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Overlooked diversity in African *Solanum* (Solanaceae): new and endangered *Solanum agnewiorum* from Kenya

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Abstract

Despite the almost universal occurrence of *Solanum* in Kenya, there continues to be a significant gap in floristic knowledge of this important genus. We describe *Solanum agnewiorum* from montane forest in the central highlands. We assess the IUCN conservation status of this species as Endangered.

Key words: Africa, Kenya, montane forest, Solanaceae, *Solanum*, *Solanum* subgenus *Leptostemonum*

Introduction

The genus *Solanum* L. is one of the most economically important genera of plants and includes the cultivated potato, tomato, and aubergine. With ca. 1500 species (J. Bennett & S. Knapp pers. comm. Sep 2006) it is also one of the largest (Frodin 2004) and most taxonomically challenging genera of plants. The Planetary Biodiversity Inventory (PBI) *Solanum* project is an international collaborative initiative working towards a modern online monographic treatment of the entire genus since 2004 (Solanaceae Source 2010). Both Solanaceae and *Solanum* diversified in circum-Amazonian tropical South America (Knapp 2002) with later radiations into the Old World (Weese and Bohs 2007). *Solanum* in Africa and Madagascar constitutes less than 10% of the species level diversity with 113 accepted species (Jaeger 1985), the majority of these endemic to the African continent. This study is part of the work towards a monographic treatment of the spiny *Solanum* (*Solanum* subgenus *Leptostemonum*) in Africa and the Flora of Tropical East Africa. For more detail on the taxonomic history of this group see Vorontsova et al. (in press); for further information on the project and descriptions of related species see Solanaceae Source (2010).

Kenyan *Solanum* represents a significant gap in the local floristic knowledge. High levels of morphological variability make identification difficult and the common occurrence and weedy habit of many species has discouraged collectors and taxonomists who have frequently dismissed these plants as "uninteresting weeds". No complete taxonomic treatment is available since Dunal (1852) and Wright (1906), published prior to the bulk of African botanical exploration. No up to date taxonomic reference material is readily available except short popular treatments by Agnew (1994) and Beentje (1994). African *Solanum* has suffered from widespread and cumulative confusion throughout its taxonomic history and the majority of herbarium determinations are out of date.

The new species described here was originally identified by Andrew and Shirley Agnew during their work towards the Upland Kenya Wild Flowers (1994) at the East Africa Herbarium in Nairobi, as documented by Andrew Agnew's handwritten notes on herbarium covers. A description of this species is published under the name "sp. J" in Agnew (1994) and Beentje (1994). It is formally described here for the first time and

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named in honour of the contribution to African *Solanum* taxonomy made by Andrew and Shirley Agnew. Their discovery has prompted a collecting trip to search for this species and *S. agnewiorum* was successfully collected in the Nyambene Hills in April 2010.

Taxonomic treatment

Solanum agnewiorum Voronts., *sp. nov.* (Figs. 1, 2b, 2c)

Solano anguivi similis sed aculeis uncinatis manifeste (nec rectis neque uncinatis), lobis folii acuminatis (nec rotundis neque acutis), inflorescentia flores 1–4 tantum (nec flores 5–22) ferenti, infructescentia baccas 1–2 tantum (nec baccas 5–22) ferenti, baccis 20-25 mm (nec 6–9 mm) diam, seminibus 5.5–6 mm (nec 1.8–2.5 mm) longis differt.

Type:—KENYA. Meru District: Igembe, Kangeta Division, Nyambene Forest, path from the forest office towards the first water reservoir, 0°13'57" N, 37°53'27" E, 2173m, 18 Apr 2010, *Vorontsova, Ficinski, Kirika, Muthoka & Muroki 196* (holotype, EA; isotypes, BM, MO, K, NY).

Perennial scrambler to 4m, heavily armed, moderately branched; young stems ascendant, sometimes tinged purple, sparsely stellate-pubescent; trichomes porrect, orange-translucent, sessile, the rays 6–8, 0.1–0.15 mm, the midpoints elongated to 0.5–1 mm, reduced on some trichomes, with minute finger-hairs between the trichomes; prickles 1.5–3 mm long, 1–2.5 mm wide at widest point, always curved, brown, glabrous, spaced 2–5 mm apart; main branches 3–4 mm in diameter, glabrescent; bark smooth or with prickle scars, brown to red-brown. Sympodial units difoliate, geminate or not geminate. Leaves simple, the blades 6–14 × 4.5–9 cm, ca. 2 times longer than wide, elliptic, membranous to chartaceous, drying concolorous to weakly discolorous, yellow-green to green-brown, sparsely stellate-pubescent on both sides; trichomes porrect, translucent, sessile, the rays ca. 8, 0.1–0.25 mm, the midpoints elongated to 0.3–1 mm, adaxially reduced with midpoints elongated to 1 mm, densely armed usually with over 20 straight prickles to 7 mm long protruding from primary to tertiary venation on both sides of the leaf; midvein raised abaxially, flat or raised adaxially, the primary veins 3–5 pairs, the tertiary venation visible on both sides of the leaf; base cuneate, often oblique; margin lobed, the lobes 2–5 on each side, 1–1.7 cm long, extending 1/4–1/3 of the distance to the midvein, deltoid, apically acuminate, the sinuses shallow, the terminal lobe longer than the rest; apex acuminate; petiole 1.2-6 cm, 1/4–1/2 of the leaf length, slender, weakly to moderately stellate-pubescent, with 2–10 straight or curved prickles, becoming straighter towards the apex. Inflorescences apparently lateral, 2–3 cm long, unbranched, with 1–4 flowers, with 1–2 flowers open at any one time; peduncle 0–5 mm long; rachis 0–0.8 cm long; peduncle and rachis sparsely stellate-pubescent, unarmed or with up to 5 curved prickles; pedicels 0.9–1.3 cm long, slender to stout, gently curved downwards, articulated less than 0.5 mm from base, moderately stellate-pubescent, with 0–5 fine straight prickles; pedicel scars small white stumps, spaced 2–7 mm apart. Plants andromonoecious, with 1–2 hermaphrodite flowers at the base and 0-2 staminate flowers at the apex of the inflorescence, the flowers all equal in size, 5-merous. Buds ovoid to ellipsoid. Calyx 3–4 mm long, divided for 1/4–1/3 of its length, the lobes 1–2 mm long, ca. 1.5 mm wide at base, deltoid, apically acuminate, unarmed or with up to 10 small straight prickles. Corolla 1.3–1.6 cm in diameter, white, opening flat, stellate, lobed for 2/3–3/4 of its length, the lobes 5–6.5 × 2.5–3.5 mm, deltoid, with a dark midvein, moderately stellate-pubescent abaxially, the trichomes porrect, irregular, orange-translucent, sessile, the rays 5–8, 0.1–0.2 mm, undulate, the midpoints shorter than the rays, lengthening towards corolla lobe apices, mostly glabrous adaxially, the trichomes variously reduced and irregular. Stamens with the filament tube ca. 1.5 mm; free portion of the filaments 0.4–0.6 mm; anthers 4–4.5 mm, free, equal, tapering, poricidal at the tips, the anther surface drying yellow to orange-brown, with occasional stellate trichomes, the pores lengthening into longitudinal slits with age, with a pronounced thick rim. ca. 0.7 mm in diameter, ovoid, glabrous, with a few stellate trichomes towards the apex; style 5.5–7.5 mm long on hermaphrodite flowers, brown, stout, straight, stellate-pubescent for most if its length, exserted 0.5–2 mm beyond the anthers, the

vestigial style ca. 3 mm long on staminate flowers; stigma clavate, papillose. Fruit a globose berry, 1–2 per infructescence, 20–25 mm in diameter, spherical throughout development, the pericarp thin, smooth, shiny, glabrous, green with dark green stripes when young, dark yellow to yellow-orange at maturity, drying orange to brown or almost black; fruiting pedicels 2.5–3.5 cm long, 10–13 mm wide at base, woody, sometimes inflated towards the apex, pendulous, with 2–10 fine prickles; fruiting calyx not accrescent, covering less than 1/6 of the mature fruit, unarmed or with up to 10 small straight prickles. Seeds ca. 15–20 per berry, 5.5–6 × ca. 4.5 × ca. 0.8 mm, flattened-reniform, often somewhat irregular in outline, dull yellow-orange, the surface with raised outlines of cells or small pits (Figs. 1, 2b, 2c).

Distribution and habitat:—Wet montane forest understorey in the Kenyan Central Highlands, 1800–2500m elevation. Remnant forest patches near Limuru, the Aberdares, Mt Kenya east (Marimba forest), and Nyambene Hills. *Croton–Brachylaena–Calodendrum* forests near Limuru and *Ocotea* forests at Nyambene Hills and the Abardares (forest classification fide Beentje 1990, Figs. 2a, 3).

Etymology:—Named after Andrew and Shirley Agnew who first realised this was a distinct taxon and provisionally described it as "sp. J.".

Additional specimens examined:—KENYA. Central Province. Kiambu District: Kangai Tea Estate, 1°05' S, 36°41' E, 2240m, 28 Jun 1987, *Luke 445* (EA); Limuru, adjacent to Limuru Girls High School, 1°07' S, 36°38'30" E, 2286m, 26 Mar 1961, *Polhill 363* (EA); near Limuru Girls High School, 1°07' S, 36°38'30" E, 2134m, 20 Aug 1961, *Polhill 445, 455* (EA); Limuru, 1°07' S, 36°38'30" E, 2439m, Oct 1937, *Van Someren 442* (EA); Limuru, 1°07' S, 36°38'30" E, 1981m, May 1945, *Nattrass 348* (EA). Meru District: Kangeta Division, Nyambene Forest, a kilometre before arriving at the Nyambene main water intake, 0°22'49" N, 38°28'20" E, 1891m, 12 Mar 2003, *Kimeu et al. KARI 11/02* (EA, K); Nyambene Forest, path to the left just after the entrance to forest, ca. 50 m after the entrance sign, 0°14'16" N, 37°53'39" E, 2097m, 17 Apr 2010, *Vorontsova et al. 195* (BM, EA, K, MO); Marimba Forest, NE Mt. Kenya, 0°02' N, 37°32' E, 2317m, 14 Oct 1960, *Polhill & Verdcourt 2993* (EA). Nyeri District: Aberdare National Park, E side, 0°28' S, 36°54' E, 8 Apr 1975, *Hepper & Field 4923* (EA, P).

Field observations:—*Solanum agnewiorum* is an easy to recognise species with distinctive acuminate leaf lobes, a dense covering of small curved prickles, and seeds significantly larger than those of any other African *Solanum* species. Occasional single-stemmed seedlings are seen on the dark forest floor (fig. 2b). Observations suggest that disperse populations of these non-reproductive seedlings are distributed throughout the forest understorey, and when a canopy gap appears they grow upwards attaching to other vegetation using prickles, developing into branched scramblers to 4 m tall and flowering.

Taxonomic placement:—Herbarium specimens of *S. agnewiorum* look deceptively similar to the common and hypervariable *S. anguivi* Lam. as its distinguishing characters in the fruit are easily overlooked due to scarcity of fruiting material. Most spiny *Solanum* shrubs from highland Africa with numerous flowers and fruits per inflorescence are part of *S. anguivi* Lam. Historically the majority of this species has been called "*Solanum indicum* L." and the epithet "*indicum*" was rejected (Hepper 1978) due to historic confusion and widespread misapplication. Richard Lester's group at the University of Birmingham have completed a multidisciplinary research programme on the species boundaries of this group and following his results we accept an inclusive concept of *S. anguivi* (for more information please see the treatment of *S. anguivi* published in Solanaceae Source, 2010). *Solanum agnewiorum* differs from *S. anguivi* by its prickles always curved (versus straight to curved in *S. anguivi*), leaf lobes acuminate (versus rounded to acute in *S. anguivi*), 1–4 flowers and 1–2 fruits per inflorescence (versus 5–22 flowers or fruits per inflorescence in *S. anguivi*), fruits 20–25 mm diameter (versus 6–9 mm diameter in *S. anguivi*), and seeds 5.5–6 mm diameter (versus 1.8–2.5 mm diameter in *S. anguivi*).

The habit and ecological niche of *S. agnewiorum* is more reminiscent of the Tanzanian endemic *S. stipitatostellatum*, another montane forest gap species scrambling up vegetation with its hooked prickles. *Solanum stipitatostellatum* has a dense covering of indumentum, entire to subentire leaves, and smaller fruits. Relationships in this group await clarification by molecular phylogenetic work currently in progress.

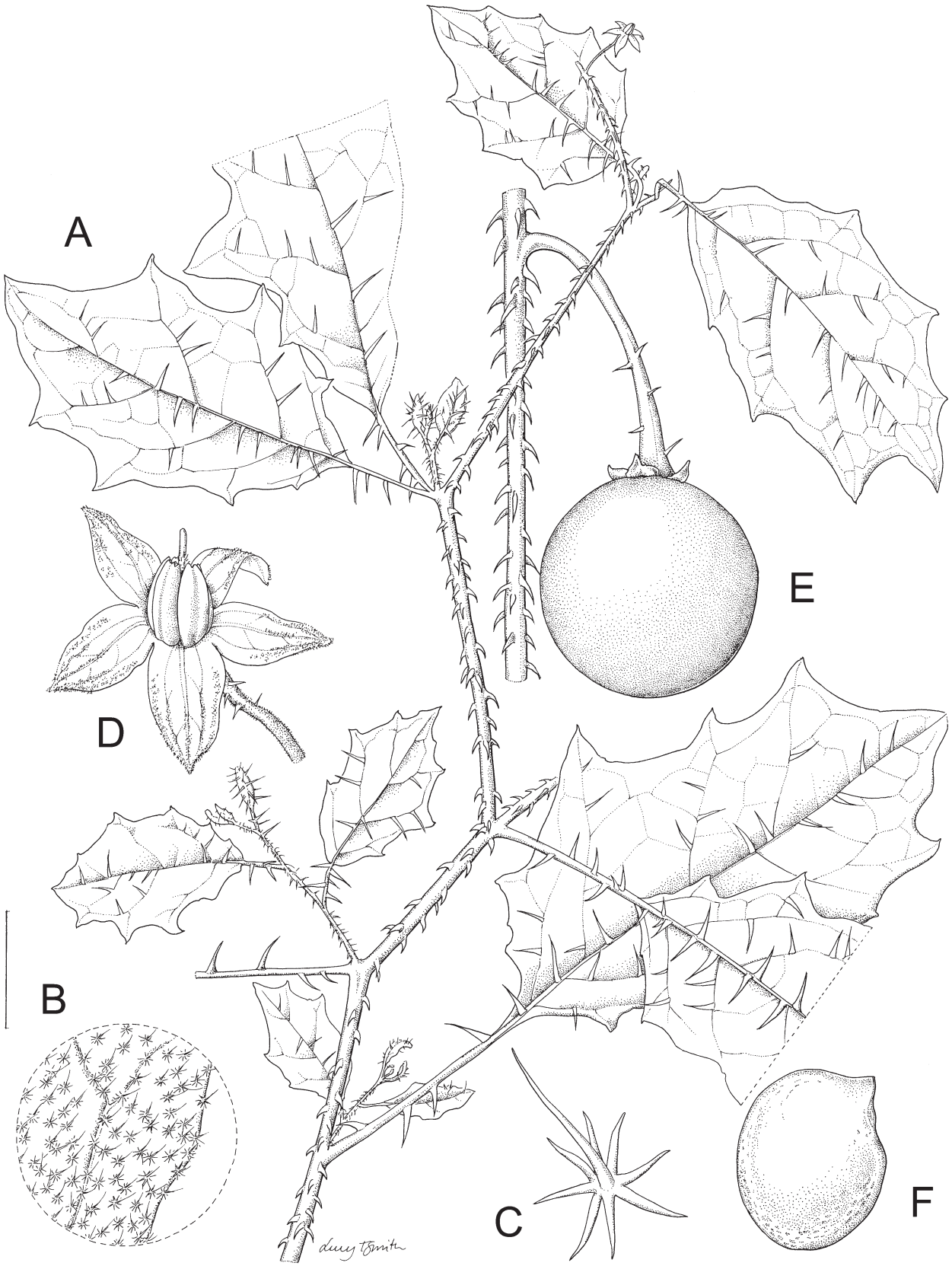

FIGURE 1. *Solanum agnewiorum* (A–D drawn from *Hepper & Field 4923*; E, F drawn from *Van Someren 422*, by Lucy T. Smith). **A.** habit; **B.** abaxial surface of leaf with stellate trichomes; **C.** stellate trichome; **D.** flower; **E.** fruit; **F.** seed. Scale bar: A = 3 cm, B = 2.5 mm, C = 0.5 mm, D = 1 cm, E = 1 cm, F = 4 mm.

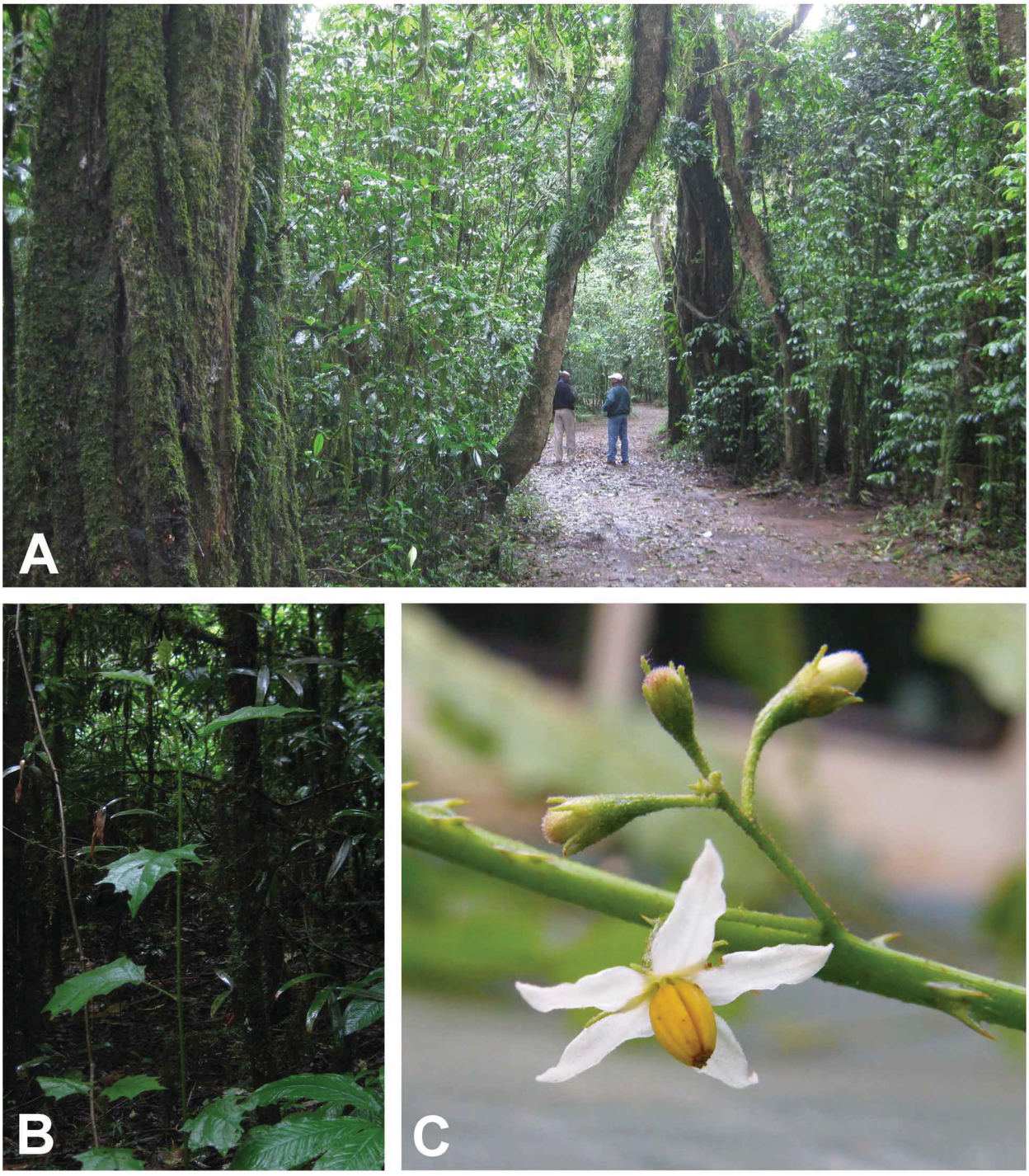

FIGURE 2. *Solanum agnewiorum* in its habitat (photographs A and B by Maria S. Vorontsova, C by Paweł Ficinski). **A.** path towards the main water intake in the Nyambene Forest, *S. agnewiorum* is commonly found on the sides of this path; **B.** seedling in the dark forest understorey; **C.** inflorescence with a short-styled flower; the hooked prickles attach to neighbouring vegetation as the plant scrambles upwards.

The collection *Vorontsova et al. 196* has been chosen as the type because the duplicates are more broadly distributed than those of older collections, and include both flowering and fruiting material as well as field photographs.

Habitat decline:—The Central Highland soils are predominantly volcanic (White 1983) and currently supporting a diversity of modern agricultural systems. Central Kenyan forests have been diminishing for

several decades due to legal excision for settlement, agriculture, industry and exchanges (Wass 1995). The following notes on forest decline in collection localities of *S. agnewiorum* have been compiled by Patrick Muthoka based on personal observations. The montane forest around Limuru and Limuru Girls High School no longer exists and no collections have made from that area since 1961. Most of the land in the Limuru and Tigoni areas is privately owned and divided for real estate development. The proximity of Limuru to Nairobi has contributed to rapid habitat destruction due to human migration. Marimba forest (part of Mt. Kenya east forest) is also under severe threat due to encroachment: the Kenyan government has cleared forest to develop the Nyayo tea plantations at the periphery of the closed forest at Marimba and Aberdare mountains, leading to an influx of workers. The only known stable population remains at the Nyambene forests that were gazetted in the 1980s (Government of Kenya 1982), and where immediate threats to the species are not observed. The Aberdare forest collection locality was not visited for this survey.

Conservation status:—Endangered (EN) based in criteria B1(b) "Extent of occurrence estimated to be less than 5000 km^2, known to exist at no more than five locations, and continuing decline, observed, inferred or projected, in the extent of habitat" (IUCN 2010).

Seed conservation:—Seeds of *S. agnewiorum* are now conserved *ex-situ* at the National Gene Bank of Kenya, through the Kenya Seeds for Life Project supported by Kew Millennium Seed Bank partnership. Seed set for this species appears low and only a small number of seeds has been preserved.

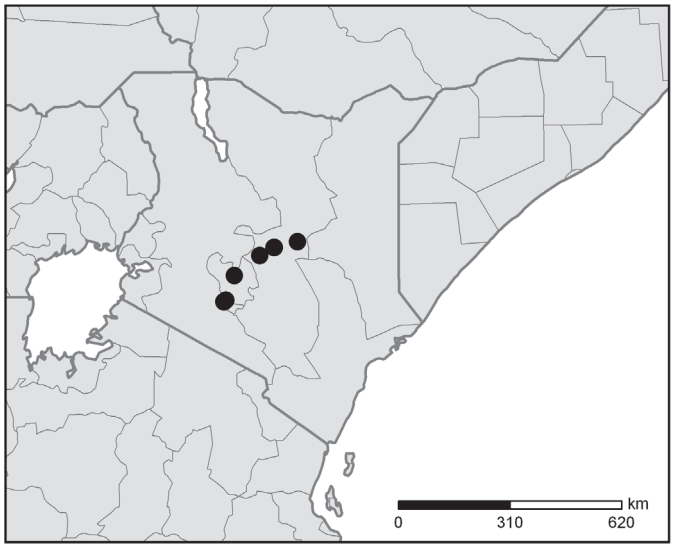

FIGURE 3. Collection localities of *Solanum agnewiorum* in Kenya.

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