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From a putative new taxon to a mutt! Formal descriptions of three new genetically divergent Mountain Pygmy Possums from Victoria and New South Wales closely associated with *Burramys parvus* Broom, 1896.

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ABSTRACT

The iconic Mountain Pygmy Possum *Burramys parvus* Broom, 1896, was originally described from Pleistocene fossil material obtained near Taralga, New South Wales.

Since then, living specimens of the same putative species have been found in alpine areas of New South Wales and Victoria broadly coinciding with the major ski resorts in each state. Presumption that these living animals are conspecific with the type material in the Australian Museum in Sydney has been made by all publishing zoologists to date in the absence of genetic evidence.

Molecular evidence published by Osborne *et al*. (2000), implied divergences in the three main extant populations of up to 680,000 years before present, which they stated "conflicts with conclusions reached by Ride and Davies (1997), that the extant populations of *B. parvus* are remnants of a species that had a more contiguous distribution as recently as 18 000 years ago."

Significantly Mitrovski *et al*. (2007) wrote "From a conservation perspective, all three areas where *B. parvus* are found should be considered as separate gene pools" implying the need for each to have taxonomic recognition.

Strahan (1988) also suggested subspecies level recognition for the regional populations of putative *B. parvus.* Following on from these works, this paper takes a conservative position and formally names all three known extant races as subspecies, separate from the fossil type material.

Unfortunately, in 2008, the government-owned "Zoos Victoria" business cross-bred Mount Hotham and Mount Buller animals at their facility at Healesville and along with translocation of specimens from Mount Hotham to Mount Buller had by 2012 successfully created a cohort of at least 50% of trapped wild Mount Buller specimens (9 of 18) as hybrids (Menkhorst *et al*. 2016), signifying that as of 2020, the pure Mount Buller lineage is probably extinct.

In other words all *Burramys* at Mount Buller are effectively Mutts!

Formal naming of the pure Mount Buller form (based on previously lodged material in the Museum of Victoria) and the Bogong Plains form (including Mount Hotham) and the main population from the Alps in New South Wales will hopefully help to prevent any other ill-conceived attempts to further mix these taxonomically distinct and allopatric populations.

Keywords: Mammals; Marsupial; taxonomy; nomenclature; Pygmy Possum; *Burramys*; *parvus*; Mount Buller; Mount Hotham; Victoria; New South Wales; new subspecies; *hosersbogensis; timdalei*; *scottyjamesi*.

INTRODUCTION

The iconic Mountain Pygmy Possum *Burramys parvus* Broom, 1896, was originally described from Pleistocene fossil material obtained at Wombeyan Caves near Mittagong in the New South Wales Southern Highlands in 1895 (Broom 1896).

A living animal, believed to be of the same species was discovered at Mount Hotham Ski Resort in Victoria in 1966, and populations of the same putative species were subsequently discovered in the Kosciuszko region of NSW in 1970 and at the Mount Buller Ski resort in 1996 (Calaby *et al.* 1971, Mansergh and Broome 1994, Heinz and Williams 1998).

Further fossil remains attributed to the same putative species were recovered from caves at Buchan Victoria and south-west of Sydney in New South Wales (Jenolan Caves) and were treated as suggesting that at the height of the last Pleistocene glacial period (ca. 20,000 years bp) a single species of Mountain Pygmy-possum had a much wider distribution around the snowline of south-eastern Australia (Ride and Davies 1997).
It has been generally assumed that since that glacial maximum receded, the range of the putative species has been contracting with a gradually warming climate and receding snowline (Caughley 1986; Mansergh and Broome 1994).

In line with the preceding, the presumption that these living animals are conspecific with the type material in the Australian Museum in Sydney has been made by all publishing zoologists to date in the absence of genetic evidence.
However molecular evidence published by Osborne *et al.* (2000), implied divergences in the three main extant populations of up to 680,000 years before present, which they stated "conflicts with conclusions reached by Ride and Davies (1997), that the extant populations of *B. parvus* are remnants of a species that had a more contiguous distribution as recently as 18 000 years ago."

These findings also effectively ruled out the idea that the three major populations were contiguous at the time of the most recent glacial maxima, this idea in effect being based solely on crude, temperature-based climate models.

Identifying the physical barriers to movement for the populations of the putative species is not easy, as 20,000 years before present, not only would vegetation regimes have been different, but so too would have been species compositions in intervening areas, including competing and predatory ones.

Noting that extant putative *B. parvus* have strict habitat requirements beyond those of maximum temperature tolerance, I did a simple inspection of topographical data to see if in fact putative *B. parvus* from the Kosciuszko region of NSW would in fact have a reasonable prospect of surviving in and passing through the areas between known current locations and the locations of Pleistocene deposits south-west of Sydney, NSW.

The need for rocky boulder habitat of cold temperatures, either due to habitat specific requirements or predator avoidance strategies, rendered most of the intervening region unsuitable, even in times of glacial maxima, furthering my belief that type *B. parvus* is almost certainly not even be conspecific with the living animals being treated as the same species.

In any event, even if the northern (New South Wales) population were to be conspecific with type *B. parvus*, it is clear based on published genetic analysis (e.g. Osborne *et al.* 2000), that both the main Victorian populations are sufficiently divergent from these and from one another, to be regarded as subspecies on the basis they are morphologically divergent, allopatric, genetically divergent for thousands of years and have no gene flow between each other.
Significantly Mitrovski *et al.* (2007) wrote "From a conservation perspective, all three areas where *B. parvus* are found should be considered as separate gene pools" further implying the need for each to have taxonomic recognition.
This paper does exactly that and formally names the two southern races, being most distant from the type fossil material as subspecies.
I go further and also formally name the northern form from the Kosciuszko region of New South Wales as another subspecies on the basis of morphological differences in the jaw between all living forms and the type fossil material (see also Broom 1896 who used the type material for examination, and Brammall and Archer 1997, who used a Victorian specimen for review purposes).
Unfortunately, in 2008, and following an internal review of the Mount Buller population, the government-owned "Zoos Victoria" business in conjunction with the State Wildlife Department that controls them, caught a number of wild specimens and cross-bred Mount Hotham and Mount Buller animals at their facility at Healesville.

Along with translocation of specimens from Mount Hotham to Mount Buller, they had by 2012 successfully created a cohort of at least 50% of trapped wild Mount Buller specimens (9 of 18) as hybrids (Menkhorst *et al.* 2016), signifying that as of 2020, the pure Mount Buller lineage is probably extinct.

In other words all *Burramys* at Mount Buller are effectively Mutts!

The alleged basis of the action by "Zoos Victoria" for creating the Mutt population at Mount Buller was due to a potentially misguided belief that the Mount Buller population was in immediate danger of extinction and in their view too small to be viable in the long term and therefore needed greater genetic diversity in the form of an infusion from the Mount Hotham population.

The scientific basis for the belief that the Mount Buller population would otherwise rapidly and inevitably die out was tenuous at best and even if it had a sound basis of scientific fact (which it did not), a better situation would have been to attempt, using the vast resources available to the government, to save that population without resorting to hybridising with the genetically divergent and allopatric Mount Hotham population.

Associated with this would be the risk of failure, after which, if the Mount Buller population actually did die out, the government people could then consider what to do in the way of successful long term re-reintroductions from elsewhere of the same or similar species, viz the Mount Hotham animals.

The worst case scenario would be the same projected end-point, viz over-running the place with Mount Hotham animals, but this second best outcome to preservation of the unique lineage, may have been wholly avoided.

I make it clear that the better case scenario would have been long term survival of the Mount Buller population as a genetically pure gene pool that to date had survived many tens of thousands of years in isolation from the others and if reasonably well managed, would have continued to do so indefinitely.
Formal naming of the pure Mount Buller form (based on types in the Museum of Victoria) and the Bogong Plains form (including Mount Hotham) will hopefully prevent introduction of other subspecies into the wholly viable, allopatric and distinct population of the Victorian Bogong Plains and draw attention to the fact that preservation of the species in their natural form should be the first option in wildlife conservation and not the creation of Mutts!

The naming of the Victorian populations in line with the above is due to the obvious contention that they are most geographically divergent from the New South Wales stock and the fossil type from north of there (presumed for the moment to be conspecific at the subspecies level) and so by simple logic, were at the outset of the investigation being the divergent specimens in need of formal taxonomic recognition.

MATERIALS, METHODS AND RESULTS

Before a decision is made to name any new taxon, reasonable steps must be taken to ensure that it is justified on all relevant grounds, including that it is morphologically, genetically and reproductively isolated from their nearest relative. Once these have been ascertained, the decision as to at what nomenclatural

level needs to be assigned to ensure stability of names and utility in the Zoological community.
That is, should the reproductively isolated and morphologically divergent entities be labelled as subspecies, full species, or potentially higher level again.

Key literature relevant to the taxonomic and nomenclatural conclusions within this paper include
Anonymous (2005), Bannister *et al.* (1988), Broom (1895, 1896a, 1896b). Broome (2001a, 2001b), Broome and Geiser (1995), Broome *et al.* (2012), Calaby *et al.* (1971), Caughley (1986), Dimpel and Calaby (1972), Fleming (1985), Geiser and Broome (1991, 1993), Gray (1841, 1845), Green (2003, 2008), Gullan and Norris (1984), Heinze and Olejniczak (2000), Heinze and Williams (2008), Heinze *et al.* (2004), Hoser (1991, 2019a, 2019b), Kerle (1984), Körtner and Geiser (1998), Mansergh and Broome (1994), Mansergh and Scotts (1989, 1990), Mansergh and Walsh (1983), Mansergh *et al.* (1989, 1990, 2010), Menkhorst and Knight (2004), Menkhorst *et al.* (2016), Mitrovski *et al.* (2005, 2007, 2008), Ng *et al.* (2013), Osborne and Christidis (2002), Osborne *et al.* (2000), Pepper *et al.* (2018), Ride (1956), Ride *et al.* (1999), Rosengren and Peterson (1989), Sanecki *et al.* (2006), Schulz *et al.* (2012a, 2012b), Shi (2012), Smith and Broome (1992), Van der Ree *et al.* (2009), Weeks *et al.* (2011, 2012), Wells and Wellington (1984, 1985) and sources cited therein.

While there is an element of doubt over the conspecfic status of the living putative *Burramys parvus* and the fossil specimens from further north, until this is resolved, it makes sense for the southern specimens to be treated as subspecies rather than separate species-level entities.
In the event that they are ultimately regarded as different species, one or more of the subspecies formally named herein can be simply elevated to full species, without significantly destabilizing the existing in use nomenclature.

All relevant previously published material was examined, including that cited herein and sources within those publications. Live and dead specimens as well as available bone specimens, were examined as was other relevant material, including past climate data for Victoria and New South Wales, past vegetation maps, previously published literature on these matters, including phylogenic treatments of other species groups distributed or range restricted in high altitude areas of south-east Australia and so on in order to gauge likely spread of extant populations in the recent geological past.

Genetic data published was also scrutinized as were papers dealing with the biology, captive breeding and other relevant facts about the relevant species.

In summary, as inferred already, the genetic evidence was definitive in that it showed 1/ That the three main living populations of *B. parvus* had remained distinct and separate well before the most recent glacial maxima about 20,000 years before present and 2/ There is no evidence available, including via the fossil record that the main region between living specimens and the fossils south-west of Sydney in New South Wales, was inhabited by any *Burramys* in the recent past.
I also note that the fossil remains of putative *B. parvus* of Pleistocene age from Buchan, Victoria are in a very different position to those from near Wombeyan and Jenolan Caves in NSW.
Those two NSW sites are widely divergent from extant populations and sit on the edge of the high altitude Blue Mountains escarpment, a significant alpine bioregion in its own right and with a high degree of alpine endemism (see for example Pepper *et al.* 2018).

By contrast, Buchan, Victoria sits on the immediate southern edge of the Victorian Great Dividing Range and is directly connected to the extant New South Wales population in the Kosciuszko region of NSW via the Davies Plain Ridge in Victoria, or alternatively via the ridgeline of high mountain peaks immediately east of there, inferring that this specimen at least was in fact of the same species and genetic lineage.
The connecting line also includes significant rocky areas that would clearly be of suitable habitat in times of glacial maxima, further supporting the above contention.
There is no extant high altitude bioregion at Buchan that in any way has endemism not seen at Mount Hotham, Buller or Kosciuszko, further implying that the Buchan specimen is in fact an outlier from a colder geological period as opposed to being a taxonomically discrete entity.

The molecular phylogeny of Pepper *et al.* (2018) confirmed that putative *Eulamprus kosciuskoi* (Kinghorn, 1923) from the Blue Mountains region of New South Wales, was in fact a different species-level taxon to the nominate form from a 5,000 feet elevation on Mount Kosciuszko.

The Blue Mountains species was in fact formally identified and named by Wells and Wellington (1984) as *Eulamprus leuraensis.*
See also the molecular phylogeny for the Mountain Dragon species complex, all treated by most authors as a single putative species, being *Rankinia diemensis* (Gray, 1841), found by Ng *et al.* (2013) to be a complex of six divergent lineages.
Hoser (2015) determined that the antiquity of divergence, morphological differences and geographical isolation and allopatry necessitated the recognition of each form as a new species and formally named the four unnamed forms.

Included in this complex, were one form from Tasmania, three from Victoria and two from New South Wales, those being one from the Blue Mountains bioregion and another from an isolated pocket further west.

In terms of these clades of Mountain Dragons formally named by Hoser (2015), Ng *et al.* (2013) had written: “there were deep genetic divergences between Victorian and NSW samples ([8.2 % mtDNA uncorrected sequence divergence), probably dating to the late Miocene-Pliocene.

Multiple phylogeographic studies have also found deep genetic breaks in southern NSW (e.g., Chapple *et al.* 2005; Symula *et al.* 2008).”

The dry habitat barriers referred to by Chapple *et al.* (2005), would of course have similarly prevented *Burramys* populations in south-east New South Wales from mixing as well, even in times of cooler and drier climates.

In simple terms, even in times of glacial maxima, there would not have been an obvious conduit for Snowy Mountains (NSW) and Blue Mountains (NSW) populations of *Burramys* to have mixed.

On the basis of the preceding one can only expect that all three main populations of living putative *Burramys parvus* are quite likely a new and different species to the original type material from south-west of Sydney, New South Wales!

However in the absence of genetic data from the fossil material, I have taken the conservative view and named the two southern forms and the NSW form as subspecies of the type fossil material.

In the event that fossil *Burramys parvus* is later shown to be in fact the same species as the living putative *B. parvus*, noting that there are documented differences in the available skull material from each as seen in the published literature (refer to Broom 1896 and comparative material from Victoria in Brammall and Archer 1997), then the taxonomy and nomenclature in this paper need never change.
If however the fossil *B. parvus* is subsequently shown to be of a different species, then one of the three forms named herein (the first) can be elevated to full species without significantly destabilising the taxonomy of all relevant populations.

Rather than run the risk of species or subspecies becoming threatened or extinct due to non-recognition of them, as shown in Hoser (2019a, 2019b), this paper has been published, even though it is clearly too late to save the Mount Buller taxon of *Burramys* in its pure form.

INFORMATION RELEVANT TO THE FORMAL DESCRIPTIONS THAT FOLLOW

There is no conflict of interest in terms of this paper or the conclusions arrived at herein.

Several people including anonymous peer reviewers who revised the manuscript prior to publication are also thanked as a relevant staff at museums who made specimens and records available in line with international obligations.

In terms of the following formal descriptions, spellings should not be altered in any way for any purpose unless expressly and exclusively called for by the rules governing Zoological Nomenclature as administered by the International Commission of Zoological Nomenclature.

In the unlikely event two or more newly named taxa are deemed conspecific by a first reviser, then the name to be used and retained is that which first appears in this paper by way of page priority and as listed in the abstract keywords.

Some material in descriptions for taxa may be repeated for other taxa in this paper and this is necessary to ensure each fully complies with the provisions of the *International Code of Zoological Nomenclature* (Fourth edition) (Ride *et al.* 1999) as amended online since.

Material downloaded from the internet and cited anywhere in this paper was downloaded and checked most recently as of 10 January 2020, unless otherwise stated and was accurate in terms of the context cited herein as of that date.

Unless otherwise stated explicitly, colour and other descriptions apply to living adult specimens of generally good health and not under any form of stress by means such as excessive cool, heat, dehydration or abnormal skin reaction to chemical or other input.

Colour descriptions of species refer to fur colour and not skin.

While numerous texts and references were consulted prior to publication of this paper, the criteria used to separate the relevant species or subspecies has already been spelt out and/or is done so within each formal description and does not rely on material within publications not explicitly cited herein.

In terms of conservation of each population of each subspecies as described below, the comments in Hoser (1991 and 2019a, 2019b) apply. I note that based on the information provided by Menkhorst (2016) the subspecies *Burramys parvus timdalei subsp. nov.* may have been literally bred out of existence, at least in its pure form.
I also note that the document "National Recovery Plan for the Mountain Pygmy-possum *Burramys parvus*", (Menkhorst 2016), wholly fails to address the primary root cause of likely declines and extinctions in populations of putative *Burramys parvus*.

This is the relentless ongoing rapid growth in the human population in Australia and environmental pressures this brings. Of course as a Victorian State Government Employee, Menkhorst is not allowed to point out the serious defects in his employer's "Big Australia Policy" which in its most recent form, was a population target of 100-125 million people in Australia and one quarter that number for Victoria, as soon as practicable (up from the 25 million nationally and 6 million in Victoria 2020).

On these numbers alone, even if humans were forcibly barricaded from the regions where the *Burramys parvus* live (being the ski resorts), the marsupials will no doubt die off from ingesting ever increasing quantities of pesticides that blow in on their insect food that emanates from farming regions nearby (Green 2008), that must as a matter of survival for humans, be farmed with ever increasing intensity.
Hence the long-term prognosis for all extant populations of putative *Barramys parvus* in the wild is in fact tenuous at best.
I need not mention the likelihood of global warming caused primarily by ongoing human overpopulation and the threat this brings to the cold climate species caught in islands of habitat in the form of mountain peaks and uplands.

Putative wild *B. parvus* will be faced with ever shrinking potential habitat to live in and how larger human populations both in Australia and globally can reduce the likelihood of this catastrophe being averted, other than by stopping population increases is unknown.

BURRAMYS PARVUS HOSERSBOGENSIS SUBSP. NOV.

LSID urn:lsid:zoobank.org:act:7DE00FBD-90BD-40FA-9E3C-9AD6E7C55292

Holotype: A preserved specimen at the Australian Museum in Sydney, New South Wales, Australia, specimen number M.36919 collected at the double toilet at Mount Perisher Ski Resort, New South Wales, Australia, Latitude -36.40 S., Longitude 148.38 E. This government-owned facility allows access to its holdings.

Paratypes: Four preserved specimens at the Australian Museum in Sydney, New South Wales, Australia, specimen numbers M24919, M.24920, M24921 and M.24922 collected from Mount Blue Cow, Kosciusko National Park, New South Wales, Australia, Latitude -36.32 S., Longitude 148.42 E.

Diagnosis: Living *Burramys parvus* Broom, 1896 of all three subspecies named herein are formally separated from the fossil type material herein treated as a fourth and nominate subspecies, namely *B. parvus parvus*.

All three newly named subspecies of *B. parvus* are readily separated from the fossil type material from near Taralga, New South Wales by the fact that the premolars are in proportion, versus slightly oversized in fossil *B. parvus* type material, which is evidence and grounds to form the basis that the living forms are at least different subspecies (also refer to Broom 1896 and comparative material from Victoria in Brammall and Archer 1997).

Besides being easily separated from one another by genetics as detailed by Osborne *et al.* (2000), the three newly named living subspecies of *B. parvus* are in turn readily separated from one another by colouration as follows:

B. parvus hosersbogensis subsp. nov. from the Kosciusko National Park, New South Wales, Australia are grey-brown above, sometimes darker in the mid-dorsal area, continuing to the top of the head; dark ring around the eye; pale grey-brown or pale brown below; light brown on the cheeks. There is some white between the eyes and the tip of the snout.
B. parvus timdalei subsp. nov. from Mount Buller in Victoria is yellow-brown above, sometimes darker in the mid-dorsal area, continuing to the top of the head; dark ring around the eye; light brown below and yellow cheeks.

There is no white between the eyes and the tip of the snout. Instead this area is a deep yellow.

B. parvus scottyjamesi subsp. nov. from the Bogong High Plains including the Mount Hotham Ski resort is grey-brown above, sometimes darker in the mid-dorsal area, continuing to the top of the head; dark ring around the eye; cream or white coloured below and light cream or white on the cheeks.

There is some white between the eyes and the tip of the snout.

B. parvus hosersbogensis subsp. nov. in life can be seen online at:

https://www.flickr.com/photos/alexismarie_meyer/4464197606/

and

https://www.flickr.com/photos/152410663@N05/35729353956/

(both last downloaded on 10 January 2020).

B. parvus timdalei subsp. nov. in life can be seen online at:

http://www.mtbuller.com.au/uploads/file/MPP_Fact_Sheet.pdf

and

https://cdn.mtbullercdn.com.au/assets/environment/mt_buller_mountain_pygmy-possum_recovery_plan_2011-2016_final.pdf

(both last downloaded on 10 January 2020).

B. parvus scottyjamesi subsp. nov. in life can be seen in Strahan

(1988) on page 168 (both images), on the front cover of Hoser (1991) as well as on page 217 of that book (different image, and clearly showing the diagnostic features of this subspecies) and images of the same animal are seen at:

http://www.edgeofexistence.org/species/mountain-pygmy-possum/

(last downloaded on 10 January 2020).

As of 2019, according to most publishing authors, there are two extant genera of pygmy possums: *Burramys* Broom, 1896 and *Cercartetus* Gloger, 1841. *Burramys* contains only one extant species, the Mountain Pygmy-possum, *Burramys parvus*, which has a lightly furred tail.

The morphologically similar *Cercartetus* as recognized in 2019 consists of four currently recognized species being *C. caudatus* (Milne-Edwards, 1877) (in fact at least 6 species), *C. Lepidus* Thomas, 1888 (in fact two species), *C. concinnus* (Gould, 1845) and *C. nanus* (Desmarest, 1818).
For evidence and reasons explaining why there are in fact more extant species than those listed as recognized above, see Osborne and Christidis (2002) and then see Hoser (2020).

The genus *Eudromicia* Mjöberg, 1916 is resurrected by Hoser (2020) for the species associated with *C. caudatus* (Milne-Edwards, 1877) based on a divergence of 16-27 MYA (Osborne and Christidis, 2002).

Cercartetus sensu lato species are separated from *Burramys* by having tails that have a feather-like appearance.

Further relevant diagnostic and other information about *B. parvus sensu lato* can be found on pages 216 and 217 of Hoser (1991).

Distribution: *B. parvus hosersbogensis subsp. nov.* is known only from the Kosciusko National Park, New South Wales, Australia.

Etymology: The name is a take on that of the type locality. This is a public toilet at the Perisher Ski Resort, where I relieved myself with a massive faeces (Australian word is “bog”), making it the site of “Hoser’s bog”. It may have been some kind of record breaker, but adding the words “potentially record breaking” to the scientific name would have made it excessively long as would have been “Hoser’s massive bog”! Hence the name “*hosersbogensis*”.

There is also a swamp or “bog nearby.

In any event, this name will be easily remembered by Australian zoologists and lay people alike and draw people’s attention to a threatened taxon.

Thankfully I did not use this toilet curing the Coronvirus epidemic of 2020, because for some months in early 2020, panic buying by people stripped shop shelves bare of toilet paper and most of the population in Australia was physically unable to obtain the commodity.

BURRAMYS PARVUS TIMDALEI SUBSP. NOV.

LSIDurn:lsid:zoobank.org:act:7805FD69-CDEB-49BA-A472-C9225440B312

Holotype: A preserved specimen at the National Museum of Victoria, Melbourne, Victoria, Australia, specimen number C37334, collected at Mount Buller Ski Resort, Victoria, Australia, Latitude -37.13 S., Longitude 164.45 E. This government-owned facility allows access to its holdings.

Paratypes: Two preserved specimens at the National Museum of Victoria, Melbourne, Victoria, Australia, specimen number C37335 and C37336, collected at Mount Buller Ski Resort, Victoria, Australia, Latitude -37.13 S., Longitude 164.45 E.

Diagnosis: Living *Burramys parvus* Broom, 1896 of all three subspecies named herein are formally separated from the fossil type material herein treated as a fourth and nominate subspecies, namely *B. parvus parvus*.

All three newly named subspecies of *B. parvus* are readily separated from the fossil type material from near Taralga, New South Wales by the fact that the premolars are in proportion, versus slightly oversized in fossil *B. parvus* type material, which is evidence and grounds to form the basis that the living forms are at least different subspecies (also refer to Broom 1896 and comparative material from Victoria in Brammall and Archer 1997).

Besides being easily separated from one another by genetics as detailed by Osborne *et al*. (2000), the three newly named living subspecies of *B. parvus* are in turn readily separated from one another by colouration as follows:

B. parvus hosersbogensis subsp. nov. from the Kosciusko National Park, New South Wales, Australia are grey-brown above, sometimes darker in the mid-dorsal area, continuing to the top of the head; dark ring around the eye; pale grey-brown or pale brown below; light brown on the cheeks. There is some white between the eyes and the tip of the snout.
B. parvus timdalei subsp. nov. from Mount Buller in Victoria is yellow-brown above, sometimes darker in the mid-dorsal area, continuing to the top of the head; dark ring around the eye; light brown below and yellow cheeks.

There is no white between the eyes and the tip of the snout. Instead this area is a deep yellow.

B. parvus scottyjamesi subsp. nov. from the Bogong High Plains including the Mount Hotham Ski resort is grey-brown above, sometimes darker in the mid-dorsal area, continuing to the top of the head; dark ring around the eye; cream or white coloured below and light cream or white on the cheeks.

There is some white between the eyes and the tip of the snout.

B. parvus hosersbogensis subsp. nov. in life can be seen online at:

https://www.flickr.com/photos/alexismarie_meyer/4464197606/

and

https://www.flickr.com/photos/152410663@N05/35729353956/

(both last downloaded on 10 January 2020).

B. parvus timdalei subsp. nov. in life can be seen online at:

http://www.mtbuller.com.au/uploads/file/MPP_Fact_Sheet.pdf

and

https://cdn.mtbullercdn.com.au/assets/environment/mt_buller_mountain_pygmy-possum_recovery_plan_2011-2016_final.pdf

(both last downloaded on 10 January 2020).

B. parvus scottyjamesi subsp. nov. in life can be seen in Strahan (1988) on page 168 (both images),

on front cover of Hoser (1991) as well as on page 217 of that book (different image, and clearly showing the diagnostic features of this subspecies) and images of the same animal at

http://www.edgeofexistence.org/species/mountain-pygmy-possum/

(last downloaded on 10 January 2020).

As of 2019, according to most publishing authors, there are two extant genera of pygmy possums: *Burramys* Broom, 1896 and *Cercartetus* Gloger, 1841. *Burramys* contains only one extant species, the Mountain Pygmy-possum, *Burramys parvus*, which has a lightly furred tail.

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For evidence and reasons explaining why there are in fact more extant species than those listed as recognized above, see Osborne and Christidis (2002) and then see Hoser (2020).

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Cercartetus sensu lato species are separated from *Burramys* by

Hoser 2020 - Australasian Journal of Herpetology 42:3-10.

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Cercartetus species are separated from *Burramys* by having tails that have a feather-like appearance.

Further relevant diagnostic and other information about *B. parvus sensu lato* can be found on pages 216 and 217 of Hoser (1991).

Distribution: *B. parvus timdalei subsp. nov.* are known only from the immediate environs of the Mount Buller Ski Resort, Victoria, Australia, with main populations centred on the Federation and Fanny's Finnish ski run areas and associated boulder fields.

Unfortunately the surviving population has been infected with specimens of the Mount Hotham lineage (Menkhorst *et al.* 2016), meaning that pure *B. parvus timdalei subsp. nov.* are as of 2020 almost certainly extinct.

Etymology: Named in recognition of Tim Dale of Warrandyte, Victoria, Australia who is a local snowboarding legend at Mount Buller, Victoria and has been for some years in recognition for his logistical services aiding wildlife conservation by providing relevant services to Snakebusters: Australia's best reptile shows, being the only hands on reptile shows in Australia that educate by letting people hold the animals.

BURRAMYS PARVUS SCOTTYJAMESI SUBSP. NOV.

LSID urn:lsid:zoobank.org:act:269AA0C7-FE7D-4445-9696-70DAE60B8DDE

Holotype: A preserved specimen at the National Museum of Victoria, Melbourne, Victoria, Australia, specimen number C27309 collected from the eastern slope of Mount Higginbotham at the Mount Hotham Ski Resort, Victoria, Australia, Latitude -36.98 S., Longitude 147.15 E.

This government-owned facility allows access to its holdings.

Paratype: A preserved specimen at the National Museum of Victoria, Melbourne, Victoria, Australia, specimen number C26917 collected from the western slope of Mount Higginbotham at the Mount Hotham Ski Resort, Victoria, Australia, Latitude -36.98 S., Longitude 147.15 E.

Diagnosis: Living *Burramys parvus* Broom, 1896 of all three subspecies named herein are formally separated from the fossil type material herein treated as a fourth and nominate subspecies, namely *B. parvus parvus*.

All three newly named subspecies of *B. parvus* are readily separated from the fossil type material from near Taralga, New South Wales by the fact that the premolars are in proportion, versus slightly oversized in fossil *B. parvus* type material, which is evidence and grounds to form the basis that the living forms are at least different subspecies (also refer to Broom 1896 and comparative material from Victoria in Brammall and Archer 1997).

Besides being easily separated from one another by genetics as detailed by Osborne *et al.* (2000), the three newly named living subspecies of *B. parvus* are in turn readily separated from one another by colouration as follows:

B. parvus hosersbogensis subsp. nov. from the Kosciusko National Park, New South Wales, Australia are grey-brown above, sometimes darker in the mid-dorsal area, continuing to the top of the head; dark ring around the eye; pale grey-brown or pale brown below; light brown on the cheeks. There is some white between the eyes and the tip of the snout.
B. parvus timdalei subsp. nov. from Mount Buller in Victoria is yellow-brown above, sometimes darker in the mid-dorsal area, continuing to the top of the head; dark ring around the eye; light brown below and yellow cheeks.

There is no white between the eyes and the tip of the snout. Instead this area is a deep yellow.

B. parvus scottyjamesi subsp. nov. from the Bogong High Plains including the Mount Hotham Ski resort is grey-brown above, sometimes darker in the mid-dorsal area, continuing to the top of the head; dark ring around the eye; cream or white coloured below and light cream or white on the cheeks.

There is some white between the eyes and the tip of the snout.

B. parvus hosersbogensis subsp. nov. in life can be seen online at:

https://www.flickr.com/photos/alexismarie_meyer/4464197606/

and

https://www.flickr.com/photos/152410663@N05/35729353956/

(both last downloaded on 10 January 2020).

B. parvus timdalei subsp. nov. in life can be seen online at:

http://www.mtbuller.com.au/uploads/file/MPP_Fact_Sheet.pdf

and

https://cdn.mtbullercdn.com.au/assets/environment/mt_buller_mountain_pygmy-possum_recovery_plan_2011-2016_final.pdf

(both last downloaded on 10 January 2020).

B. parvus scottyjamesi subsp. nov. in life can be seen in Strahan (1988) on page 168 (both images),

on front cover of Hoser (1991) as well as on page 217 of that book (different image, and clearly showing the diagnostic features of this subspecies) and images of the same animal at

http://www.edgeofexistence.org/species/mountain-pygmy-possum/

(last downloaded on 10 January 2020).

As of 2019, according to most publishing authors, there are two extant genera of pygmy possums: *Burramys* Broom, 1896 and *Cercartetus* Gloger, 1841. *Burramys* contains only one extant species, the Mountain Pygmy-possum, *Burramys parvus*, which has a lightly furred tail.

The morphologically similar *Cercartetus* as recognized in 2019 consists of four currently recognized species being *C. caudatus* (Milne-Edwards, 1877) (in fact at least 6 species), *C. Lepidus* Thomas, 1888 (in fact two species), *C. concinnus* (Gould, 1845) and *C. nanus* (Desmarest, 1818).
For evidence and reasons explaining why there are in fact more extant species than those listed as recognized above, see Osborne and Christidis (2002) and then see Hoser (2020).

The genus *Eudromicia* Mjöberg, 1916 is resurrected by Hoser (2020) for the species associated with *C. caudatus* (Milne-Edwards, 1877) based on a divergence of 16-27 MYA (Osborne and Christidis, 2002).

Cercartetus sensu lato species are separated from *Burramys* by having tails that have a feather-like appearance.

Cercartetus species are separated from *Burramys* by having tails that have a feather-like appearance.

Further relevant diagnostic and other information about *B. parvus sensu lato* can be found on pages 216 and 217 of Hoser (1991).

Distribution: *B. parvus scottyjamesi subsp. nov.* is restricted to the Bogong High Plains and associated mountains in north-east Victoria, Australia.

Etymology: Named in honour of Scotty James of Warrandyte, Victoria, Australia, in recognition for his services for snowboarding worldwide. He was the flag bearer for Australia at the 2018 Winter Olympics, where he won a bronze medal in halfpipe. He has won numerous titles since and has inspired countless young people to get out of their homes and to enjoy the outdoor environment in sport, which in turn encourages people to want to do what is needed to preserve and enhance the world's natural assets (except when locked in their homes with Coronavirus inspired government "lock downs" like in 2020).

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CONFLICTS OF INTEREST

None.

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