Euastacus vanderwerfi sp. nov., a new dwarf spiny freshwater crayfish (Crustacea: Decapoda: Parastacidae) from the Gondwana Rainforests, Lamington National Park, Queensland, Australia

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ABSTRACT

A new species of freshwater crayfish, *Euastacus vanderwerfi* sp. nov., is described from highland rainforest sites within the north branch of Running Creek and the south branch of Christmas Creek (Logan Basin), Lamington National Park, Queensland, Australia. Morphological features distinguishing it from its closest relatives, *Euastacus dalagarbe* (Coughran, 2005), *Euastacus mirangudjin* (Coughran, 2002) and *Euastacus binzayedi* (Coughran & Furse, 2013) are identified. Observations on burrowing behaviour, ecological preferences and biology are provided, along with a conservation assessment of the species as Critically Endangered B1ab(iii,v)+2ab(iii,v).

Figure 1. *Euastacus vanderwerfi* male holotype (QM-W55108) in situ. Image: R.B. McCormack

The genus *Euastacus* currently includes 55 recognized species (Ahyong 2014, McCormack & Ahyong 2017, Van Der Wal et al. 2022, McCormack & Fetzner 2024) with over 30 additional putative species awaiting formal description (Austin et al. 2022; McCormack, unpublished data).

In 2012, McCormack pragmatically grouped 50 *Euastacus* species plus 4 undescribed species into three distinct groups (dwarf, intermediate and giants) based on shared morphological (presence/absence of white stripes on juvenile somites 1 & 6 and size) and ecological traits. This new *Euastacus* (Fig. 1–4), belongs to the dwarf group, characterised by its absence of light-coloured bands on somites 1 and 6 of juveniles, diminutive stature and presence of a male cuticle partition. It is poorly spinose, primarily dwells in small streams, has adept burrowing capabilities and cryptic behaviour. The species is typically dominated by larger intermediate and giant group congeners, and particular traits differentiate it from its closest relatives. The new species differs from *Euastacus mirangudjin* by lacking numerous spines above the propodal and dactylar cutting edges. It can be readily distinguished from the sympatric *E. dalagarbe* by having more cephalic spines, a significantly larger suborbital spine, denser setation and one large and one to two smaller propodal teeth (compared to *E. dalagarbe*, which typically has a single large tooth). *Euastacus vanderwefi* sp. nov. also has striking bright blue chelae fingers and a prominent chelae colouration pattern, making it distinct from both *E. dalagarbe* and *E. binzayedi*.

Euastacus species are endemic to eastern Australia, ranging from northern Queensland to Victoria and into South Australia. The highest species diversity is concentrated in the Gondwana Rainforests of south-eastern Queensland and north-eastern New South Wales, with the dwarf group particularly abundant in these highland rainforest streams. Ten other dwarf group crayfish species occur in the surrounding area: *Euastacus angustus* (Coughran & Dawkins, 2013); *Euastacus binzayedi* (Coughran & Furse, 2013); *Euastacus dalagarbe* (Coughran, 2005); *Euastacus* sp. nov. 13 (McCormack & Ahyong, unpublished data); *Euastacus girurmulayn* (Coughran, 2005); *Euastacus guruhgi* (Coughran, 2005); *Euastacus jagabar* (Coughran, 2005); *Euastacus jagara* (Morgan, 1988); *Euastacus maidae* (Riek, 1956) and *Euastacus mirangudjin* (Coughran, 2002).

Despite the described species diversity, the distributional boundaries of these taxa remain poorly defined. Over the past 20 years, the

Australian Crayfish Project (ACP), supported by volunteers, has been systematically researching the Gondwana Rainforests to catalogue all species of the family Parastacidae and define their distribution. Specimens of this new species were first collected by hand in February 2015 from a tributary of the south branch of Christmas Creek and were preliminarily identified as *Euastacus* sp. nov. 12. Additional specimens were collected in May 2015 from a tributary of the north branch of Running Creek.

The Australian Government's Wildlife and Habitat Bushfire Recovery Program funded the 'Saving the spinys' project, which focused on conserving the 22 most at-risk *Euastacus* species, impacted by the devastating 2019/2020 megafires. As part of the project, genetic material from *Euastacus* sp. nov. 12 was analysed in a molecular taxonomic study by Deakin University (Austin et al. 2022) and identified as *Euastacus* cf. *dalagarbe* CA035/CA036, ultimately confirming the validity of this new species.

METHODS

Specimens were primarily captured by manually lifting structures within the stream and excavating burrows by hand. Detailed visual observations of burrow architecture, habitat preferences and stream conditions were recorded for each collection site. All specimen measurements are given in millimetres and all weights in grams.

At the time of capture, specimens were identified on-site. Depending on the study's requirements, either a DNA sample was taken and the specimen released, or selected specimens were vouchered for in-depth taxonomic analysis. Voucher specimens underwent examination to determine sex and injury status, and a wet weight to the nearest 0.01 gram was taken using digital scales. Morphological terminology, size descriptors and measurement techniques largely follow Morgan (1986–1997), McCormack and Ahyong (2017) and McCormack and Fetzner (2024). The occipital carapace length (OCL) was used as the standard size measurement for all specimens, with carapace length (CL) also assessed. Gastric mills were carefully removed using fine forceps inserted through the mouth and examined in specimens ranging from 24.57 to 29.21 mm OCL. Additionally, the number of urocardiac ridges was counted, excluding the first anterior ridge, as it represents an extension of a more posterior ridge.

Voucher specimens were humanely euthanised by freezing, then preserved in 70–90% ethanol. These specimens were added to the Australian Crayfish Project (ACP) collection in Port Stephens, NSW (McCormack, unpublished data), with select specimens deposited in the Queensland Museum (Brisbane, Qld) and the Carnegie Museum of Natural History (Pittsburgh, PA, USA).

All collection and handling protocols adhered strictly to ACP Standard Operating Procedures, ACP Hygiene Protocol, and the ACP Code of Practice (accessible at www.austcray.com). The geographic coordinates of each habitat site were recorded using a Garmin 64S Global Positioning System (GPS).

Tissue samples from live individuals were preserved in cell lysis buffer for subsequent DNA analysis as part of the ACP's ongoing collaborative genetics program with the Carnegie Museum of Natural History. Additional samples were preserved in 100% ethanol for a separate collaborative genetic study conducted by Deakin University (Geelong, Vic, Australia) between 2020 and 2024.

Abbreviations: asl: above sea level; *ACP:* Australian Crayfish Project; *AM:* Australian Museum; *CMNH:* Carnegie Museum of Natural History; *QM:* Queensland Museum.

Morphological abbreviations: *AdW:* (abdominal width) greatest width of abdomen (side to side), not spines-somite 3; *ArL:* (areola length) measured along midline from cervical groove to dorsal posterior of carapace; *ArW:* (areola width) minimum width of areola (narrowest/closest); *CD:* (carapace depth) vertical distance between sternal keel immediately posterior to pereopod 1 (base of chelae) and the dorsal surface of the carapace (top-bottom); *CL:* (carapace length) measured along midline from apex of rostrum to dorsal posterior margin of carapace; *CW:* (carapace width) greatest width of carapace (side to side); *DactL:* (dactylus length) maximum length along dorsal surface between distal tip and articulation joint with propodus; *D spines:* (dorsal spines); D-L spines: (dorsolateral spines); *Li spines:* (primary lateral); *Lii spines:* (secondary lateral);

OCL: (occipital carapace length) standard measure for Australian freshwater crayfish; measured from posterior margin of orbit to dorsal posterior of carapace (used as an index of size in Morgan 1986); *PropD:* (first cheliped propodus depth) maximum distance, measured between dorsal and ventral surfaces of propodal palm (side-side); *PropL:* (first cheliped propodus length) measured from propodal base to apex propodal finger; *PropW:* (first cheliped propodus width) maximum distance measured between the most mesial and lateral margins of propodal palm (including spines) top-bottom includes spines top/bottom; *RL:* (rostral length) from tip of rostrum to point on midline level with posterior extent of rostral carinae; *RW:* (rostral width) maximum width measured across posterior end of rostral carinae, from outside of each carina; *Spread:* (TAP minus TAA); *ScL:* (antennal squame [scale or scaphocerite] length) measured laterally from base to apex; *TAA:* number of teeth anterior to the margin of zygocardiac ossicle ear (gastric mill); *TAP:* number of teeth anterior to posterior margin of zygocardiac ossicle ear (gastric mill); *TEL:* (telson length) measured from posterior margin of abdominal somite 6 to tip of telson (not setation); *TL:* (total length) measured from apex of rostrum to tip of tailfan.

TAXONOMY

Order **DECAPODA** Latreille, 1802

Family **Parastacidae** Huxley, 1878

Genus ***Euastacus*** Clark, 1936

***Euastacus vanderwerfi* sp. nov.**

Euastacus cf. *dalagarbe* CA033/CA035, Austin et al. 2022

Type material: HOLOTYPE: QM-W55108, male, 11.47 g, 27.79 mm OCL, Tributary Christmas Creek, south branch, Lamington National Park, Qld, -28.316220°S, 153.117610°E, 948 m asl, RB McCormack, 10-Aug-2023.

ALLOTYPE: QM-W55109, female, 37.62 mm OCL, Tributary Christmas Creek, south branch, Lamington National Park, -28.317666°S, 153.120200°E, 999 m asl, coll. RB McCormack, C Burnes, C Van Wyk, P Van der Werf, T & J Moylan, 7-Feb-2015.

PARATYPES: QM-W55110, male, 29.21 mm OCL, 13.28 g, Tributary Christmas Creek, south branch, Lamington National Park, -28.317817°S, 153.119683°E, 993 m asl, coll. RB McCormack, C Burnes, C Van Wyk, P Van der Werf, T & J Moylan, 7-Feb-2015. ACP5477, male, 24.22 mm OCL, 7.25 g, Tributary Christmas Creek, south branch, Lamington National Park, -28.318283°S, 153.120500°E, 1011 m asl, coll. RB McCormack, C Burnes, C Van Wyk, P Van der Werf, T & J Moylan, 7-Feb-2015. ACP5476, male, 28.56 mm OCL, 11.82 g, Tributary Christmas Creek, south branch, Lamington National Park, -28.318283°S, 153.120500°E, 1011 m asl, coll. RB McCormack, C Burnes, C Van Wyk, P Van der Werf, T & J Moylan, 7-Feb-2015. QM-W55113, female, 30.40 mm OCL, Tributary Christmas Creek, south branch, Lamington National Park, -28.317817°S, 153.119683°E, 993 m asl, coll. RB McCormack, C Burnes, C Van Wyk, P Van der Werf, T & J Moylan, 7-Feb-2015. QM-W55111, female, 7.33 g, 23.92 mm OCL, Tributary Christmas Creek, south branch, Lamington National Park, Qld, -28.316060°S, 153.117470°E, 938 m asl, RB McCormack, 10-Aug-2023. ACP5574, female, 21.96 mm OCL, 5.42 g, Tributary Running Creek, north branch, Lamington National Park, Qld, -28.32173°S, 153.118683°E, 977 m, coll. RB McCormack, C Burnes, P Van der Werf, K Moy, 30-May-2015. ACP7082, female, 7.61 g, 24.57 mm OCL, Tributary Christmas Creek, south branch, Lamington National Park, Qld, -28.316270°S, 153.117820°E, 950 m asl, RB McCormack, 10-Aug-2023. ACP5573, female, 25.25 mm OCL, 8.88 g, Tributary Running Creek, north branch, Lamington National Park, Qld, -28.321366°S, 153.119117°E, 1004 m asl, coll. RB McCormack, C Burnes, P Van der Werf, K Moy, 30-May-2015. QM-W55112, male, 8.52 g, 24.92 mm OCL, Tributary Christmas Creek, south branch, Lamington National Park, Qld, -28.315990°S, 153.117210°E, 909 m asl, RB McCormack, 10-Aug-2023.

Other material examined: ACP5582, juvenile, 0.41 g, 8.38 mm OCL, Tributary Running Creek, north branch, off the Stretcher track, Lamington National Park, Qld, -28.321483°S, 53.118916°E, 1001 m asl, RB McCormack, C Burnes, P Van der Werf, K Moy, 30-May-2015. ACP7077, male, 2.33 g, 17.34 mm OCL, Tributary Christmas Creek, south branch, below Stinson wreck campsite, Lamington National Park, Qld, -28.316060°S, 153.117470°E, 938 m asl, RB McCormack, 10-Aug-2023.

Additional comparative specimens examined: *Euastacus binzayedi*. ACP6950, female, 22.59 g, 35.70 mm OCL, Binna Burra, Lamington National Park, Qld, -28.21911°S, 153.197880°E, 824 m asl, coll. RB McCormack, 27-Nov-2022. *Euastacus dalagarbe* ACP6776, male, 11.1 g, 27.83 mm OCL, Gradys Creek, Border Ranges National Park, -28.365517°S, 153.110250°E, 890 m asl, coll. RB & CA McCormack, 9-Jul-2021. *Euastacus dalagarbe* ACP5581 (CA036), female, 17.67 g, 30.88 mm OCL, Running Creek, north branch, Lamington National Park, Qld, -28.321483°S, 153.118916°E, 1001 m asl, coll. RB McCormack, C Burnes, P Van der Werf, K Moy, 30-May-2015.

Diagnosis: Male cuticle partition present. Thoracic spines absent. Rostrum short, reaching to base of antennular peduncle article 3, with 2–3 marginal spines. Carapace with first postorbital spine edge–small and pointed; second spine absent; with 2–4 small blunt cephalic spines, plus numerous smaller blunt bumps ventral to postorbital ridges; suborbital spine small to medium-sized; cervical spines absent to 1–3 small rounded poorly developed spines. Antennular basipodite spines absent. Antennal coxopodite spine small in adults. Abdomen with 0–2 Li spines on somite 2; D-L and D spines absent; abdominal boss absent. Cheliped with long thick tufts of setation arranged in rows, fingers bright blue, 1 large propodal tooth with 1–2 smaller teeth joined at base posteriorly, dorsoateral propodal spine row medium developed; ventrolateral propodal spine row absent. 4–5 mesial propodal spines; dorsal and ventral surfaces of propodus lateral to dactylar base without bumps, spines or protrusions; 1 dorsal apical propodal spine; 1 spine above propodal cutting edge; 1 spine above dorsal dactylar cutting edge; 1 apical mesial dactylar spine; mesial dactylar basal spines absent; 3 mesial carpal spines; 1 large ventral carpal spine, 1 small rounded ventromesial carpal spine.

Description

Maximum OCL: 37.62 mm (QM-W55109)

Rostrum: Rostrum short, reaching to base of antennular peduncle article 3. Rostrum narrow, carinae parallel to slightly convergent. Usually 2 marginal spines per side <28 mm OCL; 3 per side on larger specimens (4 one side on largest specimen); spines light in colour, rounded and decreasing in size proximally. Acumen similar in size to anterior marginal spines. OCL/CL 0.86–0.88; RW/OCL 0.07–0.11; RL/OCL 0.19–0.27.

Cephalon: First postorbital spine edge–small and pointed; second spine absent. Spination poor, with 2–4 small blunt yellow cephalic spines, plus a few smaller blunt bumps ventral to postorbital ridges. Antennular basipodite spine absent. Antennal coxopodite spines poorly developed to small. Interantennal spine medium width; sides scalloped; apex pointed. Suborbital spine small–medium and sharp. Lateral margin of antennal squame straight; inflated midlength to distal; reaching anteriorly as far as rostral apex; marginal spines absent. ScL/OCL 0.11–0.16.

Maxilliped 3: Laterodistal corner of ischium produced to a distinct point, mesial margin broadly rounded. Exopod distal article reaching to about mid-length of ischium, flagellum just overreaching ischium.

Thorax: Dorsal thoracic spines absent. General tubercles very small and dense. Cervical spines absent <25 mm OCL; larger animals with 1–3 small blunt poorly developed spines. Areola clearly defined; narrowest rear. ArL/OCL 0.37–0.39; ArW/OCL 0.14–0.17; CW/OCL 0.49–0.51; CD/OCL 0.47–0.52.

Abdomen: Poorly spinose. 0–2 small blunt Li spines somites 2. 1–2 barely discernible Lii spines occasionally somites 3–4. D-L spines and D spines absent. Abdominal boss absent. AdW/OCL (males) 0.47–0.49, (females) 0.48-0.49; OCL/TL 0.39–0.46.

Tailfan: Standard tailfan spines generally small to medium. Telsonic and uropodal surface and marginal spines absent. TEL/OCL: 0.29–0.33.

Keel: Pr1 close, and parallel. Pr2 close and closed. Pr3 scoops absent, medium breadth; keel after Pr3 pronounced. Pr4 broad.

Chelae: Usually intermediate in shape. Regenerating chelae usually elongated with greater spination. 1 large propodal tooth with 1–2 smaller teeth joined at base posteriorly. Distinct dappled pattern on dorsal and ventral propodal and dactylar surfaces.

Propodus: Ventrolateral spine row absent; 6–9 dorsolateral spines extending from apex to between

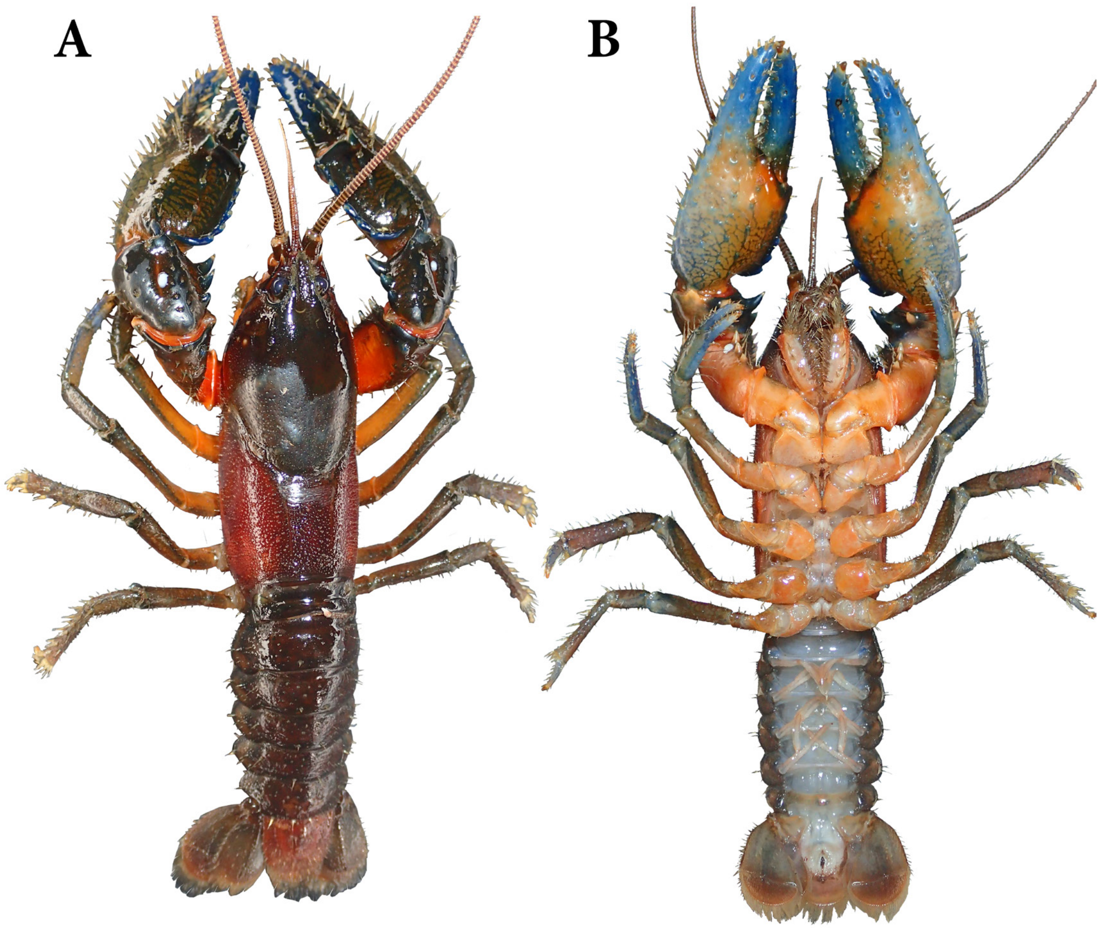

Figure 2. *Euastacus vanderwerfi* sp. nov. male holotype (QM-W55108); **A** dorsal view **B** ventral view. Images: R.B. McCormack

½ and ¾ of propodal length then gap and typically 1 spine at carpal articulation; one specimen with 11 spines full length on regenerating chelae. Generally, 4 (occasionally 5) mesial propodal spines with distinct gap between first spine (at distal edge of propodal palm) and second spine; first spine poorly developed. 1 dorsal apical spine; absent on crayfish <27 mm OCL. 1 spine above dorsal cutting edge; absent on crayfish <27 mm OCL. Dorsal and ventral surfaces of propodus lateral to dactylar base without bumps, spines or protrusions. PropLOCL 0.85–0.96; PropW (top-bottom)/PropL 0.37–0.42; PropD (side-side)/PropL 0.24–0.28.

Dactylus: 1 spine above dorsal dactylar cutting edge; ventral cutting edge spines absent. 1 apical mesial dactylar spine. Dactylar groove weakly developed. Basal spines absent. DactL/ PropL 0.52–0.57.

Carpus: 3 mesial carpal spines, distalmost distinctly larger and sharper than, and offset ventrally to, other spines. Ventral carpal spine large and sharp. 1 small blunt ventromesial spine. 1 very small rounded lateral carpal spines. Dorsal carpal spines absent. Dorsal carpal groove deep.

Merus: 5–8 very small blunt dorsal spines increasing in size with distalmost larger and pointed. Outer (distolateral) meral spine absent or very small and blunt.

Punctation: Moderate fine punctations on body, large on chelae.

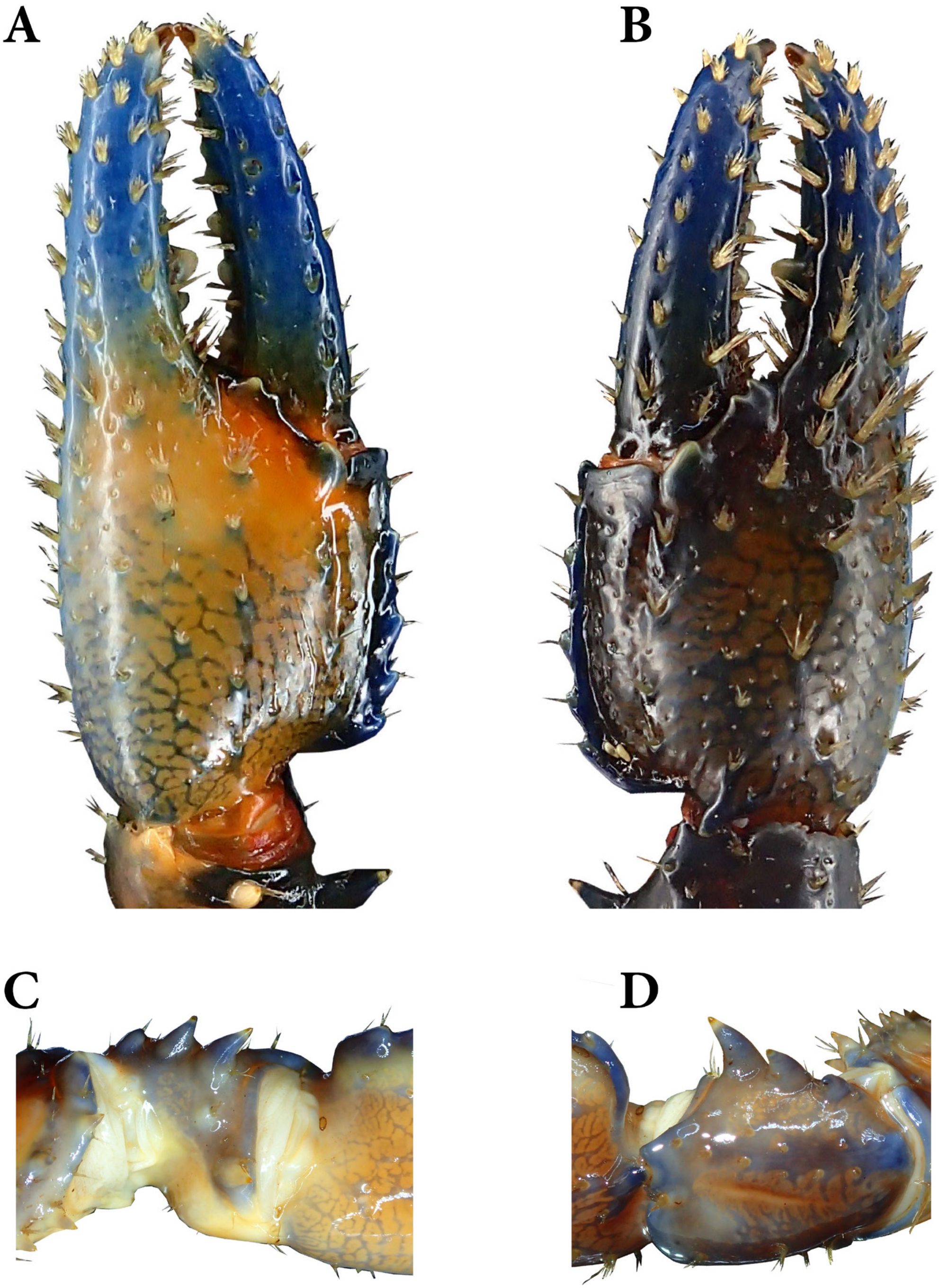

Figure 3. *Euastacus vanderwerfi* sp. nov. male holotype (QM-W55108): **A** ventral chelae **B** dorsal chelae **C** ventral carpus **D** dorsal carpus. Image: R.B. McCormack

Setation: Dense short stiff setae on thorax, abdomen and tailfan. Chelae and periopods with long thick tufts of setation arranged in rows both dorsally and ventrally.

Gastric mill: (3 specimens OCL 24.57–29.21 mm) TAP count 3.5; TAA count 1–1.5; Spread 2. Secondary zygocardiac ossicle ear absent. Urocardiac occicle with 4–5 ridges.

Juveniles: Light coloured bands on somites 1 and 6 absent.

Colouration: (Fig. 1–4). Cephalothorax predominantly dark brown to rusty-brown dorsally, transitioning to lighter brown-yellow ventrally. Abdomen primarily brown, with gradient of blue or green on lateral sides and skirt. Walking legs exhibit lighter green-blue hue. Dorsal surface of chelae dark

Figure 4. Dwarf crayfish of south-eastern Queensland. **A** *Euastacus maidae* (ACP996) Currumbin Creek, Springbrook National Park, Qld **B** *Euastacus* sp. nov. 13 (ACP6960) Nerang River, Springbrook National Park, Qld **C** *Euastacus binzayedi* (ACP6950) Binna Burra Section, Lamington National Park, Qld **D** *Euastacus vanderwerfi* (QM-W55108) Tributary Christmas Creek, south branch, South Lamington National Park, Qld **E** *Euastacus dalagarbe* (ACP2797) Tributary Brindle Creek, Border Ranges National Park, NSW **F** *Euastacus mirangudjin* (ACP6770) Camp Creek, Logan River, Qld. Images: R.B. McCormack.

brown-green, marked with distinct blue background pattern. Dactylar and propodal fingers bright blue, with vibrant blue mesial and lateral propodal spine rows. Chelae spines tipped in white, cutting edge teeth also white. Spines on lateral surface of cephalon and abdominal spines tipped in bright yellow. Ventrally, species displays light orange to red-orange coloration.

Habitat

The type locality of *Euastacus vanderwerfi* is situated in the upper reaches of Christmas Creek within Lamington National Park, Queensland (Fig. 5). The habitat consists of a small, clear-flowing stream meandering through pristine rainforest. The streams are characterized by the presence of rainforest spinach (*Elatostema reticulatum)* and stream lily (*Helmholtzia glaberrima*), which are prevalent throughout the habitat. The riparian zone along the streams is dominated by Bangalow palms (*Archontophoenix cunninghamiana*), contributing to the lush, dense vegetation typical of the rainforest environment.

Distribution

Euastacus vanderwerfi is currently known from two upper catchment locations: a tributary of the south branch of Christmas Creek and a tributary of the north branch of Running Creek, both within the Logan River drainage, Queensland (Fig. 6). In the south branch of Christmas Creek, *E. vanderwerfi* was recorded between 909 and 1011 m asl. Below 950 m asl, it occurs sympatrically with the giant spiny group crayfish *Euastacus sulcatus*. However, above 950 m, only *E. vanderwerfi* was encountered.

In contrast, in the north branch of Running Creek, the species was found between 977 and 1004 m asl, coexisting with *Euastacus dalagarbe*. *Euastacus sulcatus* was absent from this site but is abundant at lower altitudes throughout the broader drainage. The north branch of Running Creek marks the westernmost limit of *E. vanderwerfi* distribution and the easternmost boundary of *E. dalagarbe*. The easternmost extent of the *E. vanderwerfi* distribution remains undetermined.

Figure 5. Type locality: Tributary Christmas Creek, south branch; clear flowing with rainforest spinach (*Elatostema reticulatum*) and stream lily (*Helmholtzia glaberrima*).

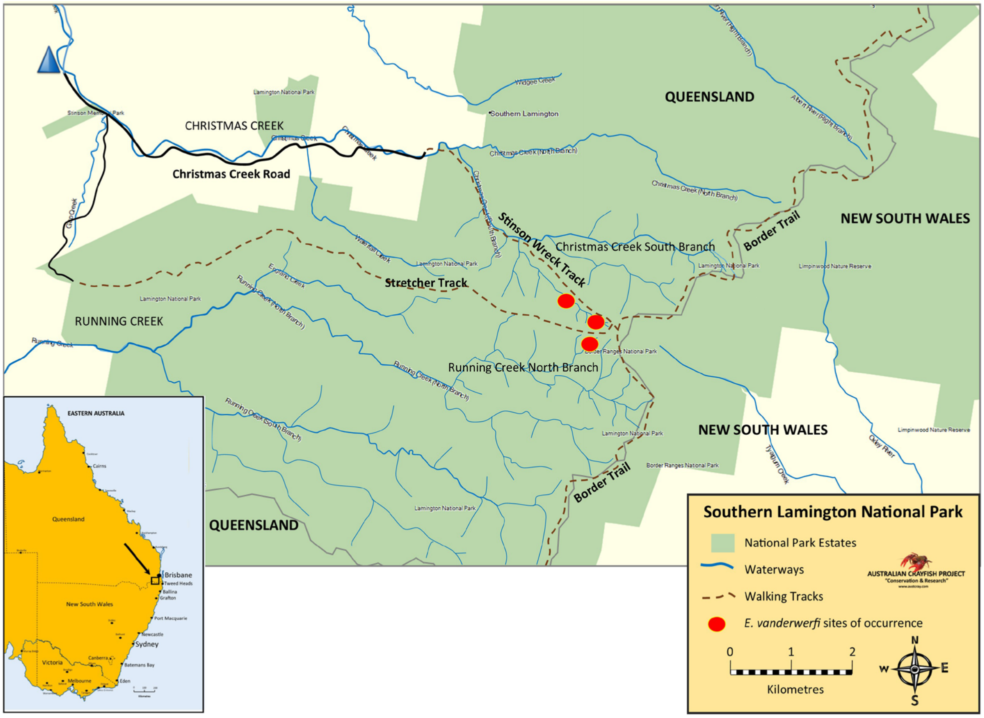

Figure 6. *Euastacus vanderwerfi* collection sites.

Reproductive maturity

Males of *Euastacus vanderwerfi* possess a cuticle partition. To estimate sexual maturity in females, the gonopores were examined for the presence and development of setae, following the criteria outlined by Turvey and Merrick (1997) and Morgan (1997). Light setation and closed gonopores indicate a female is approaching sexual maturity, while heavy setation and open gonopores are indicative of full sexual maturity. Additionally, soft, membranous, and inflated gonopores, often observed in females carrying eggs, serve as confirmation of reproductive maturity.

The largest female examined, QM-W55109, with an occipital carapace length (OCL) of 37.62 mm, was identified as sexually mature. Another female, QM-W55113 (OCL 30.40mm) displayed well-developed membranous gonopores with dense long setae around the margins, also indicating sexual maturity. All females under 25 mm OCL were found to be immature, suggesting that sexual maturity in *E. vanderwerfi* begins at around 30 mm OCL.

Burrows

The habitat of *E. vanderwerfi* consists of fast-flowing creeks that cascade down mountain valleys, with bedrock covered by large compacted boulders, smaller cobbles and coarse gravel. Loose rock is rare, and the burrow systems are extensive, complex and riddle the creek margins. Despite significant efforts, fully excavating these burrow systems has proven difficult, as disturbed crayfish quickly retreat deep into their burrows. The limited number of large adult specimens recovered reflects the challenges in capturing individuals. Specimens were typically obtained by turning over rocks along the stream banks or by digging into burrows. According to Horwitz & Richardson (1986), Australian crayfish burrows are classified into three categories based on their relationship with the water table (Types 1–3). The burrows of *E. vanderwerfi* fall into the 'Type 1b' category, meaning all burrows are connected to creek water flow, although not to open water. All captured crayfish were retrieved from flooded burrow systems where water was continuously percolating.

Like other members of the dwarf group, *E. vanderwerfi* inhabits small clear flowing streams that drain excess rainforest precipitation (Fig. 7). These streams are heavily shaded by a complete forest canopy. The burrows are generally located beside the stream, within 600 mm of the water's edge, and are constructed under structures that are typically less than 150 mm above the stream's flowing water level. The burrow systems extend below the water level, running along the creek banks where flowing water is present. However, these burrows do not surface in the surrounding riparian zone, remaining submerged and flooded.

Figure 7 illustrates that the burrows of *E. vanderwerfi* are situated beside open stream water but are not directly connected to it. At lower elevations, burrows located under rocks within the stream itself belong to *Euastacus sulcatus*.

Population density estimates

Population estimates for *Euastacus vanderwerfi* are speculative and should be regarded as best approximations, based on the ease of specimen capture and the number of observed active burrows. These estimates are provided as the number of larger individuals (>16 mm OCL) per linear meter (lm) of stream length. Smaller juveniles have been excluded from these estimates due to seasonal fluctuations in their abundance. In the tributary of the south branch of Christmas Creek, at an elevation of 900–950 m, the population density was estimated at 3–6 individuals per linear meter. At 1000 m, this estimate increased to 6–8 individuals per linear meter. At lower elevations (below 950 m), *E. vanderwerfi* was found in sympatry with *Euastacus sulcatus*, while at higher elevations only *E. vanderwerfi* was present.

Ectocommensal fauna

Euastacus vanderwerfi hosts small populations of temnocephalan flatworms (Platyhelminthes: Turbellaria), which are commonly associated with freshwater crustacean hosts, particularly parastacid crayfish (Sewell et al. 2006, Sewell 2013, Hoyal Cuthill et al. 2016, Sibraa et al. 2021). Similar to other *Euastacus* species, *E. vanderwerfi* was found to host two species of temnocephalans.

Figure 7. *Euastacus vanderwerfi* burrows beside open stream water but not connected to surface water.

Upon examining the external surfaces of *E. vanderwerfi*, we observed small white temnocephalans with six anterior tentacles (identified as *Temnohaswellia* sp.) in small numbers, typically less than 20 individuals. Additionally, we found small white temnocephalans with five anterior tentacles (identified as *Temnosewellia* sp.), also in low numbers, usually fewer than 20. Most examined crayfish hosted only a few individuals of each species, and the reason for this low population density of ectosymbionts remains unknown.

In addition, *E. vanderwerfi* also hosts colonies of ectosymbiotic worms, specifically phreodrilid oligochaetes (Pinder & Brinkhurst 1997). These worms were found on external surfaces of the crayfish exoskeleton or within grooves or cavities. Their populations were typically very low, with one or two worms located on each crayfish. These worms were most often found in the cervical groove, in the keel at Pr 1 and under abdominal somite 1 (pleon). Pinder & Brinkhurst (1997) identified *Astacopsidrilus jamiesoni* Brinkhurst, 1991, from *Euastacus* in the rainforest streams of the Gold Coast, southern Queensland, and McCormack and Coughran (2008) reported the same oligochaete from *E. maccai* McCormack and Coughran, 2008 from north-eastern New South Wales. However, the species of oligochaete occurring on *E. vanderwerfi* is yet to be confirmed.

Etymology

The species is named in honour of Mr Paul Van der Werf, whose dedication, research and enthusiasm for the conservation of spiny crayfish have significantly contributed to their ongoing protection. Paul's tireless efforts were instrumental in the discovery of this species. In 2015, after a gruelling expedition through the rainforest and mountains, we emerged with specimens in hand, both exhausted and 'dead on our feet'. The discovery of *Euastacus vanderwerfi* was not an easy achievement.

Common name: Van der Werf's crayfish.

REMARKS

Tissue samples of *Euastacus vanderwerfi* sp. nov. (under the working name of '*E.* cf *dalagarbe*') along with five other similar dwarf group species, were included in the molecular taxonomic analysis (Fig. 8) (Austin et al. 2022). The sequences of the two samples of *E. vanderwerfi* (CA033/ACP5477; CA035/ACP5574), cluster with *E. dalagarbe* sensu stricto, but the two species show a mean divergence (K2P distance) of 2.8% (range: 2.5–3.0%) which is significantly more than the intraspecific sample divergence in the other allied species (Austin et al. 2022, page 29). It is even more significant because *E. vanderwerfi* co-occurs in the same streams as *E. dalagarbe*.

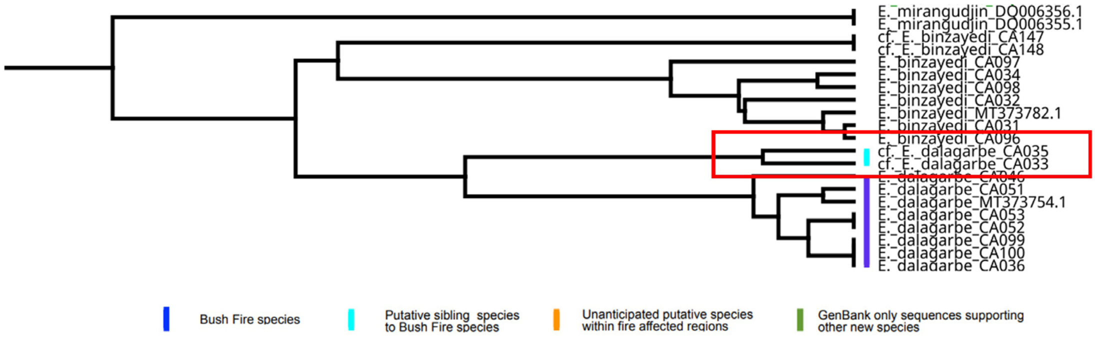

Figure 8. Extract Austin et al (2022), showing the combined COI gene tree for northern species of *Euastacus*. Blue highlight indicates putative new species divergent from bushfire-impacted species and purple highlight indicates priority bushfire-impacted species. Red box indicates where *Euastacus vanderwerfi* sits. *Euastacus vanderwerfi* CA035 = ACP5574 and CA033 = ACP5477. High resolution of the full northern COI gene tree from Austin et al (2022): https://natureglenelg.org.au/wp-content/uploads/2021/09/Saving-the-Spinys_northern-combined-COI-tree.pdf

Euastacus vanderwerfi sp. nov. represents a distinct population occurring between *E. dalagarbe* to the west and *E. binzayedi* to the east, closely resembling both. Adults can be easily distinguished from them in the field by its bright blue chelae fingers and significantly greater setation, particularly on the chelae.

Euastacus vanderwerfi sp. nov. is one of six similar dwarf group crayfish species inhabiting the Queensland side of the New South Wales border (Fig. 4). The distribution of each species is as follows (from furthest west to furthest east): *Euastacus mirangudjin* is found in the upper reaches of Camp Creek, a tributary of Running Creek (Logan River drainage) (McCormack, unpublished data). *Euastacus dalagarbe* occurs in the tributaries of Running Creek in southern Lamington National Park, also part of the Logan River drainage (McCormack, unpublished data). *Euastacus vanderwerfi* inhabits Christmas Creek (south branch) and a tributary of Running Creek (north branch), both within the Logan River drainage. *Euastacus binzayedi* is found in the upper reaches of the Nerang, Coomera and Albert River drainages in Lamington National Park (McCormack & Ahyong, unpublished data). A yet undescribed species, *Euastacus* sp. nov. 13 occupies tributaries of the Nerang River drainage (McCormack & Ahyong, unpublished data); and it occurs sympatrically with *Euastacus maidae* that extends the furthest east, being found in the eastern tributaries of the Nerang River, including Little Nerang, Mudgeeraba, Tallebudgera and Currumbin creeks, Queensland (McCormack & Ahyong, unpublished data).

Each of these six species is genetically distinct and recognized as valid species (Austin et al. 2022). In addition, several morphological characteristics support the separation of *Euastacus vanderwerfi* as a new species. Notably, *E. mirangudjin*, *E.* sp. nov. 13, and *E. maidae* all possess four mesial carpal spines, which easily distinguishes them from *E. vanderwerfi*, which has only three spines. A full list of characteristics useful in separating *E. vanderwerfi* sp. nov. from its two closest congeners is presented in Table 1.

Morphological characteristic	***E. binzayedi* Coughran & Furse, 2013**	***E. vanderwerfi* sp. nov**	***E. dalagarbe* Coughran, 2005**
Suborbital spine	Medium	Small-medium	Barely discernible to small
Setation: propodus and dactylus	Chelae large tufts, setae in rows	Chelae large tufts, setae in rows	Chelae short, sparse
Dorsal propodal pattern	Indistinct	Distinct	Indistinct
Mesial propodal spines	4–6	4–5	3–5
First mesial propodal spine (at distal edge of propodal palm)	Small pointed	Absent to small pointed, poorly developed	Small pointed, poorly developed
Dorsal apical propodal spines	1	1	1–2
Apical mesial dactylar spines	1	1	1
Spines above propodal cutting edge dorsally	0	1	1–2
Spines above dactylar cutting edge dorsally	0	1	1–2
Dorsal mesial dactylar basal spines	1	0	0
Spines lateral to dactylar base dorsally	Numerous lumps and protrusions	0	0
Spines lateral to dactylar base ventrally	Numerous lumps and protrusions	0	1
Propodal cutting teeth	1 large, plus 1 very small tooth, joined at base posteriorly	1 large plus 1–2 smaller propodal teeth, joined at base posteriorly	1 large tooth

Table 1. Morphological characteristic comparison table.

Observations on other sympatric species

In Christmas Creek, at lower elevations (<500 m), the giant group crayfish *Euastacus valentulus* Riek, 1951, is present and occurs sympatrically with another giant group crayfish, *Euastacus sulcatus*. *Euastacus valentulus* can be distinguished by its red eye sockets, whereas *E. sulcatus* has white eye sockets. Additionally, *E. valentulus* exhibits prominent dark thoracic spines, which are absent in *E. sulcatus*.

Further upstream, *E. sulcatus* extends into higher elevations and becomes sympatric with *E. vanderwerfi*. Both species possess a male cuticle partition, lack thoracic spines, and are setose. However, the two species are easily distinguishable in the field. *E. sulcatus* has a longer and sharper rostrum; prominent long sharp first postorbital ridge spines; and large sharp suborbital spines.

Threats

Climate change presents the most significant threat to the long-term survival of *Euastacus vanderwerfi*. Models predict a general reduction in annual rainfall and a rise in temperatures of approximately 1°C across much of coastal Queensland by 2030 (CSIRO 2007), accompanied by more frequent heatwaves and bushfires (Steffen et al. 2014). South-eastern Queensland already experiences extreme climatic events such as heatwaves, droughts, floods and bushfires. The Environmental Protection and Heritage (EPH) 2019 climate change projections for south-east Queensland indicate a future of reduced rainfall, harsher fire weather, hotter, and more frequent hot days.

Global climate models project a near 100% probability that most years between 2019 and 2028 will rank among the top 10 warmest years on record (Arguez et al. 2020). Climate modelling specific to Lamington National Park (ANU 2009) suggests rapid and significant changes in temperature and precipitation patterns. As a species restricted to cool, high-elevation streams, *E. vanderwerfi* is particularly vulnerable to rising water temperatures and decreasing hydrological stability. It inhabits perennial flowing streams with catchments starting at elevations of 1000 m or above, making it highly sensitive to climate-induced changes in water temperature and stream flow.

The Gondwana Rainforest World Heritage Area, where *E. vanderwerfi* is found, has already experienced a rise of 1.5°C in maximum temperatures and 1°C in mean temperatures between 1950 and 2003, with predictions of a further 1.3°C increase over 1990 levels by 2030 (ANU 2009). Any further increases in water temperature or reductions in stream flow are likely to drastically reduce the population size and geographic range of *E. vanderwerfi*. It has limited capacity to shift its range upward in response to warming temperatures, and lower elevations may become inhospitable. Even small climatic changes could have profound impacts on its population and distribution, as observed in a similar high-elevation dwarf species like *E. spinichelatus*, which experienced local extinctions due to the 2017–2020 extreme drought (McCormack & Whiterod 2024b).

The 2019/2020 megafires impacted many parts of Queensland, burning about 6,617,430 ha (3.8% of the state) and impacting at least 648 threatened species (Threatened Species Operations 2020). High intensity bushfire is another growing threat to *E. vanderwerfi*, as climate change is expected to increase the frequency and intensity of bushfires across eastern Australia (BOM 2019). While fire has long been a natural part of the Australian landscape, changing fire regimes, characterized by more intense and frequent fire, pose a major threat to biodiversity. Rainforests are generally fire-sensitive, and while they are often protected from fire by their moist conditions, they are vulnerable when they abut fire-prone vegetation or are embedded in fire-susceptible landscapes (Hunter 2003).

The 2019/2020 megafires severely impacted Lamington National Park, which contains 20,636 hectares of Gondwana Rainforest. Of this, approximately 2,114 hectares (10.2%) were burned (Commonwealth of Australia 2020). Fortunately, the known distribution of *E. vanderwerfi* was not directly affected by these fires. However, high-intensity bushfires have been documented as local extinction-level events for other cold-water, high-elevation crayfish (McCormack 2015, McCormack & Whiterod

2024a), and it is likely that *E. vanderwerfi* would be similarly vulnerable to mass mortality in the event of such fires.

Illegal trapping and collection of crayfish continue to pose challenges throughout Lamington National Park (W. Buch (QNPS) 2014 pers. comm, Forbes 2019), particularly for the larger congener *Euastacus sulcatus*. However, we do not consider this a significant threat to *Euastacus vanderwerfi*, as this species is not vulnerable to trapping due to its small size, shallow streams, burrowing behaviour and remote location, which adds a natural layer of protection.

Exotic species such as cats, foxes, pigs and goats are known to occur within the range of *E. vanderwerfi*, and these species have impacted other crayfish populations elsewhere (Green & Osbourne 1981). However, our surveys found no direct evidence of these animals affecting *E. vanderwerfi* populations.

In summary, *Euastacus vanderwerfi* faces significant risks from climate change, particularly rising temperatures, reduced stream flow, and increased bushfire frequency and intensity. These threats are likely to cause a contraction in its range and a reduction in population size, making *E. vanderwerfi* particularly vulnerable to extinction. Unfortunately, as a high-elevation species, it has limited refuge from these rapidly changing environmental conditions.

Conservation assessment

Based on the distributional information presented, the Extent of Occurrence (EOO) for *Euastacus vanderwerfi* is estimated at 0.102 km^2, with an Area of Occupancy (AOO) of 4 km^2, calculated using a 2 km cell width in the GeoCAT (Geospatial Conservation Assessment Tool), which allows for data-driven conservation assessments (Bachman et al. 2011). Based on collection data from the Australian Crayfish Project (ACP), the automated IUCN Red List assessment suggests that *E. vanderwerfi* qualifies as Critically Endangered.

Euastacus vanderwerfi meets the IUCN Red List criteria for Critically Endangered (CR) status under criteria B1ab(iii,v)+2ab(iii,v):

- Extent of Occurrence (EOO): Less than 100 km^2 (0.102 km^2 = 4 km^2), indicating a severely restricted distribution, with the species known from highland rainforest sites on either side of a mountain (one location).
- Area of Occupancy (AOO): Less than 10 km^2 (4 km^2).
- The species is found in just one location, as defined by IUCN guidelines. Although it occurs in both the Running and Christmas creeks across the range, the entirety of its habitat is vulnerable to a single major threat — namely, the impacts of climate change. This threat has the potential to affect all its high-elevation habitats simultaneously, leading to an anticipated decline in the area, extent and/or quality of habitat, as well as a reduction in the EOO due to climate-related factors such as rising water temperatures, increased bushfire risk and prolonged drought.

Based on its small population size, small geographic distribution, and the probability of future population declines due to climate change, *E. vanderwerfi* meets the criteria for listing as Critically Endangered under the Queensland Nature Conservation Act 1992. Given its highly localised distribution and dependence on cool perennial streams, this species is highly vulnerable to environmental changes, reinforcing the necessity of its Critically Endangered status.

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