

Supplementary Information, Section S2: Data, sources and code

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Here we document raw data, its sources and the code used to calculate results in the main paper. Data files are archived at <https://doi.org/10.5281/zenodo.5602216>. Code is written in R (R Core Team 2021).

1 Pama-Nyungan laminal contrast typological data

1.1 Discrete variable: presence/absence of contrast

In Section 6.1 we analyse the presence/absence of a binary phonemic laminal contrast in 216 Pama-Nyungan languages. Data is from Round (2019). Languages with the contrast are in (1) and without are in (2). Eight-character glottocodes are cited with the language names.

	Languages
(1)	Adnyamathanha adny1235, Aghu Tharnngala aghu1254, Alngith alng1239, Alyawarr alya1239, Anguthimri angu1242, Antekerrepenhe ande1247, Arabana arab1267, Ayapathu ayab1239, Badimaya badi1246, Bakanh paka1251, Barna biri1256, Bidyara bidy1243, Biri biri1256, Bularnu bula1255, Buwandik bung1264, Darkinyung hawk1239, Dhangu dhan1270, Dharawal thur1254, Dharawala bidy1243, Dharuk sydn1236, Dhay'yi dhal1246, Dhudhuroa dhud1236, Dhurga dhur1239, Diyari dier1241, Djambarrpuynu djam1256, Djapu djap1238, Eastern Arrernte east2379, Eora sydn1236, Flinders Island flin1247, Gamilaraay gami1243, Gangulu gang1268, Garlali kala1380, Gudjal gudj1237, Gugu Badhun gugul1253, Gumatj guma1253, Gundungurra gund1248, Gunggari kung1258, Gunya guny1241, Gupapuyngu gupa1247, Guugu Yimidhirr gugul1255, Guwa guwa1242, Guwamu guwa1243, Ikarranggal ikar1243, Jiwarli djiw1241, Kaantju kanj1260, Kala Kawaw Ya kala1378, Kala Lagaw Ya kala1377, Kalkatungu kalk1246, Kariyarra kari1304, Kaurna kaur1267, Kaytetye kayt1238, Keramin kera1256, Kok Nar kokn1236, Koko Bera gugul1254, Kugu Nganhcara wikn1246, Kukatj guga1239, Kungardutji wong1246, Kungkari kuun1236, Kurnu kula1275, Kurrama kurr1243, Kurtjar gurd1238, Kuugu Ya'u kuuk1238, Linngithigh leni1238, Malkana malg1242, Malthanmungu barr1247, Malyangapa maly1234, Margany marg1253, Martuthunira mart1255, Mayi-Kulan mayk1239, Mayi-Kutuna maya1280, Mayi-Thakurti ngaw1240, Mayi-Yapi mayk1239, Mbabaram mbab1239, Mbiywom mbiy1238, Mirniny mirn1243, Mithaka mith1236, Mpalitjanh mpal1238, Muruwari muru1266, Narrungga naru1238, Ndra'ngith tyan1235, Ngadjunmaya ngad1258, Ngamini ngam1284, Ngarigu ngar1297, Ngarluma ngar1287, Ngawun ngaw1240, Ngayawang uppe1415, Ngiyambaa wang1291, Ngkoth ngko1236, Ngunawal ngun1277, Nhanda nhan1238, Nhangu yann1237, Nhirrpi nhir1234, Nukunu nugu1241, Niyiparli nija1241, Ogh Unyjan kawa1290, Olkol ulku1238, Oykangand oyka1239, Pallanganmiddang pall1243, Panyjima pany1241, Parnkalla bang1339, Payungu bayu1240, Piangil wadi1260, Pirriya pirr1240, Pitta Pitta pitt1247, Punthamara punt1240, Purduna burd1238, Ritharrngu rita1239, Southern Paakintyi wilj1239, Takalak taga1279, Thaayorre thay1249, Thalanyji dhal1245, Tharrkari dhar1247, Thaynakwithi tyan1235, Umpila umpi1239, Umpithamu umbi1243, Uradhi urad1238, Wadikali wadi1261, Walangama wala1263, Wangkangurru wang1290, Wangkayutyuru wang1289, Wangkumara wong1246, Warluwarra warl1256, Warriyanga wari1262, Warrnambool warr1257, Wathawurrung wath1238, Wathi Wathi wadi1260, Watjarri waja1257, Wayilwan wayi1238, Wemba Wemba wemb1241, Western Anmatyerre west2442, Western Arrernte west2441, Western Wakaya waga1260, Wik Mungkan wikm1247, Wiradjuri wira1262, Wirangu wira1265, Woiwurrung woiw1238, Wulguru wulg1239, Yabula-Yabula yabu1234, Yadhaykenu yadh1237, Yalarnga yala1262, Yambina biri1256, Yanda yand1251, Yandruwandha yand1253, Yanyuwa yany1243, Yaraldi narr1259, Yardliyawarra yarl1236, Yarluyandi yarl1238, Yawarrawarra yawa1258, Yindjibarndi yind1247, Yingkarta ying1247, Yinhawangka yinh1234, Yiningay bidy1243, Yinwum yinw1236, Yir Yoront yiry1245, Yitha Yitha lowe1403, Yorta Yorta yort1237, Yuwaalaraay yuwa1242
(2)	Awabakal awab1243, Bilinarra bili1250, Bundjalung yugu1249, Butchulla baty1234, Dharumbal dhar1248, Djabugay dyaa1242, Djabwurung djab1234, Djinang djin1253, Djinba djin1252, Duungidjawa duun1241, Dyirbal dyir1250, Gidabal gida1240, Gumbaynggir kumb1268, Gureng-gureng gure1255, Gurindji guri1247, Guwar guwa1244, Jaru jaru1254, Kaniyang kani1276, Karajarri kara1476, Kartujarra kart1247, Katthang wori1245, Kolakngat cola1237, Kukatja kuka1246, Kuku Yalanji kuku1273, Madhi-Madhi madh1244, Malngin maln1239, Mangala mang1383, Manjiljarra many1256, Minjungbal minj1242, Mudburra mudb1240, Ngaanyatjarra ngaa1240, Nganyaywana ngan1296, Ngardily west2437, Ngarinyman ngar1235, Ngarla ngar1296, Nyamal nyam1271, Nyangumarta nyan1301, Nyawaygi nyaw1247, Pintupi pint1250, Pitjantjatjara pitj1243, Thanggati dyan1250, Turubul yaga1256, Waalubal band1358, Wajuk nyun1247, Waka Waka waka1274, Walmajarri walm1241, Wangkajunga wang1288, Wangkatja pini1245, Wardandi ward1248, Warlmanpa warl1255, Warlpiri warl1254, Warnman wanm1242, Warrgamay warr1255, Warumungu waru1265, Warungu waru1264, Yagara yaga1262, Yaygir yayg1236, Yidiny yidi1250, Yulparija yulp1239

1.2 Continuous variable: predominance of pre-palatal in nine phonotactic positions

In Section 6.2 we analyse the relative predominance of pre-palatals versus dentals in nine phonotactic contexts in 76 Pama-Nyungan languages. The proportions of pre-palatals in the nine contexts is shown below. NA indicates that the lexicon contained fewer than 20 consonantal laminals in the relevant phonotactic context, in which case the language was excluded for that variable.

Variety	Glottocode	V_a	V_i	V_u	a_V	i_V	u_V	#_a	#_i	#_u
Adnyamathanha	adny1235	0.2601	0.5909	0.5217	0.2831	0.4815	0.3538	0.0000	0.0000	0.2400
Anguthimri	angu1242	NA	0.2292	NA	0.1795	NA	NA	0.2727	NA	NA
Badimaya	badi1246	0.7303	NA	NA	0.7761	0.7692	0.5333	0.2791	0.8966	0.4884
Bakanh	paka1251	0.4333	0.8298	NA	0.6667	NA	0.6857	0.0000	NA	0.0000
Bidyara	bidy1243	0.4030	0.4815	0.4400	0.4681	0.3913	0.4082	0.0189	0.0714	0.0682
Biri	biri1256	0.5000	NA	NA	0.3714	0.6000	0.6071	0.0800	NA	NA
Bularnu	bula1255	0.3333	0.9467	0.2308	0.5568	0.8036	0.2632	0.1250	0.9000	0.2000
Dhangu	dhan1270	NA	NA	NA	0.4000	NA	NA	0.3261	0.7436	0.2429
Dhay'yi	dhal1246	0.4677	0.6000	0.7115	0.4189	0.7708	0.6552	0.2883	0.6471	0.3978
Diyari	dier1241	0.2703	0.5000	NA	0.3235	NA	0.5000	0.1481	0.1923	0.2381
Djapu	djap1238	0.3922	0.7000	0.3784	0.2326	0.8615	0.4655	0.4518	0.4237	0.2621
Gamilaraay	gami1243	0.4118	0.3125	0.0645	0.0704	0.8824	0.0476	0.0000	0.0930	0.0000
Gangulu	gang1268	0.2963	NA	NA	0.3182	NA	NA	0.1364	NA	NA
Gugu Badhun	gugu1253	NA	NA	0.2000	0.3636	NA	NA	0.2162	0.7500	0.2174
Gunya	guny1241	0.3077	0.2647	NA	0.2000	0.5417	0.2812	0.0000	0.0857	0.0270
Gupapuyngu	gupa1247	0.4930	0.9355	0.4615	0.4902	0.9730	0.4048	0.3970	0.7422	0.4294
Guugu Yimidhirr	gugu1255	NA	NA	NA	0.1000	NA	NA	NA	NA	NA
Guwamu	guwa1243	0.3404	NA	NA	0.3421	NA	0.2308	0.0244	0.1724	0.0385
Jiwarli	djiw1241	0.6562	0.8108	0.6557	0.7105	0.8125	0.6061	0.4891	0.8750	0.4375
Kalkatungu	kalk1246	0.2811	0.4876	0.5217	0.3684	0.4464	0.3750	0.2986	0.6163	0.4048
Kariyarra	kari1304	0.3016	0.9600	NA	0.6341	0.4054	0.3913	0.3571	0.9130	NA
Kok Nar	kokn1236	0.1739	NA	NA	NA	NA	NA	0.0000	NA	NA
Koko Bera	gugu1254	0.3571	NA	NA	0.3636	0.7391	NA	0.0182	NA	NA
Kugu Nganhcara	wikn1246	NA	NA	NA	0.2857	NA	NA	0.0377	NA	0.0000
Kukatj	guga1239	0.5641	0.7500	NA	0.5455	0.6538	0.4000	0.0308	0.5714	0.1600
Kurrama	kurr1243	0.4627	0.6667	0.4595	0.4444	0.7188	0.3939	0.5072	0.9455	0.5000
Kurtjar	gurd1238	0.2692	0.4688	0.5000	0.4107	NA	0.4000	0.3025	NA	0.3636
Kuugu Ya'u	kuuk1238	0.4444	0.6429	0.5873	0.4672	0.7576	0.5072	0.1774	0.6800	0.3529
Linggithigh	leni1238	0.3500	0.0667	NA	0.2143	0.1389	NA	0.5106	NA	NA
Malkana	malg1242	0.2667	0.9538	NA	0.5818	0.8276	0.2414	0.3333	NA	NA
Malyangapa	maly1234	0.4074	NA	NA	0.4348	NA	NA	0.0000	NA	NA
Margany	marg1253	0.4643	NA	NA	NA	NA	NA	0.0323	0.0417	NA
Martuthunira	mart1255	0.4248	0.8298	0.5326	0.6042	0.5972	0.2973	0.5182	0.9437	0.3494
Mirninny	mirn1243	0.4259	NA	NA	0.4091	NA	NA	0.0870	NA	0.3478
Muruwari	muru1266	0.3409	0.6538	NA	0.3770	0.8750	0.1087	0.0145	0.0566	0.0282
Ngadjumaya	ngad1258	0.9133	1.0000	1.0000	0.9292	0.9737	0.9091	0.9412	1.0000	0.9857
Ngamini	ngam1284	0.7538	0.9167	NA	0.8281	0.8824	NA	NA	NA	NA
Ngarluma	ngar1287	0.4545	0.9412	0.5286	0.5597	0.8158	0.4730	0.3740	0.9857	0.4000
Ngawun	ngaw1240	0.5833	NA	NA	0.5909	NA	0.4500	0.3000	NA	NA
Nhanda	nhan1238	0.7347	0.7778	NA	0.8286	0.9143	0.5200	NA	NA	NA
Nhangu	yann1237	0.2540	1.0000	NA	0.4324	0.7750	0.3438	0.2115	0.8088	0.3370
Nhirrpi	nhir1234	0.3182	NA	NA	NA	NA	NA	NA	NA	NA
Nukunu	nugu1241	0.5435	NA	NA	0.4872	0.7500	NA	0.0435	NA	NA
Ogh Unyjan	kawa1290	0.6364	NA	NA	0.5000	NA	NA	NA	NA	NA
Olkol	ulku1238	0.3768	0.7879	0.5185	0.5507	0.4375	NA	NA	NA	NA
Oykangand	oyka1239	0.4510	0.7692	NA	0.4571	0.5000	0.8333	NA	NA	NA
Panyjima	pany1241	0.4110	1.0000	0.6452	0.5781	0.7500	0.4737	0.5745	0.9091	0.5862
Payungu	bayu1240	0.5360	0.8246	0.5510	0.6211	0.6545	0.5500	0.4352	0.8364	0.4412
Pitta Pitta	pitt1247	0.5200	0.6538	0.6364	0.5091	0.7568	0.5625	0.2653	0.3617	NA
Purduna	burd1238	0.6897	0.7978	0.6410	0.7206	0.8088	0.6556	0.5138	0.8298	0.6809
Ritharrngu	rita1239	0.5833	0.9524	NA	0.5476	1.0000	NA	0.4946	0.8025	0.3585
Southern Paakintyi	wilj1239	0.7180	0.4756	0.4310	0.6082	0.6811	0.5909	0.0076	0.0100	0.0345
Thaayorre	thay1249	0.1739	0.4140	0.1250	0.3981	0.0494	0.0986	0.0059	0.0390	0.0076
Thalanyji	dhal1245	0.5287	0.8810	0.6486	0.6750	0.6389	0.6000	0.5556	0.8750	0.5208
Tharrkari	dhar1247	0.6842	NA	0.7619	0.7500	NA	0.6286	0.4314	0.8065	0.2955

Umpila	umpi1239	0.3981	0.6887	0.7302	0.5115	0.6750	0.6094	0.0833	0.3056	0.3871
Wangkumara	wong1246	0.6824	0.5581	0.4000	0.6308	0.7736	0.2667	0.0159	0.2167	0.1818
Warluwarra	warl1256	0.4156	0.8889	NA	0.4074	0.7045	0.2857	0.2273	0.7727	0.3158
Warriyanga	wari1262	0.6346	0.6970	0.6071	0.6275	0.7000	0.6061	0.4286	0.8182	0.4242
Watjarri	waja1257	0.5238	0.9368	0.7671	0.6500	0.8100	0.6545	0.5169	0.9114	0.6000
Wayilwan	wayi1238	0.4615	0.5625	NA	0.1667	0.9400	0.1739	0.0000	0.0000	0.0488
Wemba Wemba	wemb1241	0.5500	0.6765	0.8889	0.5875	0.7000	0.5745	0.8876	1.0000	0.9459
Western Arrente	west2441	NA	NA	NA	0.4762	1.0000	NA	NA	NA	NA
Western Wakaya	waga1260	0.6140	0.7927	0.5818	0.6316	0.7822	0.5800	0.2000	0.9423	0.3600
Wik Mungkan	wikm1247	0.5722	0.2286	NA	0.2937	0.7818	0.6207	0.0878	0.4744	0.1061
Wirangu	wira1265	0.4889	0.8889	NA	0.6667	0.6970	NA	0.2222	0.9677	0.7667
Yadhaykenu	yadh1237	0.2500	0.3784	0.4186	0.2941	0.2432	0.4182	NA	NA	NA
Yalarnga	yala1262	0.4821	0.6909	0.5769	0.5970	0.6842	0.4375	0.1639	0.3824	0.2759
Yandruwandha	yand1253	0.4921	0.5946	NA	0.4681	0.6207	0.5429	0.1064	0.1818	0.2712
Yanyuwa	yany1243	0.5864	0.9155	0.6081	0.6386	0.9557	0.6063	0.8030	1.0000	0.5467
Yarluyandi	yarl1238	0.4062	0.7407	NA	0.5161	0.4615	NA	0.0000	0.1923	NA
Yindjibarndi	yind1247	0.5833	0.8065	0.6667	0.6508	0.7273	0.6000	0.5000	0.9726	0.3380
Yinhawangka	yinh1234	0.3264	0.8375	0.6392	0.4724	0.5546	0.4000	0.5441	0.9783	0.4878
Yir Yoront	yiry1245	0.1818	NA	NA	0.3200	0.1739	NA	0.0374	0.1132	0.1489
Yorta Yorta	yort1237	0.6875	NA	NA	0.5333	0.8788	0.6364	0.1304	NA	NA
Yuwaalaraay	yuwa1242	0.3780	0.5070	0.2500	0.1348	0.8866	0.0877	0.0000	0.0261	0.0000

1.3 Wordlist sources

The 76 lexical wordlists used in Section 6.2 study are from the Ausphonlex database, under development by Round (2017), also described in Macklin-Cordes, Bower & Round (2021). All underlying wordlist data is available, either publicly in the CHIRILA database (Bower 2016) or elsewhere in published or archived form. A list of original and CHIRILA sources for the wordlists is presented below.

Adnyamathanha CHIRILA/v2/McEnteeMcKenzie

John McEntee & Pearl McKenzie. 1992. *Adna-mat-na English dictionary*. Adelaide: the authors. 125 pp.

Anguthimri CHIRILA/v1/ASEDA0240

Terry Crowley. 1989. Mbakwithi vocabulary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0240. Canberra

Badimaya

Doug Marmion. 1995. Badimaya dictionary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0615. Canberra

Bakanh

Philip J. Hamilton. 1997a. *Pakanh Alphabetical Search Index*. Oykangand and Olkola Dictionary. <http://www.oocities.org/athens/delphi/2970/pakalpha.htm>

Bidyara

Gavan Breen. 1973. *Bidyara and Gungabula grammar and vocabulary*. Vol. 8 (Linguistic Communications). Melbourne: Monash University. 227 pp.

Biri CHIRILA/v1/Terrell

Angela Terrill. 1999. Biri lexicons. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0700. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0700_access.zip

Bularnu

Gavan Breen. 1988. Bularnu grammar and vocabulary machine-readable files. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0007. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0007_access.zip

Dhangu

R. David Zorc. 2004. Yolngu Matha dictionary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0778. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0778_Access.zip

Dhay'yi

Djarayang Wunungmurra. 1993. Dhalwangu dictionary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0502. Canberra

Diyari

Peter K. Austin. 1981. *A grammar of Diyari, South Australia* (Cambridge Studies in Linguistics 32). Cambridge; New York: Cambridge University Press. 269 pp.

Djapu CHIRILA/v1/mor83

Frances Morphy. 1983. Djapu, a Yolngu dialect. In R. M. W. Dixon & Barry Blake (eds.), *Handbook of Australian languages*, vol. 3, 5 vols., 1–188. Amsterdam: John Benjamins

Gamilaraay CHIRILA/v1/ash03

Anna Ash, John Giacon & Amanda Lissarrague. 2003. *Gamilaraay, Yuwaalaraay & Yuwaalayaay dictionary*. Alice Springs, NT, Australia: IAD Press. 344 pp.

Gangulu CHIRILA/v1/Terrell

Angela Terrill. 1999. Biri lexicons. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0700. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0700_access.zip

Gugu Badhun CHIRILA/v1/sut73

Peter J. Sutton. 1973. Gugu-Badhun and its neighbours. In *Gugu-Badhun and its neighbours: a linguistic salvage study*, 24–67. Sydney: Macquarie University

Gunya CHIRILA/v1/dixbla81

Gavan Breen. 1981a. Margany and Gunya. In R. M. W. Dixon & Barry Blake (eds.), *Handbook of Australian languages*, vol. 2, 275–394. Amsterdam: John Benjamins

Gupapuyngu CHIRILA/v1/BL

Beulah Lowe & Beulah Lowe. 1976. Temporary Gupapuyngu dictionary. Milingimbi, NT, Australia

Guugu Yimidhirr

John B. Haviland. 1979. Guugu Yimidhirr. In R. M. W. Dixon & Barry Blake (eds.), *Handbook of Australian languages*, vol. 1, 5 vols., 26–180. Amsterdam: John Benjamins

Guwamu CHIRILA/v1/Austin 1980

Peter K. Austin. 1980. Guwamu vocabulary and English-Guwamu finder list. Cambridge, MA

Jiwarli CHIRILA/v2/ASEDA0435

Peter K. Austin. N.d.(a). A dictionary of Jiwarli. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0435. Canberra

Kalkatungu CHIRILA/v2/ASEDA0205

Barry J. Blake. 1990a. Kalkatungu vocabulary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0205. Canberra

Kariyarra

Sue Smythe & Manny Lockyer. N.d. Kariyarra wordlist. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0582. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0582_access.zip

Kok Nar

Bruce A. Sommer. N.d.(a). Koko Narr. Fryer Library Bruce Sommer Collection. UQFL476_b10f03_64, UQFL476_b10f03_65. Brisbane

Koko Bera

Paul D. Black & Kokoberrin Tribal Aboriginal Corporation. 2007. The Kokoberrin and their languages. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection

Kugu Nganhcara CHIRILA/v1/ASEDA0021

Ian Smith & Steve Johnson. 1989. Kugu Nganchara. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0021. Canberra

Kukatj

Gavan Breen. 1991. Kukatj grammar machine-readable files. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0022. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0022_access.zip

Kurrama

Alan C. Dench. N.d. Kurrama. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0481. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0481_access.zip

Kurtjar CHIRILA/v1/ASEDA0026

Paul D. Black & Rolly Gilbert. 1988. Kurtjar dictionary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0026. Canberra

Kuugu Yau

David A. Thompson. 1988. "sand beach" language: an outline of Kuuku Ya'u and Umpila. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0027. Canberra

Linggithigh

Kenneth Hale. 1999. A Linggithigh vocabulary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0687. Canberra

Malkana

Andrew Gargett. 2011. *A salvage grammar of Malgana, the language of Shark Bay, Western Australia* (Pacific Linguistics 624). Canberra: Pacific Linguistics. 102 pp. <https://doi.org/10.15144/PL-624>

Malyangapa

Luise A. Hercus. 1989. Maljangapa-Wadigali vocabulary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0246. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0246_access.zip

Margany CHIRILA/v1/bre81

Gavan Breen. 1981a. Margany and Gunya. In R. M. W. Dixon & Barry Blake (eds.), *Handbook of Australian languages*, vol. 2, 275–394. Amsterdam: John Benjamins

Martuthunira

Alan C. Dench. 1995. *Martuthunira, a language of the Pilbara region of Western Australia* (Pacific Linguistics Series C 125). Canberra: Pacific Linguistics. 406 pp. <https://doi.org/10.15144/PL-C125>

Mbakwithi CHIRILA/v1/ASEDA0240

Terry Crowley. 1989. Mbakwithi vocabulary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0240. Canberra

Mirniny

Geoffrey N. O'Grady & Edward M. Curr. 1988. Mirniny wordlist. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0070. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0070_access.zip

Muruwari CHIRILA/v1/ASEDA0252

Lynette Frances Oates. 1992. *Muruwari (Moo-roo-warri) dictionary: Words of an Aboriginal language of north-western New South Wales*. Albury, NSW, Australia: Graeme van Brummelen, produced with the assistance of the Australian Institute of Aboriginal & Torres Strait Islander Studies. 97 pp.

Ngadjunmaya

Wangka Maya Pilbara Aboriginal Language Centre. 2008. *Ngajumaya dictionary*. South Hedland, WA, Australia: Wangka Maya Pilbara Aboriginal Language Centre. 16 pp.

Ngamini CHIRILA/v1/brendn

Gavan Breen. 1967. Ngamini material. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. MS 117. Canberra

Ngarluma

Kenneth Hale. 1989. Ngarluma wordlist. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0037. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0037_access.zip

Ngawun CHIRILA/v2/BreenMayi

Gavan Breen. 1981b. *The Mayi languages of the Queensland Gulf Country* (A.I.A.S. New Series 29). Canberra: Australian Institute of Aboriginal Studies. 238 pp.

Nhanda CHIRILA/v1/ble01

Juliette Blevins. 2001. *Nhanda: An Aboriginal language of Western Australia* (Oceanic linguistics special publication 30). Honolulu: University of Hawai'i Press. 170 pp.

Nhirrpi CHIRILA/v1/bow-nhi

Claire Bowern. 1999. Nhirrpi vocabulary, based on fieldnotes of S. A. Wurm

Nukunu CHIRILA/v2/her92

Luise A. Hercus. 1992a. *A Nukunu dictionary*. Canberra: Department of Linguistics, Australian National University. 51 pp.

Ogh Unyjan

Bruce A. Sommer. N.d.(b). Ogh Unydjan. Fryer Library Bruce Sommer Collection. UQFL476_b09f03_s05. Brisbane

Olkol

Philip J. Hamilton. 1997b. *Uw Olkola and Uw Oykangand Alphabetical Search Index*. Oykangand and Olkola Multimedia Dictionary. <http://www.oocities.org/athens/delphi/2970/olkola.htm>

Oykangand

Philip J. Hamilton. 1997b. *Uw Olkola and Uw Oykangand Alphabetical Search Index*. Oykangand and Olkola Multimedia Dictionary. <http://www.oocities.org/athens/delphi/2970/olkola.htm>

Panyjima

Alan C. Dench. 1991. Panyjima. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0375. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0375_access.zip

Payungu CHIRILA/v1/ASEDA0394

Peter K. Austin. N.d.(d). Payungu - English dictionary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0394. Canberra

PittaPitta CHIRILA/v1/bla0275

Barry J. Blake. 1990b. Pitta Pitta wordlist. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0275. Canberra

Purduna

Albert Burgman. 2007. *Burduna dictionary: English-Burduna wordlist and thematic wordlist*. In collab. with Wangka Maya Pilbara Aboriginal Language Centre. South Hedland, WA, Australia: Wangka Maya Pilbara Aboriginal Language Centre. 86 pp.

Ritharrngu CHIRILA/v1/Heath

Jeffrey Heath. 1976. Ritharrngu. In R. M. W. Dixon (ed.), *Grammatical categories in Australian languages* (Linguistic series 22), 285–287. Canberra: Australian Institute of Aboriginal Studies

Southern Paakintyi

Luise A. Hercus. N.d.(a). Paakintyi dictionary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0525. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0525_access.zip

Thaayorre

Tom Foote & Allen Hall. 1993. *Kuuk Thaayorre dictionary: Thaayorre/English ; september, 1966-92*. Brisbane: Jolien Press. 239 pp.

Thalanyji CHIRILA/v2/ASEDA0437

Peter K. Austin. N.d.(b). A dictionary of Thalanyji. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0437. Canberra

Tharrkari

Peter K. Austin. 1992. *A dictionary of Tharrgari, Western Australia*. Bundoora, Victoria, Australia: La Trobe University. 60 pp.

Umpila

Geoffrey N. O'Grady. 1988. Umpila wordlist. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0094. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0094_access.zip

Wangkumara CHIRILA/v1/robnd

Carol Robertson. 1985. *Wangkumara grammar and dictionary*. Sydney: Department of Technical & Further Education, Aboriginal Education Unit. 90 pp.

Warluwarra

Gavan Breen. 1990. Warluwara grammar and wordlist. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0253. Canberra

Warriyangga

Peter K. Austin. N.d.(c). A dictionary of Warriyangka. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASED A 0439. Canberra

Watjarri

Doreen Mackman (ed.). 2012. *Wajarri dictionary: The language of the Murchison Region of Western Australia*. In collab. with Irra Wangga Language Centre & Yamaji Language Aboriginal Corporation. Geraldton, WA, Australia: Irra Wangga Language Centre. 249 pp. <http://www.bundiyarra.com.au/wajarriApp/> (23 July, 2018)

Wayilwan CHIRILA/v2/Wail-lex

John Giacon. N.d. Wailwan wordlist, from recordings by Janet Matthews. Canberra

Wemba Wemba

Luise A. Hercus. 1992b. *Wembawemba dictionary*. Canberra: L.A. Hercus. 116 pp.

Western Arrernte

Gavan Breen. 2000. *Introductory dictionary of Western Arrernte*. In collab. with John Pfitzner. Alice Springs, NT, Australia: IAD Press. 120 pp.

Wik Mungkan

Christine Kilham et al. 2011. *Wik Mungkan-English Interactive Dictionary*. AuSIL Interactive Dictionary Series A-6. In collab. with Charles E. Grimes & Maarten Lecompte. <http://ausil.org/Dictionary/Wik-Mungkan/lexicon/mainintro.htm> (26 July, 2018)

Wirangu

Luise A. Hercus. 1999. *A grammar of the Wirangu language from the West Coast of South Australia* (Pacific Linguistics Series C 150). Canberra: Pacific Linguistics. 239 pp. <https://doi.org/10.15144/PL-C150>

Yadhaykenu

Terry Crowley. 1983. Uradhi. In R. M. W. Dixon & Barry J. Blake (eds.), *Handbook of Australian languages*, vol. 3, 5 vols., 307–428. Amsterdam: John Benjamins

Yalarnnga CHIRILA/v1/ASEDA0204

Gavan Breen & Barry J Blake. N.d. Yalarnnga vocab. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0204. Canberra

Yandruwandha

CHIRILA source: CHIRILA/v1/breyandr

Gavan Breen. 2004. *Innamincka talk: A grammar of the Innamincka dialect of Yandruwandha with notes on other dialects* (Pacific Linguistics 558). Canberra: Pacific Linguistics. 245 pp. <https://doi.org/10.15144/PL-558>

Yanyuwa

John Bradley. N.d. Yanyuwa dictionary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0382. Canberra

Yarluyandi CHIRILA/v1/ASEDA0251

Luise A. Hercus. N.d.(b). Yarluyandi vocabulary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0251. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0251_access.zip

Yindjibarndi

Bruce Anderson, E. Richards & Summer Institute of Linguistics. N.d. Yindjibarndi dictionary. Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Indigenous Languages Collection. ASEDA 0297. Canberra. http://aiatsis.gov.au/sites/default/files/catalogue_resources/0297_access.zip

Yinhawangka

Wangka Maya Pilbara Aboriginal Language Centre. 2008. *Yinhawangka dictionary: English-Yinhawangka wordlist and topical wordlists 2008: draft 1*. South Hedland, WA, Australia: Wangka Maya Pilbara Aboriginal Language Centre. 92 pp.

Yir Yoront

Barry Alpher. 1991. *Yir-Yoront lexicon: Sketch and dictionary of an Australian language*. Vol. 6 (Trends in Linguistics: Documentation). Berlin, New York: Mouton de Gruyter

YortaYorta CHIRILA/v1/bowmor99

Heather Bowe & Stephen Morey. 1999. *The Yorta Yorta (Bangerang) language of the Murray Goulburn including Yabula Yabula* (Pacific Linguistics Series C 154). Canberra: Pacific Linguistics. 286 pp.

Yuwaalaraay

CHIRILA source: CHIRILA/v1/ash03

Anna Ash, John Giacon & Amanda Lissarrague. 2003. *Gamilaraay, Yuwaalaraay & Yuwaalayaay dictionary*. Alice Springs, NT, Australia: IAD Press. 344 pp.

2 Pama-Nyungan phylogenetic data

2.1 Reference phylogeny

Quantifying phylogenetic signal requires a reference phylogeny, and to account for phylogenetic uncertainty, a set of trees can be used (see Section 4 of the main paper). In Section 6, our reference phylogeny is a set of 100 Pama-Nyungan phylogenies with 285-tips from Bownen (2015). The tree file is available at <https://doi.org/10.5281/zenodo.5602216>. For more detail on the inference of the tree, see Macklin-Cordes, Bownen & Round (2021). The following table matches the language varieties analysed in Section 6 to the tip labels in the tree.

Variety	Glottocode	Tip label
Adnyamathanha	adny1235	Adnyamathanha
Aghu Tharrnggala	aghu1254	AghuTharrnggala
Alngith	alng1239	Alngith
Alyawarr	alya1239	Alyawarr
Anguthimri	angu1242	Mbakwithi
Antekerrepenhe	ande1247	Antekerrepenhe
Arabana	arab1267	Arabana
Awabakal	awab1243	Awabakal
Ayapathu	ayab1239	Ayapathu
Badimaya	badi1246	Badimaya
Bakanh	paka1251	Pakanh
Barna	biri1256	Barna
Bidyara	bidy1243	BidyaraGungabula
Bilinearra	bili1250	Bilinearra
Biri	biri1256	Biri
Bularnu	bula1255	Bularnu
Bundjalung	yugu1249	Yugambeh
Butchulla	baty1234	Batyala
Buwandik	bung1264	Bunganditj
Darkinyung	hawk1239	Darkinyung
Dhangu	dhan1270	Dhangu
Dharawal	thur1254	Dharawal
Dharawala	bidy1243	Dharawala
Dharuk	sydn1236	Dharuk
Dharumbal	dhar1248	Dharumbal
Dhay'yi	dhal1246	Dhayyi
Dhudhuroa	dhud1236	Dhudhuroa
Dhurga	dhur1239	Dhurga
Diyari	dier1241	Diyari
Djabugay	dyaa1242	Djabugay
Djabwurrung	djab1234	Tjapwurrung
Djambarrpuynu	djam1256	Djambarrpuynu
Djapu	djap1238	Djapu
Djinang	djin1253	Djinang
Djinba	djin1252	Djinba
Duungidjawa	duun1241	Duungidjawa
Dyirbal	dyir1250	Dyirbal
Eastern Arrernte	east2379	EasternArrernte
Eora	sydn1236	Iyora
Flinders Island	flin1247	FlindersIsland
Gamilaraay	gami1243	Gamilaraay
Gangulu	gang1268	Gangulu
Garlali	kala1380	Garlali
Gidabal	gida1240	Githabul
Gudjal	gudj1237	Gudjal

Gugu Badhun	gugu1253	GuguBadhun
Gumatj	guma1253	Gumatj
Gumbaynggir	kumb1268	Gumbaynggir
Gundungurra	gund1248	Gundungurra
Gunggari	kung1258	Gunggari
Gunya	guny1241	Gunya
Gupapuyngu	gupa1247	Gupapuyngu
Gureng-gureng	gure1255	GoorengGooreng
Gurindji	guri1247	Gurindji
Guugu Yimidhirr	gugu1255	GuuguYimidhirr
Guwa	guwa1242	Guwa
Guwamu	guwa1243	Guwamu
Guwar	guwa1244	Guwar
Ikarranggal	ikar1243	Ikarranggal
Jaru	jaru1254	Jaru
Jiwarli	djiw1241	Jiwarli
Kaantju	kanj1260	Kaanju
Kala Kawaw Ya	kala1378	KKY
Kala Lagaw Ya	kala1377	KLY
Kalkatungu	kalk1246	Kalkatungu
Kaniyang	kani1276	Kaniyang
Karajarri	kara1476	Karajarri
Kariyarra	kari1304	Kariyarra
Kartujarra	kart1247	Kartujarra
Katthang	wori1245	Katthang
Kaurna	kaur1267	Kaurna
Kaytetye	kayt1238	Kaytetye
Keramin	keram1256	Keramin
Kok Nar	kokn1236	KokNar
Koko Bera	gugu1254	KokoBera
Kolakngat	cola1237	Colac
Kugu Nganhcara	wikn1246	KuguNganhcara
Kukatj	guga1239	Kukatj
Kukatja	kuka1246	Kukatja
Kuku Yalanji	kuku1273	KukuYalanji
Kungardutji	wong1246	Kungadutyi
Kungkari	kuun1236	Kungkari
Kurnu	kula1275	Kurnu
Kurrama	kurr1243	Kurrama
Kurtjar	gurd1238	Kurtjar
Kuugu Ya'u	kuuk1238	KuukuYau
Linngithigh	leni1238	Linngithigh
Madhi-Madhi	madh1244	MathiMathi
Malkana	malg1242	Malgana
Malngin	maln1239	Malngin
Malthanmungu	barr1247	BarrowPoint
Malyangapa	maly1234	Malyangapa
Mangala	mang1383	MangalaMcK
Manjiljarra	many1256	Manjiljarra
Margany	marg1253	Margany
Martuthunira	mart1255	Martuthunira
Mayi-Kulan	mayk1239	MayiKulan
Mayi-Kutuna	maya1280	MayiKutuna
Mayi-Thakurti	ngaw1240	MayiThakurti
Mayi-Yapi	mayk1239	MayiYapi
Mbabaram	mbab1239	Mbabaram

Mbiywom	mbiy1238	Mbiywom
Minjungbal	minj1242	Minjungbal
Mirniny	mirn1243	Mirniny
Mithaka	mith1236	Mithaka
Mpalitjanh	mpal1238	Mpalityan
Mudburra	mudb1240	Mudburra
Muruwari	mur1266	Muruwari
Narrungga	nar1238	Narrungga
Ndra'ngith	tyan1235	Ntrangith
Ngaanyatjarra	ngaa1240	Ngaanyatjarra
Ngadjumaya	ngad1258	Ngadjumaya
Ngamini	ngam1284	Ngamini
Nganyaywana	ngan1296	Nganyaywana
Ngardily	west2437	Ngardily
Ngarigu	ngar1297	Ngarigu
Ngarinyman	ngar1235	Ngarinyman
Ngarla	ngar1296	Ngarla
Ngarluma	ngar1287	Ngarluma
Ngawun	ngaw1240	Ngawun
Ngayawang	uppe1415	Ngaiawang
Ngiyambaa	wang1291	Ngiyambaa
Ngkoth	ngko1236	Nggoth
Ngunawal	ngun1277	Ngunawal
Nhanda	nhan1238	Nhanta
Nhangu	yann1237	Yannhangu
Nhirrpi	nhir1234	Nhirrpi
Nukunu	nugu1241	Nukunu
Nyamal	nyam1271	Nyamal
Nyangumarta	nyan1301	Nyangumarta
Nyawaygi	nyaw1247	Nyawaygi
Nyiyaparli	nija1241	Nyiyaparli
Ogh Unyjan	kawa1290	Kunjen
Olkol	ulku1238	Olkola
Oykangand	oyka1239	UwOykangand
Pallanganmiddang	pall1243	Pallanganmiddang
Panyjima	pany1241	Panyjima
Parnkalla	bang1339	Parnkala
Payungu	bayu1240	Payungu
Piangil	wadi1260	Piangil
Pintupi	pint1250	PintupiLuritja
Pirriya	pirr1240	Pirriya
Pitjantjatjara	pitj1243	Pitjantjatjara
Pitta Pitta	pitt1247	PittaPitta
Punthamara	punt1240	Punthamara
Purduna	burd1238	Purduna
Ritharrngu	rita1239	Ritharrngu
Southern Paakintyi	wilj1239	Paakantyi
Takalak	taga1279	Tagalag
Thaayorre	thay1249	KuukThaayorre
Thalanyji	dhal1245	Thalanyji
Thanggati	dyan1250	Thanggatti
Tharrkari	dhar1247	Tharrgari
Thaynakwithi	tyan1235	Thaynakwith
Turubul	yaga1256	Durubul
Umpila	umpi1239	Umpila
Umpithamu	umbi1243	Umpithamu

Uradhi	urad1238	Uradhi
Waalubal	band1358	Bandjalang
Wadikali	wadi1261	Wadikali
Wajuk	nyun1247	Watjuk
Waka Waka	waka1274	WakaWaka
Walangama	wala1263	Walangama
Walmajarri	walm1241	WalmajarriHR
Wangkajunga	wang1288	Wangkajunga
Wangkangurru	wang1290	Wangkangurru
Wangkatja	pini1245	Wangkatja
Wangkayutyuru	wang1289	Wangkayutyuru
Wangkumara	wong1246	Wangkumara
Wardandi	ward1248	Wardandi
Warlmanpa	war1255	Warlmanpa
Warlpiri	war1254	Warlpiri
Warluwarra	war1256	Warluwarra
Warnman	wanm1242	Warnman
Warrgamay	warr1255	Wargamay
Warriangga	wari1262	Warriangga
Warrnambool	warr1257	Warrnambool
Warumungu	waru1265	Warumungu
Warungu	waru1264	Warungu
Wathawurrung	wath1238	Wathawurrung
Wathi Wathi	wadi1260	Wathiwathi
Watjarri	waja1257	Wajarri
Wayilwan	wayi1238	Wailwan
Wemba Wemba	wemb1241	WembaWemba
Western Anmatyerre	west2442	CentralAnmatyerr
Western Arrente	west2441	WesternArrarnta
Western Wakaya	waga1260	Wakaya
Wik Mungkan	wikm1247	WikMungkan
Wiradjuri	wira1262	Wiradjuri
Wirangu	wira1265	Wirangu
Woiwurrung	woiw1238	Woiwurrung
Wulguru	wulg1239	Wulguru
Yabula-Yabula	yabu1234	YabulaYabula
Yadhaykenu	yadh1237	Yadhaykenu
Yagara	yaga1262	Yagara
Yalarnnga	yala1262	Yalarnnga
Yambina	biri1256	Yambina
Yanda	yand1251	Yanda
Yandruwandha	yand1253	Yandruwandha
Yanyuwa	yany1243	Yanyuwa
Yaraldi	narr1259	Ngarrindjeri
Yardliyawarra	yar1236	Yardliyawarra
Yarluyandi	yar1238	Yarluyandi
Yawarrawarrka	yawa1258	Yawarrawarrka
Yaygir	yayg1236	Yaygirr
Yidiny	yidi1250	Yidiny
Yindjibarndi	yind1247	Yindjibarndi
Yingkarta	ying1247	Yingkarta
Yinhawangka	yinh1234	Yinhawangka
Yiningay	bidy1243	Yiningay
Yinwum	yinw1236	Yinwum
Yir Yoront	yiry1245	YirYoront
Yitha Yitha	lowe1403	YithaYitha

Yorta Yorta	yort1237	YortaYorta
Yulparija	yulp1239	Yulparija
Yuwaalaraay	yuwa1242	Yuwaalaraay

3 Data files

Data files are archived at <https://doi.org/10.5281/zenodo.5602216>, in the following directory structure:

- **data**
 - `laminals_binary.csv` a file in CSV format of languages and the presence/absence of the laminal contrast.
 - `laminals_continuous.csv` a file in CSV format of languages and continuous phonotactic variable data.
 - `PN_100_tree_sample.trees` a file in Newick format containing the Pama-Nyungan tree sample.
- **results**
 - `D_results.csv` a file in CSV format of D test results (cf Section 6.1).
 - `K_results.csv` a file in CSV format of K test results (cf Section 6.2).
 - `PamaNyungan_ACL_proportions.csv` a file in CSV format of genealogically-weighted proportions (cf Section 6.3).
 - `PamaNyungan_BM_proportions.csv` a file in CSV format of genealogically-weighted proportions (cf Section 6.3).

4 Code

The following code in R was used to calculate results. For further information about the package PhyloWeights, see section S1.

```
# Load packages
# Any missing packages can be installed with the following command:
# install.packages("packagename")
library(caper)
library(ape)
library(dplyr)
library(stringr)
library(phangorn)
library(phytools)
library(zen4R)

# Uncomment below to install phyloWeights, if it is not already installed:
# devtools::install_github("erichround/phyloWeights")
library(phyloWeights)

# Download and unzip data from Zenodo
download_zenodo("10.5281/zenodo.5602216")
unzip("Supplementary_data.zip")
setwd("Supplementary_data")

# Note that the Zenodo repository already contains original results files.
# Uncomment below to empty the results folder (ready for new output) if desired.
# file.remove(list.files("results/", full.names = TRUE))

# Read the tree sample
PN_sample <- read.tree("data/PN_100_tree_sample.trees")

#####
# D TEST
#####

# Read the data
laminals_binary <-
  read.csv("data/laminals_binary.csv",
           stringsAsFactors = FALSE)

# Create data dataframe
df <- laminals_binary %>%
  dplyr::select(tip_label, laminal_contrast)

# Plot data
mcc_tree <- phangorn::maxCladeCred(PN_sample) %>% keep.tip(df$tip_label)
tip_order <- match(mcc_tree$tip.label, df$tip_label)
tip_val <- df$laminal_contrast[tip_order]
plot(mcc_tree, type = "fan", open.angle = 160, rotate.tree = -9,
     edge.color = "grey50", show.tip.label = FALSE)
tiplabels(pch = 19 - tip_val * 18, col = "grey30", cex = 0.9, offset = 100)

# Set seed for reproducibility of stochastic processes
set.seed(1)
```

```

# Results dataframe with one row per tree
lapply(1:100,
  function(i){
    # Create caper comparative data object
    cd <- comparative.data(phy = PN_sample[[i]],
                          data = df,
                          names.col = tip_label)

    # Perform D test
    d <- phylo.d(cd,
                 binvar = laminal_contrast,
                 names.col = tip_label)

    cat(i, "")

    # Output results as one-row dataframe
    data.frame(phy = i,
               D = d$DEstimate,
               pval_random = d$Pval1,
               pval_brownian = d$Pval0)
  }
) %>%
bind_rows() %>%
write.csv(
  "results/D_results.csv", row.names = FALSE)

#####
# K TEST
#####

# Read the data
laminals_continuous <-
  read.csv("data/laminals_continuous.csv",
           stringsAsFactors = FALSE)

# Set seed for reproducibility of stochastic processes
set.seed(1)

# Create a list of data dataframes, each with
# the number of observations (n) and proportion
# pre-palatal (p) for one variable, plus
# the tip labels
n_vars <- (ncol(laminals_continuous) - 3) / 2
kdat_list <-
  lapply(1:n_vars,
    function(i) {
      # Select the needed columns
      df <- laminals_continuous %>%
        dplyr::select(tip_label, i*2 + 2, i*2 + 3)
      colnames(df)[2:3] <- c("n", "p")
      # Keep only languages with at least
      # 20 observations
    }
  )

```

```

        df <- filter(df, n >= 20)
      })
variable_names <-
  colnames(laminals_continuous)[(1:n_vars)*2 + 3] %>%
  str_sub(3) %>%
  str_replace("\\.", "#")

# Results dataframe with one row per
# tree/variable combination
lapply(
  1:100,
  function(i) {
    # Results dataframe for one tree,
    # with one row per variable
    lapply(
      1:n_vars,
      function(j) {
        if (j==1) { cat(i, "") }
        dat <- kdat_list[[j]]$p
        names(dat) <- tips <-
          kdat_list[[j]]$tip_label

        # Perform K test, including test for
        # significant phylogenetic signal
        k <- phylosig(
          tree = PN_sample[[i]] %>% keep.tip(tips),
          x = dat, test = TRUE)

        # Output results as one-row dataframe
        data.frame(
          phy = i,
          variable = variable_names[j],
          K = k$K,
          pval = k$P,
          n_lang = length(dat),
          mean_n = mean(kdat_list[[j]]$n))
      }) %>%
      bind_rows()
    }) %>%
    bind_rows() %>%
    mutate(
      context = str_extract(variable, "[CV#]_|_[CV]"),
      neighbour_V = str_extract(variable, "[aiu]")
    ) %>%
    write.csv("results/K_results.csv",
              row.names = FALSE)

#####
# Genealogically-weighted proportions
#####

# Read the typological data

```

```

dat <-
  read.csv("data/laminals_binary.csv", stringsAsFactors = FALSE) %>%
  mutate(has_contrast = 1 * laminal_contrast) %>%
  select(tip = tip_label, has_contrast)

# Remove unused languages from trees
PN_sample_pruned <- PN_sample
for (i in 1:length(PN_sample_pruned)) {
  PN_sample_pruned[[i]] <- PN_sample_pruned[[i]] %>% keep.tip(dat$tip)
}

# Get genealogically-weighted proportions
phy_ave <- phylo_average(phy = PN_sample_pruned, data = dat)

# Write to file
write.csv(
  phy_ave$ACL_averages,
  "results/PamaNyungan_ACL_proportions.csv",
  row.names = FALSE)
write.csv(
  phy_ave$BM_averages,
  "results/PamaNyungan_BM_proportions.csv",
  row.names = FALSE)

```

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