



A new species of freshwater turtle of the genus *Elseya* (Testudinata: Pleurodira: Chelidae) from the Northern Territory of Australia

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Abstract

The genus *Elseya* has had a checkered taxonomic history, but is now restricted to species characterized by an alveolar ridge on the triturating surfaces of the jaw. The Australian forms were once regarded as a single widespread species extending from the Mary River of south-eastern Queensland to the Fitzroy River of north Western Australia, but a number of Australian species have now been identified based on a combination of molecular and morphological data—*Elseya dentata*, *E. irwini*, *E. lavarackorum* and *E. albagula*. The genus is represented in New Guinea by *E. branderhorsti*, *E. novaeguineae*, *E. schultzei*, and *E. rhodini*. One additional Australian taxon first identified in 1981 and subsequently established as a distinct taxon by molecular studies, is described here. It is a large chelid turtle that can be distinguished from all other Australian members of the genus *Elseya* by the distinctive cream or yellow plastron, free of the dark streaking, blotches or suffusing present in other species; an extensive bridge with little or no abrupt angle between the bridge and the ventral surface of the plastron; a head shield broken into a series of small plates rather than a single unit; flat uncornified temporal scales; and a narrower, less robust skull. Osteologically, it can be distinguished from *Elseya dentata* by the contact of the vomer and the pterygoids. The carapace is typically a light to medium brown in color whereas the carapace of *Elseya dentata* is typically dark brown to almost black in color. Distribution is the Mary, South Alligator, East Alligator, Goyder and Mann River drainages of the north east of the Northern Territory, Australia. It does not appear to be in sympatry with any other member of *Elseya*. It is, however, in sympatry with three species of *Chelodina*, at least two species of *Emydura*, *Myuchelys latisternum* and *Carettochelys insculpta*.

Key words: Australian Snapping Turtles, Side-neck Turtles, Chelidae, Pleurodira, Arnhem Land

Introduction

In the last 20 years, understanding of species boundaries and their overall nomenclature in the turtle family Chelidae has improved enormously. Most important has been the mounting evidence for the reciprocal monophyly of the Australasian and South American radiations of these Pleurodiran turtles (Seddon *et al.* 1997; Georges *et al.* 1998) and the independent origins of the extended neck and associated changes to the shell to accommodate the extension as a convergent adaptation to piscivory (Pritchard 1984). The Australasian radiation now falls within the subfamily Chelodinae Baur 1893, the South American *Chelus fimbriatus* and sister taxa in the subfamily Chelinae Gray 1825, and species of *Hydromedusa* (sensu Guillon *et al.* 2012) and its fossil relatives in the genus *Yaminuechelys* (sensu Bona & de la Fuente 2005) in the subfamily Hydromedusinae Baur 1893.

The classification of the Australasian Chelidae at the genus level has been reasonably stable, with seven genera recognized (Georges & Thomson 2010). The so-called snake-necked chelids, characterized by exceptionally long necks, are included in the genus *Chelodina* with three major clades each represented by *Chelodina longicollis* (subgenus *Chelodina*, seven living and one fossil species), *Chelodina oblonga* (subgenus *Macrochelodina*, four living and two fossil species) and *Chelodina colliei* (subgenus *Macrodiremys*, monotypic). *Emydura* are a series of four closely related species of riverine turtles characterized by a short neck, and the lack of keratinous structures on the head apart from the tomial sheaths. The genus *Elseya* comprises eight living and two fossil short necked species

characterized by keratinous head shields and prominent low rounded temporal tubercles and an alveolar ridge on the maxillary triturating surfaces of the mouth (Boulenger 1889). Three major clades are recognized: the northern *Elseya* (nominal subgenus *Elseya*, two species) with type species *Elseya dentata*, the Queensland *Elseya* (subgenus *Pelocomastes*, three living and two fossil species) with type species *Elseya uberrima*, and the New Guinea stream *Elseya* (subgenus *Hanwarachelys*, three species) with type species *Elseya novaeguineae*, and two other taxa *E. schultzei* and *E. rhodini* (Thomson *et al.* 2015). The genus *Myuchelys* (three or four species depending upon usage/acceptance of the genus *Flaviemys*, Le *et al.* 2013; Spinks *et al.* 2015) is similar to *Elseya* but lacks the alveolar ridge. The final three genera are monotypic, if extant forms only are considered, represented by *Pseudemydura umbrina*, *Elusor macrurus* and *Rheodytes leukops* (Georges & Thomson 2010; Rhodin *et al.* 2015). *Rheodytes* includes one fossil taxon *Rheodytes devisi* (Thomson 2000).

Of these genera, the genus *Elseya* has been the most problematic. The genus was initially erected for *Elseya dentata* and *Myuchelys latisternum* (Gray 1867) with *E. dentata* (Gray 1863) later designated as the type species (Lindholm 1929). Boulenger (1889) redefined the genus as being diagnosed by the alveolar ridge. *Myuchelys latisternum* and *M. novaeguineae* were placed in the genus *Emydura*. Goode (1967) expressed little faith in the alveolar ridge as a taxonomic feature at the generic level, citing cases of variation in this feature among species of well recognised cryptodiran turtle genera, and transferred *M. latisternum* and *M. novaeguineae* back to *Elseya*. Gaffney (1979) treated *Elseya* as a junior synonym of *Emydura*, with support from McDowell (1983). Georges and Adams (1992) using molecular approaches demonstrated that *Myuchelys latisternum* and three other species formed a clade paraphyletic with respect to the remaining species of *Elseya*—their common ancestor has *Emydura* among its descendants. While this result concurred with that of McDowell (1983), the prevailing view is that the paraphyly was best resolved by splitting the genus *Elseya* (foreshadowed by Legler 1981) rather than adopting the sweeping synonymy recommended by McDowell (1983) and Gaffney (1979).

Once considered to contain a single species, the genus was shown using broad survey of allozyme markers to comprise a number of diagnosable allopatric taxonomic units distinct enough genetically to be considered species (Georges & Adams 1996), as had been long suspected (Goode 1967; Legler 1981). These have been progressively named as *Elseya irwini* (Cann 1997b), *Elseya lavarackorum* (White & Archer 1994) (as *Emydura lavarackorum*, reassigned to *Elseya* and assigned to the extant form by Thomson *et al.* 1997), and *E. albagula* (Thomson *et al.* 2006). The identity and diagnosis of *E. branderhorsti* (Ouwens 1914) has recently been clarified (Georges *et al.* 2006; Thomson *et al.* 2015) and the species complex known as *E. novaeguineae* (Meyer 1874) resolved with the resurrection of *E. schultzei* (Vogt 1911) and the description of *E. rhodini* (Thomson *et al.* 2015). *Elseya dentata* (Gray 1863) is restricted to the populations occupying the northern rivers from west Arnhem Land of the Northern Territory to the Fitzroy River of Western Australia.

Early work on the chelid fossils of Australia placed most specimens in either *Emydura* (shortnecks) or *Chelodina* (longnecks) (reviewed by Georges & Thomson 2006). However more recent studies have demonstrated that these fossils are from a range of genera and many of them are *Elseya* (Thomson & Mackness 1999; Thomson 2000). Two new fossil species of *Elseya* were described including *Elseya lavarackorum* (White & Archer 1994) later found to be a living fossil (Thomson *et al.* 1997) and *Elseya nadibajagu* (Thomson & Mackness 1999). Older fossils were also reassigned such as *Elseya uberrima* (de Vis 1897), demonstrating that this old genus was widely distributed throughout Australia. All these fossil taxa belong to the subgenus *Pelocomastes* (*sensu* Thomson *et al.* 2015).

The work on extant forms referred to above brings to completion the naming and description of all species of *Elseya* identified in the analysis of species boundaries by Georges and Adams (1996) with the exception of one—a distinctive form found in the rivers draining the Arnhem Land Plateau of northern Australia and referred to as *Elseya* sp. aff. *dentata* [Sth Alligator] (Georges & Adams 1992;1996). In this paper we provide formal description of this new taxon first identified by Legler (1981), and later verified as genetically distinct, from the Arnhem Land region of the Northern Territory, Australia.

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1. Documents privately printed and circulated under the banner Australian Biodiversity Record are not recognised as scientific publications or as publications for the purposes of nomenclature. The name *jukesii* used in such a document is not regarded here as an available name. See also Fritz, U. and Havaš, P. 2007. Checklist of chelonians of the world. *Vertebrate Zoology* 57(2):149–368, page 162.

Material and methods

We examined all available specimens of *Elseya* from the Australian Museum (AM), the Museums and Art Galleries of the Northern Territory (NTM), The Queensland Museum (QM), the Western Australian Museum (WAM), the National Wildlife Collection (NWC) and the Natural History Museum of London (BMNH). Additional specimens in the private collection of J.M. Legler (UU) and the senior author (UC) were also examined as part of the study. Names of skull elements follows that of Gaffney (1979), shell terminology follows that of Zangerl (1969) with modifications by Pritchard and Trebbau (1984); Thomson *et al.* (1997); Thomson and Mackness (1999) and Thomson *et al.* (2015). Appendix A of Thomson *et al.* (2015) lists the specimens examined for this study. Those identified as *Elseya (Elseya)* sp. aff. *dentata* (South Alligator) in that appendix are the new species described herein.

Throughout this paper, we use the genus *Elseya* in the sense of Thomson *et al.* (2006) and refer to the following three distinct clades, which are now regarded as subgenera. The subgenus *Elseya (Elseya)* comprises *E. dentata*, *E. branderhorsti* and the form described in this paper. *Elseya (Hanwarachelys)* comprises *E. novaeguineae*, *Elseya schultzei* and *E. rhodini* from the New Guinea region (Thomson *et al.* 2015). *Elseya (Pelocomastes)* comprises *E. lavarackorum*, *E. irwini*, and *E. albagula* from coastal Queensland, Australia.

Systematics

Order Testudines Linnaeus, 1758

Suborder Pleurodira Cope, 1864

Family Chelidae Gray, 1825

Subfamily Chelodinae Baur, 1893

Genus *Elseya* Gray, 1867:44

Subgenus *Elseya* Gray, 1867:44, sensu Thomson *et al.*, 2015

Elseya (Elseya) flaviventralis sp. nov.

Yellow-bellied Snapping Turtle

(Figure 1)

Type data. HOLOTYPE: NTM 13512, adult female from Pine Creek Crossing, South Alligator River Drainage, Kakadu National Park, Northern Territory, Australia. 13° 30' S 132° 28' E (Figure 2). PARATYPE and ALLOTYPE: NTM 13985, adult male from Pul Pul Billabong, South Alligator River Drainage, Northern Territory, Australia. 13° 34' S 132° 35' E (Figure 3).

Referred specimens. AM 38325-26, 40181, 40278, 43532, 128001-02, 128004, 129342; ANWC 0531; NTM 5097, 13512, 13985, 34496; QM 59285-89; UC 0304; UU 14784-92, 17904-961, 18740-759.

Distribution. The Mary, South Alligator, East Alligator, Goyder and Mann River drainages of the north east of the Northern Territory, Australia (Figure 4). It does not appear to be in sympatry with any other member of *Elseya*. It is, however, in sympatry with three species of *Chelodina*, at least two species of *Emydura*, *Myuchelys latisternum* and *Carettochelys insculpta*.

Diagnosis. *Elseya flaviventralis* is a large chelid turtle belonging to the *Elseya (Elseya)* subgenus. It can be distinguished from *Elseya dentata* and all other Australian members of the genus *Elseya* by the distinctive cream or yellow plastron, free of the dark streaking, blotches or suffusing present in other forms of *Elseya*; bridge is extensive, with little or no abrupt angle between the bridge and the ventral surface of the plastron; a head shield that is broken up into a series of small plates rather than a single unit; flat uncornified temporal scales; and a narrower less robust skull. Osteologically, it can be distinguished from *Elseya dentata* by the contact of the vomer and the pterygoids. The carapace is typically a light to medium brown in color whereas the carapace of *Elseya dentata* is typically dark brown to almost black in color.

Etymology. The name *flaviventralis* comes from a combination of the Latin words *flavus*, meaning yellow, and *ventralis*, meaning ventral surface or belly. This is a reference to consistent cream or yellow coloring of the plastron in this species that distinguishes it from its nearest relative (both phylogenetically and geographically) *Elseya dentata*, which always has some degree of black coloration on the plastron.

Related taxa. *Elseya flaviventralis* is a member of the subgenus *Elseya* (*Elseya*) and is most closely related to *Elseya dentata* and *Elseya branderhorsti*.



FIGURE 1. Adult female Yellow Bellied Snapping Turtle (*Elseya* (*Elseya*) *flaviventralis*) from Pul Pul Billabong, Kakadu National Park, Northern Territory (13° 34' S, 132° 35' E).

Description. External Morphology.

Carapace. The carapace is broadly oval but narrowed at the anterior end. The most anterior points of the carapace are in the lateral third of the first marginal and the most posterior points are either side of the supracaudal notch. Marginals 4-7 are upturned in adults and marginals 8-11 are expanded and flared. There are no medial keels present in adults, but juveniles are slightly keeled medially. Adults do not have a serrated margin, but posterior marginals of juveniles are serrated from the posterior edge of marginal 7. Whereas *Elseya dentata* will show serrations from the posterior edge of marginal 4, *Elseya albagula* from marginal 1, *Elseya irwini* from marginal 9 and *Elseya lavarackorum* from marginal 2 (Thomson *et al.* 2006). Hence, similarly sized juveniles of *Elseya flaviventralis* can be distinguished from all other species of *Elseya* on this character. Spiny protrusions are absent from the posterior edge of marginals at all growth stages. The scute surface is not deeply fenestrated. Only one specimen examined had any degree of fenestration in the carapace (AM 128004) but this appears to be an injury. The carapace is brown to dark brown, growth rings are often visible, but whether or not they are annual is unknown. The scutes of this species are often smooth and lustrous, as against the rough, matte, and textured scutes in other *Elseya*.

Plastron. Plastral formula using midline length is: pec > fem > abd > ana > int > hum > gul. The plastron is narrow with an axillary width approximately 40% of the carapace width. Bridge is extensive, little or no abrupt angle between the bridge and the ventral surface of the plastron; the posterior lobe of the plastron is longer than the anterior lobe. The anterior lobe is markedly narrower than in an *Elseya dentata* of equivalent size and this lobe is quite angular as against the more rounded shape seen in other species. Plastron color is yellow, cream or white and this species never has black streaking or mottling of the plastron, a feature that readily identifies this species from all other *Elseya*.



FIGURE 2. Dorsal and lateral views of the holotype of *Elseya (Elseya) flaviventralis* NTM 13512, adult female from Pine Creek Crossing, South Alligator River Drainage, Kakadu National Park, Northern Territory, Australia. 13° 30' S 132° 28' E. The plastron has been disarticulated. Note the uniform coloration of the plastron, free from darker streaks and blotches, and the indistinct angle between the bridge and the plastron. Scale 10 mm.

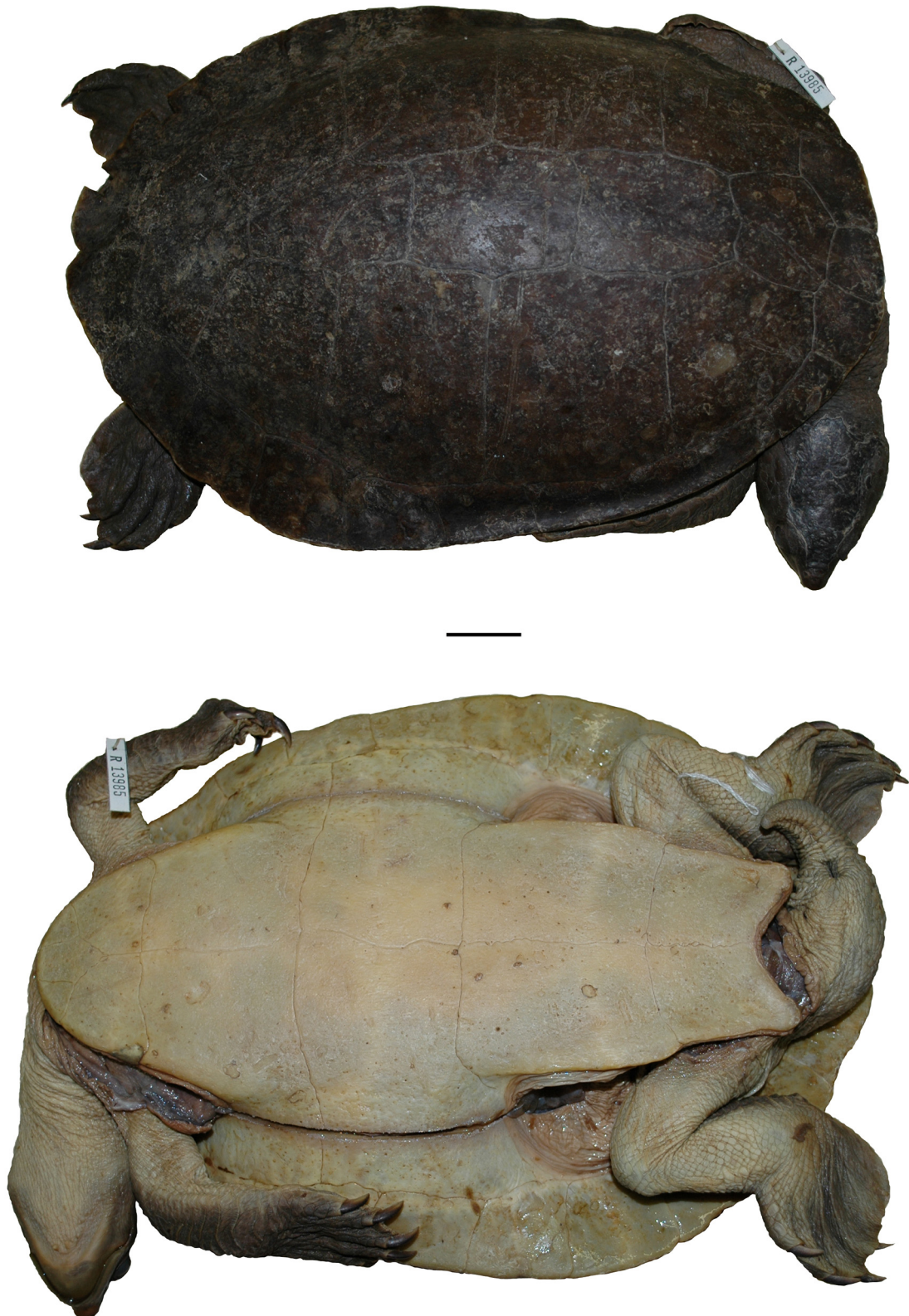


FIGURE 3. Dorsal and lateral views of the Paratype (Allotype) of *Elseya* (*Elseya*) *flaviventralis* NTM 13985, adult male from Pul Pul Billabong, South Alligator River Drainage, Northern Territory, Australia. 13° 34' S 132° 35' E. Scale 10 mm. The plastron has been disarticulated.

Head and Soft Parts. Head is large, but narrower and appears more delicate than its nearest relative, *Elseya dentata*, grey to brown on top white to cream below. The tomial sheath is yellow with no vertical barring, distinctive within the *Elseya dentata* group. The lateral sides of the head are covered in medium-sized scales but these are not raised or cornified. The parietal tubercles are rounded and small. A head shield is present which extends from the posterior of the nasals over the parietal and to the back of the skull but it does not extend down the parietal arch toward the tympanum. The head shield is fragmented, not entire as in all other *Elseya*. The dorsal surface of the neck is covered with medium sized pointed tubercles, though these are not as prominent as in *Myuchelys latisternum*. On the lower surface of the jaw there are two rounded barbels, which are larger than those in *Elseya dentata* but smaller than in the species from Queensland. The iris is green in color without a ring around the pupil and the sclera of the eye is brown. There are no dark spots on the iris anterior or posterior of the pupil. The rest of the skin is dark grey to brownish grey dorsally and cream to white ventrally. There are a series of enlarged scales on the thigh and shin region of the hind legs that form a skin flap that may assist in swimming. There are no pre-anal glands present.

Size and Sexual Dimorphism. Females grow to about 34 cm carapace length and males to about 27 cm. The largest animals measured in this study are a 325 mm female and a 265 mm male (Table 1).

TABLE 1. Selected measurements of *Elseya flaviventralis* examined in this study. CL = carapace length; CW#8 = carapace width at 7/8th marginal; CW#4 = carapace width at 4/5th marginal; PL = plastron length. All measurements are straight line and in mm.

Id. No.	Sex	CL	CW#8	CW#4	PL	HL	HWT
AM38325	F	290.66	207.36	175.57	244.36	62.75	45.11
AM38326	M	229.41	167.45	138.66	194.95	54.80	38.02
AM40278	JF	184.46	144.51	120.92	147.94	45.94	31.46
AM43532	M	250.38	181.24	154.45	208.47	62.67	40.49
AM128001	F	307.37	220.16	187.07	256.38	70.24	45.09
AM128002	F	291.23	223.84	182.27	276.00	66.47	44.12
AM128004	F	325.00	250.19	205.78	257.00	66.91	47.28
NTM5097	-	250.75	176.53	142.70	204.77	-	-
NTM13985	M	265.49	191.38	148.18	223.41	65.76	41.06
NTM13512	F	311.50	224.65	189.94	269.26	67.75	47.48
QM59285	M	248.90	180.74	151.71	-	41.65	29.20
QM59286	M	173.21	137.32	111.47	-	-	-
QM59288	J	116.73	103.19	83.07	-	32.20	23.26

Osteology. Skull. The skull of *Elseya flaviventralis* is large but delicate in structure, highly emarginated both from below and behind, to the extent that the parietal arch is narrow and hence cannot support the attachment of a head shield in this area (Figure 5). The alveolar ridge begins laterally and adjacent to the foramen praepalatium and the ridge does not exclude this foramen from view. The alveolar ridge extends posteriorly for the full extent of the triturating surface. The ridge is restricted to the maxilla and makes no contact with the palatines or premaxilla. Generally, this species is similar in alveolar ridge structure to *Elseya dentata*, but in similarly sized specimens the ridge is less distinctive. The lingual ridge of the triturating surface is serrated throughout its length and partially obscures the apertura nasalis interna. The lingual ridge extends posteriorly to almost make contact with the pterygoids. The lingual ridge begins on the premaxilla, unlike in *Elseya dentata*, and continues posteriorly along the maxilla to a point adjacent to the apertura nasalis interna where it continues onto the palatine bone. The degree of serration is less than in specimens of *Elseya dentata* of similar size, and far less than in the Queensland species.

The vomer is narrow throughout its length and contacts the pterygoids, separating the palatines. The canalis caroticus internus is closed over, but the foramen anterius canalis caroticus internus is absent. The supraoccipital is large in this species and it narrowly divides the parietals at the rear of the skull. The crista supraoccipitalis is long and extends far beyond the occipital condyle, a feature absent in the Queensland forms but present to a lesser degree in the New Guinea species.

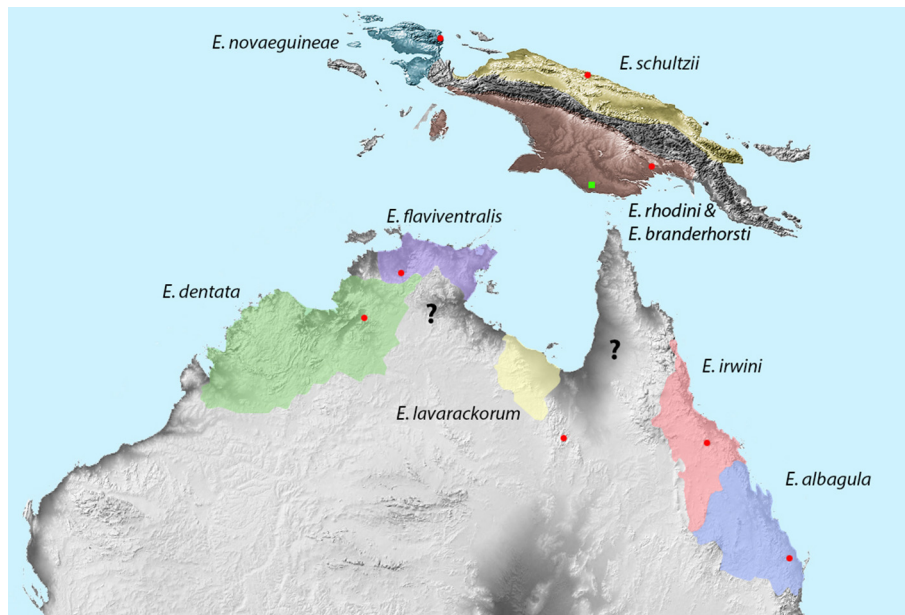


FIGURE 4. Distribution of extant species in the genus *Elseya*. The ranges of *Elseya rhodini* and *Elseya branderhorsti* overlap to the west and including the Fly River drainage. Type localities are shown as red dots, with the exception of *E. branderhorsti* (green dot). The type locality for *E. lavarackorum* is outside range because it was described from a fossil from Riversleigh now outside its present range. *E. rhodini* occupies small streams and tributaries; *E. branderhorsti* occupies tidal regions, lower reaches and lakes, so the two are seldom found in microsympatry.

Cervicals. The centra all possess sagittal blades that are far less developed when compared to its sister species *Elseya dentata*. Each sagittal blade is concave in shape from the lateral view (flat in *Elseya dentata*) and is narrow and concentrated at the anterior end. The transverse processes are large and triangular in shape and occupy the middle third of the centrum. They protrude horizontally from the neural arch whereas they angle downwards in *Elseya dentata*. The postzygophoses are large, almost join in the midline and are slimmer in overall structure than in *Elseya dentata*. The neural spine is completely absent in this species which distinguishes it from all other *Elseya*.

Shell. As a member of the *Elseya* (*Elseya*) subgenus this species has a prominent medial constriction in the anterior bridge strut suture, a feature shared with *Elseya dentata*. Exposed neurals have been observed in one specimen of this species (QM59285) as an individual variant; however, this animal is also aberrant in other shell features. This species has a less robust, thinner shell than *Elseya dentata* but much stronger buttressing, as evidenced by the stronger and more intricate anterior bridge struts.

Discussion

Elseya flaviventralis is a large, distinctive, short-necked turtle from the Arnhem Land region of the Northern Territory of Australia. First identified as distinctive by Legler (1981), the taxon was clearly delineated at the level of species by 4 fixed allelic differences in broad parapatry from its closest relative *Elseya dentata* (Georges & Adams 1992; 1996). The new species, *Elseya flaviventralis*, together with *E. dentata* and *E. branderhorsti*, form the clade commonly referred to as the *Elseya dentata* subgroup (Thomson *et al.* 1997) formalized recently as the nominate subgenus *Elseya* (Thomson *et al.* 2015). This clade is identified by the presence of a medial constriction in the anterior bridge strut, long crista supraoccipitalis and a less distinct alveolar ridge than its eastern counterparts.

The relationships among the species of *Elseya* is not yet clear. The new species *Elseya flaviventralis* has *Elseya dentata* or *E. branderhorsti* as its sister taxon (Georges & Adams 1992; Todd *et al.* 2014; Spinks *et al.* 2015). The subgenus *Hanwarachelys* (Thomson *et al.* 2015) appears to lie phylogenetically between the subgenera *Elseya* and *Pelocomastes*, as sister taxon to subgenus *Elseya* (Georges & Adams 1992; Georges *et al.* 1998; Le *et al.* 2013; Spinks *et al.* 2015).

This paper brings to a close the lengthy process of describing the numerous species identified through the examination of species boundaries using the multilocus approach of allozyme electrophoresis (Georges & Adams 1992;1996; Georges *et al.* 2002) accompanied by morphological analysis (Legler & Cann 1980; Legler 1981; Cann & Legler 1994; Cann 1997a;c;b; Thomson *et al.* 2000; Thomson *et al.* 2006).

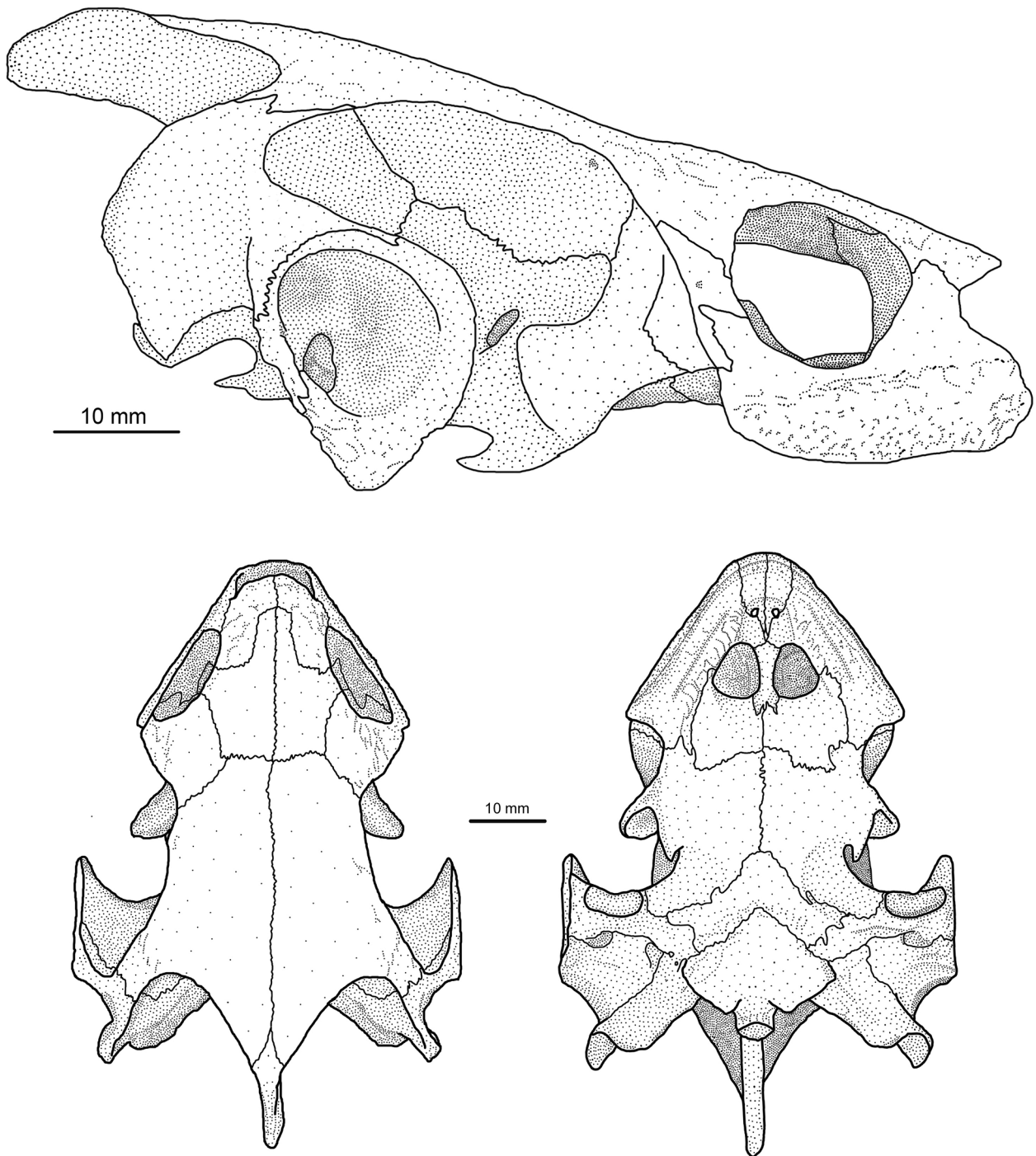


FIGURE 5. Lateral, Dorsal and Ventral views of the skull of *Elseya flaviventralis*. See Thomson et al. 2015; 2006 for comparative skulls of other *Elseya* species.

Acknowledgements

We would particularly like to thank the museum collection managers who have permitted the extended loans of specimens used in this study. Patrick Couper (QM), Ross Saddler (AM), Paul Horner (NTM) and Peter Pritchard (CCF). We also thank John Legler (UU), Colin McCarthy (BMNH) and John Cann for access to specimens in their care. We would also like to thank two anonymous reviewers for their helpful comments and Uwe Fritz for his editorial review of this paper.

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