Melanesia holds the world's most diverse and intact insular amphibian fauna

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Supplementary Methods and Results

Estimating the 'species diversity deficient'

Summary data on both named species and candidate species richness indicated that Papua New Guinea has far more taxa than the western (Indonesian) part of New Guinea. To produce coarse estimates of the extent to which this disparity may be due to underestimation of species diversity in the Indonesian parts of New Guinea due to lack of survey, we extrapolated patterns and trends from better-known Papua New Guinea. First, we calculated ratios of area against numbers of a) recognised, b) candidate and c) the combined total of recognised and candidate species for Papua New Guinea. These area-based ratios were then used to generate a suite of estimates for the likely total species diversity in the combined region of Papua and West Papua Provinces in Indonesia. We then generated estimates of the potential numbers of overlooked endemic species in Indonesia (i.e. predicted number of endemic species minus recognised endemics) under assumptions of 80% and 70% endemism. These percentages of endemism approximate levels of endemism for the two regions based on known taxa (80-82%, see Table S2), and a more conservative 70% based on the premise that further survey will show that some known species occur across international borders.

For calculating land area in Papua New Guinea we excluded the islands of eastern Melanesia, which have a distinctive and largely unique biota, giving a land area of 405,788km^2. The number of recognised species in this area is 335. The land area to species ratio is 1 species per 1211 km^2. For the land area of Indonesia we included Papua and West Papua, but excluded Maluku with its seemingly depauperate insular biota, giving a total land area of 415170 km^2.

These estimates are admittedly coarse, but in all cases suggest the Indonesian species diversity is likely double the current known number of species, and may include between 68–190 as yet unrecognised species that are not in our list of candidate species (Table S2).

Supplementary Table 1: Summary of the generic allocation of candidate frog species from Melanesia known to the authors of this work.

Genus	Est. # candidate species
Austrochaperina	5
Barygenys	2
Callulops	3
Choerophryne	18
Cophixalus	9
Copiula	9
Cornufer	9
Hylophorbus	15
Litoria	47
Mantophryne	2
Nyctimystes	10
Oreophryne	28
Paedophryne	1
Papurana	29
Sphenophryne	1
Xenorhina	5
Total	193

Supplementary Table 2. Estimates of frog species diversity in Indonesian parts of New Guinea based on extrapolation of area to diversity relationships in Papua New Guinea (excluding the islands of East Melanesia). The bold numbers represent current numbers of species, candidate species or candidate + recognised species in each of the two main regions. In all categories the predicted total number of species for Indonesian New Guinea (in green) is much higher than the current number of known species. Further analyses based on varying levels of predicted endemism in Indonesia suggest between 68–190 endemic species remain undescribed and undocumented on the Indonesian side of New Guinea.

			Indonesia Endemism Estimates	
	PNG (excl. East Melanesia)	Indonesia (excl. Maluku)	70% endemism	80% endemism
Land area estimates (sq km)	405,788	415,170		
Recognised species	**335**	**187**		
Endemic recognised species	**269**	**154**		
% endemism	80%	82%		
Ratio of species to area for PNG	1: 1211 km^2			
Indonesia species diversity estimates on PNG ratios		343	240	274
Estimated additional Indonesian species		156	86	120
Candidate species	**145**	**25**		
Endemic candidate species	**141**	**23**		
Ratio of species to area	1: 3192 km^2			
Indonesia species diversity estimates on PNG ratios		130	91	104
Estimated additional Indonesian species		105	68	81
Total Recognised + Candidate	**480**	**212**		
Ratio of total species to area	1: 964 km^2			
Indonesia species diversity estimates on PNG ratios		431	301	344
Estimated additional Indonesian species		244	147	190

Supplementary Table 3. Mean, standard deviation and median of estimated distribution size for the four most species-rich families of Melanesian frogs derived from extent-of-occurrence estimates generated by the IUCN. The megadiverse microhylids have particularly small ranges, but many taxa remain known only from their type localities.

Name	N	Mean (km2)	SD (km2)	Median (km2)
Ceratobatrachidae	58	17,402	48,640	7,047
Pelodryadidae	132	121,840	443,390	2832
Microhylidae	303	13,216	53,923	426.8
Ranidae	14	178,184	205,259	115,626

Supplementary Table 4. Summary list of Critically Endangered, Endangered, or Vulnerable frogs from Melanesia.

Species	GAA Category	GAA2 category	Region	Range	**Country**
Oreophryne siegfriedi	CR	CR	Sky Islands	Mt Elimbari	Papua New Guinea
Oreophryne sanguinopicta	DD	CR	Sky Islands	Mt Simpson	Papua New Guinea
Cophixalus timidus	DD	CR	Sky Islands	Mt Simpson	Papua New Guinea
Cophixalus misimae	DD	CR	Island	Misima Island	Papua New Guinea
Oreophryne ezra	NE	CR	Island/sky island	Sudest Island	Papua New Guinea
Paedophryne kathismaphlox	NE	CR	Sky Islands	Mt Simpson	Papua New Guinea
Oreophryne penelopeia	NE	CR	Island/sky island	Normanby Island	Papua New Guinea
Oreophryne matawan	NE	CR	Sky Islands	Mt Simpson	Papua New Guinea
Cornufer parkeri	VU	EN	Island	Bougainville	Papua New Guinea
Cophixalus sphagnicola	LC	EN	Sky Islands	Owen Stanley mountains	Papua New Guinea
Choerophryne gudrunae	DD	EN	Sky Islands	Adelbert Ranges	Papua New Guinea
Cornufer parilis	NE	EN	Island	Santa Isabel	Papua New Guinea
Oreophryne cameroni	NE	EN	Sky Islands	Adelbert Ranges, and Torricelli Mountains	Papua New Guinea
Oreophryne picticrus	NE	EN	Island	Misima Island	Papua New Guinea
Litoria rueppelli	VU	VU	Island	Maluku	Indonesia
Sphenophryne rhododactyla	DD	VU	Sky Islands	Owen Stanley mountains	Papua New Guinea
Cornufer wolfi	LC	VU	Island	Bougainville	Papua New Guinea
Cornufer cheesmanae	DD	VU	Mainland	Northern New Guinea	Indonesia; Papua New Guinea
Cophixalus nubicola	VU	VU	Sky Islands	Mt Michael	Papua New Guinea
Cornufer minutus	LC	VU	Island	Bougainville	Papua New Guinea
Cornufer nexipus	DD	VU	Island	New Britain	Papua New Guinea (Bismarck Archipelago)
Austrochaperina novaebritanniae	VU	VU	Island	New Britain	Papua New Guinea
Cornufer desticans	NE	VU	Island	Choiseul and	Solomon Islands

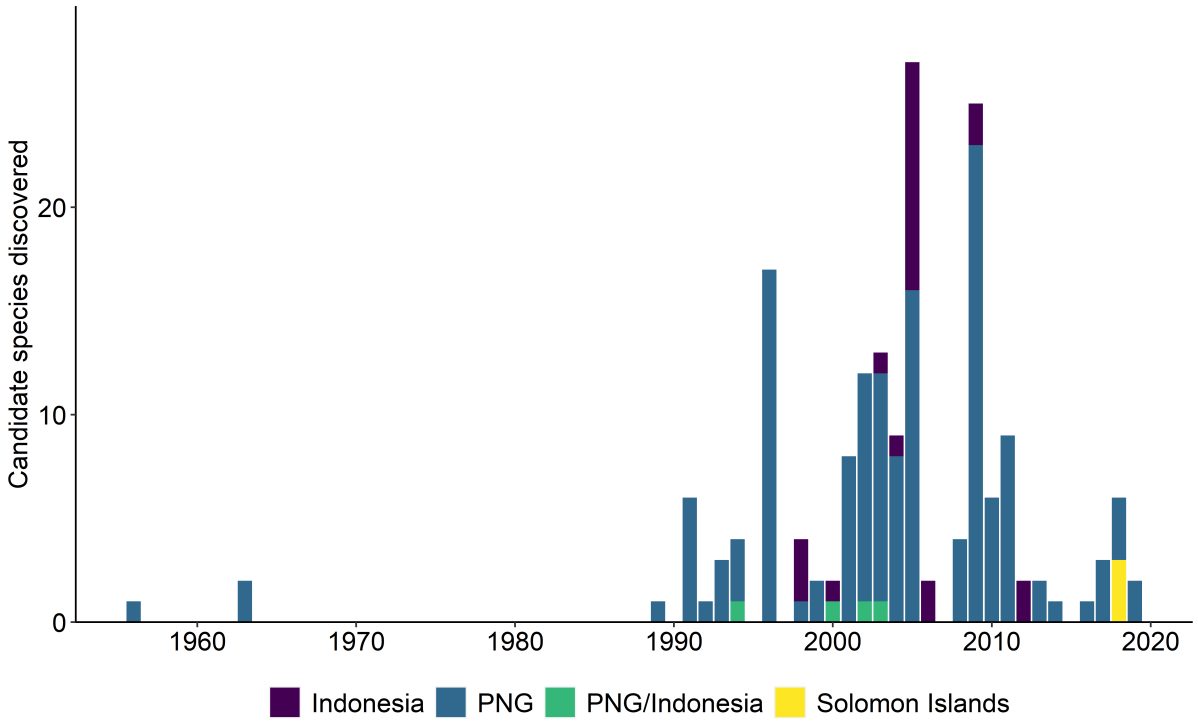
				Santa Isabel	
Choerophryne alpestris	NE	VU	Sky Islands	Central Cordillera	Papua New Guinea
Cophixalus amabilis	NE	VU	Island	Woodlark Island	Papua New Guinea
Cophixalus clapporum	NE	VU	Island	Woodlark Island	Papua New Guinea
Cophixalus tenuidactylus	NE	VU	Sky Islands	Owen Stanley Mountains	Papua New Guinea
Barygenys apodasta	NE	VU	Island	Woodlark Island	Papua New Guinea
Cornufer citrinospilus	NE	VU	Island/sky island	Nakanai Mountains	Papua New Guinea
Mantophryne insignis	NE	VU	Island	Woodlark Island	Papua New Guinea
Oreophryne phoebe	NE	VU	Island	Woodlark Island	Papua New Guinea

Supplementary Table 5. Change in the number of species listed under different IUCN categories between the first Global Amphibian Assessment in 2004, and the second Global Amphibian Assessment in 2019.

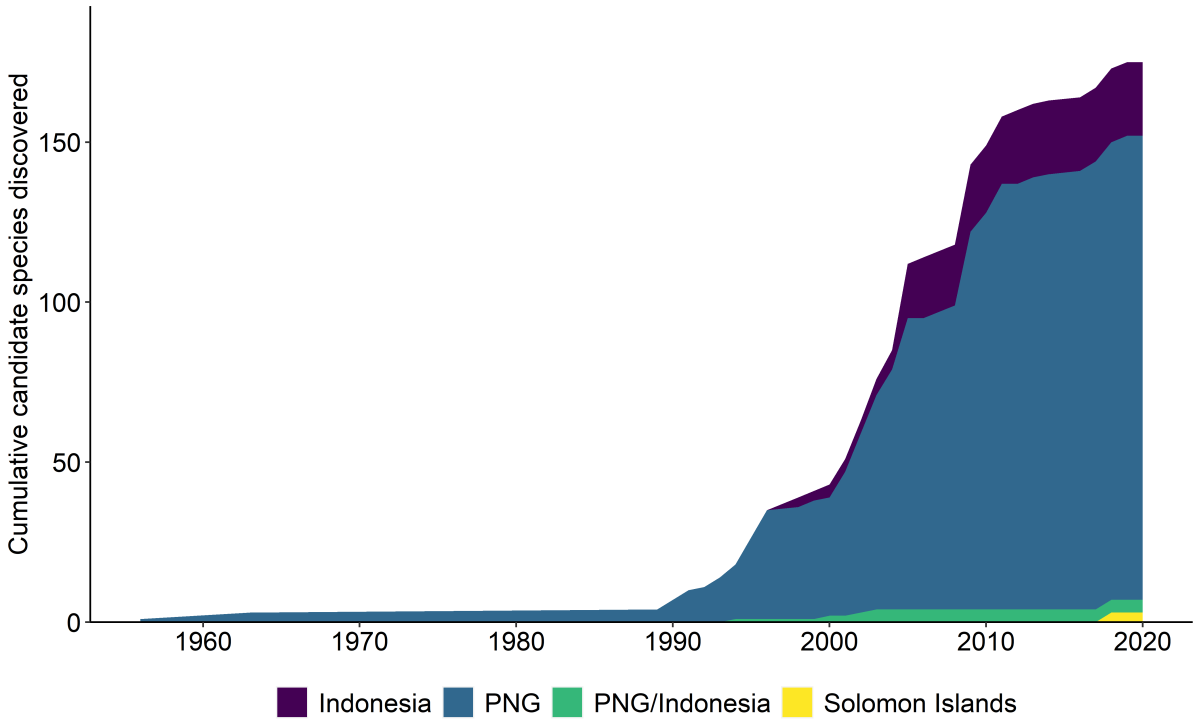
	2004	2019
CR	1	8
EN	2	6
VU	13	17
NT	1	8
LC	157	349
DD	197	125
NE	142	-

Supplementary Table 6. Criteria under which frog species were listed during IUCN assessments

	2004		2020	
	B1ab(iii)	D2	B1ab(iii)	D2
CR	1		8	
EN	1		6	
VU	5	7	8	9
NT			1	1
LC			28	6
DD			9	8



Supplementary Figure 1. Known year of first collection for candidate species of Melanesian frog discovered between 1956-2020, but not yet described at the time this paper was being prepared in late 2021.



Supplementary Figure 2. Cumulative summary data for candidate species of frog from Melanesia discovered between 1956-2020, but not yet described at the time this paper was being prepared in late 2021.

Supplementary References: Summary list of literature and resources highlighting candidate species of frog from Melanesia. This list does not capture all candidate species in our lists, but highlights the diverse and growing number of studies emphasising that species diversity in Melanesia remains underestimated.

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