

Ganguroo robustiter sp. nov. (Macropodoidea, Marsupialia), a middle to early late Miocene
basal macropodid from Riversleigh World Heritage Area, Australia

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SUPPLEMENTARY DATA 3

Nexus-formatted character matrix for the 42 taxa included in our phylogenetic analyses, from Prideaux and Warburton (2010). Outgroup taxa was *Hypsiprymnodon moschatus*. ? = missing data; - = inapplicable.

#NEXUS

BEGIN TAXA;

DIMENSIONS NTAX=42;

TAXLABELS

'Hypsiprymnodon moschatus'
'Ekaltadeta ima'
'Bettongia moyesi'
'Bettongia penicillata'
'Potorous tridactylus'
'Purtia mosaicus'
'Wakiewakie lawsoni'
'Ngamaroo archeri'
'Lagostrophus fasciatus'
'Troposodon minor'
'Wabularoo naughtoni'
'Bulungamaya delicata'
'Ganguroo bilamina'
'Ganguroo bites'
'Ganguroo robustiter'
'Wanburoo hilarus'
'Hadronomas puckridgi'
'Sthenurus andersoni'
'Simosphenurus occidentalis'
'Procoptodon goliah'
'Dorcopsoides fossilis'
'Dorcopsis veterum'
'Dorcopsulus vanheurni'
'Setonix brachyurus'
'Thylogale billardieri'
'Petrogale brachyotis'
'Bohra illuminata'
'Dendrolagus bennettianus'
'Dendrolagus matschiei'
'Protemnodon anak'
'Congruus congruus'
'Wallabia bicolor'
'Prionotemnus palankarinnicus'
'Kurrabi mahoneyi'
'Lagorchestes conspicillatus'
'Lagorchestes hirsutus'
'Baringa nelsonensis'
'Onychogalea unguifera'

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'Macropus eugenii'
'Macropus fuliginosus'
'Macropus pavana'
'Macropus robustus'
;
ENDBLOCK;

BEGIN CHARACTERS;
  DIMENSIONS NCHAR=83;
  FORMAT DATATYPE=STANDARD MISSING=? GAP=- SYMBOLS="01234";
  CHARLABELS
    [1] 'Rostrum depth relative to posterior (neurocranial) portion of cranium'
    [2] 'Marked cranial foreshortening (brachycephaly)'
    [3] 'Level of basicranial plane relative to palatalplane'
    [4] 'Splanchnocranium anteroventral deflection'
    [5] 'Superficial masseter origin on jugal'
    [6] 'Large ectoglenoid process'
    [7] 'Postglenoid process'
    [8] 'Neurocranium element contact'
    [9] 'Ectotympanic proportions'
    [10] 'Maximum occiput breadth relative to height'
    [11] 'Foramen magnum size relative to occiput size'
    [12] 'V-shaped squamosal inflation between occiput and posterior end of
zygomatic arch'
    [13] 'Relative anteroposterior length of upper incisors'
    [14] 'I1 shape'
    [15] 'I3 anterobuccal crest'
    [16] 'I3 lingual surface'
    [17] 'Number of cuspules/ridgelets on P3 anterior to large posterior cusp'
    [18] 'Deep cleft on main crest of P3 and p3 immediately posterior to anterior
most cuspule'
    [19] 'P3 lingual cingulum'
    [20] 'P3 lateral constriction immediately anterior to posterolingual cusp'
    [21] 'Upper cheek tooth row shape in transverse plane'
    [22] 'Molar progression'
    [23] 'Molar morphology'
    [24] 'Preprotocrista development'
    [25] 'Postprotocrista orientation'
    [26] 'Postprotocrista development'
    [27] 'Postprotocrista division'
    [28] 'Postparacrista development'
    [29] 'Postmetacrista/postmetaconulecrista development'
    [30] 'Morphology of symphyseal plate of dentary'
    [31] 'Buccinator sulcus on dentary'
    [32] 'Anterior extent of masseteric canal'
    [33] 'Insertion area for middle masseter muscle'
    [34] 'Mandibular condyle shape'
    [35] 'Position of i1 occlusal surface during incisor occlusion'
    [36] 'i1 morphology'
    [37] 'Enamel distribution on i1'

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[38] 'Morphology of p3'
 [39] 'Buccal side of p3'
 [40] 'Cheek tooth row shape in dorsoventral plane'
 [41] 'Molar crown height index'
 [42] 'Premetacristid development'
 [43] 'Slight postmetacristid'
 [44] 'Postprotocristid development'
 [45] 'Cristid obliqua form'
 [46] 'Paracristid and cristid obliqua division'
 [47] 'Development of postentocristid and posthypocristid'
 [48] 'Lophid enamel crenulations'
 [49] 'Tuber calcanei posteromedial expansion'
 [50] 'Relative length of talus articular region on calcaneus'
 [51] 'Step of calcaneus–cuboid articulation'
 [52] 'Ventromedian facet of cuboid articulation on calcaneus'
 [53] 'Relative breadth of calcaneus–talus articulation'
 [54] 'Distinctness of medial and lateral talar facets on calcaneus'
 [55] 'Shape of lateral talar facet on calcaneus'
 [56] 'Medial projection of sustentaculum tali of calcaneus beyond edge of
 medial talar facet'
 [57] 'Shape of sustentaculum tali of calcaneus'
 [58] 'Posterior extent of sustentaculum tali'
 [59] 'Orientation of talar trochlear crests'
 [60] 'Height of medial trochlear crest on talus relative to lateral crest'
 [61] 'Medial malleolar process/fossa on talus'
 [62] 'Metatarsal IV length relative to calcaneus length'
 [63] 'Metatarsal IV relative breadth'
 [64] 'Metatarsal IV distal epiphysis breadth'
 [65] 'Metatarsal V relative breadth'
 [66] 'Metatarsal V plantar ridge'
 [67] 'Relative length of fibular articular facet on tibia'
 [68] 'Relative length of anterior tibial crest'
 [69] 'Shape of anterior tibial crest'
 [70] 'Length of tibia relative to that of femur'
 [71] 'Development of greater trochanter crest of femur'
 [72] 'Angle of ilium to ischium'
 [73] 'Position of rectus femoris origin on ilium'
 [74] 'Iliopubic process at junction of ilium and pubis'
 [75] 'Relative length of ischium to ilium'
 [76] 'Area of supraspinous fossa relative to infrapinnous fossa of scapula'
 [77] 'Scapula acromion shape'
 [78] 'Displacement of acromion relative to glenoid fossa on scapula'
 [79] 'Relative size of medial tuberosity to lateral tuberosity on humerus'
 [80] 'Development of deltoid tuberosity vs. pectoral crests on humerus'
 [81] 'Relative width of trochlear notch posterior margin on ulna'
 [82] 'Olecranon length/shape relative to length of ulna'
 [83] 'Radius cross-section depth (mid-length) to width of the diaphysis,
 measured at the mid-length of the diaphysis from between the epiphyseal plates'

;
 STATELABELS

- 1
shallow
intermediate
deep,
- 2
absent
present,
- 3
'same plane or slightly higher'
'markedly higher',
- 4
marked
intermediate
minimal,
- 5
shallow
'deep, with distinct orbital rim',
- 6
absent
present,
- 7
absent
small
large,
- 8
'frontal-squamosal'
'parietal-alisphenoid',
- 9
small
'thick, wide, rugose, ventrally keeled',
- 10
'deeper than broad'
'broader than deep',
- 11
small
large,
- 12
absent
present,
- 13
'I2 and/or I3 not reduced relative to I1'
'I2 distinctly shorter than I1 and I3'
'I2 and I3 distinctly shorter than I1',
- 14
subcylindrical
'slightly broadened'
'markedly broadened',
- 15
'absent or very small, restricted to anterior end'
distinct,

cuspules'	16	'no anterolingual crest or lingual shelf' 'anterolingual crest present, no lingual shelf' 'anterolingual crest and small lingual shelf present',
	17	'five or more' four three 'less than three',
	18	absent present,
	19	'absent or very low, fine' 'low, narrow to moderately broad, tapered anteriorly' 'broad, not raised into crest along lingual edge, with or without
		'broad, raised into low crest along lingual edge' 'raised into high crest along lingual edge',
	20	absent present,
	21	straight 'bowed laterally',
	22	absent present,
	23	bunodont bunolophodont bilophodont,
	24	'strongly developed, confluent with precingulum' 'small but distinct' absent,
	25	'restricted to lingual side of tooth' 'extends into interloph valley near to tooth midline',
	26	'short, thick' 'fine, low' intermediate 'high, thick, strongly developed',
	27	absent 'incipiently or completely divided into two components',
	28	present 'absent or very fine and low',

L-shape'	29	'both distinct'
		'postmetaconulecrista enlarged, postmetacrista absent or very weak',
	30	'shallow, smooth or very slightly rugose'
		'deep, rugose'
		'deep, very rugose, and anteriorly expanded',
	31	absent
		'broad, deep concavity'
		'narrow, shallow'
		'narrow, deep',
	32	'to below anterior cheek teeth'
		'to below posterior cheek teeth'
		'posterior to m4 (near vertical)',
	33	'small to moderately proportioned'
		'broad and concave'
		'large, terminates ventrally at distinct ridge',
	34	'barrel shaped, not tapered medially'
		'oval or circular'
		'barrel shaped, tapered medially',
	35	'i1 rests on crowns of I2 and I3, and posterior facet of I1'
		'i1 rests on palate, bordered by I2 and I3',
	36	'procumbent, thin and elongate'
		'procumbent blade with thick enamel flanges'
		'slightly robust with thin enamel flanges'
		'markedly upturned and robust',
	37	'principally buccal side'
		'buccal enamel layer extended to completely encircle crown '
		'separate lingual enamel layer present',
	38	'blade with many fine serrations along length of crown'
		'crown markedly curved in lingually at posterior end, forming rounded
		'straight or slightly curved blade with fewer coarser serrations'
		'base of crown markedly broadened relative to length',
	39	'lacks eminence, cingulid, or crest'
		'bears posterobuccal eminence'
		'bears well-developed buccal cingulid or crest',
	40	'flat or very slightly convex'
		'markedly convex dorsally',
	41	

	'low (< 0.45)'
	'intermediate (0.45-0.75)'
	'high (> 0.75)',
42	
	'well developed, confluent with paracristid'
	'moderately developed'
	'weakly developed or absent',
43	
	present
	absent,
44	
	distinct
	'slight or absent',
45	
	'restricted to buccal side of tooth'
	'straight or slightly curved, terminates near tooth midline low on
posterior face of protolophid'	
	'distinctly kinked, terminates near tooth midline low on posterior face
of protolophid',	
46	
	absent
	present,
47	
	'postentocristid distinct, meets large posthypocristid'
	'both crests fine or absent'
	'posthypocristid present, adjacent to distinct central groove',
48	
	absent
	present,
49	
	absent
	present,
50	
	'long (> 0.43)'
	'intermediate (0.43-0.35)'
	'short (< 0.35)',
51	
	incipient
	'markedly stepped or slightly bevelled'
	'slightly smoothed, oblique'
	smoothed,
52	
	absent
	'continuous with dorsolateral facet'
	'separate, distinct, well-developed'
	'reduced, confluent with dorsomedial facet',
53	
	'intermediate (0.40-0.45)'
	'narrow (< 0.40)'
	'broad (> 0.45)',

54	'confluent, smoothly continuous anteriorly' 'continuous anteriorly, but facet contours distinct' 'distinct, separate facets',
55	'untapered or marginally tapered medially' 'slightly or moderately tapered medially' 'markedly tapered medially',
56	'absent or very slight' marked,
57	'straight (anteroventrally oriented) or very slightly curved' rounded square,
58	'roughly in line with fibular facet' intermediate 'significantly posteriorly placed from fibular facet',
59	'oblique (anterolaterally oriented)' 'anteroposteriorly oriented',
60	'subequal in height (trochlear groove shallow)' 'medial crest slightly higher' 'medial crest distinctly higher, with trochlear groove deep',
61	'fossa intermediate, no distinct process' 'fossa intermediate, process small, slightly medially extended' 'fossa broad/shallow, process large and medially extended' 'fossa narrow/deep, process small, slightly medially extended',
62	'intermediate (1.5-2.4)' 'long (> 2.4) ' 'short (< 1.5)',
63	'narrow (< 0.12)' 'intermediate (0.12-0.16)' 'broad (> 0.16)',
64	'narrow relative to ligament attachments' 'distinctly broad relative to shaft width, minimum development of ligament attachments',
65	'intermediate (0.07-0.13)' 'narrow (< 0.07)' 'wide (> 0.13)' 'highly to extremely reduced',
66	'small, posteriorly restricted'

	absent
	'elongate, well developed',
67	'short (< 0.62)'
	'long (> 0.62)',
68	'intermediate (0.20-0.26)'
	'long (> 0.26)'
	'short (< 0.20)',
69	'stepped-in distally'
	'not stepped distally, curves smoothly into diaphysis',
70	'intermediate (1.10-1.45)'
	'short (< 1.10)'
	'long (> 1.45)',
71	'distally flared or intermediate'
	'distally narrowed'
	'distally flared and markedly broadened',
72	'slight angle'
	'aligned in same plane'
	'large angle',
73	'distinctly separate from acetabular rim'
	intermediate
	'adjacent to acetabular rim',
74	'very small, pointed'
	'long, well-developed, square in outline'
	'short, broad'
	'very large',
75	'long (> 0.7)'
	'short (< 0.7)',
76	'roughly equal'
	'supraspinous fossa roughly half area'
	'supraspinous fossa roughly one-third area'
	'supraspinous fossa much smaller than infraspinous fossa',
77	'anterodorsally curved'
	straight,
78	'caudal to the cranial margin of the glenoid fossa'
	'cranially displaced',
79	'slightly smaller'
	'distinctly smaller'

80 subequal,
 'deltoid insertion poorly developed'
 'intermediate, small deltoid tuberosity connected by oblique ridge'
 'large deltoid tuberosity separated from pectoral crest by sulcus',
 81 wide
 narrow,
 82 'long, deep'
 intermediate
 reduced,
 83 'intermediate (1.3-1.5)'
 'shallow (< 1.3)'
 'deep (1.5-2.0)'
 'very deep (> 2.0)',

;

MATRIX

'Hypsiprymnodon moschatus'	0000000000 0000000000 0000000000
0000000000 0000000000 0000000000 0000000000 000	
'Ekaltadeta ima'	0000001000 00????0000 0000000000 000?000000
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'Bettongia moyesi'	00010011?? ??00000000 0000000000
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'Bettongia penicillata'	0001001000 0000000000 0000000000
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'Potorous tridactylus'	0001000000 0000001000 0000000000
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'Purtia mosaicus'	?????????? ???????0?? ?01??????0 ???????000
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'Wakiewakie lawsoni'	?????????? ???????0?? ?00??????0 000????000
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'Ngamaroo archeri'	?????????? ???????0?? ?01??????0 000????000
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'Troposodon minor'	?????????? ???0?02010 0020120001
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'Wabularoo naughtoni'	?????????? ???????0?? ?02??????0 2??????200
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'Bulungamaya delicata'	?????????? ???????0000 0010000000
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'Ganguroo bilamina'	0001001100 0000000010 0021110000
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'Wanburoo hylarus' ?????????? ?00010020 0022110000 2101?10210
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 'Simosthenurus occidentalis' 2112012111 0010011040 1022111002
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 'Dorcopsulus vanheurni' 0000001100 1001101001 0022110000
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 'Setonix brachyurus' 0000002100 0002101010 1022120000
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 'Protemnodon anak' 1000002101 1002102030 1022120000
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 'Wallabia bicolor' 0000002100 0002102030 1022120000
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 'Prionotemnus palankarinnicus' ???0????? ???2102010 1022130100
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 'Macropus eugenii' 0000002100 0002103010 1022130110
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 'Macropus fuliginosus' 0000002100 0002103000 1121130110
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;
ENDBLOCK;

BEGIN ASSUMPTIONS;
    OPTIONS DEFTYPE=UNORD POLYTCOUNT=MINSTEPS;
ENDBLOCK;

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LITERATURE CITED

Prideaux, G.J., and N. M. Warburton. 2010. An osteology-based appraisal of the phylogeny and evolution of kangaroos and wallabies (Macropodidae: Marsupialia). *Zoological Journal of the Linnean Society* 159:954–987.