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Redescription of the South African dwarf chameleon, *Bradypodion nemorale* Raw 1978 (Sauria: Chamaeleonidae), and description of two new species

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ABSTRACT

This paper reexamines the taxonomic status of the dwarf-chameleon species, *Bradypodion nemorale*, which was described from the indigenous forests of Nkandla and Qudeni north of the Tugela Valley (Raw, 1978). Since that time additional populations have been found at Entumeni Forest, Dlinza Forest, Eshowe and Ongoye Forest. While these have all been regarded as a single species (Branch, 1988, 1998) this paper shows that there are actually three distinct taxa in this area. *Bradypodion nemorale* is therefore redescribed and diagnoses and descriptions are provided for the two new species, *B. nkandlae* n. sp. and *B. caeruleogula* n. sp.

ADDITIONAL KEY WORDS

Dwarf chameleon, South Africa.

INTRODUCTION

Raw (1978) described the species, *Bradypodion nemorale*, from the Nkandla and Qudeni forests of Zululand, KwaZulu-Natal, South Africa. Klaver & Böhme (1986, 1997) have followed this usage, as has Branch (1988, 1998).

The present study re-examines the taxonomic status of *B. nemorale* in the light of similar populations that have been discovered at Entumeni Forest, Dlinza Forest, Eshowe and at Ngoye (Ongoye) Forest, as well as in respect of the Nkandla population which appears to be completely isolated from the Qudeni population (Raw, 1995, 2002).

A molecular phylogenetic study of *Bradypodion* by Tolley *et al* (2003) did not include material of topotypic *B. nemorale*. Nevertheless, their finding that the populations from the Nkandla and Dlinza Forests fall into separate clades confirms the separate status of the three taxa considered in this paper. Their finding that *B. setaroi* also comprises a separate clade confirms the status of that coastal taxon as distinct from the higher-altitude populations considered below.

MATERIALS AND METHODS

Some 687 preserved *Bradypodion* specimens were examined during studies on the South African dwarf chameleons. The abbreviations used for collections housing specimens used in this paper are:

LR – LRG Raw Private Herpetological Collection, South Africa & Greenford, UK.

NMP – Natal Museum, Pietermaritzburg, KwaZulu-Natal, South Africa.

Qualitative data were collected where possible; except for the holotype of *B. nemorale*, specimens used in this study were collected alive, allowing significant characters such as colour to be observed. Juveniles may lack some of the features that are useful for adults as they have not developed fully. The characters used in diagnosing and describing these species are mainly external and are as follows: snout length vs diameter of orbit; casque profile (adult); posterior temporal (squamosal) crest in relation to lateral parietal crest; median parietal crest form; temporal crest development; subocular tubercle shape and location; gular groove colour; gular lobe arrangement; gular lobe shape; gular lobe distal tip shape; longitudinal flank grooves; posterior dorsolateral scale patterns; flank tubercle enlargement; flank tubercle rows; dorsal crest extent; dorsal tubercle arrangement; general scalation and scale arrangement on side of body. Many of these visual characters appear to be important in the mating, aggression and species recognition displays of these chameleons. The descriptions of hemipenes (where available) follow the terminology of Klaver and Böhme (1986).

Where, as in this study, the identification of taxonomic diversity is a major objective, a species can be regarded, for practical purposes and in the absence of detailed information on genetic relationships, as any population that can be distinguished in some consistent way from other populations, whether sympatric, parapatric or allopatric. This may mean that some taxa may later be shown not to warrant full species rank, but, until more detailed genetic studies have been done, it is preferable to identify potential discontinuities rather than to assume subspecific status. In many respects this concept is very similar to the Phylogenetic Species Concept also known as the Practical or Diagnostic Species Concept (de Queiroz & Donoghue 1988, 1990).

TAXONOMIC ACCOUNT

The division of these populations into three species is mainly based on differences in the form and colour in life of two characters, namely the presence and colour of longitudinal grooves or striations along the flanks of the body, and the colour of the gular grooves. These are regarded as significant for species recognition since the flanks and throat are inflated during inter-individual displays. *Bradypodion nemorale* from Qudeni Forest differs from the other related populations in lacking any lateral grooves while the other populations have red lateral grooves. The Nkandla Forest population has white gular grooves while the Entumeni Forest, Dlinza Forest and Eshowe populations have dark blue-grey gular grooves. The geographically close proximity of these latter populations also suggests that they form a single interbreeding taxonomic unit. A specimen seen and photographed in the Ngoye Forest appeared to belong to this form but was not examined and so cannot be assigned to it with any certainty. In view of these differences, it appears that these three isolated populations should no longer be considered a single species. The holotype of *B. nemorale* was collected in the Qudeni Forest so this population is redescribed from material restricted to this locality to remove any composite details but will retain the name while the other two populations are described as new species.

Redescription of *Bradypodion nemorale* Raw 1978

Bradypodion nemorale Raw, 1978: 265-269, figs. 1, 2; Raw, 1995: 19. (in part, Qudeni Forest specimens only).

Holotype. NMP 1474, an adult female in the Natal Museum collection, Pietermaritzburg, collected by R F Lawrence, C S Holliday and T Schofield, 16-23 February, 1953 (figure 1).

Paratypes. LR 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 2761, 2762, 2763, 2764, 2773, 2774, 2775, 2776 and 2793 (Note that paratypes LR 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912 and 913 are now assigned to *B. nkandlae*).

Type locality. Qudeni Forest, Zululand, KwaZulu-Natal, South Africa (28°41'S 30°53'E).

Diagnosis. A medium-sized dwarf chameleon. Casque strongly raised. Subocular tubercle not or only slightly raised. Cranial crests developed and distinct but not swollen or horn-coloured. Gular lobes longer than broad. Throat region pigmented with white gular grooves. Flanks without longitudinal grooves. Dorsal crest distinct, continuing on tail.



Figure 1. *Bradypodion nemorale* Raw, 1978, holotype (NMP 1474).

Description. Snout sharp, distance from tip to anterior edge of orbit greater than diameter of orbit. Casque distinctly raised; not produced posteriorly, median parietal crest convex. Posterior temporal (squamosal) crest continuing parallel to lateral parietal crest at side of casque; median parietal crest raised to form a less-distinct ridge; paraparietal tubercles present anteriorly; inter-orbital tubercles present; temporal crests distinctly developed. Subocular tubercle not raised and not bordering mouth. Colour of interstitial skin of gular grooves white. Gular lobes all more or less equal in size. Gular lobes mostly rounded, distal tip papillate, without denticulate edges. Flanks without longitudinal grooves or striations. Posterior dorsolateral scales not forming a discernable pattern of alternating larger and smaller scales. Flank tubercles slightly enlarged, forming single row. Dorsal crest extending along tail; tubercles equal or sub equal. Tail length less than head-and-body length; tail slender without a distinct tip region.

Counts. The type has 11 gular lobes (range 9-15, mean 11,71, median 12; n = 21) and 27 dorsal tubercles (range 14-29, mean 21,6, median 21; n = 21).

Size. Largest female (NMP 1474 - Holotype) has head-and-body length 80 mm and tail length 65 mm. No adult males are available for comparison.

Coloration. Basic colour is shades of brown, more or less uniform, with white gular grooves.

Hemipenes. Not known.

Reproduction. Not known.

Field notes. This rather elusive species has been collected on road verges in indigenous forest.

Distribution. Known from the Qudeni Forest north of the Tugela River, Zululand.

Recorded localities and specimens examined. Qudeni Forest (28°36'S 30°52'E): LR 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925 (FL Farquharson, MN Harris & LRG Raw, 23 April 1977); 2761, 2762, 2763, 2764, 2773, 2774, 2775, 2776, 2793 (DRJ., KL, LA, LRG & PEV Raw, January 1992); and NMP 1474 (RF Lawrence, CS Holliday & T Schofield, 16-23 February, 1953).

Etymology of specific name. This is derived from the Latin, *nemoralis*, meaning living in or frequenting groves or woods, and refers to the preferred forest habitat of the species (Raw, 1978). While Zululand Dwarf Chameleon has been proposed as a common name (Branch, 1988), this is not the only dwarf Chameleon

found in Zululand. In view of its localised distribution, the substitute name of Qudeni Dwarf Chameleon is suggested as being more appropriate.

Comment. The type series of *Bradypodion nemorale* Raw 1978 has been shown to comprise two taxa, *nemorale* and *nkandlae*. A paratype specimen (LR925) was previously erroneously illustrated (in life) as a specimen from Nkandla Forest (Raw, 1978, fig. 2).

***Bradypodion nkandlae* n. sp.**

Synonymy. *Bradypodion nemorale* Raw, 1978: 265-269; Raw, 1995: 19. (in part, Nkandla Forest specimens only).



Figure 2. *Bradypodion nkandlae* n. sp., holotype (LR 900).

Holotype. LRG Raw Collection number LR900 collected by FL Farquharson, MN Harris and LRG Raw on 23 April 1977 (figure 2). This is presumably an immature specimen but no obviously adult specimens of this taxon have yet been collected.

Type locality. Nkandla Forest, Zululand, KwaZulu-Natal, South Africa.

Paratypes. LR 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884 - Nkandla Forest (FL Farquharson, MN Harris & LRG Raw, February 1977), 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912 and 913 - Nkandla Forest (FL Farquharson, MN Harris & LRG Raw, 23 April 1977).

Diagnosis. A smaller species with raised parietal region of casque. Throat region pigmented, with white gular grooves. Flanks with red longitudinal grooves.

Description. Snout sharp, length from tip to anterior border of orbit less than diameter of orbit. Casque raised, median parietal crest concave. Posterior temporal (squamosal) crest replacing lateral parietal crest at side of casque; median parietal crest raised to form an abrupt-edged keel; para-parietal tubercles present anteriorly; inter-orbital tubercles present; temporal crests with lower temporal crest poorly developed except for posterior tubercle and posterior temporal crest tubercles reduced. Subocular tubercle not raised and not bordering mouth. Colour of interstitial skin of gular grooves white. Gular lobes with median lobes largest. Gular lobes mostly triangular, distal tip papillate, without denticulate edges. Flanks with red longitudinal grooves or striations. Posterior dorsolateral scales forming a slightly discernable pattern of alternating larger and smaller scales. Flank tubercles slightly enlarged, forming a single row. Dorsal crest not reaching tail; tubercles not strongly differentiated forming a slight pattern. Tail length less than head-and-body length; tail slender and without a distinct tip region.

Counts. The type has 8 gular lobes (range 8-20, mean 14.69, median 15; n = 42) and 25 dorsal tubercles (range 11-28, mean 18, median 18; n = 42).

Size. Holotype (LR 900, largest male): Head-and-body length 48 mm; tail length 45 mm. Largest female (LR 882) head-and-body length 47 mm; tail length 45 mm.

Note: The small size and immature appearance of the available specimens made accurate gender determination very difficult.

Coloration in life. A subadult male was brown with irregular greenish blotches, mainly along upper flank but also forming irregular islands of colour on the lower flank. Slightly enlarged tubercles along middle of flank orange; tubercles of dorsal crest reddish brown. Skin on flanks arranged into longitudinal pattern with intervening grooves orange. Scattered enlarged tubercles on flanks, limbs and tail orange. Throat grooves greyish white and eyelids with thin greenish lines radiating outward from eye.

Hemipenes. Everted left hemipenis of LR 880 (subadult) short, broadening towards apex. Four inward curving, denticulate rotulae on apex grouped in anterior and posterior pairs. The outermost of each pair largest. Basal surfaces smoothly calyculate. Sulcus spermaticus passing along posterior base of organ before turning sharply length-wise between enlarged, fleshy lips to end on outer side of organ. Right hemipenis forming a mirror image of the left.

Reproduction. Has not been observed.

Field notes. This elusive species has been collected on road verges in the indigenous Nkandla Forest. When originally collected it was suspected that this may be a neotenic species. Since no obvious adults have yet been found this is still possible but it seems more likely that all the specimens collected to date are actually juveniles.

Distribution. Known from the Nkandla Forest north of the Tugela River, Zululand.

Recorded localities and specimens examined.

Nkandla Forest (28°37'S 31°4'E): LR 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884 (FL Farquharson, MN Harris & LRG Raw, February 1977), 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912 and 913 (FL Farquharson, MN Harris & LRG Raw, 23 April 1977).

Etymology of specific name. The Latinised genitive noun “of Nkandla” refers to the origin from the Nkandla Forest. If a common name is required, it is suggested that Nkandla Dwarf Chameleon would be suitable.

***Bradypodion caeruleogula* n. sp.**

Synonymy. *Bradypodion nemorale* (non Raw, 1978) Tilbury in Branch, 1988: 143 (in part). *Bradypodion nemorale* (non Raw, 1978) Branch, 1988 (in part, plate 95 (4)).

Bradypodion nemorale (non Raw, 1978) Branch, 1998.



Figure 3. *Bradypodion caeruleogula* n. sp., holotype (LR 2777).

Holotype. LRG Raw Collection number LR 2777. An adult female collected by DRJ, KL, LA, LRG & PEV Raw in January 1992 (Figure 3).

Type locality. Eshowe, Zululand, KwaZulu-Natal, South Africa.

Paratypes. LR 2770, 2790; 2816, 2847 - Entumeni Forest (DRJ, KL, LA, LRG & PEV Raw, January 1992); LR 2765, 2768, 2769, 2772, 2777, 2778, 2779, 2780, 2789, 2817, 2818, 2833 and 2834 - Eshowe (vicinity Dlinza Forest) (DRJ, KL, LA, LRG & PEV Raw, January 1992).

Diagnosis. Living animals can be distinguished from other *Bradypodion* by the dark blue-grey gular grooves and red lateral flank grooves.

Description. Snout sharp, distance from tip to anterior edge of orbit greater than diameter of orbit. Casque distinctly raised, not produced posteriorly; median parietal crest straight. Posterior temporal (squamosal) crest replacing lateral parietal crest at side of casque; median parietal crest raised to form a less-distinct ridge; paraparietal tubercles present anteriorly; inter-orbital tubercles present; temporal crests with lower temporal crest not developed except for posterior tubercle and posterior temporal crest tubercles reduced. Subocular tubercle not raised and not bordering mouth. Colour of interstitial skin of gular grooves blue-grey. Gular lobes all more or less equal in size. Gular lobes mostly narrowly triangular and sharply pointed, not papillate or with denticulate edges. Flanks with red longitudinal grooves or striations. Posterior dorsolateral scales forming a slightly discernable pattern of alternating larger and smaller scales. Flank tubercles slightly enlarged; forming single row. Dorsal crest not reaching tail; tubercles strongly differentiated to form a very distinct pattern. Tail length less than head-and-body length in females, longer in males; tail slender without a distinct tip region.

Counts. The type has 14 gular lobes (range 14-20, mean 16,67, median 17; n = 15) and 14 dorsal tubercles (range 11-22, mean 15,3, median 15; n = 15).

Size. Holotype (LR 2777) head-and-body length 62 mm, tail length 54 mm. Largest male (LR 2847) head-and-body length 62 mm, tail length 54 mm. Largest female (LR 2833) head-and-body length 67 mm, tail length 56 mm.

Coloration in life. (Entumeni – LR 2790 and Eshowe – LR 2789) Overall colour greyish-green or yellow. Throat grooves dark grey-blue. Eyelids with dark greenish lines radiating outwards. Tubercles on dorsal crest and numerous tubercles on flanks, limbs and tail orange. Flanks with 9-12 reddish-orange irregular stripes in grooves on flanks. Gular crest white.

Hemipenes. LR 2847 has right hemipenis with finely calyculate sides and four apical rotulae. Outer posterior rotula distinctly larger than inner posterior rotula. Both anterior rotulae much smaller. Sulcus spermaticus passing posteriorly around the base then turning to form a channel up the posterior of the outer side. Left hemipenis incompletely everted.

Reproduction. Has not been observed but Tilbury (1988) reported the observation of six newborn in a bush with a wild female in late September.

Field notes. This species has been collected while sleeping on leaves on trees in indigenous forest and on hedges in suburban gardens. Reisinger, *et al*, (2006) have recently reported on the habitat associations and conservation status of this new taxon.

Distribution. Known from the Entumeni Forest, Dlinza Forest and Eshowe north of the Tugela River, Zululand. Similar chameleons also occur in the Ngoye Forest but their identity with this species has not been confirmed.

Recorded localities and specimens examined.

Entumeni Forest (28°52'S 3°19'E): LR 2770, 2790; 2816, 2847 (DRJ, KL, LA, LRG & PEV Raw, January 1992). Eshowe (vicinity Dlinza Forest) (28°52'S 31°28'E): LR 2765, 2768, 2769, 2772, 2777, 2778, 2779, 2780, 2789, 2817, 2818, 2833 and 2834 (DRJ, KL, LA, LRG & PEV Raw, January 1992).

Sight record. Ngoye Forest (28°52'S 31°22'E): specimens not preserved.

Etymology of specific name. This is derived from *caeruleus* (Latin, dark blue) and *gula* (Latin, throat) and refers to the dark blue-grey of the gular grooves. It is used as a noun in apposition. Formerly included under the common name Zululand Dwarf Chameleon (Branch, 1988). If a common name is required then perhaps Eshowe Dwarf Chameleon would be appropriate but Reisinger, *et al*, (2006) have suggested the more restrictive name of Dhlinza Dwarf Chameleon.

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