



Two new relict *Syncordulia* species found during museum and field studies of threatened dragonflies in the Cape Floristic Region (Odonata: Corduliidae)

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Abstract

Red List assessments often require the verification of records and taxonomy in museum collections and the field. Such research during an assessment of threatened dragonflies in the Cape Floristic Region (CFR) biodiversity hotspot, led to the discovery of two new narrow-range endemic *Syncordulia* species, bringing the known total to four in the genus. The new species, *Syncordulia legator* and *S. serendipator*, are described with emphasis on their identification, ecology and biogeography. Morphological diversity within the genus and the absence of obvious close relatives suggest an ancient and isolated presence in the CFR, emphasizing the uniqueness and conservation importance of the region's endemic odonate fauna.

Key words: Anisoptera, *Syncordulia*, South Africa, conservation, systematics, biogeography, key

Introduction

The Cape Floristic Region (CFR) in South Africa is a globally-significant biodiversity hotspot (Myers *et al.* 2000). It is home to a substantial number of localized, specialist and threatened dragonfly species (Samways 1999; 2006; Grant & Samways 2007; Samways & Grant 2007). Taxonomic verification is a first step towards their conservation. This study relates to the phylogenetically significant dragonfly genus *Syncordulia* (Corduliidae), which is almost entirely endemic to the CFR. Corduliids, as traditionally defined, but excluding macromiines, are much more poorly represented in Africa than in the Holarctic, Neotropics and Australasia. The family may be a paraphyletic assemblage of groups basal to Libellulidae (e.g. May 1995), which is the dominant anisopteran family in Africa today (Kalkman *et al.* 2007). Corduliids were first discovered in the Cape region by Barnard, who described the adults (1933) and larvae (1937) of the new genus *Presba* with the species *P. piscator* and *P. venator*. Lieftinck (1961) found that *P. piscator* was a synonym for *Syncordulia gracilis*, whose origin had remained unknown for over twelve decades. *Presba* thus fell into synonymy with the genus *Syncordulia*, which Selys-Longchamps (1882) had erected for the species described by Burmeister (1839). Because *Syncordulia* species are localized and scarce, collected specimens and even sight records are few. Recent investigations in collections and the field doubled the number of known species in the genus from two to four.

Method and material

Research on *Syncordulia* was intensified in early 2006 as part of a Red List assessment of South African Odonata (see Samways 2004; 2006). In February 2006, the first examinations of Elliot Pinhey's collections in NMBZ were conducted since his work on the fauna (1951; 1984; 1985). We also reviewed material in BMNH, CUMZ, RMNH, SAMC, SUEC and TMSA, and undertook intensive field assessments. We then collated species records in an MS Access (Kaufeld 2003) database and mapped the species using ArcGIS 3.2a (ESRI 1997).

Abbreviations

Ax: antenodal cross-veins, Ax1: first antenodal (counted from base) etc., Cux: cubital cross-veins, Fw: forewing(s), Hw: hindwing(s), Pt: pterostigma, Px: postnodal cross-veins, S1: first abdominal segment, S2–3: second and third abdominal segments etc.

Acronyms for collections

BMNH: Natural History Museum, London; CUMZ: Museum of Zoology of Cambridge University, Cambridge (UK); MCZ: Museum of Comparative Zoology of Harvard University, Cambridge (USA); NMBZ: Natural History Museum of Zimbabwe, Bulawayo; RMNH: Nationaal Natuurhistorisch Museum Naturalis, Leiden; SAMC: South African Museum, Cape Town; SUEC: Stellenbosch University Entomology Collection, Stellenbosch; TMSA: Transvaal Museum, Pretoria.

Results

Of ten NMBZ specimens studied in February 2006 labelled as *S. venator*, three were correctly identified, while six pertained to a new *Syncordulia* species. These six were collected by the lepidopterist Neville Duke in 1975 and 1977 during his attempt to rediscover another elusive Cape endemic, *Orthetrum rubens* Barnard, which has not been recorded since (Pinhey 1979; Samways 2006). The tenth, a female, could not be ascribed to any known species. Similar females and matching males, pertaining to a second new species, were discovered the following month during field assessments. Single overlooked specimens of the first new species were also found in SAMC and SUEC, as well as a pair in the RMNH, which had been presented as paratypes of *S. venator* by Barnard. This new species was rediscovered in the field in October 2006.

Systematic part

Syncordulia Selys — 'Presbas'

Gomphomacromia (*Syncordulia*) Selys, 1882: clxviii [type species: *Epopththalmia gracilis* Burmeister, 1839; by monotypy].

Syncordulia Selys, 1882 – Kirby (1890: 52).

Presba Barnard, 1933: 167 [type species: *Presba venator* Barnard, 1933; by original designation]; junior synonym – Lieftinck (1961: 410).

Etymology. The etymology of *Presba* was never specified, but probably derives from the Greek *presbys* (elder). Meaning honoured or august, it conveys the distinct and ancient character of the genus. Barnard (1933) honoured two friends, an angler and a hunter (of insects), with the names *piscator* and *venator*. In keeping with this, it seems appropriate to honour 'the gatherer'. We propose *legator* to highlight the legacy of collectors like Pinhey and Duke, who assembled most material of the species by that name. As was the case

for the fourth species, most new species are chance discoveries: *serendipator* is derived from ‘The Three Princes of Serendip’. Horace Walpole coined the word serendipity to describe how the fairy-tale’s heroes “were always making discoveries, by accidents and sagacity, of things which they were not in quest of” (Winstanley 1984). The names acknowledge the importance of collections and renewed surveys and emphasize that voucher specimens play an important role in conservation biology. The form *presba* is feminine, and therefore does not match well with Barnard’s names, which are masculine nouns (H. Fliedner in litt.). However, because Barnard did not specify the etymology and gender of *Presba*, and because we regard the names as nouns in apposition, we do not amend them, placing nomenclatory stability and uniformity above a possible imbalance of gender.

Diagnosis. The only corduliid genus in the region, where its venation is unique: (1) Fw with 7–10 Ax and 5–8 Px; (2) sectors of arculus not fused; (3) Fw with one, Hw with two Cux; (4) triangles, subtriangles and supratrangles in all wings uncrossed (save occasional exceptions); (5) Fw discoidal field of single cell-row at base; (6) Hw arculus distinctly proximal of triangle; (7) anal loop bow-shaped, with 6–11 cells in males and 9–14 in females. A notable feature of all species is that the eyes are bluish grey, whereas they are typically bright green in Corduliidae (including Macromiinae).

Key to *Syncordulia* species

Unique characters of each morphological type in the genus are asterisked: *gracilis*, *serendipator* and *legator-venator*. These are potential autapomorphies of the groups (see Discussion).

- 1 Synthorax with dark-bordered cream stripes posterior to humeral and metapleural sutures*. Costa pale, contrasting with dark Pt*. Dorsal carina of S2–9 pale* (Fig. 1). ♂: Abdomen slender, thickest (indistinctly in dorsal view) at S4–6* (Fig. 1). Cerci only bent toward each other at tips*; epiproct almost as long as cerci, with a pair of small dorsal teeth at about midlength (sometimes lost) and an apical knob* (Fig. 5). ♀: Vulvar scale with inconspicuous appressed and incurved lateral lobes* (Fig. 13)..... *gracilis*
- Synthorax rather more uniform, at most darker on sutures. Costa dark, like Pt. Dorsal carina of S2–9 (largely) black (Figs 2–4). ♂: Abdomen club-shaped, thickest (in dorsal and lateral view) at S7–8 (Figs 2–4). Cerci bent toward each other at about midlength, obscuring epiproct in dorsal view; epiproct less than three-quarters as long as cerci, apex without knob but hooked (Figs 10–12). ♀: Vulvar scale with prominent, often finger- or petal-like, lateral lobes (Figs 14–16)..... 2
- 2 Pale markings on S3–8 concentrated apically on segments (Fig. 4). ♂: Cerci stout, less than 3x as long as S10, robustly angled ventrally near base and laterally near apex*; epiproct bifurcate* (Fig. 12). S1 ventrally without spikes; hamules massive* (Fig. 8). ♀: Lobes of vulvar scale less than half as long as the distance between their bases (Fig. 16)..... *serendipator* **n. sp.**
- Pale markings on S3–8 concentrated basally on segments (Figs 2–3). ♂: Cerci slender, over 3x as long as S10, at most weakly angled ventrally near midlength and laterally near base*; epiproct triangular (Figs 10–11). S1 ventrally with pair of spikes*; hamules small (Figs 6–7). ♀: Lobes of vulvar scale over half as long as the distance between their bases* (Figs 14–15) 3
- 3 Small dorsal plate at base of each costa is pale, contrasting with dark surroundings. S3–10 brown-yellow, with contrasting narrow black line over dorsal carina and broadly black sides (Fig. 2). Sum of Fw Ax and Px equals 24–28. ♂: Cerci not angled laterally; epiproct just under half as long as cerci (Fig. 10). Ventral spikes on S1, border of genital fossa and genital lobe pale, contrasting with dark surroundings; spikes short (Fig. 6). ♀: Lobes of vulvar scale narrow and finger-like; cerci about 2x as long as S10 (Fig. 14)
..... *legator* **n. sp.**
- Costal plates dark, like surroundings. S3–10 deep red-brown grading into black at base and along dorsal

carina; basal black enclosing pairs of contrasting whitish triangular spots (Fig. 3). Sum of Fw Ax and Px equals 28–35. ♂: Cerci angled laterally near base; epiproct half as long as cerci or slightly longer (Fig. 11). Ventral spikes on S1, border of genital fossa and genital lobe dark, like surroundings; spikes long (Fig. 7). ♀: Lobes of vulvar scale broad and petal-like; cerci about as long as S10 (Fig. 15) *venator*

***Syncordulia gracilis* (Burmeister) — ‘Yellow Presba’**

Figs 1, 5, 9, 13, 17–18.

Epophthalmia gracilis Burmeister, 1839: 847. Holotype ♂: origin unknown (MCZ) [not examined, but diagnosed in detail by Liefstinck (1961: 414)].

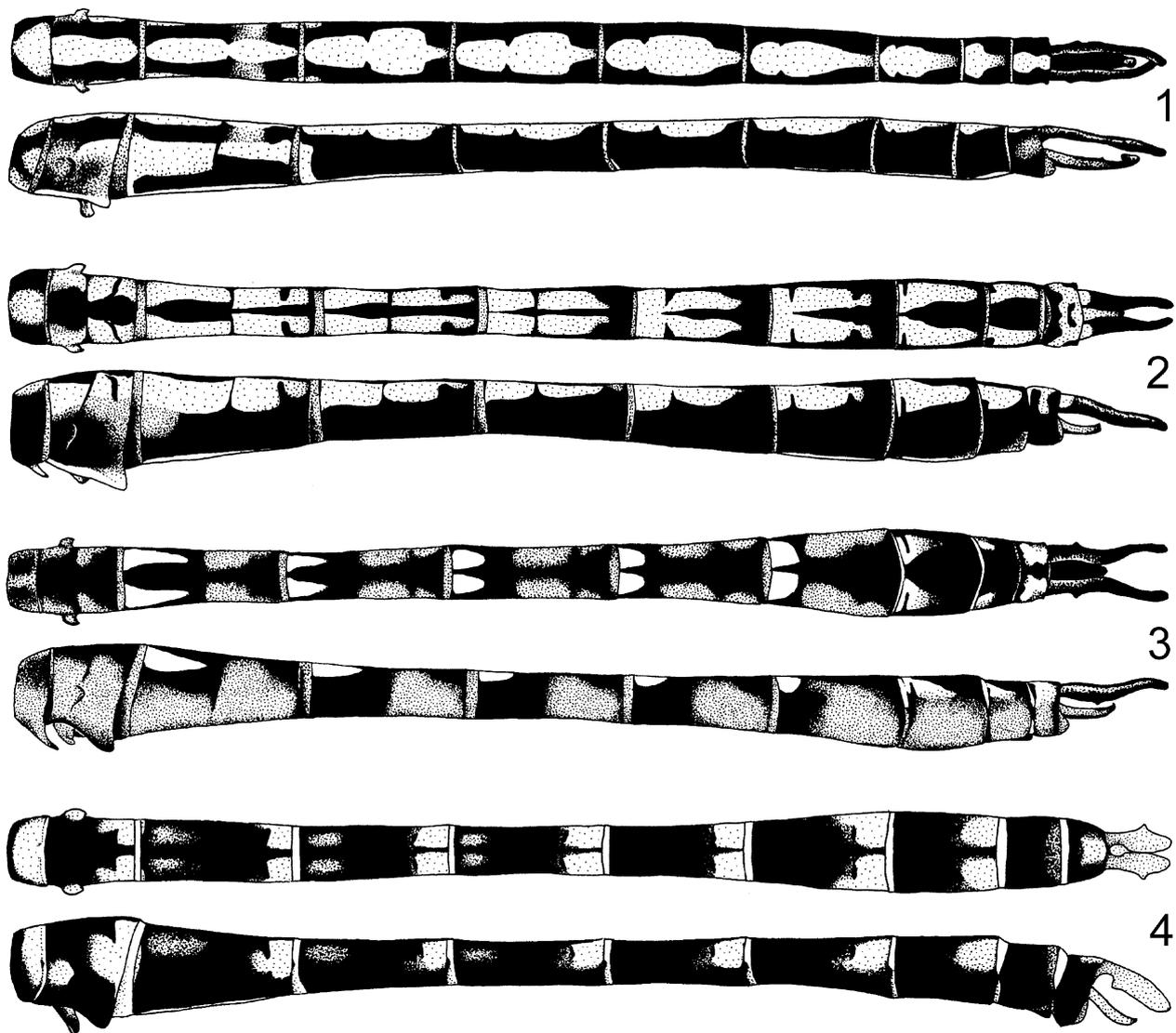
Oxygastra gracilis (Burmeister, 1839) – Selys-Longchamps (1871: 307 bulletin, 73 reprint).

Gomphomacromia (*Syncordulia*) *gracilis* (Burmeister, 1839) – Selys-Longchamps (1882: clxviii).

Syncordulia gracilis (Burmeister, 1839) – Kirby (1890: 52).

Presba piscator Barnard, 1933: 168. Lectotype ♂ (designated by Kimmins 1968: 299): Cape Province, Groot Drakenstein, xii.1931, A.C. Harrison (BMNH) [examined]; junior synonym – Liefstinck (1961: 410).

Chlorosoma gracilis (Burmeister, 1839) – Anonymous, in litt. in Liefstinck (1961: 414).



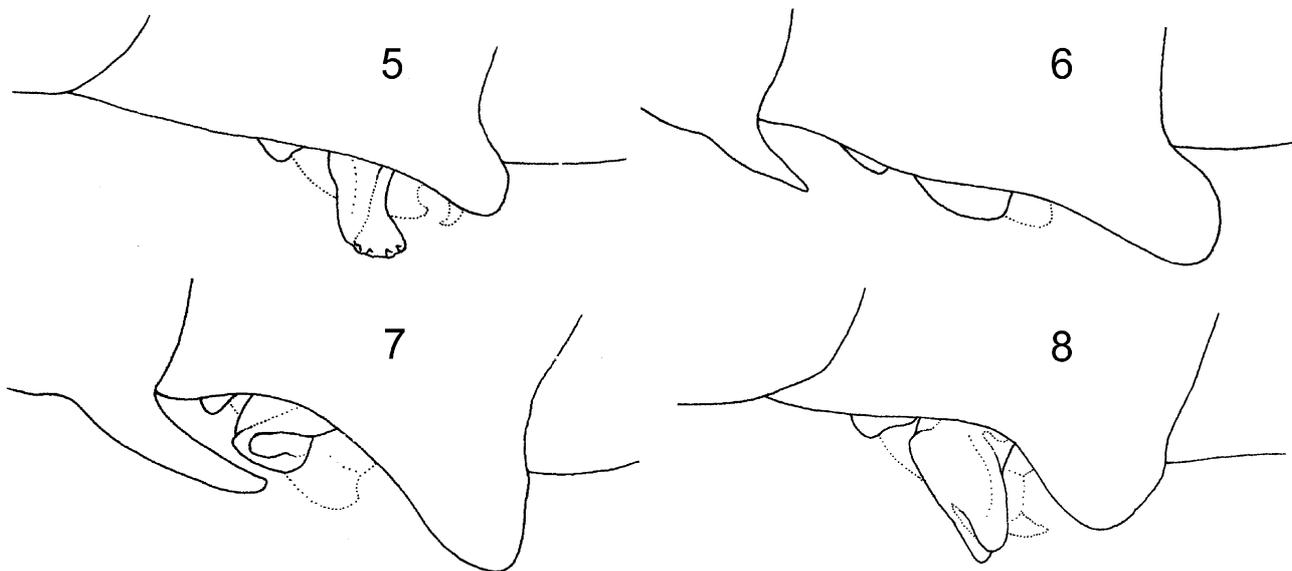
FIGURES 1–4. *Syncordulia* male abdomen in dorsal (above) and lateral (below) view. (1) *S. gracilis*; (2) *S. legator* n. sp.; (3) *S. venator*; (4) *S. serendipator* n. sp.

Further material: 1 ♂, Natal, Cat[h]kin Peak, 5.x.1948, Dr. H.A. Newton (NMBZ); 1 ♀, Cape Province, Ouderbosch [= Oubos], near Rivier Zonderend [= Riviersonderend], 15.xii.1968, C.G.C. Dickson (NMBZ); 1 ♀, Cape Province, Matroosberg, 16.xii.1975, Neville Duke (NMBZ); 5 ♂, 3 ♀, Bain's Kloof, N. of Stellenbosch, 1–6.xii.1987, D.A.L. Davies (CUMZ); 1 ♂, Du Toit's Kloof, N. of Stellenbosch, 1.xii.1987, D.A.L. Davies (RMNH); 1 ♂, Western Cape, Bontebok National Park, rest camp at Breede River, 9.xi.1997, D. Paulson (Coll. D. Paulson); 1 ♀, Eastern Cape, Prentjiesberg, Moorivier, 10.xi.2000, M.J. Samways and R. Kinzig (SUEC); 7 ♂, Kogelberg Nature Reserve, Oudeboschrivier, 18.xi.2000, M.J. Samways (SUEC); 1 ♀, Kogelberg Nature Reserve, hawking over fynbos, date unknown, P.B.C. Grant (Coll. M. May).

Observations: 1 ♂, Kogelberg Nature Reserve, Palmiet River, 16.xi.2000, M.J. Samways; 1 ♀, Kogelberg Nature Reserve, Oudeboschrivier, 2.i.2002, M.J. Samways.

Unverified records: larval exuviae (cannot be identified to species), Ceres, iii.1922, K.H. Barnard (Barnard 1937; not found in SAMC); larval exuviae (cannot be identified to species), Bain's Kloof, Wellington Mts, Breede River side, v.1933, K.H. Barnard (Barnard 1937; SAMC).

Range and ecology. This species has a greater extent of occurrence than other *Syncordulia* (Fig. 17), but the area of occupancy is relatively small. In the Western Cape it is restricted to the south-western mountains, but is fairly widespread there (Fig. 18), while single locations in the Eastern Cape and KwaZulu-Natal are the only ones of the genus outside the Western Cape. This disjunct distribution suggests that the species's area of occupancy was once much greater. Details of adult activity in the Western Cape are given by Samways & Grant (2007), with the first individuals appearing in October, a peak in November and December, and rapid decline in January. At least in the Western Cape, *S. gracilis* is distinctly a fynbos species, associated with small, rapid, stony-bottomed streams and rivers. In the Eastern Cape, it is known from streams with solid rocky bottoms. Adults typically remain away from water, hawking over low bushes.



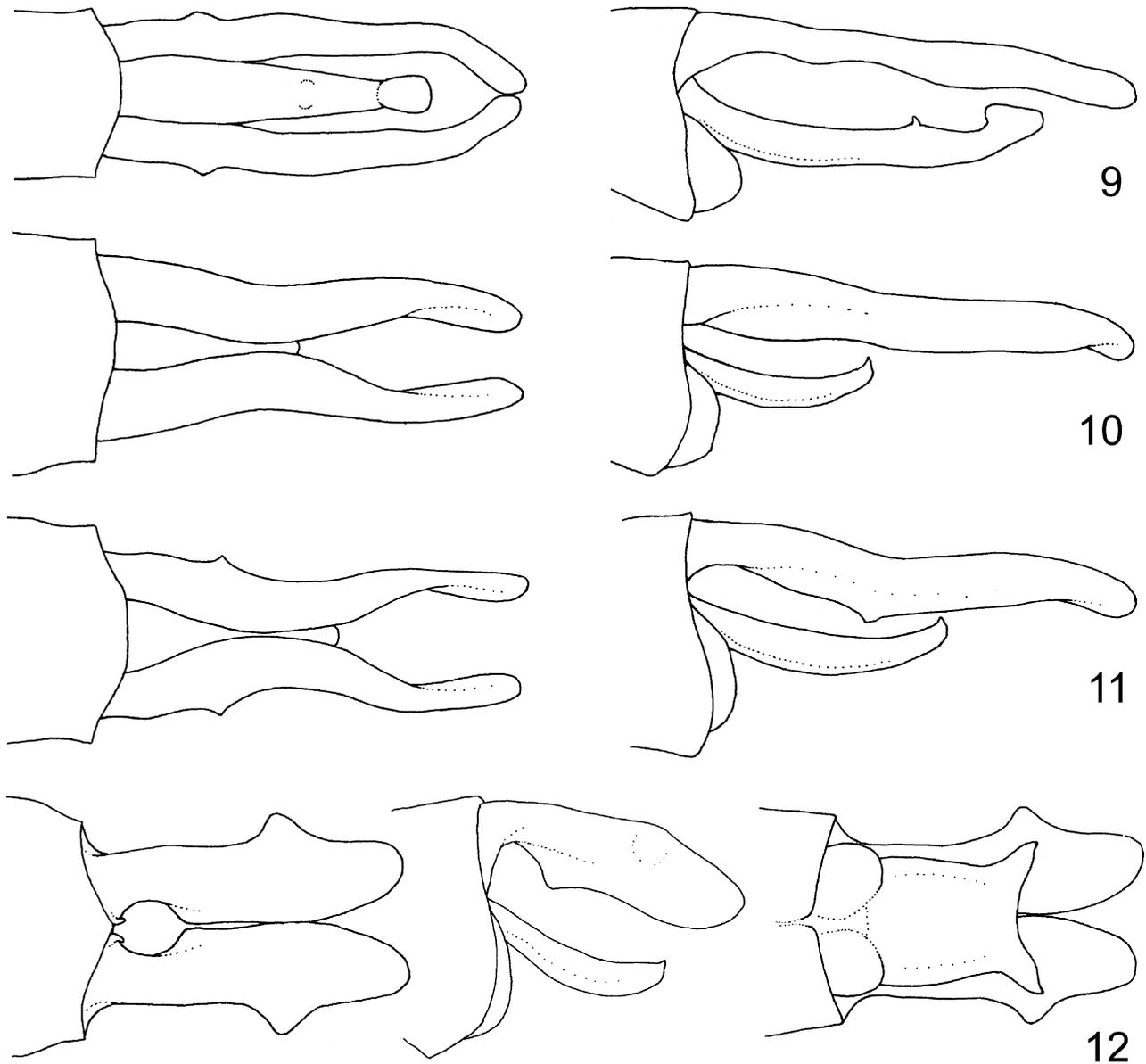
FIGURES 5–8. *Syncordulia* male secondary genitalia in lateral view. The penis is indicated by dotted lines, as its position is variable. (5) *S. gracilis*; (6) *S. legator* n. sp.; (7) *S. venator*; (8) *S. serendipator* n. sp.

***Syncordulia legator* n. sp. — ‘Gilded Presba’**

Figs 2, 6, 10, 14, 19.

Type material: Holotype ♂, paratype ♀, Cape Province, Fransc[h]hoek Pass, 20.xi.1975, Neville Duke (NMBZ).

Further material: 1 ♂, 1 ♀ (paratypes *venator*), Cape Province, French Hoek [= Franschhoek], 8.x.1933, K.H. Barnard (RMNH); 1 ♂ Hott[entots] Holl[and] Mts, Steenbras, xi.1932, K.H. Barnard (SAMC); 1 ♂, W. Cape Province, Clanwilliam, 17.ix.1977, Neville Duke (NMBZ); 2 ♂, 1 ♀, Cape Prov., Hawekwasberg [= Hawequas Mts], Du Toit's Kloof, 5.xi.1977, Neville Duke (NMBZ); 1 ♀, SW Cape, upper reaches of the Palmiet River (19°25'E 34°34'S), 20.xii.1992, leg. unknown (SUEC); 3 ♀ Western Cape Province, Franschhoek Pass, lower Du Toit's River, 18.x.2006, M.J. Samways and J.P. Simaika (SUEC).



FIGURES 9–12. *Syncordulia* male appendages in dorsal (left), lateral (right) and ventral (*S. serendipator* **n. sp.** only) view. (9) *S. gracilis*; (10) *S. legator* **n. sp.**; (11) *S. venator*; (12) *S. serendipator* **n. sp.**

Description. Holotype male. Measurements (mm): total length: 49.4, abdomen length (excluding appendages): 34.7, Fw length: 32.3, Hw length: 30.9, Fw Pt: 3.0. Head brownish yellow, darkened at base of labrum, centres of postclypeus and antefrons, dorsum of vertex and lateral corners of occipital triangle; postgenae with two smudged dark bars near excision of eye margin. Anterior and dorsal surfaces of head covered with dense black hairs, posterior surfaces with longer but equally dense pale hairs. Thorax glossy dark brown, broadly but indistinctly black on humeral, metapleural and ventral part of interpleural sutures; middorsal carina contrasting pale brown-yellow. Thorax densely covered with pale long hairs, especially long on mesepisternum. Legs

black, pale keels present on anterior face of slightly more than apical half of fore and middle tibiae, and just over three-quarters of hind tibiae. Venation and Pt blackish, more basal Ax brown. In contrast, dorsal sclerites at base of costa of all four wings (the ‘intermediary’ or ‘distal costal’ plates) pale yellow. Wings clear, very faintly smoky towards tips. Membranule pale grey, slightly darker on outer-posterior border. Venation typical of genus. 8 Ax in both Fw, 5 in Hw; 6 Px in Fw, 7 in Hw; anal loops of 7 cells. Abdomen slightly clubbed, brown-yellow, marked with black as in Fig. 2, ventral border of tergites narrowly pale yellow (broadest on border of genital fossa), contrasting with black sides. Sternites black. Appendages black, save yellow spot at base of cerci, shaped as in Fig. 10; in lateral view, cerci straighter and epiproct shorter than in *S. venator* (epiproct 40–47% as long as cerci vs 50–56%). Secondary genitalia as in Fig. 6. Hamules deeply folded longitudinally, their borders concealed behind border of genital fossa. Anterior half of hamule black, posterior half pale yellow. Ventral borders of tergite of S1 posteriorly drawn out into elongate processes: this pair of ventral spikes reaching about 20% of distance from base of S2 to tip of genital lobe (about 40% in *S. venator*). Profile of genital fossa (lateral view) straighter than in *S. venator*.

Paratype female. Measurements (mm): total length: 48.9, abdomen length (excluding appendages): 35.5, Fw length: 33.5, Hw length: 32.0, Fw Pt: 3.0. Heavier than holotype with straight-sided abdomen, but coloration similar. All wings lightly but distinctly yellow in subcostal and cubital spaces, approximately to Ax2 and Cux1, and faintly smoky anteriorly from base to tip. 8 Ax in both Fw, 5 in Hw; 6 Px in Fw, 7–8 in Hw; anal loops of 11 cells. Vulvar scale appressed, black, as in Fig. 14 with distinct finger-like lateral extensions. Cerci black, slender with pointed tips, about twice as long as S10 and paraprocts (clearly longer than in *S. venator*).

Variation. Coloration rather consistent, but may be darker than in Fig. 2 and wings are tinged deeper in younger specimens. Size variation is considerable, as in *S. venator*. Males (n = 5): abdomen length (excluding appendages): 31.1–34.7 mm, Hw 27.4–32.5 mm, Fw 7–8 Ax and 5–7 Px, anal loop of 6–9 cells. Females (n = 5): abdomen length (excluding appendages): 32.0–35.7 mm, Hw 31.6–33.2 mm, Fw 7–8 Ax and 5–6 Px, anal loop of 10–11 cells.

Range and ecology. This species has been recorded from the Cederberg and the Hawequas and Hottentots-Holland Mountains (Fig. 19). It is associated with tree-lined streams with distinct deposition zone pools. It flies swiftly up and down streams, over boulders and pools, and over fynbos. It has been recorded from September, earlier than any other *Syncordulia*, to December.

Syncordulia venator (Barnard) — ‘Mahogany Presba’

Figs 3, 7, 11, 15, 20.

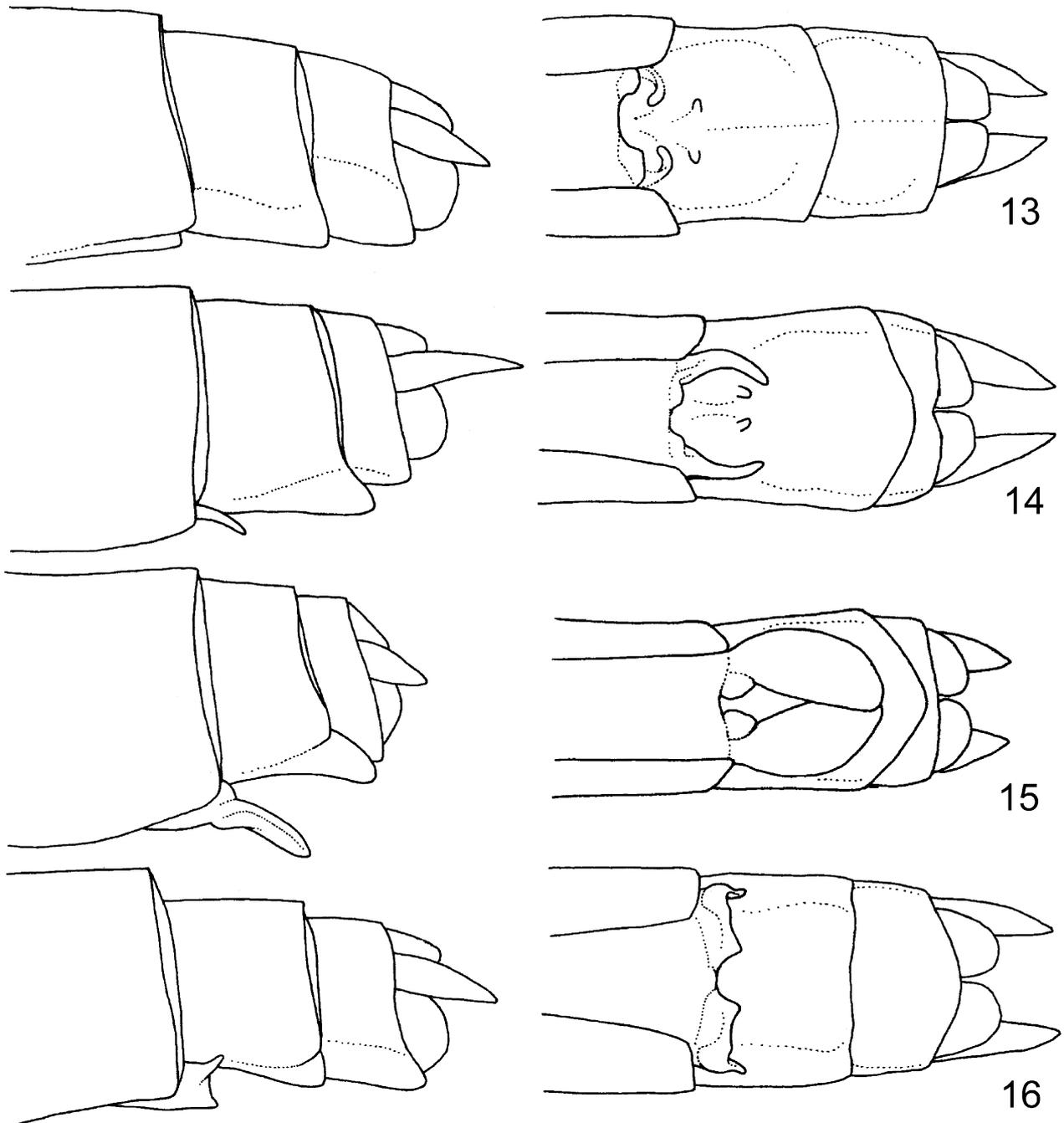
Presba venator Barnard, 1933: 167. Lectotype ♂ (designated by Kimmins 1968: 301): Cape Province, French Hoek [= Franschoek], xii.1932, K.H. Barnard (BMNH) [examined].

Syncordulia venator (Barnard, 1933) – Lieftinck (1961: 415).

Further type material: Paratype ♀ (‘allotype’), Cape Province, French Hoek, xii.1932, K.H. Barnard (BMNH); paratype ♂, Hott[entots] Holl[and] Mts, East side, 4000 ft, i.1933, K.H. Barnard (BMNH).

Further material: 1 ♂ Hott[entots] Holl[and] Mts, East side, 4000 ft, xi.1932, K.H. Barnard (SAMC); 1 ♀ Hott[entots] Holl[and] Mts, East side, 4000 ft, i.1933, K.H. Barnard (SAMC); 1 ♂, 2 ♀ Cape Province, French Hoek, xii.1932, K.H. Barnard; 3 ♂, 1 ♀ Cape, Table Mt, Orange Kloof, i.1933, H.G. Wood (SAMC); 1 ♂, Cape, Bain’s Kloof, Wellington Mts, Witte River, i.1934, H.G. Wood (SAMC); 1 ♂, Cape, Table Mt, Orange Kloof, 7.i.1934, K.H. Barnard (BMNH); 1 ♂, Cape, Table Mt, Orange Kloof, 7.i.1934, leg. unknown (NMBZ); 1 ♀, Cape Province, Ladismith, Garcia’s Pass Forestry, 15.xi.1940, G. van Son (TMSA); 1 ♂, George, Jonkersberg, 18.xi.1940, G. van Son (TMSA); 1 ♀, Cape, Bain’s Kloof, Wit River, xii.1949, Museum Staff (SAMC); 2 ♀, Cape Province, Knysna, Kruis Valley, N. of Buffelsnek Forest, 22.i.1971, Cottrell (NMBZ); 3 ♂, Robinson Pass, N. of Mosselbaai, 9–13.xii.1987, D.A.L. Davies (CUMZ); 1 ♂, ♀, Du Toit’s

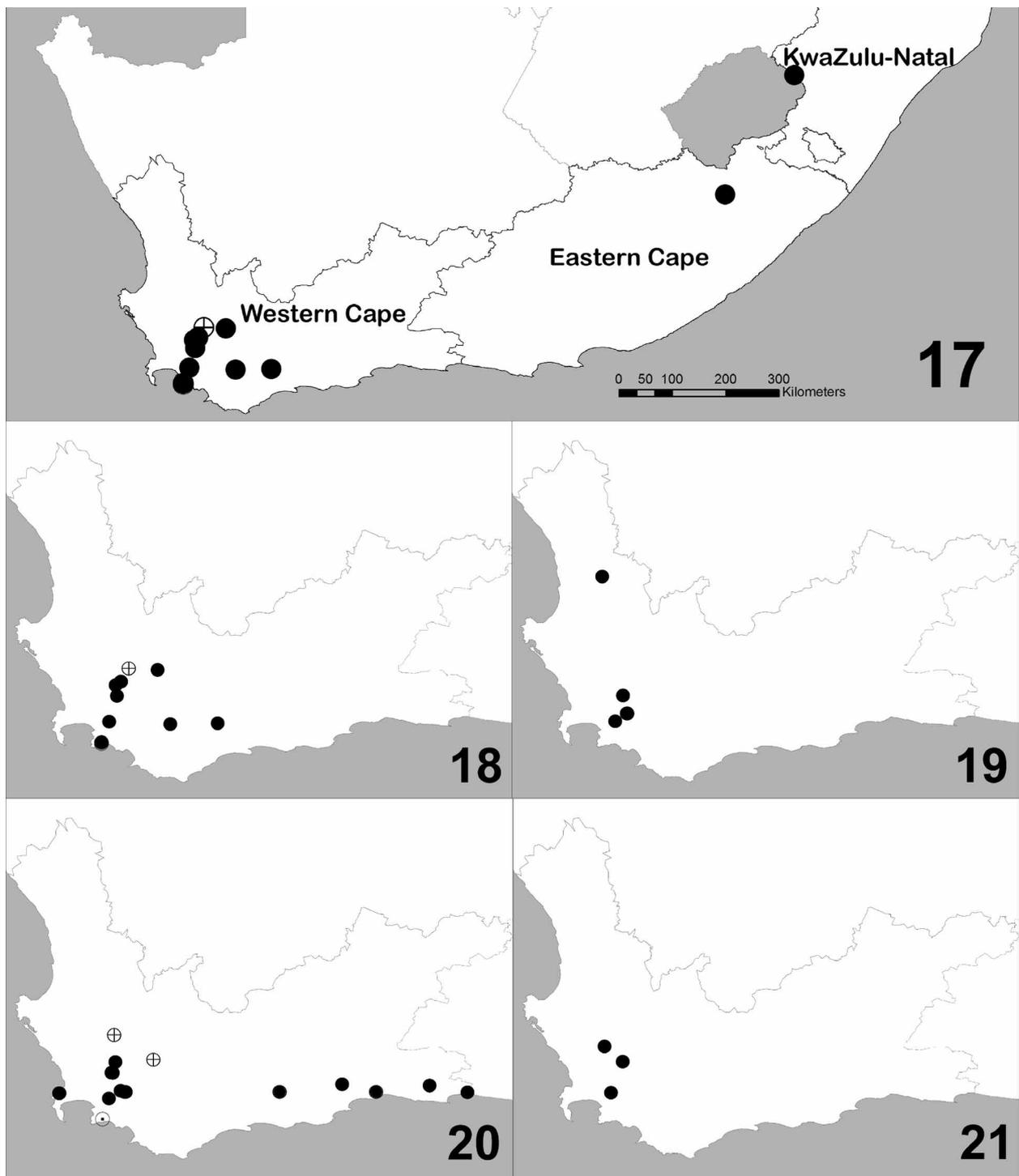
Kloof, 13.xii.1996, M.J. Samways (SUEC); 1 ♂, Villiersdorp, 15.xii.1996, M.J. Samways (SUEC); 1 ♀, Du Toit's Kloof, 9.xi.1999, M.J. Samways (SUEC); 1 ♀, Villiersdorp, 11.xi.1999, M.J. Samways (SUEC); 1 ♀ (teneral), Table Mountain, 22.xi.2005, J.P. Simaika, M.J. Samways & T.R. New (SUEC); 1 ♂, border of Western and Eastern Cape, Bloukrans River at crossing of R102, broad rocky river in forested gorge, 30.i.2006, K.-D.B. Dijkstra (RMNH); 1 ♂, Western Cape, Table Mountain, gorge above Hely Hutchinson Dam, rocky stream in fynbos, 22.ii.2006, K.-D.B. Dijkstra (RMNH); 1 ♀, Western Cape, Limietberg Nature Reserve, Du Toit's Kloof, Kromrivier, 12.xi.2006, M. Samways, M.J. Samways, J.P. Simaika & J. Ott (SUEC); 1 ♂, 1 ♀, Limietberg Nature Reserve, Bain's Kloof, Witte River, 14.xi.2006, J.P. Simaika & J. Ott (SUEC); 2 ♂, Western Cape, Villiersdorp Wild Flower Garden and Nature Reserve, 16.xi.2006, A.A. Johnson, J.P. Simaika & J. Ott (SUEC); 1 ♂, without data (SAMC).



FIGURES 13–16. *Syncordulia* female abdomen tip in lateral (left) and ventral (right) view. (13) *S. gracilis*; (14) *S. legator* n. sp.; (15) *S. venator*; (16) *S. serendipator* n. sp.

Observations: 1 ♂, Western Cape, Kogelberg Nature Reserve, 15.xii.2003, M.J. Samways.

Unverified records: larval exuviae (cannot be identified to species), Keerom[s]berg, Worcester, i.1930, K.H. Barnard (Barnard 1937; not found in SAMC); larval exuviae (cannot be identified to species), Great Winterhoek Mountains, Tulbagh, i.1934, K.H. Barnard and H.G. Wood (Barnard 1937; not found in SAMC).



FIGURES 17–21. Geographical distribution of *Syncordulia* species in South Africa (17) and the Western Cape (18–21). Legend: solid circles: verified records; dotted circles: observations; crossed circles: unverified records. (17–18) *S. gracilis*; (19) *S. legator n. sp.*; (20) *S. venator*; (21) *S. serendipator n. sp.*

Range and ecology. This species, although localized, is widely distributed throughout the mountains of the Western Cape (Fig. 20). It occurs with the three other species in the mountains of the south-western West-

ern Cape, but it is the only *Syncordulia* known from Table Mt and in a string of sites along the Langeberg range, east to the Eastern Cape border. It is associated with fast-flowing streams with large boulders and deposition pools, bordered by bushes or trees. It is mainly a summer species, with records from early November to late February.

***Syncordulia serendipator* n. sp. —‘Rustic Presba’**

Figs 4, 8, 12, 16, 21.

Type material: Holotype ♂, paratype ♀ (in copula with holotype), paratype ♀ (ovipositing), Western Cape, Witrivier, Bain’s Kloof, 17.iii.2006, J.P. Simaika and M.J. Samways (SUEC).

Further material: 1 ♀, Cape Province, Riebeeck Kasteel [= Riebeek-Kasteel] Mtn, 9.iii.1971, C.G.C. Dickson (NMBZ); 1 ♂, Jonkershoek Nature Reserve, Stellenbosch, 19.iii.2006, J.P. Simaika (SUEC); 1m#, Bain's Kloof, 18.ii.2007, M.J. Samways, M. Samways and J.P. Simaika (SUEC).

Description. Holotype male. Measurements (mm): total length: 51.6; abdomen length (excluding appendages): 34.8; Fw length: 34.0; Hw length: 31.4; Fw Pt: 2.9. Head, including postgenae, warm brown-yellow throughout, with two small dark spots on central postclypeus and black margins posteriorly along eyes. Labium cream, with brown smudges along inner borders of central and lateral lobes. Anterior surfaces (up to vertex) of head covered with dense black hairs, posterior (up to occipital triangle) surfaces with finer and longer pale hairs. Thorax glossy brownish black, with paler areas concentrated on central and dorsal portions of thoracic plates: middorsal carina and antearlar sinuses are warm brown-yellow, as is a band across the mesepisterna adjacent to (and of similar width as) sinuses; most of the central mesepimeron, dorsal corner of metepisternum and posterior half of metepimeron. Thorax densely covered in long whitish hairs. Legs black, femora dorsally warm brown-yellow. Pale tibial keels present on anterior face of just under apical half of fore and middle tibiae, and just over three-quarters of hind tibiae. Venation and Pt black, except for pale brown subnode and basal antenodal cross-veins. Base of costa and adjacent plate dorsally pale brown, marked with black. Wings clear, very faintly yellow at base. Membranule grey. Venation typical of genus. 9 Ax in both Fw, 7 in Hw; 7–8 Px in Fw, 8 in Hw; anal loop of 9 cells. Abdomen club-shaped, black, S1–8 with warm brown-yellow paired dorso-apical markings as shown in Fig. 4, S9 unmarked and S10 with small dorso-subapical spot. Basal halves of S3–5 dorsally blackish brown with centres grading to paler brown. Sternites brown-black. Auricles and intersegmental rings brown-yellow. Tergites covered with fine whitish hairs, longest on undersides of S1–2 and S8. Appendages (Fig. 12) robust, epiproct two-thirds as long as cerci; cerci stout and dark brown, becoming paler grey-brown towards tips. Cercus bearing two blunt teeth: one ventral and sub-basal, the other lateral and subapical. Epiproct broad, warm brown-yellow, shallowly and widely incised posteriorly, separating into two diverging tips that each bear a single black tooth at apex. Secondary genitalia as in Fig. 8. Hamules massive, leaf-shaped, folded longitudinally, with black-brown exterior and cream interior. Ventral borders of tergite of S1 not drawn out to form a pair of spikes.

Paratype female. Measurements (mm): total length: 50.0, abdomen length (excluding appendages): 35.5, Fw length: 34.2, Hw length: 33.3, Fw Pt: 2.7. More robust than holotype and pale areas more extensive but darker in tone (thus less distinct). Anterior face of frons darker and dark spots on postclypeus larger. Centres of most thoracic plates broadly pale, with black stripes along sutures and beside middorsal carina. Venation darker than in holotype; all wings lightly but distinctly yellow at base, approximately to arculus. 9–10 Ax in both Fw, 7 in Hw; 8 Px in Fw, 8–9 in Hw; anal loops of 9 cells. Abdomen thicker than in holotype, not clubbed, S9–10 relatively longer than in other *Syncordulia* females (Fig. 16). Abdominal pattern as in male, but pale markings more extensive (extending about to midpoint of each segment), also present on S9, and enclosing pairs of small black transverse hyphens near segment’s apex and dorsal carina on S2–8 (connected to black dorsal carina on S2–4), approximately in middle of each pale area. These dashes are obscured by the

greater extent of black in the holotype. Vulvar scale appressed, black with narrow brown-yellow border with wide medial incision and short (less than a third of lateral length of S9) lateral extensions (Fig. 16). Cerci black, pointed but with blunt tips, about 1.3x as long as S10 and paraprocts.

Variation. Females may have strongly reduced dark markings, e.g. no spots on postclypeus and abdomen dorsally largely pale brown, although broadly black laterally. The Riebeek-Kasteel female has the thorax pale with only dark lines over the sutures; its abdomen is only narrowly black along the dorsal carina and transverse subbasal sutures of S2–8; the dorsum of S9–10 and the cerci are pale. Males (n = 2): abdomen length (excluding appendages): 34.5–34.8mm, Hw length: 31.4–32.4mm, Fw 9 Ax and 7–8 Px, anal loops of 8–9 cells. Females (n = 2): abdomen length (excluding appendages): 35.5–36.7 mm, Hw length: 33.3–33.7 mm, Fw 8–10 Ax and 6–7 Px, anal loops of 9–10 cells.

Range and ecology. This species is only known from three separate localities, in different mountain ranges in the CFR (Fig. 21). Probably owing to habitat specialization, it has a very small area of occupancy. It is a powerful flier, patrolling deposition pools of streams strewn with large boulders, and virtually treeless. It oviposits in pools by swiftly flying over and dipping its abdomen. On overcast days and late in the afternoon, it may leave the water's edge and fly swiftly over mountain sides even near mountain peaks.

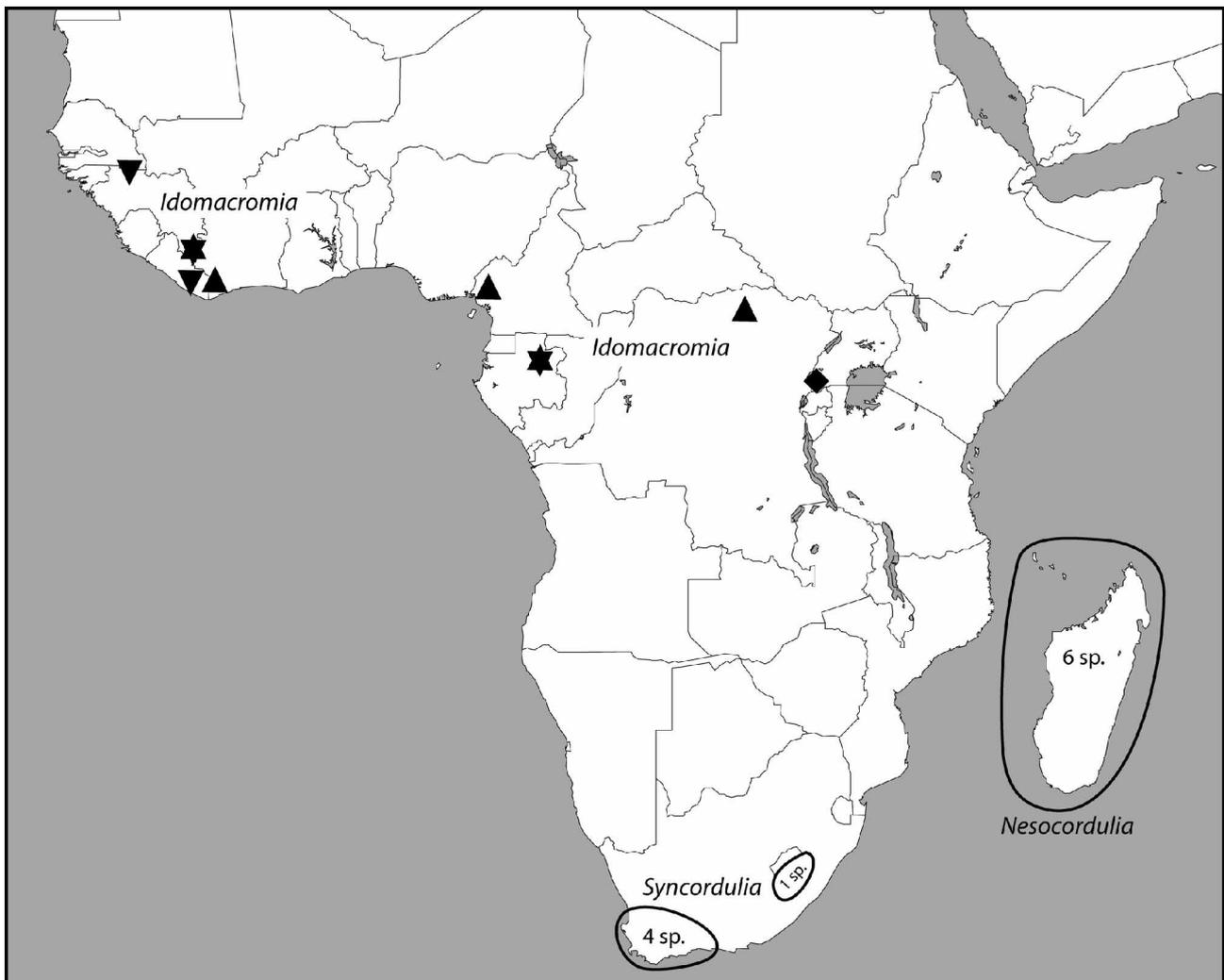


FIGURE 22. Distribution of ‘gomphomacromiine’ Afrotropical Corduliidae. *Nesocordulia* and *Syncordulia* species are not indicated separately, but the number of species in each region is provided. *Idomacromia* species are separated (diamond: *I. jilliana* Dijkstra & Kisaky; inverted triangle: *I. lieftincki* Legrand; standing triangle: *I. proavita* Karsch; star: both *I. lieftincki* and *I. proavita*).

Discussion

Relationships

Selys-Longchamps (1882) first described *Syncordulia* as a subgenus of *Gomphomacromia* and Fraser (1957) defined the Gomphomacromiinae to include it. The subfamily is largely founded on plesiomorphic characters of venation, and like the Corduliidae is probably para- or polyphyletic. However, other similarities suggest that the relatives of *Syncordulia* are within this assemblage of relict ‘corduliids’. Three genera with 14 species are found in the Neotropics, as well as the monotypic genus *Oxygastra* in the western Mediterranean and six *Nesocordulia* species in Madagascar and the Comoros (Carvalho *et al.* 2004; Legrand 1984b; May 1992; von Ellenrieder & Garrison 2005). The group is richest in Australia (8 genera, 15 species) and it is not surprising that *S. gracilis* was first thought to be Australian (Carle 1995; Lieftinck 1961; Theischinger & Watson 1978; Watson 1980). Lieftinck (1961) believed the Mediterranean *Oxygastra* or alternatively an Australian genus (*Hesperocordulia*, *Lathrocordulia* or *Micromidia*) to be closest to *Syncordulia*.

Fleck & Legrand (2006) considered the Madagascan genus *Nesocordulia* nearest the equatorial African *Idomacromia*, but did not compare *Syncordulia* despite its geographic proximity (Fig. 22). Fraser (1957: 109) created the monogeneric Idomacromiinae, but because “the majority of the characters are Gomphomac[r]omi[i]ne and I am of opinion that it is a highly specialized off-shoot of this subfamily” effectively placed it within Gomphomacromiinae. These three Afrotropical genera share a similar penial structure (Legrand 1984a; own observations) with *Oxygastra* and the neotropical *Neocordulia*, two genera that are likely to be each other’s sister group (cf. Fleck & Legrand 2006). The Australian *Micromidia* (and to some degree *Austrophya* and *Hesperocordulia*) shares the remarkable spikes of S1 with two *Syncordulia* species. Although the secondary genitalia may provide reliable clues on relationships, these similarities too may be plesiomorphic. As each ‘corduliid’ genus is defined by a confusing mix of apo- and plesiomorphies, molecular analysis may elucidate relationships. Unfortunately this has not yet clarified the position of *Syncordulia* (pers. comm. H. Karube and M. May). The nearest relatives of the other relict odonate group in South Africa, two genera of synlestid damselflies, are possibly also Australian (Brinck 1955; Dijkstra & Clausnitzer 2006), but this is wholly speculative.

Morphologically, *Syncordulia* falls into three distinct groups: (1) *S. gracilis* (*Syncordulia* s.s.); (2) *S. legator* and *S. venator* (*Presba*); and (3) *S. serendipator* (see key for autapomorphies). The remarkable morphological diversity might warrant the reinstatement of *Presba* and the creation of a third genus. Venation, by which odonate genera were traditionally defined, within *Syncordulia* is uniform. Such characters are often homoplasious and plesiomorphic and therefore of relatively little value (see Dijkstra & Vick 2006 for a discussion): the venation of *Syncordulia* is for instance similar to the Australian genera *Austrocordulia* and *Lathrocordulia*. Sexual characters may define ‘gomphomacromiine’ genera more soundly. All Australian genera, for instance, possess marked autapomorphies of the secondary genitalia, often supported by features of the vulvar scale and male appendages. While the three South African groups each possess clear autapomorphies, with morphological diversity within *Syncordulia* appearing almost as great as that between Australian genera, these are not obvious for the three combined. However, nomenclatorial stability favours the current classification, until the depth of difference between these probably ancient species is sufficiently examined.

Biogeography

It is tempting to link the history of *Syncordulia* to that of the fynbos biome which they predominantly inhabit, especially because their centre of occurrence overlaps with the area of greatest plant diversity in the CFR (e.g. Moline & Linder 2006). The Cape is the most remote corner of a continent with a prolonged history of isolation. Until about 30 million years (Ma) ago, South America and Australia were still in contact through Antarctica, from which Africa had completely separated over 100 Ma before (Sanmartín & Ronquist 2004). Nonetheless the flora had an austral character (e.g. with *Casuarina*, *Araucaria*, Proteaceae) in the Paleocene,

and although the present CFR was covered in warm temperate forest, fynbos elements were found in Namaqualand (Coetzee 1993; Morley 2000). Many plant groups typical of the CFR were present by the Eocene (Galley & Linder 2006), but the Cape vegetation remained rather tropical until the upwelling of cold water off the South African coast started to block off summer rainfall about 8–10 Ma ago, establishing the fynbos biome at its current position only 3–5 Ma ago (Coetzee 1993; Goldblatt 1997; Linder & Hardy 2004; Tolley *et al.* 2006). However, Axelrod & Raven (1978) mapped fynbos in Namibia and Botswana 25–30 Ma ago, although it was possibly restricted to mountains about 10–15 Ma ago (Linder & Hardy 2004).

Galley & Linder (2006) found that trans-Indian Ocean relationships, mostly with Australia, dominate the CFR plant radiations. However, the Cape groups were estimated to have diverged between 80 and 37 Ma ago, well after continental links were lost. The phylogeny of basal passerines suggest possibly direct dispersal from Australia to Africa about 45–50 Ma ago along continental fragments including Kerguelen, Crozet and Madagascar, where a temperate climate would have prevailed (Fuchs *et al.* 2006; Jønsson & Fjeldså 2006). The chironomid midges of the genera *Afrochilus* and *Archaeochilus* are considered a classic example of Gondwanan relicts among southern African arthropods (Saether & Ekrem 2003). However, the species may have diverged only in the past 10 Ma; their Australian relatives in *Austrochilus* are about 18 Ma old (Martin *et al.* 2003). While there is no estimate of the divergence of these genera, the data suggest a much less ancient history than assumed by Gondwanan vicariance (>120 Ma). Tolley *et al.* (2006) found the South African endemic radiation of *Bradypodion* chameleons to predate the emergence of fynbos in its present location and considered their dispersal from forest into fynbos as secondary, as some vegetation transitions may be as recent as 10,000 years ago.

Summarizing, existing studies suggest that the CFR biota, including Africa's assumed austral odonates (*Syncordulia* and possibly Synlestidae) may not be of 'Gondwanan' age and have even more recently attained their current habitat and range. *Syncordulia* inhabits cold and nutrient-poor streams, which are almost devoid of more widespread Afrotropical Odonata. The relict midges are similarly cold-stenotherm (Saether & Ekrem 2003). The montane character of their habitat and the absence of strongly competitive species there, suggest that the gomphomacromiines in South Africa are the last vestiges of an older Afro-montane odonate assemblage, surviving in a habitat to which they are better adapted than the more competitive and advancing modern Afrotropical species. The fynbos habitat created recently by the cold upwelling in the Cape Region may be their last refuge from extinction. There are indications that the fynbos flora did not evolve under the summer-dry conditions now prevalent in its centre of diversity (Axelrod & Raven 1978). This may also be true for the CFR odonates, and it would be worthwhile to investigate the role of summer-drought and winter-rain in their ecology.

Ecology and conservation

This study has shown that a detailed examination of threatened species in a biodiversity hotspot can unearth previously unknown species. The validation of historical records, for instance, stimulates a closer look at museum collections (Ponder *et al.* 2001). It was surprising that two new species, which are seemingly large and visible, should be found in what is considered a well-explored area. This is in part due to the superficial similarity of the species, as well as similarities of their biology. The four species are broadly sympatric (Figs 18–21) and could all occur within a single river system. Three species, for instance, were recorded both from Bain's Kloof (only *S. legator* missing) and Du Toit's Kloof (*S. serendipator* missing). In both cases the three were recorded within a 20-year period and the missing species is known from surrounding sites.

Indications of seasonal segregation and different habitat preferences are only preliminary. Our data suggest that *S. gracilis* and *S. legator* adults are mainly on the wing in spring, emerging in October and September respectively, and disappearing by January and December. The season of *S. venator* is concentrated in summer, from November to late February. The recorded earliest and latest dates indicate that simultaneous adult activity of the two most closely related species (*S. legator* and *S. venator*) is only for about a quarter of

their combined flight season. Three records of *S. serendipator* are in March, the only *Syncordulia* adults collected in that month, a fourth in late February. Little is known about their larval ecology (Barnard 1937), but the species may well differ in their preferred microhabitats, for instance in relation to the exposure, size, current and substrate of stream sections.

All species rely on cool, clear and rocky streams in fynbos or lightly wooded landscapes. The threat of invasive alien plants has been pervasive in such habitats in the CFR. As these aliens gradually extended and intensified their hold, they shaded out local populations of rare and sensitive odonate species, including those of the genus *Syncordulia*. However, their populations may now have stabilized through the large scale removal of aliens. The huge national effort to remove these was stimulated by the need to improve hydrology and create jobs, rather than for biodiversity conservation, but has led to the recovery of the odonate assemblage (Samways *et al.* 2005).

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