

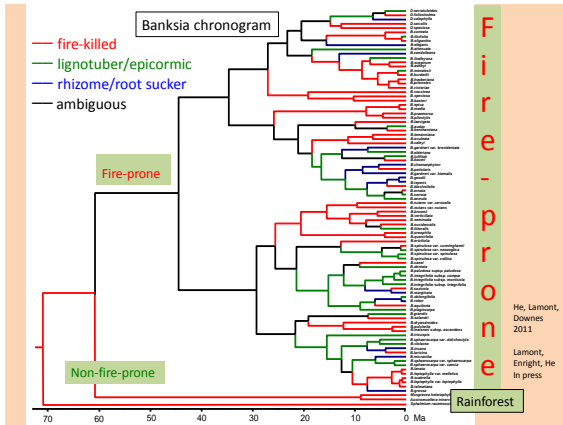
Fire-driven trait evolution great Gondwanan family Proteaceae



Byron Lamont, Tianhua He, Katherine Downes



49/90 banksias killed

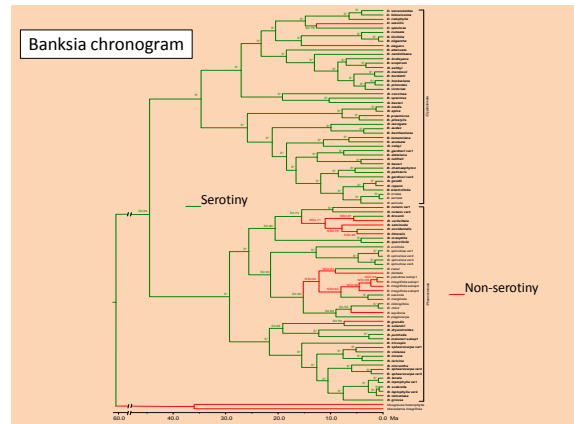
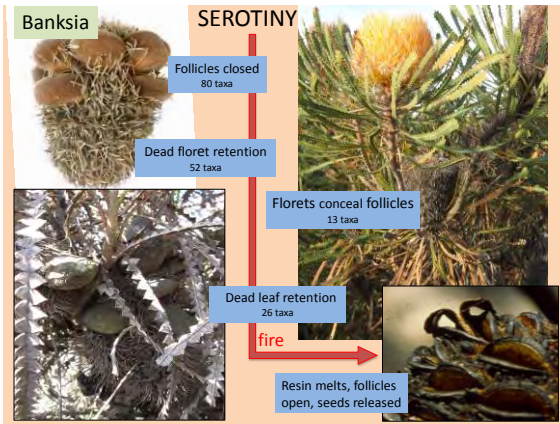


Banksia	Origin	Oldest species	Paleocene /Eocene	Oligocene	Miocene	Pliocene	Quaternary
	Ma	Ma	61-35	34-24	23-5.4	5.3-1.9	1.8-0
Species diversification rate	60.8	19.2	0.07	0.15	0.35	0.10	0.10
Non-clonal:	60.8	19.2	0.07	0.12	0.30	0.11	0.09
Nonsprouter	>26.5	19.2	?	?	1.43	0.13	0.15
Lignotuberous	>21.5	18.6	?	?	?	0.06	0.10
Epicormic	18.6	15.5	—	—	?	0.11	0.00
Clonal	15.6	15.6	—	—	0.41	0.06	0.05

Lamont, Enright, He submitted

Epoch/Period:	Miocene		Pliocene	Quaternary	
Ma	Time of origin	Oldest species	23-5.4	5.3-2.7	2.6-0
Species diversification rate	27.8	14.0	1.93	0.22	0.09
Fire response (Cape proteas only):					
Killed	27.8	14.0	1.14	0.26	0.11
Lignotuberous	18.4	12.1	0.23	0.25	0.04
Rhizomatous	10.6	10.6	0.17	0.46	0.09
Epicormic	4.9	4.9	—	0.19	0.00

Chronogram from Valente et al 2010, traits added by Lamont and Downes, analysed by Tianhua He (unpubl)



	Banksia	Origin	Oldest species	Paleocene / Eocene	Oligocene	Miocene	Pliocene	Quaternary
		Ma	Ma	61-35	34-24	23-5.4	5.3-1.9	1.8-0
Serotiny	Serotinous	60.8	19.2	0.07	0.12	0.34	0.11	0.10
	Non-serotinous	15.5	12.7	—	—	0.28	0.14	0.06
Dead florets	Retained	60.8	19.2	0.07	0.06	0.36	0.14	0.10
	Retained, conical fruits	25.9	12.7	—	0.09	0.17	0.51	0.10
	Shed	23.6	9.1	—	—	0.74	0.16	0.13
Dead leaves	Shed	60.8	19.2	0.07	0.06	0.40	0.11	0.11
	Retained	25.9	8.5	—	0.09	0.34	0.10	0.12

He, Lamont, Downes 2011

Epoch/Period:			Miocene	Pliocene	Quaternary
Ma	Time of origin	Oldest species	23-5.4	5.3-2.7	2.6-0
Serotiny (Cape proteas only)					
Yes	27.8	14.0	1.65	0.27	0.10
No	5.9	3.3	—	0.36	0.00

Lamont, He, Downes unpubl

Conclusions

1. Fire-prone habitats can be traced back to 61 Ma for **Banksia**, 28 Ma for **Protea** and 85 Ma for the entire family **Proteaceae**.
All arose ultimately from rainforest (non-fire-prone) ancestors.
2. Some traits that have fitness benefits in the presence of fire can be traced back to the origin of their clade. Others are more recent in origin:
Banksia: Resprouting via lignotubers > 21.5 Ma, epicormic buds 18.6 Ma, rhizomes/root suckers 15.6 Ma
 Serotiny and dead floret retention 61 Ma (concealing fruits 26 Ma)
 Dead leaf retention 26 Ma.
Protea: Resprouting via lignotubers 28 Ma, rhizomes 10.6 Ma, epicormic buds 5 Ma. Serotiny 28 Ma.
Franklandia → **Mimetes** (SWA, Cape) clade: Soil seed-storage 76 Ma.
Adenanthos → **Mimetes** ((SWA, Cape) clade: Soil-storage with ant-dispersal 44.5 Ma.
Petrophile/Aulax clade (SWA, Cape): Serotiny 73.5 Ma.
3. The evolution of all fire-related traits described here is correlated with the occurrence of fire.
Coupled with their fire-fitness advantages, this makes them **fire adaptations!**