SHORT COMMUNICATION

Hydrocotyle asterocarpa, H. decorata and H. perforata (Araliaceae), three new Western Australian species with spicate inflorescences

Three new species of Hydrocotyle L. from the south-west of Western Australia are described and illustrated herein. All three species differ from most members of the genus in being annuals with spicate inflorescences (rather than umbellate) and highly ornate fruits with prominently lobed or raised dorsal and lateral ribs. Their close relationship with the widespread Australian species H. medicaginoides Turcz. is discussed and a key is provided. All three species have conservation priority.

Key to annual species of Hydrocotyle with spicate inflorescences

1. Schizocarps with 6 wing-like lobes developing from the dorsal and lateral ribs
2. Wings spreading, orbicular, margins rugulose.................................................................H. medicaginoides
2: Wings ascending above fruiting styles, shape and margins not as above
3. Wings becoming inflated at maturity, margins entire or shallowly lobed .........................H. asterocarpa
3: Wings flattened at maturity, marginal lobing undulate to finger-like...............................H. decorata
1: Schizocarps with 2 slender wings along the dorsal ribs, lateral ribs raised .....................H. perforata

Hydrocotyle asterocarpa A.J.Perkins, sp. nov.

Type: saline lake east of Scaddan, Western Australia [precise locality withheld for conservation reasons], 20 October 2017, A.J. Perkins AJP-WA 140 (holo: PERTH 08935068; iso: AD, CANB, MEL, NSW).


Annual herbs with a basal rosette of leaves and branched stems bearing leaves and dense spicate inflorescences, 2–6 cm high, 2–15 cm wide. Stems erect (in smaller plants) to decumbent (in larger plants), light green to reddish green, terete, villous. Stipules white, ovate to linear lanceolate, 1.5–4.0 mm long, 0.5–2.5 mm wide, membranous, translucent, fimbriate along margins. Petioles 5–45(–50) mm long, light green, villous. Leaf blades simple, dorsiventral, carnose, rhombic to trilobed in juvenile leaves, trilobed to pedately lobed in mature leaves, 4–12 mm long, 4–18 mm wide; adaxial surface glabrous to subglabrous to puberulous, light green to yellowish green; abaxial surface slightly lighter in colour than adaxial, subglabrous to puberulous. Leaf margins toothed; teeth rounded to obtuse, glabrous to occasionally tipped with acute hairs. Median leaf lobes elliptic to obovate, 4–11 mm long, 3–8 mm wide, with 1–3 marginal teeth. Lateral leaf lobes 4–11 mm long, 3–10 mm wide, with 2–9 marginal teeth, incised into 2 asymmetrical lobules in pedate leaves; leaf sinuses 10–90% of lateral lobe length. Inflorescences spicate, leaf-opposed, 8–24-flowered. Peduncles terete, longer than subtending leaf, 5–25 mm long, villous. Involucral bracts absent. Rachis 4–16 mm long. Pedicels light
green, 0.1–0.2 mm. Flowers all hermaphrodite, protandrous, densely arranged along the rachis. Sepals absent. Petals 5, cream to light creamy yellow, ovate, 0.8–1.0 mm long, 0.5–0.6 mm wide. Filaments light cream, 0.5–0.6 mm long. Anthers creamy yellow to crimson, elliptic, 0.3 mm long. Ovaries light green at anthesis, orbicular to obovate, dorsal and lateral ribs lobed towards their apices. Schizocarps bilaterally flattened, symmetrical, broadly obovate, 6 prominent wings developing on the apical lobing of the dorsal and lateral ribs, light green during early development turning creamy brown at maturity and often remaining persistent on the carpophore beyond the senescence of the plants; commissure 85–95% the length of mericarps (excluding the wings). Mericarps minutely colliculate, 1.0–1.5 mm long, 1.0–1.3 mm wide; dorsal and lateral ribs raised along the basal half with prominent wings at their apices; wings 0.4–0.9 mm long, ascending well above the fruiting styles, ovate to oblong, margins entire or with shallow lobing, apices often falcate with obtuse to acute tips, wings often enlarging, becoming inflated at maturity; mericarp surface between dorsal and lateral ribs appearing pitted due to raised reticulate ridges; surface between lateral ribs and median ribs similarly covered by raised reticulate ridges; mature mericarps remaining persistent to the carpophore beyond the senescence of the plants. Carpophores persistent, acerose. Fruiting styles swollen at the base, 0.6 mm long, reflexed. Cotyledons oblong in the seedlings. (Figure 1)

Diagnostic features. Hydrocotyle asterocarpa can be distinguished from all other taxa in Hydrocotyle by possessing the following combination of characters: annual herbs with dense spicate inflorescences; schizocarps star-like due to 6 prominent wings that ascend well above the fruiting styles and are formed from apical lobing of the dorsal and lateral ribs; mericarp wings often enlarging and becoming inflated at maturity; mericarp surfaces appearing pitted due to raised reticulate ridges between the dorsal, lateral and median ribs; mature mericarps remaining persistent to the carpophore (and the infructescences remaining intact) beyond the senescence of the plants; carpophores acerose and persistent (Figure 1A–C).


Phenology. This species is a winter annual, with flowering and fruiting occurring from September to early November.

Distribution and habitat. Hydrocotyle asterocarpa is currently known from areas north of Esperance, around Scaddan and eastward towards Mt Ney, all within the Mallee bioregion (Western Australian Herbarium 1998–) (Figure 2). Plants grow in sandy loam soils surrounding the margins of inland salt lakes, in low open shrubland, often in sheltered positions around mature plants of Tecticornia and Frankenia spp. (Figure 1D).

Conservation status. Hydrocotyle asterocarpa is listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name H. sp. Truslove (M.A. Burgman 4419). This species is known from several general localities around Scaddan, scattered eastward for about 55 km (Figure 2).

Etymology. The epithet asterocarpa is derived from the Greek astero-, ‘starry’, and -carpus, ‘fruit or seed’, in reference to the star-shaped schizocarps of this species (Figure 1B, C). The common name ‘Starry Pennywort’ is here suggested.
Affinities. *Hydrocotyle asterocarpa* is morphologically similar to the widespread Australian winter annual, *H. medicaginoides* (Figure 3), and the two rare Western Australian annuals, *H. decorata* A.J.Perkins and *H. perforata* A.J.Perkins, due to all four species possessing dense spicate inflorescences, subsessile flowers, schizocarps with prominent dorsal and lateral ribs that are often lobed or winged.
at maturity, mericarp surfaces ornamented with reticulate ridges and pits (Figures 3–5), and persistent carpophores. The mature mericarps in all four species also remain attached to their carpophores beyond the senescence of the plants in late spring to early summer.

The inflorescence of *H. medicaginoides* has been previously interpreted as being umbellate (Duretto 1999), but with the disarticulation of the mericarps (or removal of the mericarps from the infructescence) it is revealed to be predominantly spicate in structure. Small plants of *H. medicaginoides* may produce umbellate inflorescences (of 3–5 flowers) due to low flower numbers, but most plants typically produce dense spicate inflorescences of 6–12 flowers, like those in *H. asterocarpa*, *H. decorata* and *H. perforata* (Figures 1, 3–5).

Both *H. asterocarpa* and *H. medicaginoides* are known to occur in similar habitats, preferring sites around saline lakes or saline coastal swamps, often associated with low chenopod shrublands (Figures 1D, 3D) and have been found growing sympatrically around Scaddan in Western Australia (Western Australian Herbarium 1998--; AVH 2017). *Hydrocotyle asterocarpa* can be readily distinguished from *H. medicaginoides* based on differences in the schizocarp morphology. Primarily, the schizocarp wings in *H. asterocarpa* ascend well above the fruiting styles, with the margins entire or occasionally with shallow lobing and the apices often falcate with obtuse to acute tips (Figure 1B, C). In *H. medicaginoides*, the wing-like lobes are spreading (not ascending), rugulose along the margins and orbicular in shape (Figure 3B, C). Overall, the ascending wings in *H. asterocarpa* give the dense spicate infructescences in this species a spiky or ‘prickly’ appearance (Figure 1A–C), whereas the infructescences in *H. medicaginoides* are more spherical to elliptic in profile (Figure 3A, B).
Figure 3. *Hydrocotyle medicaginoides*. A – portion of flowering plant *in situ* showing dense spicate inflorescences and infructescences; B – spicate infructescence with mature schizocarps; C – lateral view of a mature schizocarp showing wing-like lobes with rugose margins and pitted mericarp surfaces; D – typical habitat. Scale bars = 5 mm (A); 1 mm (B, C). Voucher: A.J. Perkins AJP-WA 125 (A, B, C). Photographs by A. Perkins.
Hydrocotyle decorata A.J.Perkins, *sp. nov.*

*Type:* Lake King, Western Australia [precise locality withheld for conservation reasons], 22 October 2017, A.J. Perkins AJP-WA 144 (*holo:* PERTH 08935033; *iso:* AD, CANB, MEL, NSW).


Annual herbs with a basal rosette of leaves and branched stems bearing leaves and spicate inflorescences, 1–4 cm high, 2–30 cm wide. *Stems* decumbent, straight to sinuous, light green to crimson, terete, villous. *Stipules* white, lanceolate to linear lanceolate, 1.0–4.0 mm long, 0.5–2.2 mm wide, membranous, translucent, finely fimbriate along margins. *Petioles* 5–40(–50) mm long, light greenish yellow to reddish green, villous. *Leaf blades* predominantly simple or occasionally compound, dorsiventral, carnose, rhombic to trilobed in juvenile leaves, trilobed to pedately lobed in mature leaves or sometimes trifoliolate, 4–20 mm long, 6–30 mm wide; adaxial lamina surface glabrous or subglabrous to puberulous, light green to yellowish green; abaxial lamina surface slightly lighter in colour than adaxial, subglabrous to puberulous. *Leaf margins* toothed; teeth rounded to obtuse, glabrous to occasionally tipped with short acute hairs. *Median leaf lobes* elliptic to obovate, 4–18 mm long, 3–12 mm wide, with 1–6 marginal teeth. *Lateral leaf lobes* 3–18 mm long, 3–15 mm wide, 3–9 marginal teeth, incised into 2 asymmetrical lobules in pedate leaves; leaf sinuses in simple leaves 10–95% of lateral lobe length. *Inflorescences* leaf-opposed, spicate, 6–26-flowered. *Peduncles* terete, longer than subtending leaves, 4–45 mm long, villous. *Involucral bracts* absent. *Rachis* 3–10 mm long. *Pedicels* light green, 0.1–0.2 mm long. *Flowers* all hermaphrodite, protandrous, densely arranged along the rachis. *Sepals* absent. *Petals* 5, predominantly cream to light creamy yellow with light crimson on the abaxial surface towards the apex, ovate, 0.8–1.0 mm long, 0.5–0.6 mm wide. *Filaments* light cream, 0.6 mm long. *Anthers* predominantly crimson to occasionally creamy yellow, elliptic, 0.3 mm long. *Ovaries* light green at anthesis, orbicular, dorsal and lateral ribs lobed towards their apices. *Schizocarps* bilaterally flattened, symmetrical, broadly obovate, 6 prominent wings developing on the apical lobing of the dorsal and lateral ribs, light green during early development turning creamy brown at maturity; commissure 90–95% the length of mericarps (excluding the wings). *Mericarps* minutely colliculate, 1.2–1.5 mm long, 0.9–1.2 mm wide; dorsal and lateral ribs raised with prominent wings along the entire length of the ribs; wings 0.3–1.0 mm long, ascending with undulate to obtusely lobed margins appearing finger-like with lobes variable in length and number along margin, wings remaining flattened at maturity; mericarp surface between dorsal and lateral ribs with 2 rows of pits either side of a raised undulate ridge running in parallel with the lateral rib; surface between lateral ribs and median ribs similarly with 2 rows of pits either side of a raised undulate ridge running alongside the lateral rib. *Carpophores* persistent, acerose. *Fruiting styles* swollen at the base, 0.5 mm long, reflexed. *Cotyledons* lanceolate in the seedlings. (Figure 4)

**Diagnostic features.** *Hydrocotyle decorata* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: decumbent annual herbs with dense spicate inflorescences; schizocarps with 6 prominent wings formed from apical lobing of the dorsal and lateral ribs; mericarp wings ascending, flattened (and remaining so at maturity), margins with distinct undulate to finger-like lobing; mericarp surface between the dorsal and lateral ribs with 2 rows of pits separated by a raised undulate ridge (running parallel with the lateral ribs), similarly
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Figure 4. *Hydrocotyle decorata*. A – flowering plant *in situ* showing the habit and spicate inflorescences; B – infructescence with developing schizocarps bearing winged lobes; C – lateral view of a mature schizocarp showing winged lobes and pitted mericarp surface; D – typical habitat. Scale bars = 2 cm (A); 1 mm (B, C). Vouchers: A.J. Perkins AJP-WA 142 (A); M. Graham G 215-19 (B, C). Photographs by A. Perkins.
the mericarp surface between the lateral and median ribs with 2 rows of pits separated by a raised undulate ridge; carpophores acerose and persistent (Figure 4A–C).


Phenology. This species is a winter annual, with flowering and fruiting occurring from September to November.

Distribution and habitat. Hydrocotyle decorata is known to occur near Lake King in the Mallee bioregion and Lake Cowan (near Norseman) in the Coolgardie bioregion (Western Australian Herbarium 1998–; AVH 2017) (Figure 2). Plants grow in sandy loam soils surrounding the margins of inland salt lakes, in low open shrubland, often in sheltered positions around mature plants of Tecticornia and Frankenia spp. (Figure 4D).

Conservation status. Hydrocotyle decorata is listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name H. sp. Hexaptera (T. Erickson TEE 173). The two areas of occurrence for this species are over 220 km apart (Figure 2).

Etymology. The epithet is derived from the Latin decoratus, ‘decorative’, in reference to the elaborate ornamentation of the fruit in this species (Figure 4B, C). The common name ‘Decorative Pennywort’ is here suggested.

Affinities. Hydrocotyle decorata differs from H. asterocarpa by having schizocarp wings that remain flattened at maturity (becoming inflated in H. asterocarpa), wings with undulate to finger-like lobing of the margins (mostly entire margins or occasionally shallowly lobed in H. asterocarpa) (Figures 1B, 4B). In contrast, the prominent lobing of the dorsal and lateral ribs in H. medicaginoides is spreading (not ascending) (Figure 3B, C) and only the dorsal ribs are narrowly winged in H. perforata (Figures 1B, C, 5B, C). Additionally, pitting on the mericarp surfaces in H. decorata are in two distinct rows separated by raised undulate ridges running in parallel with the lateral ribs (Figures 2B, 3B), whereas pitting on the mericarp surfaces in H. asterocarpa and H. medicaginoides are irregular in arrangement, being interspersed amongst the reticulate ridges (Figure 1C).

Hydrocotyle perforata A.J.Perkins, sp. nov.

Type: south of Balladonia Motel, Eyre Highway, Western Australia [precise locality withheld for conservation reasons], 16 September 1980, K.R. Newbey 7477 (holo: PERTH 03539873; iso: CANB 352120).


Annual herbs with a basal rosette of leaves and branched stems bearing leaves and spicate inflorescences, 2–7 cm high, 1–5 cm wide. Stems ascending, straight to sinuous, light green to crimson in colour, terete, villous. Stipules white, lanceolate to linear-lanceolate, 1.0–3.0 mm long, 0.5–1.5 mm wide, membranous, translucent, lanciniate to fimbriate along margins. Petioles 4–15 mm long, light green, villous. Leaf blades simple, dorsiventral, carenose, rhombic to shallowly trifoliate in juvenile leaves, shallow to deeply trifoliate in mature leaves, 3–6 mm long, 3–12 mm wide; adaxial lamina surface light green, subglabrous to puberulous; abaxial lamina surface slightly lighter in colour than adaxial, subglabrous to puberulous. Leaf margins toothed; teeth rounded to obtuse or occasionally acute. Median leaf lobes ovate to oblancoate, 3–6 mm long, 2–4 mm wide, with 1–3 marginal teeth. Lateral leaf lobes 2–6 mm long, 2–4 mm wide, with 1–4 marginal teeth; leaf sinuses 20–80% of lateral lobe length. Inflorescences leaf-opposed, spicate, 6–20-flowered. Peduncles terete, longer than subtending leaf when in fruit, 3–20 mm long, villous. Involucral bracts absent. Rachis 3–6 mm long, glabrous to sparsely villous. Pedicels light green, 0.2–0.5 mm long. Flowers all hermaphrodite, protandrous, densely arranged along the rachis. Sepals absent. Petals 5, cream with light crimson on the abaxial surface towards the apex, ovate, 0.5–0.8 mm long, 0.4–0.5 mm wide. Filaments light cream, 0.4–0.5 mm long. Anthers crimson or occasionally creamy yellow, elliptic, 0.2–0.3 mm long. Ovaries light green at anthesis, orbicular, dorsal and lateral ribs distinctly raised in profile. Schizocarps bilaterally flattened, symmetrical, broadly elliptic to broadly obovate, light green during early development turning reddish brown to dark brown at maturity, dorsal and lateral ribs prominently raised; commissure 90–95% the length of mericarps. Mericarps minutely verrucate to colliculate, 0.4–0.8 mm long, 0.6–0.8 mm wide; dorsal ribs conspicuous, bearing a slender wing at maturity; wing margins repand; lateral ribs prominently raised; mericarp surface between dorsal and lateral ribs with 2 longitudinal rows of pits bordered by raised undulate ridges; surface between lateral ribs and median ribs similarly with 2 (rarely 3) longitudinal rows of pits bordered by raised undulate ridges; ridges surrounding pits becoming thickened and more prominent leading up to fruit maturation. Carpophores persistent, acerose. Fruiting styles swollen at the base, 0.4–0.5 mm long, reflexed. Cotyledons oblong to oblancoate in the seedlings. (Figure 5)

Diagnostic features. Hydrocotyle perforata can be distinguished from all other taxa in Hydrocotyle by possessing the following combination of characters: ascending annual herbs with dense spicate inflorescences; broadly elliptic to broadly obovate schizocarps with slender wings along the dorsal ribs; lateral ribs raised (but not lobed); mericarp surfaces distinctly pitted with 2 longitudinal rows of pits bordered by raised undulate ridges between the dorsal and lateral ribs, similarly with 2 rows of pits between lateral ribs and median ribs; carpophores acerose and persistent (Figure 5A–C).


Phenology. This species is a winter annual, with flowering and fruiting occurring from September to November.

Distribution and habitat. Hydrocotyle perforata is currently known from a locality near Salmon Gums in the Mallee bioregion and four localities south-west of Ballardina in the Coolgardie bioregion (Western Australian Herbarium 1998--; AVH 2017) (Figure 2). This species grows in sandy loam soils
Figure 5. *Hydrocotyle perforata*. A – herbarium voucher showing a fertile plant with flowers and developing fruit borne on spicate inflorescences; B – infructescence showing mature schizocarps with pits in longitudinal rows; C – lateral view of a mature schizocarp showing slender wings along the dorsal ribs, raised lateral ribs and pitted mericarp surface; D – typical habitat in the Salmon Gums area. Scale bars = 5 mm (A), 1 mm (B, C). Vouchers: K.R. Newbey 7266 (A); G. Cockerton & N. McQuoid LCH 15782 (B, C). Photographs by A. Perkins.
surrounding the margins of inland salt lakes and in granitic sandy loams surrounding exposed granite outcropping or shallow granite sheeting of variable drainage.

Conservation status. *Hydrocotyle perforata* is listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name *H.* sp. Coraginaensis (K.R. Newbey 7477).

Etymology. The epithet is derived from the Latin *perforatus*, ‘perforated’, in reference to the perforated or pitted ornamentation of the fruit in this species (Figure 5A–C). The common name ‘Pitted Pennywort’ is here suggested.

Affinities. The schizocarps of *Hydrocotyle perforata* differ from *H.* medicaginoides, *H.* asterocarpa and *H.* decorata by having slender flattened wings along the dorsal ribs only (Figure 5B, C) and the lateral ribs being raised (lateral ribs with prominent lobing in *H.* medicaginoides, *H.* asterocarpa and *H.* decorata). Also, the undulate ridges that border the pits on the mericarp surfaces become thickened as the fruit reaches maturity, giving this species their distinctively pitted schizocarps (Figure 5A–C).

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References


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