Genetic analysis of species identity of turtles from the Roper River collected as part of the Beetaloo Basin Geological and Bioregional Assessment (GBA)

Report to the Research Institute for the Environment and Livelihoods (RIEL), Charles Darwin University, in support of the Beetaloo Basin Geological and Bioregional Assessment Program

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Cover:

Elseya dentata from the Roper River. Photo: John Cann.

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BRIEF

To undertake analyses of genotyping of snapping turtles (genus *Elseya*) of northern Australia with the objective of identifying to species, turtles caught as part of the GBA surveys of the Beetaloo Basin, Northern Territory.

VARIATION TO THE BRIEF

None

PRINCIPAL FINDINGS

The range of the Gulf Snapping Turtle (*Elseya lavarackorum*) is extended to include the Roper River of the Northern Territory. It is now known to occupy the Nicholson-Gregory drainage, the Calvert Drainage and the Roper Drainage. It probably occupies the intervening river drainages, having gone undetected because of its superficial similarity to *Elseya dentata*.

Elseya lavarackorum is sympatric with *Elseya dentata* in the Roper River, but there was no evidence of hybridization or admixture. This confirms the identity of the two as distinct species.

Elseya dentata from the Roper and Limmen Bight drainages is distinctly different from *Elseya dentata* from the Daly River extending west into the Kimberley, and probably represents a new and distinct taxon.

Additional observations are provided, including a revised key to the relevant species.

PREAMBLE

Freshwater turtles of Australia and the region are dominated by the family Chelidae, a group found only in Australasia and South America even in the fossil record. As such they are of clear Gondwanan origin, and provide a unique contribution to global turtle biodiversity.

The Northern Territory has the highest diversity of freshwater turtles, with eight species in the Daly River catchment alone. The lowlands of the Daly support the Northern Snapping Turtle *Elseya dentata*, the Northern Snake-neck Turtle *Chelodina rugosa*, the Northern Red-face Turtle *Emydura victoriae*, the Northern Yellow-face Turtle *Emydura tanybaraga*, and the Pig-nose Turtle *Carettochelys insculpta* (Carettochelyidae). The sections of the Daly River above the Arnhem Land escarpment, including the plunge pools and gorges that dissect the plateau, support the Sandstone Snake-neck Turtle *Chelodina burrungandjii*, Worrell's Turtle *Emydura subglobosa worrelli*, and the Common Sawshell Turtle *Myuchelys latisternum*.

Elsewhere in the Northern Territory, the species-level diversity is less well known. The focal drainage of the Roper River has confirmed records of *Chelodina rugosa* in the lowland swamps, *Chelodina burrungandjii* in the streams that dissect the Arnhem Land Plateau (e.g. Wilton River), *Chelodina canni* in the upstream semiarid wet-dry regions of low relief (and Maria Island), *Emydura subglobosa worrelli* in the substantial dry-season spring water fed sections of the river (and associated permanent lentic waters) *and Elseya dentata*. There is a single record of *Carettochelys insculpta* from Roper Bar, but it is considered a transient, as there are no known established breeding populations in the Roper drainage.

Further to the east, we have *Chelodina rugosa* in the floodplains of all rivers through to the border of the NT with Queensland (including the Limmen-Bight, McArthur and Calvert), *Chelodina canni* recorded from the McArthur River, *Emydura subglobosa worrelli* and *Elseya dentata*. *Elseya lavarackorum* was identified in the Calvert River from diagnostic characters of the carapace and girdle articulation points, substantially extending its range from the Nicholson-Gregory drainage (Lawn Hill National Park). The extent of the range of *Elseya lavarackorum* to the east and west of its redefined distribution is poorly defined.

This study examines tissue samples collected from across the ranges of *Elseya dentata*, *Elseya flaviventralis* and *Elseya lavarackorum* to clarify species identity and distributions.

DATA

The data comprise single nucleotide polymorphisms (SNP) generated using representational sequencing undertaken by a commercial partner Diversity Arrays Technology Pty Ltd. A substantial dataset was already in existence, complemented by 13 additional individuals provided by the Beetaloo survey team.

PRELIMINARY ANALYSIS

Data generation

Tissue samples typically comprised a small sliver of skin tissue taken from the trailing edge of the clawless toe of the hind foot, preserved in 95% ethanol and stored at -20^{o}C.

DNA was extracted by Diversity Arrays Technologies (DArT Pty Ltd, Canberra, Australia -- https://www.diversityarrays.com/) using a NucleoMag 96 Tissue Kit (Macherey-Nagel, Düren, Germany*)* coupled with NucleoMag SEP (Ref. 744900) to allow automated separation of high quality DNA on a Freedom Evo robotic liquid handler (TECAN , Männedorf, Switzerland). Tissue was first incubated overnight (skin) with proteinase K, adjusted in concentration depending on the tissue.

Sequencing for SNP genotyping was done using DArTseq™ (DArT Pty Ltd) which uses a combination of complexity reduction using restriction enzymes, implicit fragment size selection and next generation sequencing. To achieve the most appropriate complexity reduction (the fraction of the genome represented, controlling average read depth, and number of polymorphic loci), four combinations of restriction enzymes (PstI enzyme combined with either HpaII, SphI, NspI and MseI) were evaluated and restriction enzyme combination of PstI (recognition sequence 5'-CTGCA|G-3') and SphI (5'-GCATG|C-3') were selected.

DNA samples were processed in digestion/ligation reactions with two different adaptors annealed to the two restriction enzyme overhangs. The PstI-compatible adapter included the Illumina flow cell attachment sequence, a sequencing primer sequence, a barcode region of variable length and the PstI-compatible overhang sequence. The reverse adapter contained flow cell attachment sequence and SphI-compatible overhang sequence. Only fragments generated by the PstI-SphI double digest were effectively amplified in 30 rounds of polymerase chain reaction (PCR). Amplifications consisted of an initial denaturation step of 94°C for 1 min, followed by 30 cycles of PCR with the following temperature profile: denaturation at 94°C for 20 s, annealing at 58°C for 30 s, and extension at 72°C for 45 s, with an additional final extension at 72°C for 7 min. After PCR, equimolar amounts of amplification products from each sample were pooled and applied to c-Bot (Illumina) bridge PCR for sequencing on the Illumina Hiseq2500. The sequencing (single end) was run for 77 cycles.

SNP genotyping

Sequences generated from each lane were processed using proprietary DArT Pty Ltd analytical pipelines. One third of samples were processed twice from DNA, using independent adaptors, to allelic calls as technical replicates, and scoring consistency (repeatability) was used as the main selection criterion for high quality/low error rate markers. The DArT analysis pipelines have been tested against hundreds of controlled crosses to verify mendelian behaviour of the resultant SNPs as part of their commercial operations.

The data generated from the current Beetaloo Basin samples were combined with prior data generated for species of *Elseya* in northern Australia as a single service by DArT to ensure cross comparability (Service Ref: DFwt21-6118). The resultant data were provided in 2-row format as a csv file. These raw data were reconciled with the Wildlife Tissue Collection database (UC<Aus>) and stored in binary format for ease of access.

Sampled populations and sample sizes are given in Table 1.

Table 1. Drainages from which samples were drawn and sample sizes. Note that the definitive site for *Elseya lavarackorum* is the Nicholson-Gregory drainage, and in particular Lawn Hill Gorge from where the samples were obtained. Thirteen samples were provided from the Beetaloo Basin surveys.

Elseya dentata					
WA Carson R	WA King Edward R	NT Victoria R	NT Fitzmaurice R	NT Daly: Flora R	NT Daly R
9	9	12	10	10	12
NT Roper	NT Roper-Wilton	NT Limmen Bight	NT Limmen Bight: Cox	NT Limmen Bight: Arnold	NT Calvert
13	2	1	5	1	10
Elseya flaviventralis					
NT Mary	NT South Alligator	NT East Alligator			
3	6	4			
Elseya lavarackorum					
QLD Gregory					
11					
Beetaloo Samples					
NT Roper					
13					

Additional filtering

The SNP data and associated metadata were read into a genlight object (R package {adegenet} on the CRAN repository) to facilitate processing with package dartR (also on CRAN). The raw data had 172,145 loci scored. The data were filtered on repeatability (loci with < 0.99% repeatability across technical replicates removed) and read depth (retaining only loci with a read depth in the range 5-100x). Only one of closely linked loci, that is, occupying the same sequence tag were retained. Individuals with a low call rate were removed (< 50% of loci called – GK_06[Carson River], GK_07[King Edward River], GK_06[Carson River], GK_01[Carson River], GK_01[Carson River]) before filtering out loci with a low call rate (< 90%). Any monomorphic loci arising because of the removal of individuals or populations were also deleted. The resultant dataset had 19,914 loci screened for each of 126 individuals.

Given the low within-population sample sizes (n < 11), we did not filter loci for departures from Hardy-Weinberg Equilibrium (HWE) or Linkage Disequilibrium. We regard the data remaining after this additional filtering (*ca* 20,000 retained SNP markers) as highly reliable. The data are stored in binary format in file "Report_DFwt21-6118_SNP_filtered.Rdata".

ANALYSIS

PCA

A Principal Components Analysis was undertaken with individual turtles as the entities and their genotypes as the attributes. This is a method for extracting structure from the data, essentially constructing a new frame of reference by calculating linear combinations of the allele scores across loci and ranking the resultant new axes in order of their contribution to capturing the variance among individuals.

The PCA yielded 5 informative dimensions from 125 original dimensions and passed diagnostics (no negative eigenvalues). PCA Axis 1 explained 84.3 % of the total variance, PCA Axis 1 and 2 combined explained 89.6 % of the total variance, and PCA Axis 1-3 combined explained 91.2 % of the total variance. A two-dimensional plot provides an adequate summary (Figure 1).

The specimens clearly fall within three well defined aggregations, one of which can be assigned to *Elseya dentata sensu stricto* and *Elseya flaviventralis*, a second that is a putative new taxon currently assigned to *Elseya dentata*, and a third corresponds to *Elseya lavarackorum*. The assignment of group 3 to *Elseya lavarackorum* is confident, because it includes the two localities from which the species is known to occur, the Nicholson-Gregory where it was first discovered as an extant species, and the Calvert River where it was identified from skeletal fragments with diagnostic characters.

Both group 2 and group 3 include specimens collected as part of the baseline surveys within the Beetaloo Basin (Appendix – Table 3).

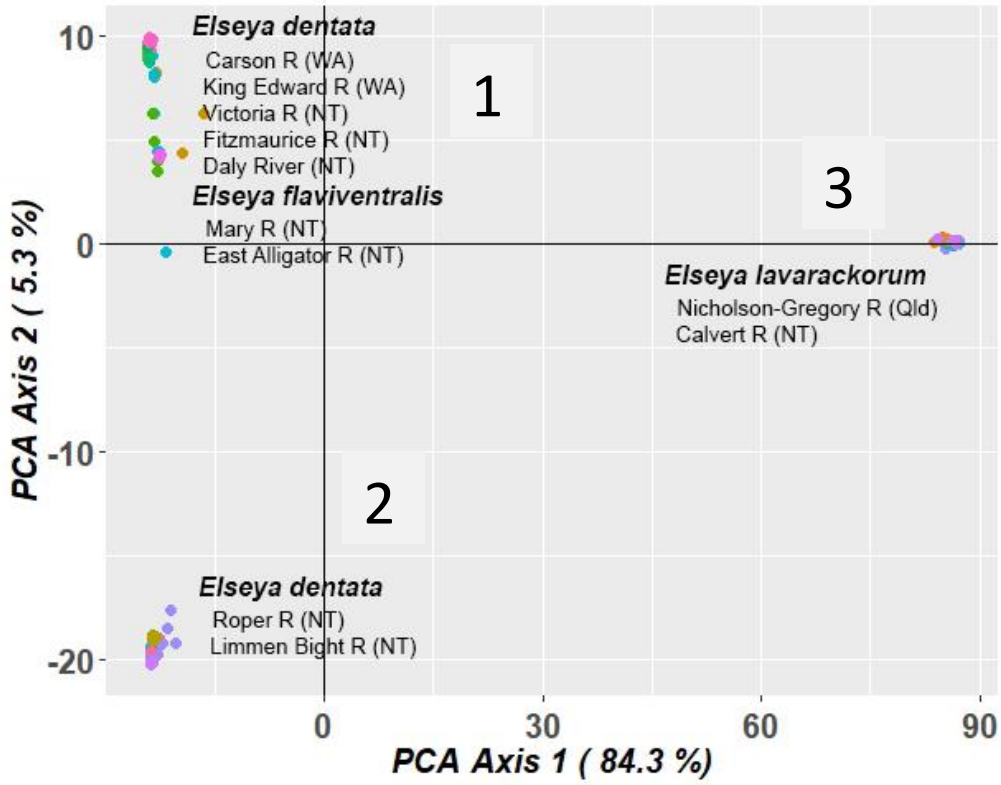

Figure 1. The turtles fell into three clear groupings. One grouping was an aggregation of specimens of *Elseya dentata* from the rivers of the Kimberley (WA) east to the Daly River (NT) but also including what has been regarded as *Elseya flaviventralis* from Arnhem Land (NT). A second grouping (lower left) included specimens of Elseya dentata from the Roper River (2 locations) and the Limmen Bight River (3 locations). The third grouping comprised turtles from the Nicholson-Gregory R (Qld), within the known range of *Elseya lavarackorum* and the Calvert R (NT) where *Elseya lavarackorum* was identified from bone fragments by Scott Thomson. Specimens of *Elseya* collected as part of the Beetaloo project fall into both clusters 2 and 3.

Assignment Analysis

Private alleles are alleles present in one population but absent in other populations. We use private alleles to assess the likely membership of an individual in a putative source population. If the individual comes from the putative source population, then it is unlikely to have alleles at any locus that are not present in the source. In practice, because of the finite size of samples, an individual will show private alleles in comparison with its source, simply through sampling error. However, they will be relatively few compared with the private alleles possessed by an individual in comparison with a population or species from which it was not drawn. Table 2 shows the counts of private alleles in each of the individuals sampled in the Beetaloo Basin surveys compared with *Elseya dentata* from the same drainage and *Elseya lavarackorum* from the Nicholson-Gregory drainage. Note that in all but two cases, the field identities based on superficial morphology were correct (Table 2).

The identities of the individuals are clear, reinforcing the conclusions drawn from the PCA analysis.

Table 2. Counts of private alleles in each of the individuals sampled from the Roper River during the Beetaloo Basin surveys when compared with the Roper River *Elseya dentata* and the Nicholson-Gregory *Elseya lavarackorum*.

Specimen	Field ID	PRIVATE ALLELES		Determination
		Elseya dentata Roper R	*Elseya lavarackorum* Nicholson	
E01	E. lavarackorum	10918	1034	E. lavarackorum
ED1	*E. dentata*	65	13022	*E. dentata*
ED2	*E. dentata*	63	12973	*E. dentata*
ED3	*E. dentata*	36	13001	*E. dentata*
ED4	*E. dentata*	58	13085	*E. dentata*
EG_ED08	*E. dentata*	10878	500	*E. lavarackorum*
EG_ED10	*E. dentata*	42	13041	*E. dentata*
EG_ED11	*E. dentata*	55	13035	*E. dentata*
EG_ED12	*E. dentata*	33	13053	*E. dentata*
EG_EL04	*E. lavarackorum*	10885	336	*E. lavarackorum*
EG_EL05	*E. lavarackorum*	38	13050	*E. dentata*
EG_EL06	*E. lavarackorum*	10881	341	*E. lavarackorum*
EG_EL07	*E. lavarackorum*	10870	390	*E. lavarackorum*

An additional sample collected by H. Bradley Shaffer from the Roper (HBS_32212) and identified as *Elseya dentata* is referred to *Elseya lavarackorum*.

Evidence of hybridization/admixture

There was no indication in the data of hybridization and/or admixture between *Elseya lavarackorum* and *Elseya dentata* despite being present in microsympatry.

Revised distribution for Elseya lavarackorum

Elseya lavarackorum is known to reside in the Nicholson-Gregory drainage (Qld) where it was first located, and has since been identified from the Calvert River (NT) based on examination of shell fragments. The current study extends its range north west to the Roper River of the Northern Territory where it is sympatric with *Elseya dentata* . It is unlikely that its distribution extends further west because of the barrier represented by the Arnhem Land Plateau, a barrier that appears to have led to substantial divergence between *Elseya dentata* in the rivers from the Daly west to the Kimberley, and *Elseya dentata* from the Roper east to the Limmen Bight. The easterly extent of the range of *Elseya lavarackorum* remains uncertain.

Structure within Elseya dentata

The substantial structure within *Elseya dentata* suggests that it comprises two distinct taxa, one occupying the rivers from the Daly River west to at least the Calvert River. The second putative undescribed taxon resides in the Roper and Limmen-Bight drainages. *Elseya* flaviventralis occupies the drainages from but not including the Roper River west to the Mary River (NT).

Morphological observations

Examples of photographs of the two species, *Elseya dentata and Elseya lavarackorum* serve to show the distinction between the two (refer figure captions).

Figure 2. Photographs of *Elseya dentata* from the Roper River drainage, NT. Intergular scute that penetrates deeply to almost separate the humerals; low blunt tubercles on the neck typically not arranged in anteroposterior rows; iris distinct; ramphotheca of upper jaw uniform in colour, without vertical streaks; no red flushing on the limbs. There are clear differences in the pattern of coloration of the temporal region between *Elseya dentata*, depicted here with cream/yellow dots on each temporal tubercle, and *Elseya lavarackorum* with a reticulated pattern in the temporal and dorsal head regions (Figure 3); this fades with age.

Figure 3. Photographs of *Elseya lavarackorum* from the Roper River drainage, NT. Note; an intergular scute that only moderately penetrates to separate the humerals, at most half way; low blunt tubercles on the neck, if present, arranged in anteroposterior rows; iris not distinct in life (a character not clearly evident in flash photographs); ramphotheca of upper jaw with vertical streaks, variable in intensity; red flushing on the limbs (fading or absent with age). There are clear differences in the pattern of coloration of the temporal region between *Elseya dentata* with cream/yellow dots on each temporal tubercle (Figure 2), and *Elseya lavarackorum* with a reticulated pattern in the temporal and dorsal head regions (depicted here); this fades with age.

Figure 4. Photographs of *Elseya lavarackorum* from the Nicholson-Gregory River drainage (Lawn Hill, Qld). Intergular scute that only moderately penetrates to separate the humerals, at most half way; iris not distinct in life (a character not clearly evident in flash photographs); ramphotheca of upper jaw with vertical streaks, variable in intensity; red flushing on the limbs, (faded or absent with age) (lower left); reticulation pattern in the temporal region (fades with age). Some aged individuals have extensive light blotching of the head and neck (lower right). Note that the leading and trailing spot on the iris is an uncommon variant, found occasionally in the Nicholson-Gregory populations, not yet observed in the Roper River populations. Photos: Alistair Freeman.

Key to turtle species of the Roper River (Chelidae)

Key to Genera

1 Forelimbs each with five claws; gular scutes separated by the intergular; intergular scute in broad contact with the anterior margin of the plastron 2

– Forelimbs each with four claws; gular scutes in contact; intergular scute not in broad contact with the anterior margin of the plastron..... ***Chelodina***

2 Surface of the temporal region covered with distinct regular scales or low tubercles; dorsal surface of the head with a prominent head shield which may be entire or fragmented; cervical scute absent (except as a rare variant).....3

– Skin of the temporal region smooth, sometimes broken into regular scales of low relief; dorsal surface of head without a prominent head shield; cervical scute present (except as a rare variant); prominent eye stripe in males and younger individuals of both sexes ..... ***Emydura subglobosa worrelli***

3 Alveolar ridge absent; head shield distinct, well defined; posterior process of the head shield extends laterally down the parietal ridge toward the tympanum; temporal tubercles uniform in colour; prominent pointed tubercles on the neck..... ***Myuchelys latisternum***

– Prominent alveolar ridge on the triturating surfaces of the mouth; head shield distinct, well defined but no prominent process of the head shield extending down the parietal ridge toward the tympanum; tubercles on the neck, if present, blunt, not pointed ..... ***Elseya***

Key to Chelodina

1 Plastron broad, covering or almost covering the anterior orifice of the shell in ventral view; intergular scute approximately twice as long as the suture between the pectoral scutes; length of head and neck equal or slightly less than length of the carapace; dorsum of neck with many blunt conical tubercles; fluid with a pungent odour secreted from ducts in the inguinal and axillary pockets when distressed .... ***Chelodina canni***

– Plastron narrow, covering only about half of the anterior orifice of the shell in ventral view; intergular scute approximately the same length as or shorter than the suture between the pectoral scutes; head and neck longer than carapace; dorsum of neck lacking obvious tubercles; fluid from ducts in the inguinal and axillary pockets if with noticeable odour, not pungent.....**2**

2 Width of head moderate, not dramatically wider than the neck; intergular distinctly separates the gulars; two barbels on the chin, if present; lowlands .... ***Chelodina rugosa***

– Head very broad, dramatically wider than the neck, gulars in narrowly in contact, or if not in contact, barely so; multiple prominent barbels forming a linear series on each mandible; sandstone country and escarpments ..... ***Chelodina burrungandjii***

Key to Elseya

1 Extensive lingual ridges in addition to the alveolar ridges on ramphotheca; intergular moderately separates the humerals, at most half; head shield modest, typically not extending forward to cover the dorsal surface of the head between the eyes; patterning of temporal and head region reticulate .... ***Elseya lavarackorum***

– Lingual ridges on ramphotheca absent; intergular deeply separates the humerals, at least half; head shield extensive, robust, extending forward to cover the dorsal surface of the head between the eyes; patterning of temporal and head region not reticulate **3**

2 Plastron and bridge of low relief, little or no abrupt angle between the bridge and the ventral surface of the plastron; plastron cream or white, unblemished by streaks, darker borders of the scute sutures, or other darker markings; head shield fragmented; scales on temporal region of head of low relief, not prominent; Arnhem Land ..... ***Elseya flaviventralis***[1]

– Plastron with abrupt angle between the bridge and the ventral surface of the plastron; plastron yellow, cream or white, with streaks of brown or black, and/or darker borders to the scutes or other darker markings (after removal of any staining); head shield entire; scales on temporal region of head of raised, prominent, often with a cream or yellow patch on each temporal tubercle ..... ***Elseya dentata***

[1] not yet recorded from the Roper

CONCLUSION

The range of the Gulf Snapping Turtle (*Elseya lavarackorum*) is extended to include the Roper River of the Northern Territory. It is now known to occupy the Nicholson-Gregory drainage, the Calvert Drainage and the Roper Drainage. It probably occupies intervening river drainages, having gone undetected because of its superficial similarity to *Elseya dentata*.

Elseya lavarackorum is sympatric with *Elseya dentata* in the Roper River, but there was no evidence of hybridization or admixture. This confirms the identity of the two as distinct species.

Elseya dentata from the Roper and Limmen Bight drainages is distinctly different from *Elseya dentata* from the Daly River extending west into the Kimberley, and probably represents a new and distinct taxon.

Appendix

Table 3. A list of specimens, the drainage basin from which they were drawn, and the species assignment based on their clustering against axes PC1 and PC2 of the PCA ordination. Refer also to Table 2 for additional evidence of the species assignment for the specimens collected during the Beetaloo Surveys.

id	pop	PC1	PC2	Species assignment
GK_03	Carson	-16.6362	3.77643473	Elseya dentata
GK_02	King Edward	-20.18909	6.83005496	Elseya dentata
GK_10	King Edward	-18.61102	6.83005496	Elseya dentata
UC_1072	Daly	-20.65081	7.61686794	Elseya dentata
UC_0973	Daly	-20.58133	7.98730125	Elseya dentata
GK_05	Carson	-14.22733	5.48476889	Elseya dentata
GK_04	King Edward	-20.08273	5.31890191	Elseya dentata
UC_0379	Daly	-20.48788	7.75346309	Elseya dentata
GK_05	Carson	-20.06951	6.98892352	Elseya dentata
GK_04	King Edward	-20.00878	7.00971291	Elseya dentata
UC_0894	Daly	-20.45742	7.81570625	Elseya dentata
UC_0260	Daly	-20.69609	7.98841931	Elseya dentata
GK_07	King Edward	-20.2499	7.69222564	Elseya dentata
UC_0958	Daly	-20.76979	7.81529026	Elseya dentata
UC_0264	Daly	-20.55461	7.78569375	Elseya dentata
GK_12	Carson	-20.08949	7.00371648	Elseya dentata
GK_09	King Edward	-20.75736	7.7875264	Elseya dentata
UC_0965	Daly	-20.70063	8.01619035	Elseya dentata
UC_0363	Daly	-20.76694	7.99301867	Elseya dentata
GK_12	Carson	-20.59938	7.43665254	Elseya dentata
GK_09	King Edward	-20.73889	7.64151333	Elseya dentata
UC_0972	Daly	-20.75454	7.55554401	Elseya dentata
UC_0910	Daly	-20.63772	7.72418915	Elseya dentata
UC_0261	Victoria	-20.6558	8.27189891	Elseya dentata
GK_02	King Edward	-20.10251	6.95305209	Elseya dentata
UC_0954	Daly	-20.7471	7.89887062	Elseya dentata
UC_0258	Victoria	-20.73093	8.23668469	Elseya dentata
AA072600	Flora	-20.61388	7.72017215	Elseya dentata
AA072505	Fitzmaurice	-20.57297	8.2521791	Elseya dentata
AA072519	Victoria	-20.57814	8.44473845	Elseya dentata
AA072602	Flora	-20.66868	7.8023745	Elseya dentata
AA072512	Fitzmaurice	-20.64111	8.25147602	Elseya dentata
AA072520	Victoria	-20.51829	8.28021724	Elseya dentata
AA072603	Flora	-20.66918	7.80632546	Elseya dentata
AA072513	Fitzmaurice	-20.56175	8.2468928	Elseya dentata
AA072521	Victoria	-20.55028	8.07576253	Elseya dentata
AA072628	Flora	-20.65001	7.7963664	Elseya dentata
AA072605	Flora	-20.67958	7.61454618	Elseya dentata
AA072514	Fitzmaurice	-20.63652	8.26289939	Elseya dentata
AA072522	Victoria	-20.48469	8.29939726	Elseya dentata
AA072631	Flora	-20.66031	7.4837977	Elseya dentata
AA072606	Flora	-20.60782	7.77452137	Elseya dentata

AA072516	Fitzmaurice	-20.69688	8.21342944	Elseya dentata
AA072523	Victoria	-20.31573	8.42144491	Elseya dentata
AA072632	Flora	-20.66102	7.84909895	Elseya dentata
AA072500	Fitzmaurice	-20.70665	8.19916957	Elseya dentata
AA072517	Fitzmaurice	-20.65131	8.17351001	Elseya dentata
AA072524	Victoria	-20.51633	8.14073119	Elseya dentata
AA072633	Flora	-20.59259	7.81490191	Elseya dentata
AA072502	Fitzmaurice	-20.64143	8.32254813	Elseya dentata
AA072518	Fitzmaurice	-20.65294	8.23420356	Elseya dentata
AA072400	Victoria	-20.61962	8.37881354	Elseya dentata
AA072525	Victoria	-20.50601	7.97487541	Elseya dentata
AA072637	Flora	-20.645	7.65387283	Elseya dentata
AA072503	Fitzmaurice	-20.76269	8.1672016	Elseya dentata
AA072402	Victoria	-20.63857	8.2558736	Elseya dentata
AA072526	Victoria	-20.67092	8.28421256	Elseya dentata
HBS_32207	Roper	-19.45125	-16.1597179	Elseya dentata [Roper]
HBS_32215	Roper	-17.96919	-15.3410914	Elseya dentata [Roper]
HBS_32208	Roper	-19.08357	-16.2961309	Elseya dentata [Roper]
HBS_32211	Roper	-19.46112	-16.5213142	Elseya dentata [Roper]
HBS_32213	Roper	-19.51165	-16.9293543	Elseya dentata [Roper]
HBS_32206	Roper	-19.75859	-16.9963184	Elseya dentata [Roper]
HBS_32214	Roper	-17.50924	-16.5376607	Elseya dentata [Roper]
UC_0713	Limmen Bight	-20.31075	-16.5359855	Elseya dentata [Roper]
EG_EL05	Beetaloo	-20.32253	-17.0820742	Elseya dentata [Roper]
EG_ED09	Arnold	-19.6503	-16.2636847	Elseya dentata [Roper]
ED3	Beetaloo	-20.24415	-17.2512447	Elseya dentata [Roper]
EG_ED10	Beetaloo	-20.27498	-17.1418256	Elseya dentata [Roper]
ED5	Cox	-19.75127	-16.4164205	Elseya dentata [Roper]
ED4	Beetaloo	-20.40849	-16.9431821	Elseya dentata [Roper]
EG_ED11	Beetaloo	-20.37247	-17.1560173	Elseya dentata [Roper]
ED6	Cox	-20.20324	-16.3083869	Elseya dentata [Roper]
HBS_32228	Roper	-18.53657	-15.9009654	Elseya dentata [Roper]
EG_ED12	Beetaloo	-20.40995	-17.1580772	Elseya dentata [Roper]
ED7	Cox	-20.1653	-16.4246281	Elseya dentata [Roper]
HBS_32229	Roper	-20.36224	-17.4910701	Elseya dentata [Roper]
AA020063	Wilton	-20.28524	-16.947133	Elseya dentata [Roper]
ED8	Cox	-20.21377	-16.399363	Elseya dentata [Roper]
HBS_32230	Roper	-20.29163	-17.0524224	Elseya dentata [Roper]
AA020065	Wilton	-20.27456	-16.8094351	Elseya dentata [Roper]
ED9	Cox	-20.22366	-16.378393	Elseya dentata [Roper]
HBS_32216	Roper	-20.35074	-17.0900007	Elseya dentata [Roper]
ED1	Beetaloo	-20.21709	-17.3410956	Elseya dentata [Roper]
HBS_32217	Roper	-20.25225	-17.230455	Elseya dentata [Roper]
ED2	Beetaloo	-20.19738	-17.2130246	Elseya dentata [Roper]
UC_0214	East Alligator	-20.21136	5.44746427	Elseya flaviventralis
UC_0212	East Alligator	-19.7057	3.11881014	Elseya flaviventralis
UC_0946	Mary (NT)	-19.75187	3.84296245	Elseya flaviventralis
UC_1070	Mary (NT)	-19.74513	3.83762982	Elseya flaviventralis
UC_0213	East Alligator	-19.85486	3.67026877	Elseya flaviventralis

UC_0215	East Alligator	-20.16047	4.15304675	Elseya flaviventralis
UC_0946	Mary (NT)	-19.81543	3.87373626	Elseya flaviventralis
AA072365	South Alligator	-19.69554	3.74601383	Elseya flaviventralis
AA072368	South Alligator	-19.72104	3.76327152	Elseya flaviventralis
AA072372	South Alligator	-19.65617	3.66525874	Elseya flaviventralis
AA072683	South Alligator	-19.53467	3.81252759	Elseya flaviventralis
AA072684	South Alligator	-19.71824	3.77476296	Elseya flaviventralis
AA072686	South Alligator	-19.70507	3.69401281	Elseya flaviventralis
HBS_32212	Roper	73.23561	-0.11960954	Elseya lavarackorum
EL011	Calvert	74.59498	0.13665376	Elseya lavarackorum
AF_EL017	Gregory	74.17737	-0.07109075	Elseya lavarackorum
EL01	Calvert	72.67942	0.21901831	Elseya lavarackorum
AF_EL018	Gregory	74.60708	0.12731717	Elseya lavarackorum
ES01	Calvert	72.88144	0.04961767	Elseya lavarackorum
AF_EL019	Gregory	74.18464	0.06051035	Elseya lavarackorum
ES02	Calvert	73.34319	0.14879621	Elseya lavarackorum
AF_EL012	Gregory	73.97685	0.14068122	Elseya lavarackorum
AF_EL020	Gregory	74.03387	0.08973765	Elseya lavarackorum
ES03	Calvert	71.87682	0.06634143	Elseya lavarackorum
AF_EL013	Gregory	74.26328	0.06695267	Elseya lavarackorum
AF_EL021	Gregory	73.48998	0.06655182	Elseya lavarackorum
ES04	Calvert	73.46714	0.09370262	Elseya lavarackorum
AF_EL014	Gregory	74.41646	0.10524174	Elseya lavarackorum
EL008	Calvert	74.36214	0.15364286	Elseya lavarackorum
TS0022	Calvert	72.37066	0.08242301	Elseya lavarackorum
AF_EL015	Gregory	74.35866	0.05095303	Elseya lavarackorum
EL009	Calvert	74.50624	0.13809533	Elseya lavarackorum
AF_EL016	Gregory	74.57864	0.08399304	Elseya lavarackorum
EL010	Calvert	73.41566	0.19446005	Elseya lavarackorum
EG_EL06	Beetaloo	74.62742	0.13624294	Elseya lavarackorum
UC_0321	Gregory	74.72872	0.06240091	Elseya lavarackorum
EO1	Beetaloo	72.11876	0.28472264	Elseya lavarackorum
EG_EL04	Beetaloo	74.58166	0.07582398	Elseya lavarackorum
EG_EL07	Beetaloo	74.39301	0.04026507	Elseya lavarackorum
EG_ED08	Beetaloo	73.9937	0.15975219	Elseya lavarackorum