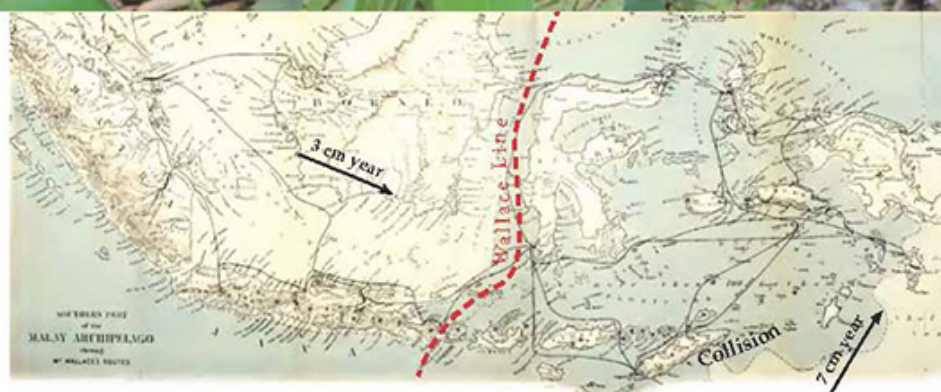


WALLACEA SYMPOSIUM: CONNECTING ASIA TO THE AUSTRALIAN CONTINENT

ABSTRACTS



Topics include:

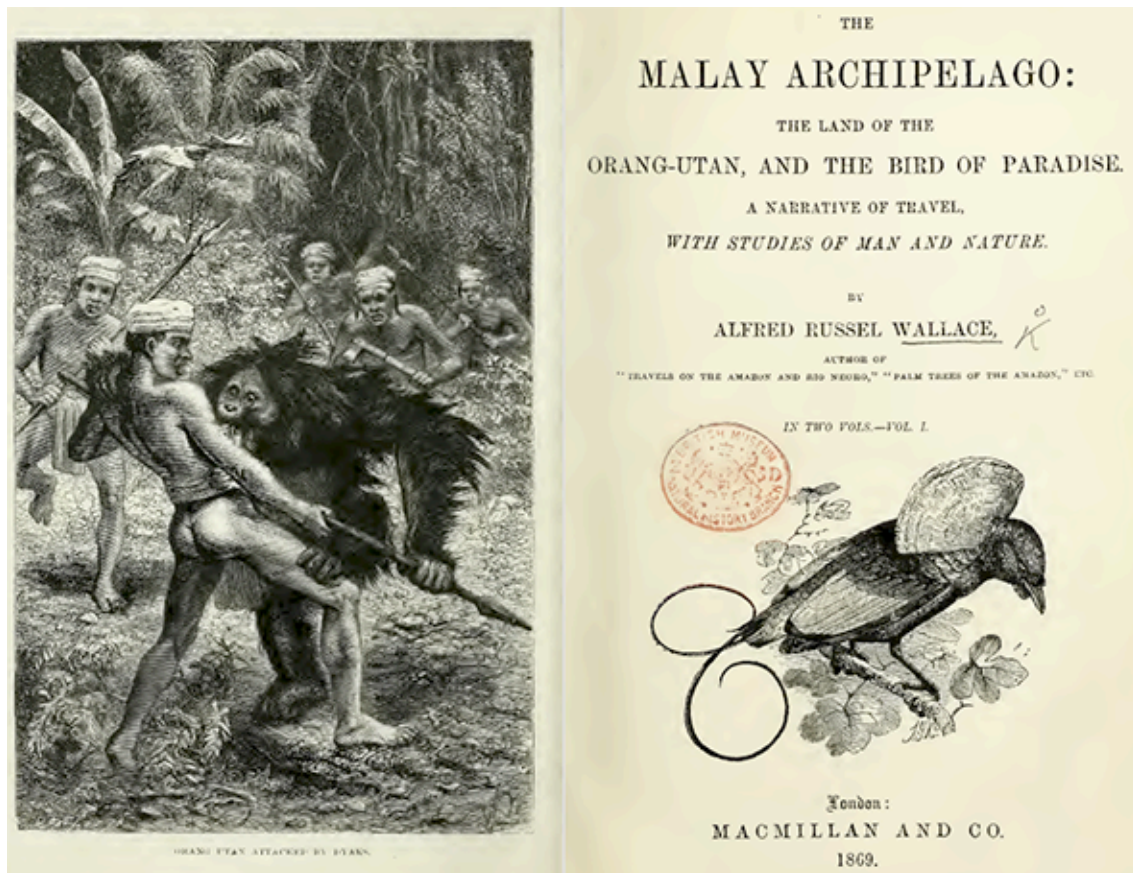
- Alfred Russel Wallace - the man
- On-going collision between Australian continent and Asia: geological evidence
- Animal and plant biogeography across Wallace Line
- Migration of humans across Wallacea to Australia
- Aspects of modern humans and environments

Hosted by:
Royal Society of Western Australia &
The Oceans Institute, University of Western Australia

Indian Ocean Marine Research Centre Auditorium
61 Fairway, Crawley,
Perth, Western Australia

Information and registration for this FREE event at www.rswa.org.au

Commemorating 150 years since the publication of Alfred Russel Wallace's classic book on the geology, biota, and human populations of what later became known as Wallacea



Digital copies of the two volumes of this book are available, free of charge, from the Biodiversity Heritage Library (at <https://www.biodiversitylibrary.org/item/104498>)

**Abstracts are arranged in order of the *Schedule of Talks*
*The Abstracts have been formatted but not edited***

Schedule of Talks

Friday 14 February

9.00-9.15 am: Opening of Symposium

9.15-9.45 am: **Patrick Armstrong**: *Alfred Russel Wallace: The Man*

9.45-10.15 am: **David Haig**: *Wallacea - connecting Asia to the Australian Continent*

10.15-10.45 am: **Patricia Vickers-Rich**, John van Wyhe, Steve Pritchard, Steve Thompson, George Quinn, Tom Rich, Jeff Smith, Peter Trusler: *In the steps of Alfred Russel Wallace. The Making of a Documentary*

10.45-11.30 am: Morning Tea (provided at the symposium; gold-coin donation welcomed)

11.30-12 noon: **Peter Veth, Sven Ouzman, Sam Harper**: *People, Place and Paint - Human Identities in Wallacea from Pleistocene to Present*

12-12.30 pm: **Moyra Wilson**: *Geological evolution, marine environmental change and the global reefal biodiversity hotspot in SE Asia*

12.30-1 pm: **Debra Judge**: *Eating across the line(s): Dietary diversity and children's growth in Timor-Leste.*

1-2.15 pm: Lunch (participants to provide their own lunch)

2.15-2.45 pm: **Ron Johnstone** OAM: *Australian-Wallacean avifaunal connections, dispersal and migration.*

2.45-3.15 pm: **Ric How** and Linc Schmitt: *Where dragons reside and snake evolve: Interpreting reptiles in Wallacea.*

3.15-3.45 pm: **Peter Baillie**: *Changing perceptions on the geological development of the Makassar Straits.*

3.45-4.30 pm: Afternoon Tea (provided at symposium; gold-coin donation welcomed)

4.30-5.00 pm: **Giada Bufarale**: *Natural history of the Kimberley coral reefs*

5.00-5.30 pm: **S. Anna Florin**: *Early Plant food use at Madjedbebe, northern Australia: Archaeobotanical evidence for the adaptation of early modern humans to new environments in Sahul.*

5.30-6.00 pm: **Tiina Manne**: *Prey choice in Pleistocene and Holocene northern Australia.*

Saturday 15 February

9-9.30 am: **David Haig**: *8 million years of collision between the Australian continent and Asia, and the uplift history of Timor.*

9.30-10 am: **John van Wyhe**: *Wallace in the light of historical method.*

10-10.30 am: **Kathryn McMahon**, Udhi E. Hernawan, Kor-Jent Van Dijk, Gary A. Kendrick, Ming Feng, Edward Biffin and Paul S. Lavery: *Historical processes and contemporary ocean currents drive genetic structure in the seagrass *Thalassia hemprichii* in the Indo-Australian Archipelago.*

10.30-11.15 am: Morning Tea (provided at symposium; gold-coin donation welcomed)

- 11.15-11.45 am: **Paul Whincup**: *The quest for Wallace's Ternate house*
- 11.45-12.15 pm: **Linc Schmitt** and Ric How: *Around the Lines: the impact of contemporary and historical sea barriers on the evolution of bats in southern Wallacea.*
- 12.15-12.45 pm: **Elise Matheson**: *A history of highland subsistence: a study of the Archeobotanical evidence from the Ivane Valley sites in Papua New Guinea.*
- 12.45-2 pm: Lunch (participants to arrange their own lunch)
- 2-2.30 pm: **Kevin Kenneally** AM: *The Wallacea connection with Kimberley of northwestern Australia: Floristic separation in time and space*
- 2.30-3.00 pm: **Eujay McCartain**: *Timor: a case study of Gondwana geological heritage in Wallacea.*
- 3.00-3.30 pm: **Eckart Håkansson**: *Free-living bryozoans - a convergent global succession with roots on both sides of the Wallacean line*
- 3.30-4.00 pm: **Holly Ellen Smith**, Joseph Bevitt, Ulf Garbe, Yan Rizal, Jahdi Zaim, Mika Rizki Puspaningrum, Aswan, Agus Trihascaryo, Gilbert J. Price, Julien Louys.
Computed tomographic imaging of vertebrate-bearing breccia deposits in Southeast Asian caves.
- 4.00-4.30 pm: Afternoon Tea (provided at symposium; gold-coin donation welcomed)
- 4.30-5.00 pm: **Mark Brundrett**: *Is Western Australia the world's most important centre for evolution of key functional traits in plants?*
- 5.00-5.30 pm: Jose Nano, **David Haig**, Eujay McCartain: *Slabs of Asia overthrust onto the Australian continental margin and the future of Wallacea.*

Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 9.15–9.45 am

Alfred Russel Wallace: The Man

Patrick Armstrong

The University of Western Australia

Sometimes referred to as the ‘Father of Biogeography’, Alfred Russel Wallace is known as the co-founder of the theory of evolution, and was well-versed in zoology, botany, anthropology, politics, astronomy and psychology. Although sometimes notorious for his unpopular and eccentric beliefs – including spiritualism and opposition to vaccination - he is still recognized as one of the leading figures in nineteenth-century British science.

Patrick will describe Wallace’s long life, from 1823 to the eve of World War I, and show him to be, in many ways, a more interesting character than his fellow scientist and co-originator of the notion of evolution through natural selection, Charles Darwin. Wallace was a man who was at certain times in his life plagued with misfortune: legal issues, the early death of his siblings, difficulty in obtaining full-time employment, and relationship troubles all vexed him. The talk will describe the life of a restless traveller who, although he grew up with ‘a very ordinary education’, became one of the most influential scientists of his time. Differences between Darwin’s ideas and those of Wallace will be mentioned, and a brief insight into his personality offered.

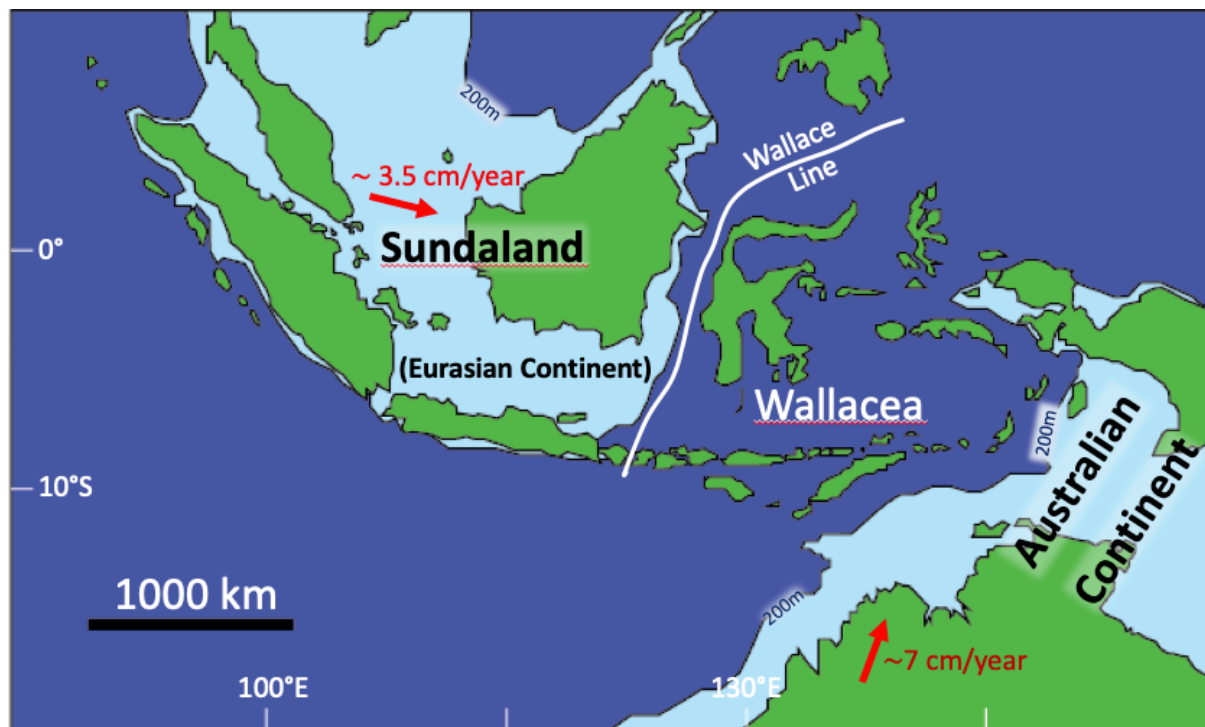
Patrick's recently published book "*Alfred Russel Wallace (Critical Lives)*" will be available for purchase at the Symposium

Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 9.45–10.15 am

Wallacea: Connecting Asia to the Australian Continent - Introduction

David Haig

Oceans Graduate School, The University of Western Australia



This talk will describe the physical setting of Wallacea and adjacent regions. It will outline the Gondwanan components of Sundaland and the significance of the Mesotethyan and East Gondwanan interior rift systems in Permian and early Mesozoic Gondwana. It will pose questions such as:

- (1) Has the Australian continent on the Australian Plate (moving at about 7 cm/ year to the north-north-east) already collided with Sundaland, part of the Eurasian Continent, moving south-east at a rate of about 3-4 cm/year?
- (2) What was the outline of the Australian continent before entering the collision zone?
- (3) Was there ever a land or shallow-sea connection between the Australian Continent and Sundaland?
- (4) What is the significance and geological histories of the Java Trench and the Timor Trough and the other deep-water straits separating the present-day Australian continent from Sundaland?

Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 10.15–10.45 am

In the steps of Alfred Russel Wallace. The Making of a Documentary

Patricia Vickers-Rich¹, John van Wyhe, Steve Pritchard, Steve Thompson, George Quinn,
Tom Rich, Jeff Smith, Peter Trusler

¹Monash University, School of Earth, Atmosphere and Environment, Melbourne

Wallacea is well named, for it was in honour of the curious adventurer Alfred Russel Wallace who was out making his living, and refreshing his mind, collecting the biota of this region in the 1850's and 1860's. He was confronted by how the biota of this region differed significantly across short stretches of water, as he plied his trade. As George Gaylord Simpson noted in his seminal paper (Simpson, 1977), there were many lines in this area where on one side the biota was quite different than on the other side. The most famous of these, Wallace's Line, threads its way through Wallacea notably between Bali and Lombok, where on one side the biota in Wallace's time was mainly Asian and on the other side quite different, very Australian. Little did he know at the time that the movement of continents had something to do with this, with Australia at times in the past lying far south of its present position and only as it moved north during the past 130 million + years, did it come into closer contact with Asia. Only in the 1960's did the concept of plate tectonics, providing the mechanism supporting the older idea of Wegner's, continental drift, fully explain the reason for Wallace's observations and the basis for Wallacea. The doco produced for the Singapore Science Centre exhibition by Steve Pritchard recounts some of Wallace's adventures that coupled with the paradigm shift from stable to mobile continents in the 1970's (Mayr, E., 1972; Raven & Axelrod, 1972; Vickers-Rich, *et al.*, 1991) led to an explanation of what puzzled Wallace in the mid-19th century. And this is captured in the documentary "In the Steps of Alfred Russel Wallace."

Mayr, E., 1972. Continental drift and the history of Australia bird fauna. *Emu*, 72 (1): 26-28.

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Simpson, G. G., 1977. Too many lines: the limits of the Oriental and Australian zoogeographic region. *Proc. Am. Phil Soc*, 121 (2): 107-120.

Vickers-Rich, P., Monaghan, J. M., Baird, R. F., Rich, T. H., Thompson, E. M. & Williams, C., 1991. *Vertebrate Palaeontology of Australasia*. Pioneer Design Studio in cooperation with Monash University Publications Committee, Melbourne: 1437 pp.

Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 11.30–12.00 noon

People, Place and Paint
Human Identities in Wallacea from Pleistocene to Present

Peter Veth^{1,2}, Sven Ouzman² and Sam Harper²

¹UWA Oceans Institute, ²UWA Centre for Rock Art Research + Management

The peopling of Sahul >50,000 years ago is an event – or series of events – known to us through archaeological investigations and genetic research. The latter source of evidence gives some indication of the ancestry of the First Australians – but who were they really? We present initial results from the Kimberley Visions: rock art style provinces of North Australia ARC project which explore both rock art and social linkages across northern Australia. These connections build on previous research, and we expand these linkages further to include desert fringes to the south, and island SE Asia to the north – where dating programs have identified 41,000-year-old painted rock art. Visually, this rock art – which consists of large irregularly infilled animal depictions – is very similar to what is thought to be one of the Kimberley's oldest rock art types. Rock art provides a direct window in the past as perceived and intended by the creators of these images.

We focus on the early human history between Sunda and Sahul, using rock art as a proxy for human movement – physically and culturally, linking Borneo (Sunda), Sulawesi (Wallacea) and Sahul (Kimberley). This approach repositions human activity away from the modern geography to a model in which Wallacea may have been less a line of division than a common landscape for people, who we have until now largely studied in geographic isolation.

Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 12.00–12.30 pm

Final title coming

Moyra Wilson

School of Earth Sciences, The University of Western Australia

Abstract coming

Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 12.30–1.00 pm

Eating across the line(s): Dietary diversity and children's growth in Timor-Leste

Debra S Judge

School of Human Sciences, The University of Western Australia

The prehistory of Timor-Leste includes multiple waves of dispersal to the island from the North, the East, and the West. Pre-colonial diets were based in tubers, sago and gathered and hunted wild foods. Hunting buffalo, pigs and cuscus provided protein. Cereal production/swidden increased as a side product of colonial pacification and attempts to increase grain production (maize and rice). Over the last 40 years, preference for rice increased relative to maize, sweet potatoes, and cassava. The low cost of rice and its ease of cooking mean that rice is the basic foodstuff of most Timorese households; more nutritious maize is less common across households and more seasonal. For many rural households, means of production have changed little in the last century. Buffalo still plough the rice paddies and hoes are more common than hand plows. Households with higher dietary diversity are characterised by consuming more legumes and meat products, but the association of meat consumption with ceremonies typically held during the dry season persists and results in higher variance in protein availability.

Our longitudinal work on family ecology and children's growth in mountainous Ossu and the coastal plains of Natarbora find persistence of poor child growth resulting from poor nutrition as measured by low dietary diversity (especially during the wet season) and lasting impacts of adverse climatic events (e.g. La Nina) that constrain harvests. While development of the agricultural sector over the past 20 years has increased production, indicators of resulting improvements in rural children's nutrition have changed very slowly. Subsistence farmers' ability to produce food is constrained by land availability, inconsistent rainfall, and the availability of labor. As a result, while child survival has improved, children continue to be shorter, thinner, and more susceptible to illness than under better environmental conditions.

Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 2.15–2.45 pm

Australian-Wallacean Avifaunal Connections, Dispersal and Migration

R.E. Johnstone and J.C. Darnell

Department of Ornithology, Western Australian Museum,
Locked Bag 49 Welshpool DC Western Australia 6986

The islands of eastern Indonesia span the boundary of the oriental and Australian biogeographic regions, two of the world's most distinct biological realms. Between 1987 and 1997 a series of joint surveys between the Western Australian Museum and Museum Zoologicum Cibinong, Java, Indonesia to the major islands of Nusa Tenggara (Lesser Sundas) and southern Moluccas of Indonesia were carried out. The purpose was to record the distribution and examine the taxonomy of the terrestrial vertebrates throughout the region. In this context an extensive series of observations were made, and specimens collected across the zone of complex speciation and taxonomy. Also, between 1970 and 2009 extensive avifaunal surveys were carried out throughout the Kimberley and Pilbara regions of Western Australia. Here again the focus was to gain information on the distribution, status, habitat preferences, breeding seasons, seasonal movements and migrations for all species including visitors to these regions and including offshore islands (Ashmore Reef and Christmas and Cocos (Keeling) islands). Overall these studies have generated a great deal of new knowledge on the taxonomic status, zones of contact, hybrid zones, effects of ecological barriers, speciation, transequatorial migration and avian traffic between Asia and Australia.

This presentation examines some of the avian diversity patterns, connections, dispersal and migration within the Australian-Wallacean region, especially between Western Australia and the eastern Lesser Sundas and highlights some biogeographic affinities between these regions. It will show that our understanding of complex endemism and speciation within Wallacea remains incomplete and further targeted exploration will almost certainly discover new species and subspecies.

Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 2.45–3.15 pm

Where dragons reside and snakes evolve: Interpreting reptiles in Wallacea

Ric How^{1,2} and Linc Schmitt¹

¹ School of Human Sciences, The University of Western Australia

² Department of Terrestrial Zoology, Western Australia Museum

Relationships of the biota in eastern Indonesia have captured the imagination of biologists since the classic work of Alfred Russel Wallace in the region over 160 years ago. This area of geographic overlap in biotas derived from both Asian and Australasian regions now bears his name, Wallacea. Indubitably, the best known and studied reptile of Wallacean region is the remarkable Komodo dragon, the world's largest lizard and a member of the principally Australian family of monitor lizards. Not only are islands within Wallacea home to this iconic reptile, but they are also the location of a huge variety of reptile families, containing hundreds of species, whose ancestors originated in either Asia or Australia. Vertebrate surveys over 30 years ago supported the high diversity of reptiles in Wallacea but also indicated that many species had evolved and become endemic to the region - like the Komodo dragon.

Ongoing morphological and molecular studies by the Western Australian Museum and The University of Western Australia have shown many genera of snakes have evolved new species within the region, thus increasing the number of known endemic taxa. Our studies also illustrate the evolutionary significance of population isolation during the millennia when sea levels, and island connectivity, changed during the Pleistocene glaciations. A reappraisal of the snake assemblage relationships on Wallacean islands, based on these new data, illustrates that major discontinuities occur between islands that were isolated throughout the Pleistocene by altered sea levels.

Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 3.15–3.45 pm

**Changing Perceptions on the Geological Development of the Makassar Straits,
Indonesia**

Peter Baillie

The University of Western Australia

The Makassar Straits, comprising a north-south orientated seaway, approximately 600 km long, 100–200 km wide with water depths greater than 2000m situated between Borneo and Sulawesi (formerly Celebes) are the spiritual heartland of Wallacea, as it was here that Alfred Russell Wallace first recognised the spectacular divide between Asian and Australo-Pacific biogeography and set up the resultant “Wallace Line”.

He also made an astute geological observation: “In this Archipelago there are two distinct faunas rigidly circumscribed, which differ as much as those of South America and Africa, and more than those of Europe and North America: yet there is nothing on the map or on the face of the islands to mark their limits. The boundary line often passes between islands closer than others in the same group. I believe the western part to be a separated portion of continental Asia, the eastern the fragmentary prolongation of a former Pacific continent.” (letter to Henry Bates, 1858).

During the twentieth century, numerous studies were made of the onshore geology of Borneo and Sulawesi but it was not until the advent of marine seismic acquisition and the discovery of major hydrocarbon deposits in the Mahakam Delta in the 1970s that any attention was given to the offshore geology of the Makassar Straits.

The formation of the Makassar Straits and nature of underlying crust has long been the subject of scientific debate. Previous interpretations have suggested either purely continental or continental-to-oceanic rifting in the Eocene, Middle Tertiary, Miocene or Pliocene, trapped Cretaceous oceanic crust or an actively forming Neogene-Quaternary foreland basin for the formation of the Makassar Straits.

The presentation will utilise modern seismic and high-resolution bathymetric data to illustrate the geological development of the Makassar Straits together with petroleum prospectivity and natural hazards.

Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 4.30–5.00 pm

Natural history of the Kimberley coral reefs

Giada Bufarale

Curtin University, Perth

The Kimberley coast is a remote region located in the north western continental margin of Australia. This complex landscape is characterised by a unique marine environment, considered as one of the world's greatest biodiversity hotspots, where coral reefs are particularly ubiquitous, exploiting abundant rocky substrate for fringing reef development. The reefs occur in sheltered and exposed settings and seemingly endure extreme environmental conditions including: (1) high turbidity and sediment input, (2) elevated water temperatures, (3) macrotidal range (up to 11 m), (4) significant subaerial exposure during low tides, and (5) frequent cyclones. Despite these extreme conditions, the coral biodiversity in the Kimberley is far richer than in the inner Great Barrier Reef (GBR).

A combination of remote sensing, multibeam and reef habitat surveys, sub-bottom profiling and associated sedimentological work produced a reef geodatabase, providing the first detailed geospatial study of coral reefs within the bioregion. More than 800 reefs have been documented and multibeam data showed that some surveyed reef flats have elevations higher than the mean sea level, and required a modified geomorphic reef classification scheme to be developed for the Kimberley, which includes a new "high intertidal" geomorphic class of reef. High-resolution acoustic data, acquired along selected reefs, revealed that pre-existing substrate has influenced the successive reef morphology. Global sea-level changes, controlled by ice age fluctuation events, provided a signal which is recorded in successive stages of the reef growth, separated by hiatuses. Reef cores and radiocarbon dating indicated that the initiation of reef growth occurred very soon after post-glacial marine flooding of the continental shelf, some 8000 years ago, this is almost 5000 years earlier than equivalent inshore GBR reefs.

Early plant food use at Madjedbebe, northern Australia: Archaeobotanical evidence for the adaptation of early modern humans to new environments in Sahul

S. Anna Florin^{1*}, Andrew Fairbairn^{1,2,3}, Chris Clarkson^{1,2}, May Nango⁴, Djaykuk Djandjomerr⁴

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2. Australian Research Council Centre of Excellence for Australian Biodiversity and Heritage, University of Wollongong, Wollongong, New South Wales 2522, Australia.
3. Department of Archaeology, Max Planck Institute for the Science of Human History, Kahlaiche Strasse 10, 07745 Jena, Germany.
4. The Gundjeihmi Aboriginal Corporation, 5 Gregory Place, Jabiru NT, 0886, Australia.

* Corresponding author: stephanie.florin@uqconnect.edu.au

The movement of early modern human populations across the Wallace Line and into Sahul has been considered a marker of behavioural modernity. However, models to explain this movement often highlight the ‘easiest’ path of dispersal, emphasising the lure of high-ranked coastal resources and suggesting that diet breadth remained narrow during the earliest phases of human expansion (Mellars et al., 2013; O’Connell and Allen, 2012). This paper presents the archaeobotanical analysis of charred plant macrofossils from Phase 2 at Madjedbebe, 65-53kya (Clarkson et al., 2017). It identifies the remains of underground storage organs (USOs), fruits, nuts and other plant foods and investigates the diet breadth and landscape use of early populations in Sahul. The findings produced have implications for our understanding of the behaviour, cognitive flexibility and subsistence strategies of the early modern human groups moving across Wallacea and allows for models of dispersal to be tested at the eastern end of this migration.

References

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Wallacea Symposium: Connecting Asia to the Australian Continent
Friday 14 February, 5.30–6.00 pm

Prey choice in Pleistocene and Holocene northern Australia

Tiina Manne

School of Social Science, The University of Queensland

Although archaeofaunal assemblages from northern Australia are limited, records suggest an early adoption of "broad-spectrum" diets. Inland, key prey items consist of small- to medium-sized mammals and reptiles, with large kangaroos being exploited less frequently. On the coast, marine shellfish, fish, turtles were featured alongside smaller-sized terrestrial resources. Published ethnographic data from the Western Desert has previously noted that prey size does not adequately predict rank, and that pursuit costs appear to play a more important role. In fact, large kangaroos were viewed as a high-risk enterprise, especially if the right technology had been left at home.

In this presentation, I provide an overview of recent developments in northern Australian archaeology in terms of zooarchaeology. I examine new data from Pleistocene and Holocene faunal assemblages from northern Australia, and explore how animal behaviour and seasonality may have affected prey rank. Finally, I discuss some potential explanations for why a broad-spectrum diet may have been attractive – or necessary, as people entered Sahul.

8 million years of collision between the Australian continent and Asia, and the uplift history of Timor

David Haig

Oceans Graduate School, The University of Western Australia

Collisions between tectonic plates progress over millions of years. The island of Timor lies in the collision zone between the north-north-east moving Australian Plate and the east to south-east moving Eurasian Plate. Timor is at the leading edge of the Australian Continent in a collision zone with Sundaland, a promontory of the Eurasian Continent. Prior to collision, the Timor region formed part of Timor–Scott Plateau, a deep-water submarine plateau of attenuated continental crust that was similar to present-day Exmouth Plateau.

Four progressive phases have been recognized in the continuing collision.

1. Late Miocene — Subduction of the Australian Plate and the leading edge of Timor-Scott Plateau beneath the southern edge of Sundaland (represented by a volcanic arc):

The subduction resulted in chaotic deformation of the sedimentary succession present on Timor-Scott Plateau including (1) Late Carboniferous to mid Jurassic strata of the East Gondwana Interior Rift Association deposited before the continental breakup that formed the Indian Ocean, and (2) Late Jurassic shallow-water deposits overlain by Cretaceous to early Late Miocene deep-water pelagites of the Timor-Scott Plateau Association. During this phase of collision vast slabs of crust (including metamorphic, volcanic and sedimentary units of the Overthrust Terrane Association) derived from Sundaland were thrust across the margin of the Australian continent (see final talk of Symposium). The result was some of the most chaotic geology of any region on Earth.

2. Latest Miocene to Late Pliocene — Jamming of subduction: This resulted in a tectonically quiet interval with Timor submerged below 500 m water depth and most below 1000 m. A rain of pelagic carbonate sediment (mainly skeletons of minute ocean plankton) formed chalk across the island. Gradual shallowing took place during this time, but most of the island remained below 1000 m water depth.

3. Late Pliocene to Early Pleistocene — tearing of subduction slab: This resulted in extensive high-angle faulting (and earthquake activity) that formed (1) the steep-sided limestone fatus (peaks) that characterize the Timor landscape; and (2) aprons of sediment, including debris slides and turbidite flows, around the rapidly rising land masses. Further from the elevated areas, deep-water pelagic carbonate deposition continued.

4. Mid Pleistocene to present — aseismic domal uplift: After tectonic equilibrium was reached following slab tear, subduction is reversing (southward under Wetar) and the eastern part of Timor, at least, is experiencing very low levels of earthquake activity. However, it is undergoing broad domal uplift, the history of which can be traced through elevated coral-reef terraces. The highest, still preserved example is of mid Pleistocene age and almost 1500 m above present sea level.

Wallacea Symposium: Connecting Asia to the Australian Continent
Saturday 15 February, 9.30–10.00 am

Wallace in the light of historical method

John van Wyhe

Department of Biological Sciences,
Fellow of Tembusu College,
National University of Singapore
Director of Darwin Online

http://darwin-online.org.uk/people/van_wyhe.html

jmv21@fastmail.co.uk

Everyone knows the story of A.R. Wallace. But unlike other Victorian naturalists, for the past fifty years most writers on Wallace have not been trained, professional historians. His story has in fact evolved enormously from the historical figure who died in 1913. The new Wallace story is attractive in many ways and it sells well. While some writers on him have been outrageous conspiracy theorists, most have simply followed what all of the books and articles say about him. Unwittingly, however, the story or stories of Wallace predominant today fly in the face of historical method and an informed contextual analysis.

Wallacea Symposium: Connecting Asia to the Australian Continent
Saturday 15 February, 10.00–10.30 am

Historical processes and contemporary ocean currents drive genetic structure in the seagrass *Thalassia hemprichii* in the Indo-Australian Archipelago

Kathryn McMahon¹, Udhi E. Hernawan, Kor-Jent Van Dijk, Gary A. Kendrick, Ming Feng, Edward Biffin and Paul S. Lavery

¹ School of Science & Centre for Marine Ecosystems Research, Edith Cowan University

Understanding spatial patterns of gene flow and genetic structure is essential for the conservation of marine ecosystems. Contemporary ocean currents and historical isolation due to Pleistocene sea level fluctuations have been predicted to influence the genetic structure in marine populations. In the Indo-Australian Archipelago (IAA), the world's hotspot of marine biodiversity, seagrasses are a vital component but population genetic information is very limited. Here, we reconstructed the phylogeography of the seagrass *Thalassia hemprichii* in the IAA based on single nucleotide polymorphisms (SNPs) and then characterized the genetic structure based on a panel of 16 microsatellite markers. We further examined the relative importance of historical isolation and contemporary ocean currents in driving the patterns of genetic structure.

Results from SNPs revealed three population groups: eastern Indonesia, western Indonesia (Sunda Shelf) and Indian Ocean; while the microsatellites supported five population groups (eastern Indonesia, Sunda Shelf, Lesser Sunda, Western Australia and Indian Ocean). Both SNPs and microsatellites showed asymmetrical gene flow among population groups with a trend of southwestward migration from eastern Indonesia. Genetic diversity was generally higher in eastern Indonesia and decreased southwestward. The pattern of genetic structure and connectivity is attributed partly to the Pleistocene sea level fluctuations modified to a smaller level by contemporary ocean currents.

Wallacea Symposium: Connecting Asia to the Australian Continent
Saturday 15 February, 11.15–11.45 am

The quest for Wallace's Ternate house

Paul Whincup

Jakarta, Indonesia. paul@envirosc.com

Ternate is a small volcanic island in the North Moluccas Province of Indonesia where Alfred Russel Wallace based himself for three years from 1858 to 1861 and from where he dispatched his famous Ternate Essay to Charles Darwin outlining his theory of evolution. The location of his house on Ternate has been the subject of conjecture for many years.

Paul Whincup, a hydrogeologist based in Indonesia, argued that it should be possible to identify the site using one of Wallace's key criteria described in his Journal *The Malay Archipelago*, namely the presence of a deep well 'which supplied me with pure cold water'. After initiating a census of old wells in the general area described by Wallace, a credible site closely corresponding with all Wallace's criteria has been identified and has been accepted as such by the mayor of Ternate. He has indicated his willingness to purchase the site on behalf of the Ternate City Council, build a replica Wallace House and establish a Wallace Biodiversity Museum.

Wallacea Symposium: Connecting Asia to the Australian Continent
Saturday 15 February, 11.45–12.15 pm

Around the Lines: the impact of contemporary and historical sea barriers on the evolution of bats in southern Wallacea

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Wallacea is well known for its biogeographic "lines" intended to demark regions with fauna of Oriental or Australian origins. Located between the Asian and Australian Realms, and with considerable environmental diversity and gradients, southern Wallacea is also a valuable setting for the study of recent evolutionary events. Over 40 years ago, in his seminal paper "*Too many lines; the limits of the Oriental and Australian zoogeographic regions*", the eminent American biologist George Gaylord Simpson critiqued the seven "lines" (plus modifications!) proposed for the region. Do these biogeographic lines really reflect major barriers to species movement? In the spirit of Simpson, we examined genetic diversity *within* ten bat species that are widespread in southern Wallacea, each traversing at least two "lines". Clearly, the proposed lines do not explain the distribution of these bat species, but are they associated with population discontinuity (i.e. structure) within these volant mammals?

For seven of these species, the major subdivisions of population structure, where present, are directly associated with the sea-barriers that persisted throughout most, if not all, of the Pleistocene. These persistent sea barriers are, and have been, a potent barrier to gene flow for these seven species, even with their putative capacity to fly across them. However, Wallace's Line, between Bali and Lombok, is not any more prominently associated with restriction in movement than the other persistent Pleistocene barriers.

Four species show an attenuation from west to east in their genetic diversity within islands (heterozygosity). Likely factors contributing to this trend include increasing isolation from large mainland Asian source populations, declining effective population sizes towards the east, and natural selection associated with west to east ecological and climatic trends. As a consequence of the changes in heterozygosity, the eastern populations are probably more prone to extinction, thus assisting in isolating populations further to the east and thereby aiding speciation.

With 30% endemism in bat species and strong population structure associated with sea-barriers in the majority of species we have examined, southern Wallacea is not simply a transitional zone between Asia and Australia but a dynamic region in its own right - as first proposed by Simpson over 40 years ago.

Wallacea Symposium: Connecting Asia to the Australian Continent
Saturday 15 February, 12.15–12.45 pm

**A history of highland subsistence: a study of the Archaeobotanical evidence from the
Ivane Valley sites in Papua New Guinea**

Elise Matheson and Andrew Fairbairn

The University of Queensland

The highlands of New Guinea are an area of great archaeological interest. However, current archaeological understandings of the dynamics of the occupation and subsistence strategies of the highland zone are restricted, due to the scarcity of sites that have received botanical investigation. As such the theories that have been popularised regarding subsistence in the highland zone of New Guinea are founded on very limited data. The most promising of which comes from the Ivane Valley archaeological sites, where evidence for the exploitation of *Pandanus iwen* is seen throughout the sequence (Summerhayes et al. 2010). However, apart from the identification of *Pandanus iwen* in the archaeological record at Ivane, the rest of the archaeobotanical sequence has been largely ignored. The Ivane Valley archaeological sites' stratigraphic sequences are the oldest and longest sequences of intermittent occupation in the highland zone, spanning from 49,000BP to the early to mid-Holocene, with a hiatus during the LGM. As such these sites present a great opportunity for investigating the long-term nature of subsistence in the highlands and examining to what extent subsistence strategies changed through time. This presentation will investigate the findings of an analysis of the archaeobotanical records from four of the Ivane Valley sites (Kosipe Mission, Vilakuav, Joes Garden, and South Kov), looking specifically at evidence of subsistence. The study has highlighted the importance of having extensive regionally specific reference collections. This project has expanded current understandings of subsistence in the Highlands to include another variety of nut, as well as geophytes (as of yet unidentified) both of which make up a significant proportion of the vegetative archaeobotanical assemblage throughout all four sites. The results of this study indicate that there was continuity in the resources exploited by hunter-gatherers in the Ivane Valley, despite the hiatus in occupation seen during the LGM, and the environment changes that resulted

Wallacea Symposium: Connecting Asia to the Australian Continent
Saturday 15 February, 2.00–2.30 pm

The Wallacea connection with Kimberley of northwest Australia: Floristic separation in time and space

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Wallace noted the strong faunistic divide around the area of convergence between the Australian and Eurasian plates that would come to be known as the ‘Wallace Line’. Wallace, however, was less forthcoming when describing floristic differences and determination of the significance of Wallace’s line for plants has proven more complex than for the fauna. Wallacea does share a number of plant genera and species found in the Kimberley region of Western Australia, particularly in the genera *Eucalyptus* (Myrtaceae), *Acacia*, *Vachellia* (Leguminosae), fleshy-fruited species restricted to the monsoon rainforests and mangroves. I will consider if they are ancient relics or opportunistic immigrants.

Why does the Wallacea region come to have such a unique community of flora (estimated at 30,000 species of ferns and angiosperms) and fauna, and very high levels of endemism so distinct from its geographical neighbours? This can be explained by the deep-water channels that form semi-permeable barrier to any species that couldn’t swim or fly, ensuring that Wallacea was essentially geographically isolated from a whole suite of flora apart from chance colonisation events that created a ‘slow bleed’ from either Asia or Australia/New Guinea. Examples of this appear to be two terrestrial orchid species (*Diuris fryana* and *Pterostylis timorensis*), both of which are endemic to Timor but have strong Australian affinities. During glacial maxima, the Sunda and Sahul shelves became land areas connected with Asia and Australia, respectively, whereas sea barriers remained within the islands of Wallacea. Consequently, the floras of the two shelves are more homogeneous than the Wallacean flora. Wallacea is a distinct area because it comprises many endemic drought tolerant floristic elements.

When writing about the coryphoid palm *Livistona* in his book on the Malay Archipelago, Wallace commented that it had ‘the most complete and beautiful fan-leaf I have ever seen’. The genus *Livistona* was described from Australia by the botanist Robert Brown in 1810 and E.J.H. Corner in ‘The natural history of palms’ (1966) concluded that *Livistona* lingers as an outpost of Asian colonisation when with the wetter climate it travelled with the rain forest across Australia; it is not a relic of Gondwanaland or Antarctica’. Recent research by Crisp et al. (2010) has shown that 18 of the 34 species of the fan palm genus *Livistona* (Arecaceae) are restricted to Australia and southern New Guinea, east of Wallace's Line, an ancient biogeographic boundary between the former supercontinents Laurasia and Gondwana.

The Kimberley was never an isolated human landscape, with considerable trade, movement and contact with the outside world for at least the last few hundred years. Prior to European settlement, Macassan fishers from the islands of Roti, and Makassar visited the Kimberley coast (known to them as ‘Kayu Jawa’) in large fleets of wooden sailing vessels, known as

Kenneally continued:

prahaus to harvest an edible holothurian *bêche-de mer*, also known as trepang or sea cucumber. Aboriginal people traded with the Indonesians, perhaps worked for them, and some may even have sailed back to Roti or Makassar with them. Evidence of Maccassan activity on the Kimberley coast can be seen today in the stone fire hearths used for boiling the *bêche-de mer* and the occurrence of the introduced Tamarind tree (*Tamarindus indicus*) that they brought with them.

In this presentation I will consider dispersal mechanisms that would allow species the greatest chance of movement to and from oceanic islands. These include:

- Fly or float in the air e.g. birds, bats, spores and seeds
- Float in the sea e.g. mangroves seeds, sea beans
- Raft on logs e.g. fungi, seeds, epiphytic ferns and orchids
- Hitchhike on other animals e.g. seeds ingested by birds and bats or carried on feathers or feet
- Episodic events e.g. cyclones, storm surges, tsunamis. flooding and earthquakes
- War and conflict
- Refugee arrivals (e.g. 'boat people')
- Illegal people smuggling and trafficking
- Illegal trade in natural resources (e.g. *bêche-de mer*, giant clam, nesting seabirds and their eggs)
- Illegal foreign fishing (and seizure of vessels)

Wallacea Symposium: Connecting Asia to the Australian Continent
Saturday 15 February, 2.30–3.00 pm

Timor: a case study of Gondwana geological heritage in Wallacea

Eujay McCartain

School of Earth Sciences, The University of Western Australia

The biogeographic zone of Wallacea encompasses numerous islands, including Timor, between the Australian continent and Sundaland, the southeast extent of the Asian continent. With a few exceptions the islands and oceanic gateways between the Pacific-Indian oceans of Wallacea were formed and deformed through the collision of the Australian continent with Sundaland. Both sides of this collision include Gondwanan derived geology.

Sundaland, and western-most Wallacea, comprises continental crust and overlying strata rifted from Gondwana prior to the final breakup in the Late Jurassic. Likewise, the Australian continent comprises inherited Gondwana crust and overlying strata. The geometry of the pre-collisional northern margin determined by the breakup of Gondwana played a critical role in the formation of Wallacea. This inherited Gondwana geology has played and continues to play a key role in the geological, biogeographical and social evolution of Wallacea.

Whilst not without challenges Timor provides a great field laboratory to understand the Gondwanan geological heritage of Wallacea. To date Gondwana strata spanning the Late Carboniferous to Middle Jurassic have been documented on Timor. These strata primarily represent marine depositional systems including deep to shallow marine carbonate and siliciclastic systems.

This Gondwana geological heritage plays a key role in many of the physical and social facets of Timor-Leste with three investigated here. We will look at (1) a range of landscapes sculpted from Gondwana geology many of which have significant geotourism potential; (2) the rich Gondwanan fossil heritage which formed the basis for many seminal paleontological papers in the early 20th century; and (3) the resource potential of the Gondwana strata exposed on Timor.

Wallacea Symposium: Connecting Asia to the Australian Continent
Saturday 15 February, 3.00–3.30 pm

**Free-living bryozoans – a convergent global success with roots on both sides of the
Wallacean line**

Eckart Håkansson

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Biogeography is intimately linked to phylogeny and plate tectonics. Hence, conspicuous patterns in the distribution of any particular group may hold pertinent information regarding not only the distribution and distribution pathways but also constrain phylogenetic modelling. Prominent active examples are the Isthmus of Panama and the Wallace Line, both of which are relevant to multiple groups of plants and animals. A very special case operating in both these examples is the spectacularly polyphyletic ‘group’ of the free-living bryozoans, where convergent and iterative evolution is running wild.

At least four main clades of the free-living bryozoans may be recognized globally:

1) The polyphyletic group of Late Cretaceous “*Lunulites*” constitutes the early hot-spot for free-living bryozoans, stretching across northern and eastern Europe, centred around the Late Cretaceous Chalk Sea. There is evidence to suggest that no clades from this group survived the end of the Paleocene. 2) The strictly monophyletic family Cupuladriidae reached its peak in the Miocene–Recent period of time, with a dominant presence throughout the tropical-subtropical realm – except in Australasia. 3) The monophyletic group Heliodomidae reached its peak in the recent oceans, with a subordinate presence in the warmer regions of the Globe – except in Australia. 4) The polyphyletic group of Australasian bryozoans with ‘*Lunulites*-type’ morphology had their first appearance in the Maastrichtian–Thanetian of the Carnarvon Basin, reaching a prominent peak in the Miocene–Recent – particularly in eastern parts of Australasia, with a few species venturing into the southern part of South America.

Since the Middle Miocene, the Wallacea Terrane has been the home of a single species of both the Cupuladriidae and the Heliodomidae, with only *Cupuladria guineensis* crossing the Wallace line into Australasia. In contrast, none of the Australasian free-living species in the tropical parts of Australasia appears to have ventured across the Wallace Line, in spite of high densities of some of the more conspicuous taxa.

Computed tomographic imaging of vertebrate-bearing breccia deposits in Southeast Asian caves

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Our research records spatial information from vertebrate-bearing breccia deposits of caves in Southeast Asia to interpret taphonomic characteristics and infer the complex taphonomic history of incorporated faunal assemblages. This study establishes the dominating factors responsible for accumulation and preservation of these vertebrate remains. Fieldwork was undertaken in the Padang Highlands of western Sumatra, in three key cave localities; Lida Ajer, Ngalau Gupin and Ngalau Sampit. A single block sample was excavated from each discrete breccia site in these three localities and non-invasive computed tomographic imaging was performed. The internal composition of thirteen breccia deposits in total were analysed before any destructive preparation. Tomographic reconstruction of the raw data was performed using VGStudio Max 3.2 software, rendering three dimensional images from the two-dimensional CT scans. This method provides evidence of complex breccia formation at the macroscopic level that would otherwise have been destroyed using conventional methods. Analysis of the rendered three-dimensional images has revealed diverse structural, geological, sedimentological, trace fossil and fossil evidence. Identification of these agents creates a suitable lithostratigraphic record of cave formation, reformation and destruction. Understanding the stratigraphical progression of the cave sites has revealed principal evidence of the palaeoenvironmental history of each cave site. This study highlights the potential for analyses of seemingly homogeneous breccia deposits in anthropological and palaeontological studies in the caves of Southeast Asia in the future. Namely, the potential of tomographic imaging to offer a contemporary method of analysis in complex depositional environments that has removed all other taphonomic evidence. This data could strengthen our understanding of the ancient rainforest migrations and occupation by early humans and associated palaeofauna across Sundaland and the islands of Wallacea.

Wallacea Symposium: Connecting Asia to the Australian Continent
Saturday 15 February, 4.30–5.00 pm

Is Western Australia the world's most important centre for evolution of key functional traits in plants?

Mark Brundrett

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A global study of mycorrhizal associations has revealed that Australia is unique and the southwest of Western Australia even more so. This is due to the presence of an exceptionally high number of plant families and genera with variable root traits due to recent switching of plant nutrition strategies. Most other regions are dominated by plant families that have consistent arbuscular mycorrhizas (AM), an association that arose with the first land plants, along with ectomycorrhizal (EM) and nonmycorrhizal (NM) plant families that diverged from AM plants in the Cretaceous (Brundrett & Tedersoo 2018). Australia also has many plant families where ancestral traits have remained consistent, but highly diverse families such as the Fabaceae and Myrtaceae have root traits that are highly variable. These include genera where some species have switched from AM to EM, retained both associations (EM-AM), or have NM cluster roots. These Novel and Complex Root (NCR) clades constitute the third wave of mycorrhizal evolution and have originated in the past 30 Ma coinciding with continental aridification after separation from Antarctica (Brundrett 2017). These trends explain why Australia is a global diversity hotspot for plants with specialised nutrition, with at least 1/3 of all species of EM plants, numerous NM plants with cluster roots, as well as 1/4 of all carnivorous plants.

Reasons for switching root types can potentially be determined by linking divergence dates for key groups of plants to the climate history of Australia, but soils and fire are also very important. NCR clades are most diverse in the ancient landscapes of the Southwest Australian Floristic Region (SWAFR). This plant diversity hotspot has extremely old and infertile soils, but landscapes are also spatially complex, allowing greater opportunities for edaphic specialisation by plants and perhaps also lower rates of extinction due to landscape stability and refugia. The SWAFR may well be the best location on earth for studying the long-term impacts of climates and soils on plant evolution and diversity, by providing a preview of future soil conditions elsewhere on earth. Furthermore, West Australian plants provide many other exceptional ecological and evolutionary case studies including many with highly specific and complex pollination mechanisms, as well as drought and fire survival traits.

Brundrett MC. 2017. Global diversity and importance of mycorrhizal and nonmycorrhizal plants. In: Tedersoo L, ed. *Biogeography of Mycorrhizal Symbiosis*. Cham, Switzerland: Springer International Publishing. 533-556.

Brundrett MC, Tedersoo L. 2018. Evolutionary history of mycorrhizal symbioses and global host plant diversity. *New Phytologist* **220**: 1108-1115.

Wallacea Symposium: Connecting Asia to the Australian Continent
Saturday 15 February, 5.00–5.30 pm

**Slabs of Asia overthrust onto the Australian continental margin and the future of
Wallacea**

Jose Nano¹, **David Haig**², Eujay McCartain³

¹ Institute of Petroleum and Geology, Dili, Timor-Leste

² Oceans Graduate School, The University of Western Australia

³ School of Earth Sciences, The University of Western Australia

Timor lies in the collision zone between the Australian Continent and Sundaland (see first talk by Haig on Saturday 15). Stratigraphic units in Timor can be grouped into three main **pre-collision** associations. Each association is found in geographically distinct areas on the island and has rock units unique to the association. Two of these associations have affinities to similar successions in sedimentary basins on the present-day Australian margin. These include the East Gondwana Interior-Rift Association (EGIRA) containing late Paleozoic and early Mesozoic strata; and the late Mesozoic to early Late Miocene Timor-Scott Plateau Association (T-SPA).

Distinct from these Australian-related associations, is the Overthrust Terrane Association (OTA). The stratigraphic components of this association are best known in the Cablac Mountain, Mundo Perdido, Laritame, and Matabian regions in Timor-Leste. The sedimentary units of this association include Late Triassic and Early Jurassic shallow-water limestones that were originally deposited on the Gondwanan margin and were on crustal blocks that rifted away during mid to late Jurassic spreading of the Indian Ocean, eventually colliding with the southern margin of Sundaland during the Late Cretaceous (or perhaps as late as the early Paleogene). These old peri-gondwanan deposits are overlain by deep-water carbonate pelagites of Cretaceous to Paleocene age deposited well away from any land area. The Middle Eocene to earliest Miocene deposits include deep-water pelagites containing debris-slide deposits and carbonate turbidites, deep-water siliciclastic turbiditic deposits, shallow-water limestones, as well as volcanoclastics and volcanics. These diverse units signify a dramatic change in tectonic activity in nearby land areas (considered to be on the southern margin of Sundaland) during the Middle Eocene.

The OTA rocks in Timor-Leste show little signs of deep burial and maintained a high crustal position during the Late Miocene phase of collision between Sundaland and Timor-Scott Plateau at the leading edge of the Australian continent. Large slabs of OTA were overthrust onto the crumpled Australian margin.

In this talk, we will illustrate the rock succession found during recent mapping led by Jose Nano in the Matabian region of Timor-Leste. We will demonstrate the importance of identifying clast types in conglomerates in order to "stitch" together the various units of the OTA so that a coherent reconstructed stratigraphic history can be presented, prerequisite to any understanding of how the island of Timor formed. We will further speculate on the future of Timor and Wallacea during the continuing collision between the Australian Continent and Sundaland.