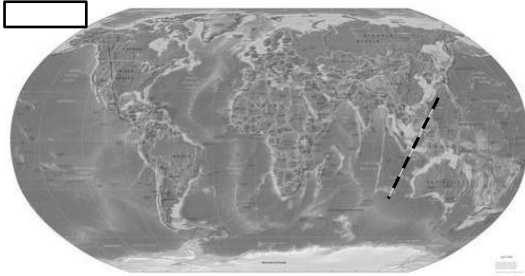


Relationships of Floras (& Faunas)

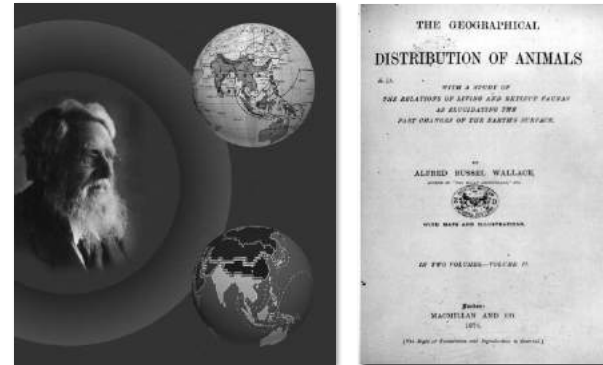
Knowledge of earth and organism histories now permit closer examination of relationships of disjunct floras and faunas.

- Southern Hemisphere temperate
- Southern Hemisphere tropics
- the Wallace Line
- Eastern Asian - Eastern North American temperate



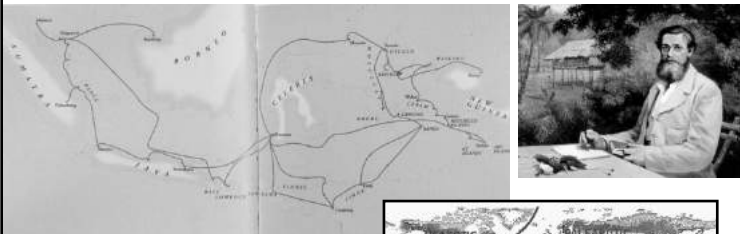
The Wallace Line

Alfred Wallace, one of the premier zoobiogeographers, wrote the definitive treatise “*Distributions of Animals*” in 1876 where he summarized the known distributions and causes of their biogeographical patterns



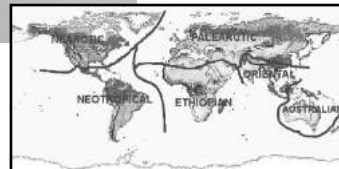
The Wallace Line

Alfred Wallace’s main interest was in the vertebrate fauna of the Indo-Malay Archipelago from Asia to Australia where he clearly saw a sharp faunistic break



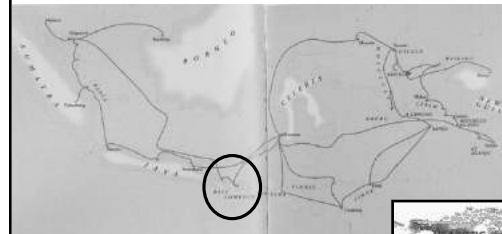
Wallace’s 1854 – 1862 expedition in Indo-Malay (1848-1852 South America with Henry Bates)

Sclater’s & Wallace’s faunistic regions



The Wallace Line

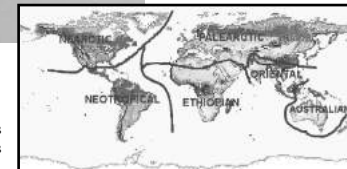
“*In the archipelago . . . there are two distinct faunas rigidly circumscribed, which differ as much as those of South America and Africa, and more than those of Europe and North America*” [Letter to Henry Bates in London (1858)]



Probably his most important trip he ever made was a 6 km ferry ride from Bali to Lombok

Wallace’s 1854 – 1862 expedition in Indo-Malay (1848-1852 South America with Henry Bates)

Sclater’s & Wallace’s faunistic regions



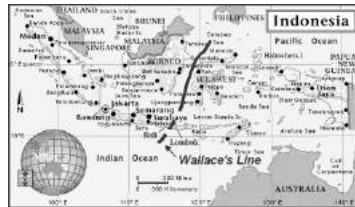
The Wallace Line

"In the 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" [Letter to Henry Bates in London (1858)]

"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"



Looking east from Bali across 6 km Lombok Straits



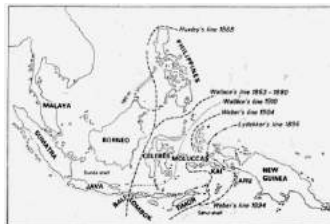
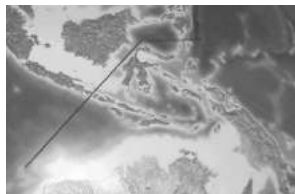
The Wallace Line

Wallace graphically depicts what has since been termed the "Wallace Line" in his book by showing birds and mammals that are found in the Oriental (Borneo, left) and Australian (New Guinea, right) sides



Cover plate from *Distributions of Animals*

The Wallace Line



- Wallace Line — the imaginary line separating the Oriental and Australian biotas — extends between Bali and Lombok and between Borneo/Philippines and Sulawesi
- Several other lines have been proposed in the region based on particular groups of animals or plants.
- Main issue with most lines is what do with Sulawesi (Celebes)

The Wallace Line

Sulawesi, with its mixture of Oriental and Australian fauna, was so perplexing to Wallace, that he vacillated back and forth on where to place the island



Crested black macaque



Bear cuscus (marsupial)



Backbone of Sulawesi

The Wallace Line



The "Wallace Line" biogeographical riddle was elegantly solved with the continental drift theory of Alfred Wegener and the more recent plate tectonic basis as a mechanism for Earth evolution

Earth and Life Evolve Together

The Wallace Line

Now know that the two regions are different continental plates that have been moving independently — the Asian and Australian plates



The IndoMalay - New Guinea Archipelago area includes island groups mostly confined to either of two continental shelves:

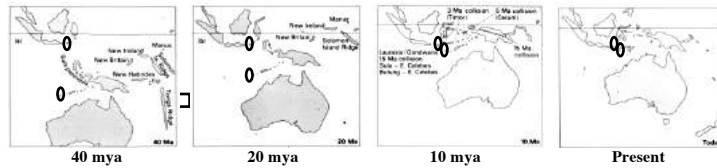
Sunda shelf — Asian

Sahul shelf — Australian

The Wallace Line

Collision of the Australian plate with the Asian plate occurred between 15-5 mya

Note the origins of Bali and Lombok, forming the Wallace Line

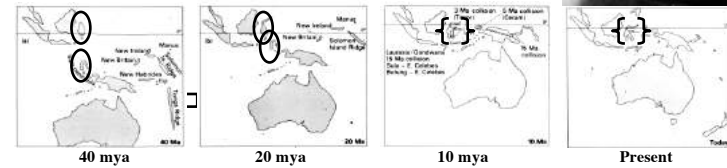


The Wallace Line

Collision of the Australian plate with the Asian plate occurred between 15-5 mya

Note the origins of Bali and Lombok, forming the Wallace Line

Sulawesi is a hybrid island from both plates!



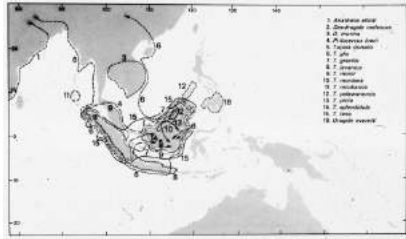
The Wallace Line – is it real?



Tree shrews (family Tupaiidae) were indicated by Wallace as honoring this biogeographical line. An Asian group whose entire range gets as far east as Bali and Borneo but not to Lombok or Sulawesi



Tree shrew family & individual species distributions



The Wallace Line – is it real?

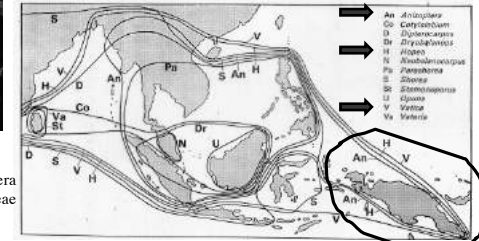


Borneo dipterocarp

Do plants honor the Wallace Line?

All but 3 of the genera of Diptocarpaceae honor the Wallace Line – to New Guinea

Surprising considering the winged fruit in the family is designed for (limited?) dispersal



Distribution of genera of Diptocarpaceae

A Biogeographical and Phylogenetic Analysis of Diptocarpaceae: Do They Honor the Wallace Line?
 Amelia Krug and Kenneth Sysma
 University Of Wisconsin, Department Of Botany
 amelia.krug@gmail.com, kjsysma@wisc.edu

The family Diptocarpaceae (Malvales) is divided into three subfamilies (Dipteroideae, Miconideae, and Pakistimideae) and a geographical distribution. Dipteroideae consists of 23 genera and about 475 species, most of which are found across the eastern range of island forest rain forest in India and Sri Lanka to West Malacca (Culley et al., 1996). All three species radiations directly with the biogeographic boundary of the Wallace Line. However, some genera including *Anisodactylus*, *Hopea*, *Vatica*, *Shorea*, and *Dipterocarpus* have crossed over the boundary of the line (Whitmore 1988, Fig. 2). The goal of this study is to determine whether species crossed over the Wallace Line subsequent to the collision of the Sunda and Sahul Plates 25 Ma, or earlier and over greater oceanic distances.

Materials and Methods
Taxon Sampling: The cpDNA sequences (trnL-trnF and rbcL-rnp) intergenic spacer of 70 species from the subfamily Dipteroideae, including 20 species from the subfamily Miconideae, and 2 winged species were gathered from GenBank and aligned within MEGA4.0.01.0X.8.

Analyses: Dipteroideae trees were estimated using BEAST v2.0 using fixed rates and divergence estimates of Dipteroideae (Meyer 1993), Dipteroideae (Dietrich et al., 2011), Dipteroideae (Kjelson et al., 1997), and Malvales (Dietrich et al., 2011) partitioned into four partitions: trnL-trnF, rbcL, and rnp. Posterior probabilities were calculated using PAST 3.0 on Parsimony and Maximum Likelihood as bootstrap (10,000) estimates.

With four fossil calibrations (Malvales, Dipteroideae, Dipteroideae, and Dipteroideae fossils) the Anisodactylus node was found to have originated 177 million years ago (Ma) (95% CI = 1.93-3.6), the Dipteroideae node was 161 Ma (95% CI = 1.93-3.6), the Shorea node was 161 Ma (95% CI = 1.93-3.6), and the Vatica node was 161 Ma (95% CI = 1.93-3.6). Our results suggest that five geographically widespread species originated before the Sunda and Sahul plates collided 25 Ma. The species which these genera known to have the most widespread distribution include *Anisodactylus*, *Shorea*, and *Dipterocarpus* from an eastern range. The Anisodactylus node was found to have originated in the 95% CI = 1.93-3.6 Ma, while the Dipteroideae node was originated 157 Ma (95% CI = 1.93-3.6). These dates suggest the dipteroideae reaching the Sunda and Sahul plates 25 Ma after the Wallace Line originated 25 Ma after the Sunda and Sahul plates collision.

The shortest distance between the plates after collision is around 20 miles between Bali and Lombok. Most flora and fauna presumably evolved when separated by a sea exceeding 1000 miles and remains drastically different, especially in the Sunda and Sahul areas (Whitmore 1988). The three species that crossed over the Wallace Line most likely did so over shorter distances while their parent species remained in island areas of distribution. For some species, this may not be the case and the parent species may have largely distributed than these recently diverged.

Further research regarding the dispersal capabilities of the dominant two-winged fruit of dipteroideae species and clear study of the topology of large geographically distributed species are needed to clear up discrepancies.

Diptocarpaceae chronogram

3 genera and 8 species make it to New Guinea on Sahul Shelf . . .

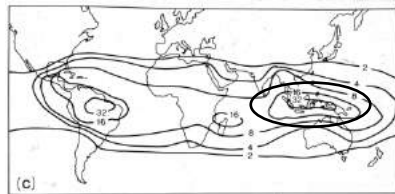
. . . and within last 10 myr – so dipterocarps do honor Wallace’s Line!

The Wallace Line – is it real?



Do palms honor the Wallace Line?

Greatest center of diversity of palms is in the IndoMalay archipelago — how do they respond to the Wallace Line?



The Wallace Line – is it real?

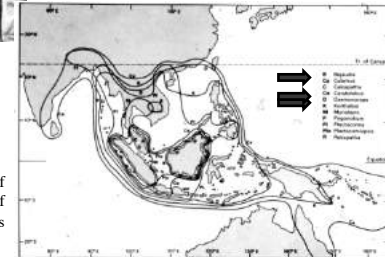


Rattan palm

Rattan palms are essentially Asian with all but 3 genera restricted west of Lombok and Sulawesi

For the 3 genera east of Wallace Line, only 1 species each crosses the line

but timing of these dispersals east are not known



Distribution of different genera of rattan palms

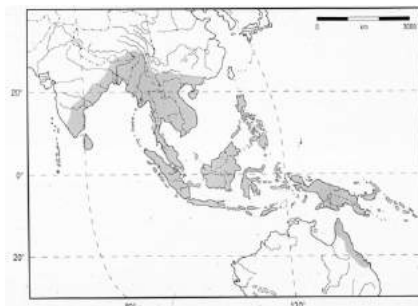
The Wallace Line – is it real?



fishtail palm

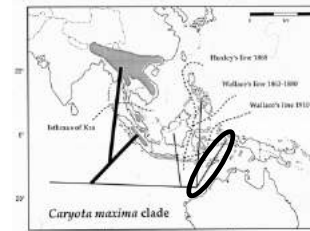
The genus *Caryota* (fishtail palms) is widespread across the IndoMalay - New Guinea region

Does it NOT support the Wallace Line?



Distribution of *Caryota*

The Wallace Line – is it real?



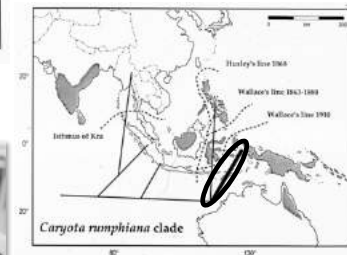
Species relationships within two different groups of fishtail palms and their biogeographical distributions



Bill Hahn

Although fishtail palms appear not to honor the Wallace Line as a genus, only the most recent speciation events in each clade have generated species crossing the line.

Perhaps these occurred after plate contact occurred? – no dates are available yet



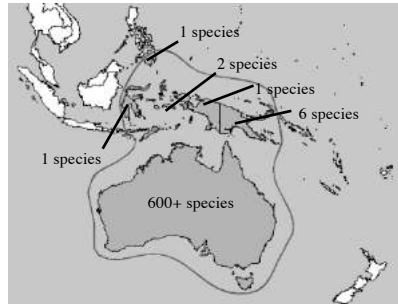
The Wallace Line – is it real?



Gum eucalypt

Eucalyptus (Myrtaceae) is an Australian genus and basically honors the Wallace Line from the east

Date of 4 species in Wallacea not known



Distribution of
Eucalyptus