **CHAPLIN** (Museum of Victoria/University of Melbourne) studied the taxonomy, ecology and conservation genetics of grassland earless dragons (Agamidae, *Tympanosryptis* spp) in Queensland. A field trip found the Northern Darling Basin lineage of earless dragons in several localities. Preliminary data has suggested that this is indeed a hybrid species, likely to have arisen from a historical hybridisation event millions of years ago between *T. condaminensis* and *T. tetraporophora*. Continued divergent evolution appears to have occurred since this hybridisation event.

Mr Timothy Lindsay COLLINS (University of New England) studied the genetic diversity and taxonomy of the rare and endangered *Eucalyptus magnificata* L.A.S Johnson and K.D. Hill (Myrtaceae). The northern populations near Tenterfield and Warwick are thought to be different varieties but they may be new species instead of part of a larger more genetically diverse population with a greater demographic range. This study has found that a modified method of extraction uses a far smaller leaf sample and far less solvent, and that dried herbarium samples retain their leaf oil profiles for up to 44 years. There are three distinct chemotypes within *E. magnificata* that can be distinguished from the closely related taxa *E. baueriana, E. conica* and *E. polyanthemos*. A paper has been submitted for publication.

Belinda **FABIAN** (Department of Biological Sciences, Macquarie University) investigated extrafloral nectaries and their nectar production. The extrafloral nectaries on the leaves attract ants that provide protection from herbivores in return for the nectar. The morphology of four species of wild cotton (*Gossypium* spp) with abundant nectaries that produced copious nectar was investigated. The nectaries secrete sugary nectar but the sugar composition is different to that in the phloem sap. The nectar also contains some amino acids and proteins. Thus the nectaries have processed the phloem sap. About 1% of the carbon fixed by photosynthesis is secreted as nectar. The investment in nectar from extrafloral nectaries does not change in experiments with elevated carbon dioxide.

Ms Jodi **FOX** (University of Tasmania) surveyed the physical volcanology of the Cenozoic volcanics of northwest Tasmania. Field work has established a complex succession of pillow lavas, sills, lobate lavas, volcanic breccia and tuffs at Cape Grim, northwest Tasmania. All of the units were deposited in a submarine environment and were emplaced in relatively rapid succession. Argon dating will establish the ages of the units.

Mrs Anuradhi **JAYAWEERA** (Macquarie University) studied the effect of sexual cannibalism on male ejaculatory expenditure in the false garden mantids (*Pseudomantis albofimbrata*). The females attack the male prior to copulation and only about 40% of males succeed in transferring sperm to their partners. Males do not seem to have evolved any defensive mechanisms such as preference for less risky females. Tests compared the number of sperm transferred by males in non-cannibalistic matings, in cannibalistic matings and in experimentally manipulated headless matings. Cannibalised and headless males behaved similarly and transferred significantly more sperm than uncannibalised males, suggesting cannibalised males invest more/all of their sperm and that the removal of the head might play a role in triggering this increased sperm allocation.

Dr Anne **KEMP** of Griffith University investigated the reason why there is no recruitment of lung fish in water storage areas. Most lung fish now live in dams where there is little submerged aquatic plants that are plentiful in shallow flowing streams where they would normally breed. Eggs were collected from three water storage areas and the development of the embryos studies in the lab. Many young embryos are grossly abnormal and if they hatch, they do not live for long. Pollution is unlikely to be the cause of deaths as the pollutants are different in each of the dams but the abnormalities are the same. It is more likely that the adults are unable to find enough nutritious food to stock the eggs with sufficient nutrients for normal development. Lungfish are unable to synthesis their own volatile fatty acids and rely on obtaining them from food rich in these nutrient, viz. snails and clams. There are very few snails and clams in water storage areas.

Ms Melanie **Laird** (University of Sydney) investigated the uterine changes in preparation for pregnancy in the marsupials the fat tailed dunnart, the brush-tailed possum and the tammar wallaby. For live birth, the surface cells of the uterus must undergo remodelling to allow implantation of the embryo and this process is essential in eutherian mammals. In the brush-tailed possum, microscopy identified distinctive secretive morphological changes before implantation. The changes that are likely to be essential for implantation and remodelling is remarkably similar for all mammals. An adhesive molecule, talin, is essential for implantation in the rat and is present in the marsupials but has different actions. Unlike both the rat and the fat-tailed dunnart, in the tammar wallaby, the embryo is non invasive, i.e. it does not penetrate the uterine tissue. It is likely that talin plays a more species-specific role in marsupials. A publication is being prepared.

Miss Michaela **LARSSON (**University of Technology) Ciguatera fish poisoning results from eating contaminated fish and it is a problem world wide. There have been large outbreaks in Australia with two fatalities and more than 1400 cases documented in the last 50 years. Ciguatoxins are produced by dinoflagellates from the genus *Gambierdiscus* that was thought to be monospecific, but molecular techniques have defined at least 12 species. This project aimed to identify the strains isolated from Australian waters using molecular methods and to characterise the toxin profiles of each strain. Two sites were sampled: Heron Island Qld within *Gambierdiscus'* known tropical range and a temperate inlet in NSW, the most southerly population in Australia. Eleven strains were isolated from Heron Island and five strains from Merimbula. Species identification of these strains is in process. The ciguatoxin profile for each strain has been established. None of the 16 strains isolated produced ciguatera toxin but most produced a type of maitotoxin. The strains isolated from Merimbula are of particular interest because they did not produce any detectable toxins.

Ms Rachel **Levin**, University of New South Wales studied the genetic and physiological basis of coral bleaching. Corals rely on their symbiotic dinoflagellates (*Symbiodinium* spp) for photosynthesis and different populations of *Symbiodinium* can confer differing levels of heat tolerance on their host. A heat sensitive and a heat tolerant strain were kept at 32°C and both showed no physiological stress for nine days, but both displayed up-regulation of meiosis genes that promote adaptation. After 13 days, the heat sensitive population suffered a significant decrease in photosynthesis and a leakage of reactive oxygen species (ROS) from the cells. Only the heat tolerant population showed an up-regulation of the ROS scavenging genes and directly correlates to susceptibility to coral bleaching. This work has been published.

Levin, R.A., Beltran, V.H., Hill R. et al (2016). Sex, scavengers, and chaperones: Transcriptome secrets of divergent *Symbiodinium* thermal tolerance. *Mol. Biol. Evol.* Advance Access, July 3 2016

Mr Timothy **Morris** (University of New South Wales) aimed to show that an apex predator has cascading effects on vegetation and nutrients. The dingo exclusion fence provides an ideal opportunity to study areas with and without dingoes. Kangaroos grazing effects are high inside the fence where they are largely free of predation and low outside of the fence where they coexist with dingoes. Inside the fence, where dingoes are rare and kangaroos abundant, grass growth was consistently less than outside the fence, where dingoes are common and kangaroo herbivory is low or non-existent. Soil nutrients displayed similar patterns: less inside the fence than outside the fence. There is thus a link between top predator and basic ecosystem processes. This challenges widely held views that bottom-up forces largely control ecosystem functioning and gives support for top-down forces as the dominant regulator of ecosystems. These findings have social and economic relevance: dingoes could be enlisted for conservation of native species and the rehabilitation of degraded land. Cattle raising would benefit economically from dingoes through suppression of kangaroos, but the calves would be subjected to predation. The impact of dingoes on sheep can be devastating. Farmers usually regard dingoes as pests and it would be hard to convince them of their ecosystem benefits.

Mr Matt J. **NIMBS** (Southern Cross University). The biogeography of heterobranch sea slugs in south-eastern Australia. The sea slug distribution is well known near major population centres but not elsewhere. This project made a comprehensive study of some 580 species of sea slugs around the coast of New South Wales and southern Queensland. The results will provide a database for changes in distribution that might occur with climate change. Sea slugs are found mainly in tropical marine areas and species diversity decreases with latitude. This study shows that the Sunshine Coast, Coffs Coast, Port Stephens and Sydney have peaks in diversity. Port Stephens hosts the southern range extensions for twelve species, one species being 2,200 km south of its present accepted southern extension of the northern Great Barrier Reef. This work is being written up for publication.

Miss Mae Marjore NOBLE (Australian National University) investigated the population biology and ecology of the threatened Murray crayfish in upland streams. Murray crayfish are relatively well known in their lowland habitat but little is known about their population biology in upland streams. This is concerning because spiny crayfish are thought to play an important role in nutrient recycling and trophic linkages in freshwater ecosystems. Ms Noble found that the Murray crayfish are habitat specialists that display a strong habitat preference for intermediate water flow velocity, deeper pools, areas with a high percentage of overhanging vegetation and a streambed of gravel and boulders. Major shifts in their preferred habitat conditions have resulted in a 91% decline in the preferred pools over a six-year period. The threatened Murray crayfish are particularly sensitive to changes in their preferred stream habitat conditions. This work has been published:

Noble, M.M. and Fulton, C.J. (2016). Habitat specialisation and sensitivity to change in threatened crayfish upland streams. *Aquatic conservation: marine and freshwater ecosystems*. DOI: 10.1002/aqc/2620

Ms Parisa NOORIAN (University of New South Wales) investigated an iron-dependent antiprotozoal factor in *Vibrio vulnificus. V. vulnificus.*is an opportunistic pathogen responsible for septicaemia following ingestion of contaminated raw oysters and wound infections on exposure to infected seawater. It has the highest reported mortality rate for seafood related diseases. It inhabits coastal marine environments where it is exposed to protozoan predation. Bacteria evolve anti-protozoal mechanisms that may increase its virulence. One strain of *V. vulnificus* shows toxicity towards a filter-feeding ciliate but this toxicity is dependent on iron

in the media. The aim of this project was to identify the genetic factors that contribute to the survival of *V. vulnificus* in its natural environment. Experiments showed that of the many strains of *V. vulnificus*, only one was resistant to grazing by the protozoans. A total of 255 genes were expressed differentially in iron depleted conditions. Some of the genes are involved in ammonia production that is also toxic to protozoans. Work continues on the evaluation of other secondary metabolites.

Mr Niels **RUEEGGER** (Southern Cross University) studied roost selection by Australian tree hollow-using bats. Many species of microbats use tree hollows for shelter and daytime resting, and females congregate in large hollows for breeding. Land clearing for any use means loss of habitat for the bats. Several designs of bat boxes were tested and multi-chambered, narrow boxed were the best, at least for some species.

Mr Ryan **SIMS** (School of BEES, University of NSW) studied the critically endangered box gum grassy woodland and its response to exclusion of livestock. Only about 10% of the once widespread box gum grassy woodland remains and it is subjected to numerous restoration projects. Mining approval requires that large areas of woodland and secondary grassland be offset and rehabilitated, and there are other restoration projects as well. The most cost effective method removes the stock and hopes that the ecosystem will recover. Numerous projects have shown that this results in poor restoration and suggests a legacy of problems from past farming practices. Fenced areas have been set up to test several hypotheses about restoration, but it will take several years for the results to develop.

ASSEMBLY OF THE AUSTRALIAN FLORA OVER THE LAST 65 MILLION YEARS: WHAT WE HAVE LEARNED FROM DNA: the Linnean Macleay Memorial Lecture, given by Dr Mike Crisp.

Analysis of the DNA gives us a molecular phylogeny that can then be tied in with environmental change over the last 50 million years (my). During this time, Australia went from mostly rainforest that contracted about 15 my ago, to mainly sclerophyllous heath to largely desert during the glacial cycles of the last 2 my.

The DNA records the story of life. Some of it does not change: some *E. coli* DNA is the same as ours. Some other DNA is species specific. By comparing the DNA of two species, we know their evolutionary changes since they last shared a common ancestor, millions of years ago. By working out how fast the molecular clock ticks, we can reconstruct when evolutionary changes in lineages occurred. The molecular clock is considered more reliable now that key points are matched up with the fossil record.

Livistona, the fan palm has eighteen species in Australia. The DNA shows the first common ancestor migrated into Australia 10-20 my ago. In Southeast Asia, its homeland, it is mainly found in ever-wet rainforests, but in Australia it inhabits monsoonal environments. It is usually found in gallery forests along watercourses. The monsoon adapted lineage thrived in northern Australia

Australia drifted away from Gondwana some 30 my ago. This separation fragmented the flora of the southern lands (vicariance). So the big question is: did Australia's unique flora evolve in situ from this remnant of the old Gondwanan flora or did it migrate in from elsewhere? Most of the Australian flora has relatives elsewhere. If the age of the common ancestor is less than 30 my, then migration into Australia is a possibility. The fan palm example given above migrated in from Southeast Asia.

The DNA shows that 95% of the flora migrated in from elsewhere. This leaves only 5% for vicariance. Examples of vicariance are *Nothofagus*, different species in Australia/New Guinea and in South America: *Callitris* in Australia and the closely related *Fitzroya* in South America: Proteaceae, Casuarinaceae, *Eucalyptus* and Bossiaceeae (Fabaceae). Examples of migrants into Australia are *Brachychiton*, *Solanum*, *Olearia* and *Cycas*. The position of *Acacia* is uncertain as it is borderline.

This is a surprisingly high percentage of the flora that migrated into Australia. Propagules must have somehow crossed large tracts of ocean between the southern continents and Asia. Was it storms, tsunamis or birds? We don't know, but the evidence is that it happened. It was probably more important that the propagules found a suitable ecological niche for them to become established at the new location.

Much of the Australian flora is fire-adapted and rapidly recovers from being burnt. Eucalypts have epicormic buds under the bark that sprout out after a fire. There are other means of recovery: seeds may be

held in hard woody capsules that only open after a fire and while the above ground parts of the plant are burnt off, the root stocks survive and readily re-sprout.

Remarkably, *Eucalyptus* fossil flowers and fruits 52 my old have been found in Patagonia, in a volcanic landscape next to rainforest, surrounded by a caldera lake. Phylogenetic analysis of the fossil morphological features combined with a sequence study of extant eucalypt species confirms that it is nested in *Eucalyptus*. This is the oldest fossil record of *Eucalyptus* and fire adaptation probably evolved soon after it moved out of the rainforest. The family Myrtaceae originated in rainforest and *Allosyncarpia*, the nearest relative to *Eucalyptus*, lives in rainforests of Kakadu, and it not fire tolerant.

Fire has been part of the environment for a very long time, more than 60 my. Charred cellular structures have been found in a late Cretaceous deposit in central Australia, where the pollen and leaf fragments indicate a burnt heathland. Fire frequency was higher in the late Cretaceous/ Palaeocene (approximately 65-55 my ago) but decreased when the climate became wetter in the Eocene (55-45 my ago).

About 25 my ago, the climate was very wet, and there was a gradient: wetter in the south east and drier to the north-west. The climate became drier about 22 my ago. The gymnosperms did not handle this change very well and there were many extinctions of the conifers that required wet habitats. A few lineages adapted, e.g. *Callitris* and *Macrozamia* are found in central Australia today. Angiosperm lineages were not so badly affected. Xeromorphic traits developed, such as sunken stomates (*Casiuarina* stems, *Banksia* leaves) and rolled leaves (*Triodia*) that protect the stomates.

The sclerophyll biome became widespread as the climate dried. Sclerophyll usually requires acid soils, hence when the limestone of the Nullabor was uplifted about 14 my ago, it split the southern sclerophyll biome into southeastern and southwestern communities, and species could diverge. The monsoon biome is also young, possibly up to 39 my old. There have been multiple shifts of eucalypts into the monsoonal biome. Migrants from Africa and south-east Asia may have come pre- adapted to the monsoonal climate, e.g. *Adansonia* and *Cycas*.

Triodia is dominant in the arid zone and while it is a grass lineage, it is really a shrub and gives shelter to many animals. Some species have stomates only on one side of the leaf and when the leaf rolls up, the stomates are enclosed. This is very important for the water economy. A trait such as this may allow the lineage to change habitat, but it may arise as an adaptation after moving into a new habitat.

LINNEAN SOCIETY OF NEW SOUTH WALES

For Security reasons, there is now a locked gate between the car park and the Classroom. If it is locked when you come to a lecture, just wait and someone will come and let you in.

PROGRAMME

Wednesday 19 October at 6 pm, in the Classroom, Royal Botanic Gardens
Enter through the gate to the Herbarium Car park on Mrs Macquaries Rd.

A/Prof JES SAMMUT

School of Biological, Earth and Environmental Sciences, University of New South Wales

TRANSFORMING DIETS AND LIVES IN THE HIGHLANDS OF PAPUA NEW GUINEA THROUGH FISH FARMING

More than 80% of people in Papua New Guinea (PNG) are unemployed and live on less than $1.50 a day. Despite an abundance of natural resources to produce food, access to protein is limited leading to nutritional deficiencies. Many rural people successfully produce vegetables crops, but livestock and animal production is uncommon or small-scale. In the absence of refrigeration, slaughtered farmed animals, such as pigs and chickens, usually need to be consumed immediately. Pigs are often kept only for ceremonies and do not provide a regular source of protein. Fish farming is an emerging industry in PNG. Sustainably farmed fish can provide access to protein on a regular basis, and small ponds can be excavated in vegetable gardens and potentially utilise garden refuse as fish feed. Nevertheless, fish farming in PNG is not currently as productive or profitable as in nearby countries. The Australian Centre for International Agricultural Research (ACIAR) has funded a series of inland aquaculture projects that aim to develop the industry sustainably, and to reduce the cost of formulated feeds and dependency on fishmeal as a source of protein in feeds. The current project is conducting research on sustainable and alternative feeds, and ways of improving fish farming practices, broodstock management and fingerling production. In my presentation I will give an overview of the research and also outline social impacts of fish farming, particularly how it has transformed the lives of villagers. I will discuss our past and current projects' Fish for Prisons and Fish for Schools programs, our outreach activities in remote communities, working with Raskol gangs, drug addicts, criminals and urban youth programs, and using fish farming as a means of developing human capacity. The presentation will be illustrated with images of people, communities and fish farming practices.

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Refreshments will be served from 5.30 pm
Everyone welcomed