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***Nesocrambe*, a new genus of *Cruciferae* (*Brassicaceae*) from Soqotra, Yemen**

Abstract

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The new genus *Nesocrambe*, with the sole species *N. socotrana*, endemic to the island of Soqotra, is described and illustrated. Its affinities and taxonomic position within the family are discussed. It is concluded that *Nesocrambe* is apparently closest to *Hemicrambe*, which has a disjunct distribution in NW Africa and Soqotra, and, like that genus, is a relict of the old Miocene flora which once extended around the coasts of the Mediterranean Sea. *Nesocrambe* is restricted to moist, shady places on limestone pinnacles and cliffs along an exposed and isolated ridge at the extreme western end of Soqotra. Its conservation status is considered.

Introduction

During an expedition to the Soqotra Archipelago (Republic of Yemen) in the spring of 2001 a novel crucifer was discovered on a hitherto unexplored mountain ridge at the dry western end of the main island of Soqotra. Several fruiting plants were found and, after a thorough search of the area, a solitary plant, bearing three flowers, was also discovered. The new taxon is a perennial with lyrate-pinnatifid leaves, yellow flowers and seeds with conduplicate cotyledons. However, it is the fruits which are the most distinctive feature. They are delicately pendent on reflexed, rather weak pedicels; each is two-membered with the distal segment about twice as long as the proximal. Both segments are terete, indehiscent and without obvious venation – there is no trace of valves in the proximal segment. The distal segment is somewhat “waisted”, i.e. constricted in the proximal half. Both distal and proximal segments are one-seeded. The segments are without septa and in each the single seed is embedded in pith-like tissue.

Relationships. – The two-membered fruit and seeds with conduplicate cotyledons clearly place the new plant in the tribe *Brassicaceae*, however, neither its generic nor its subtribal position is clear. A literature survey of genera with two-membered fruits in the *Brassicaceae* revealed no obvious generic affinities (Hedge 1976, Maire 1965, 1967, Schulz 1936). The greatest superficial resemblance is perhaps with a group of species in the subtribe *Raphaninae* including *Ceratocnemum*

Coss. & Balansa, *Didesmus* Desv., *Otocarpus* Durieu, *Eremophyton* Bég., *Fortuynia* Shuttlew. ex Boiss. and *Rapistrum* Scop. p.p. These have one seed in the valvar (proximal) portion and another in the beak (distal segment) (Hedge 1976, Schulz 1936). However, they are all annuals or biennials and their fruits are very different in appearance. The fruit of the new species is perhaps most similar to those of *Rapistrum*, but these differ in several important respects: they are held on a thickened pedicel and have a spherical, rugose distal segment.

Traditionally, great emphasis has been placed on fruiting characters in delimiting genera within the *Cruciferae*, however, it became clear that fruiting characters alone would not enable us to reveal the affinities of our new plant. Recently some authors have even questioned the overriding importance of fruiting characters in the family. Gómez-Campo (1980) comments that evolution in fruits is very rapid in the *Brassicaceae* and that not too much weight should be placed on fruiting characters. More recently, Al-Shehbaz (1999), in his consideration of the generic placement of species excluded from *Arabidopsis* Heynh., emphasised the importance of using vegetative and floral characters in delimiting genera.

Only two other members of the tribe *Brassicaceae*, both endemic, were previously known from Soqotra. The first, *Erucastrum rostratum* (Balf. f.) Gómez-Campo (recently transferred to *Erucastrum* from *Hirschfeldia*), is an annual which, like our new plant, has two-membered siliquae. However, the fruits of *Erucastrum* differ fundamentally in structure with the distal segment one-seeded and indehiscent whilst the proximal segment is many-seeded and dehiscent. The second, *Hemicrambe fruticosa* (C. Townsend) Gómez-Campo, is a member of a dispecific genus with a remarkably disjunct distribution, with the second species, *H. fruticulosa* Webb, occurring over 6900 km away in Morocco (Gómez-Campo 1977). *H. fruticulosa* is somewhat similar in facies to the new taxon although it is rather more shrubby and has white flowers and undivided leaves. Interestingly our new plant is perhaps more comparable with the Moroccan species, *H. fruticulosa*, which also has yellow flowers and lyrate-pinnatifid leaves. However, the fruit of *Hemicrambe* Webb is quite different: the distal segment is flattened and contains 1-4 seeds whilst the proximal segment is sterile and has vestigial dehiscent valves.

Regardless of the differences in fruiting characters, the similarity in facies of our new plant and *Hemicrambe* suggests a possible affinity. Gómez-Campo (1977) notes that *Hemicrambe* is unique in *Brassicaceae* in having patent median nectaries – significantly a character it shares with our new plant. It is also notable that the new plant and both species of *Hemicrambe* are perennials, whereas all *Raphaninae* and most other *Brassicaceae* are annuals or biennials. So in a number of floral and vegetative attributes (Table 1) the new plant is similar to *Hemicrambe*, but, given the current emphasis on fruit characters in delimiting genera in the *Brassicaceae* and the divergent fruit type of the new species, we consider it would be somehow misplaced in *Hemicrambe*.

Having failed to find a genus to conveniently accommodate our new plant, it was decided that the only option was to place it in a genus of its own, within the *Brassicaceae*. Its position within that tribe is still problematic. It is clearly related to *Hemicrambe*, which is included in the subtribe *Raphaninae* (Gómez-Campo 1977). However, Gómez-Campo (1980) notes that the subtribe *Raphaninae* is rather controversial, reflecting its probable polyphyletic origin. More recently Warwick & Black (1997a, b) used chloroplast DNA (cpDNA) to examine phylogenetic relationships within the tribe *Brassicaceae*. Their work supported the monophyletic origin of the tribe and indicated six major lineages, which do not agree with the currently recognized subtribes. The subtribes *Brassicinae*, *Moricandiinae* and *Raphaninae* are divided into two lineages: (1) *Nigra* and (2) *Rapa-Oleracea*. Whereas *Ceratocnemum* Coss. & Balansa, *Cordylolobus* Desf., *Guiraoa* Coss., *Hemicrambe*, *Kremeriella* Maire, *Muricaria* Desv., *Otocarpus* Durieu and *Raffenaldia* Godr. are in the *Nigra* lineage, *Raphanus* L. (subtribe *Raphaninae*) is included in the *Rapa-Oleracea* lineage. In conclusion, taking into account the present uncertainty over the taxonomy of the *Brassicaceae*, it seems best to place the new species in a genus of its own, in the *Brassicaceae*, close to *Hemicrambe*.

Table 1. Comparing *Hemicrambe* and *Brassicaceae* sp. nova (*M.20021*).

	<i>Brassicaceae</i> sp. nova (<i>M.20021</i>)	<i>Hemicrambe fruticosa</i>	<i>Hemicrambe fruticulosa</i>
Habit	perennial herb	subshrub	subshrub
Leaves	simple to lyrate-pinnatisect	simple with irregularly crenate-dentate margin	lyrate-pinnatipartite
Fruit	2 segments	2 segments	2 segments
Distal segment	cylindrical, indehiscent; 1-seeded	flattened, indehiscent; 1-4-seeded	flattened, indehiscent; 1-4-seeded
Proximal segment	indehiscent; vestigial valves absent; 1-seeded; cylindrical	dehiscent; vestigial valves present; sterile; flattened	dehiscent; vestigial valves present; sterile; flattened
Fruiting pedicels	reflexed	reflexed	reflexed
Sepals	patent, hooded; not saccate at base	patent, hooded; not saccate at base	patent, hooded; not saccate at base
Petal colour	yellow	white	yellow
Stigma	capitate	capitate	capitate

***Nesocrambe* A. G. Mill., gen. nova (Brassicaceae)**Typus: *Nesocrambe socotrana* A. G. Mill.

Cruciferarum-Brassicearum ab omnibus aliis generibus fructu singulari differt; *Hemicrambe* verosimiliter affinis, cui *Nesocrambe* habitu perenni, fructibus pendentibus et nectariis medianis prominentibus similis est sed a qua segmentibus ambobus fructus semen unum solum continentibus.

Perennial herb, somewhat woody below. *Leaves* simple to lyrate-pinnatisect. *Sepals* hooded at apex, somewhat spreading, not saccate at base. *Petals* yellow, spathulate, rounded above and attenuate into a claw below. *Stamens* six with filiform filaments. *Lateral nectaries* bimamillate; median nectaries conical, patent. *Ovary* terete, narrowly ovoid, 2-membered: proximal segment without valves, 1-ovulate; distal segment 1-ovulate; stigma capitate. *Siliquae* cylindrical, without obvious venation, 2-membered, both segments indehiscent, 1-seeded, septum absent, seeds embedded in pith-like tissue. *Cotyledons* conduplicate.

Monospecific. Endemic to the island of Soqotra. The generic name is derived from Greek *nesos*, island, and *krambe* (adapted in Latin as 'crambe'), cabbage.

***Nesocrambe socotrana* A. G. Mill., sp. nova**

Holotype: Republic of Yemen, western Soqotra, Sharahin, 12°31'N, 53°20'E, in shady cracks and gullies amongst limestone pinnacles, 450 m, erect perennial herb, flowers bright yellow, 6.2. 2001, Miller, Atkinson, Khulaidi, & Taleeb *M.20021* (E; isotypes: B, UPS, herbarium of the Soqotra Biodiversity Unit in Hadibu on Soqotra, herbarium of AREA, Ministry of Agriculture, at Dhamar, Yemen). – Fig. 1.

A *Hemicrambe fruticosa* (C. Townsend) Gómez-Campo forma fructuum, foliis simplicibus usque lyrato-pinnatisectis et floribus luteis differt.

Perennial herb, somewhat woody below, glabrous throughout. *Stems* up to 20 cm long, mainly hidden in cracks in the rock faces, with the leaves congested on short spur shoots at the tips of the

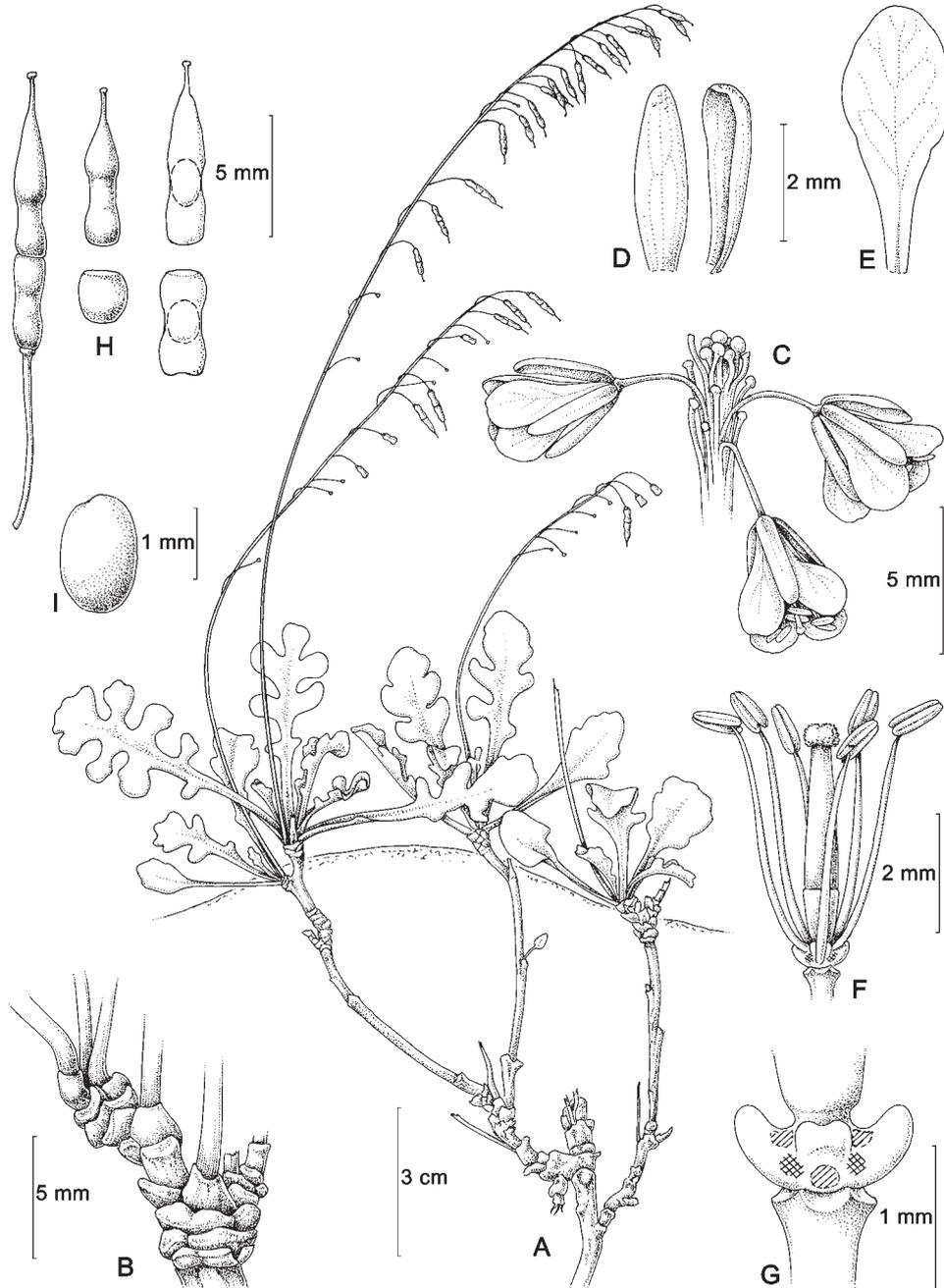


Fig. 1. *Nesocrambe socotrana* – A: habit; B: leaf bases; C: tip of inflorescence; D: sepals; E: petal; F: stamens and ovary; G: nectaries; H: fruit, showing variation in distal and proximal segments and position of seed; I: seed. – Drawings by Mary Mendum (RBG Edinburgh) from the type collection.

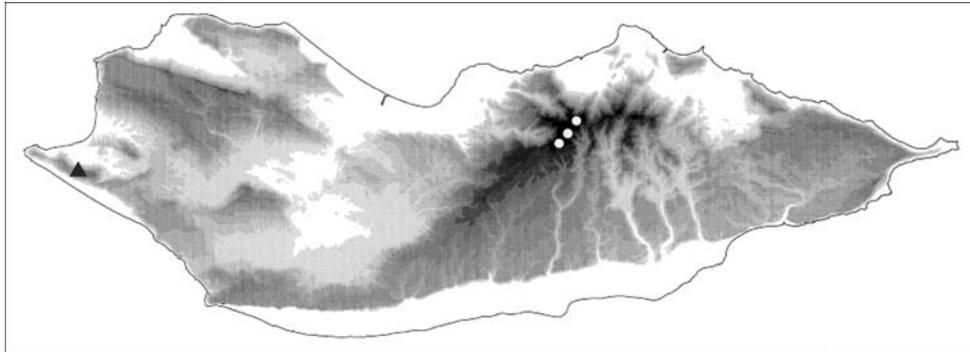


Fig. 2. Soqotra Island and distribution of the Soqotran endemics *Nesocrambe socotrana* (black triangle) and *Hemicrambe fruticosa* (white dots).

stems; older stems pale brown, with prominent, whitish, corky remains of leaf petioles on the old spur shoots. *Leaves* congested on short shoots at the tips of the stems, appearing as basal rosettes above the hidden stems, slightly fleshy, obovate to oblanceolate in outline, rounded at apex and long attenuate into the petiole below; lamina simple with a few rounded teeth or usually lyrate-pinnatifid to lyrate-pinnatisect, 1-3 × 1-2 cm, with 3-5 pairs of lateral lobes and a larger terminal lobe; lateral lobes triangular or oblong to obovate, rounded; terminal lobe broadly obovate to obcuneate; petiole 2-4 cm. *Inflorescence* 10-45-flowered, 10-20 cm long, erect, the flowers deflexed, ebracteate; pedicels 2-3 mm at anthesis, lengthening to 7 mm in fruit. *Sepals* oblong, subequal, c. 3.2 × 1-1.4 mm, hooded at apex, spreading at anthesis. *Petals* yellow, spatulate, 4.3-4.5 × c. 2 mm. *Median nectaries* conical, patent, c. 1 mm long. *Longer stamens* c. 3.3 mm long, shorter stamens c. 3.1 mm long; anthers c. 1 × 0.3 mm. *Ovary* terete, narrowly ovoid, c. 3.8 × 0.5 mm; stigma capitate. *Siliquae* delicately pendent, hanging to one side (secund) on rather thin reflexed pedicels, cylindrical, 7-9 × 1.5-2 mm, smooth; distal segment 1-seeded, 6-7.5 mm long, waisted, seed positioned at waist, narrowed at tip into a c. 0.8 mm style; proximal segment, 1-seeded, cylindrical, 1.7-4 mm long; seeds oblong-ovoid, yellowish brown, smooth, 1.4-1.5 × 0.5-0.6 mm.

Note. – The flower measurements are based on the only three flowers seen. These were on a short shoot which had developed after the main shoots were in fruit. Cruciferous flowers on such shoots are frequently smaller than typical and can be rather anomalous.

Habitat. – *Nesocrambe* is found on an inhospitable and windswept ridge at the western end of Soqotra. The ridge is composed of rather loose basement crystalline rocks (apparently granite) capped by limestone. The plants grow at an altitude between 400 m and 530 m in shady, relatively humid cracks and gullies in the limestone and are associated with *Euclea divinorum* Hiern, *Clerodendron leucophloem* Balf. f., *Poskea socotrana* (Balf. f) G. Taylor, *Teucrium balfourii* Vierh., *Kalanchoe farinacea* Balf. f., *Boswellia popoviana* Hepper, *Lotus mollis* Balf. f., *Taverniera sericophylla* Balf. f., *Lavandula nimmoi* Benth., *Launaea crepoides* Balf. f. and a number of as yet undescribed new species in several genera.

This region of Soqotra is generally dry as witnessed by the sparse vegetation. However, the highest points of the ridge trap mist and limited precipitation from the SW (summer) and NE (winter) monsoons, creating a small area of relatively humid conditions in an otherwise desertic environment. Similar small refugia of moist conditions are found on the desertic island of Samha (Hughes & Miller, in press) and on Soqotra, principally in the high pinnacles of the granitic Hageger mountains in the NE of the island (the home of *Hemicrambe fruticosa*). It is noticeable that *Nesocrambe* occurs only on the limestone and not on the nearby igneous rocks. This is similar

to the situation described by Danin (1999) in Sinai and southern Jordan where “relative mesophytes”, relicts of moister periods, survive in refugia on cliffs. These refugia are in areas of smooth rock (such as limestone) where run-off from the large areas of bare rocks contributes significant amounts of water to the soil in the crevices. The niche occupied by *Nesocrambe* is similar to those described by Danin and could explain why this “relative mesophyte” occurs in an otherwise dry environment and, furthermore, explains why it is restricted to the limestone and absent from the nearby igneous rocks, which are heavily cracked and fissured and in consequence would have greatly reduced run-off.

Biogeographical considerations. – The perennial habit is relatively uncommon in the *Brassicaceae* and in many other extant Mediterranean *Cruciferae*. The biennial and annual life-cycles of most Mediterranean *Brassicaceae* are considered to be adaptations for enduring the enhanced seasonality after the Pliocene (Gómez-Campo 1980). These annuals and biennials are thought to derive from perennial ancestors that lived in the much milder conditions of the Miocene. The woodiness of certain species in the *Brassicaceae* (e.g. Canarian *Crambe* L., Madeiran *Sinapidendron* Lowe, *Brassica balearica* Pers., *B. somalensis* Hedge & A. G. Mill., *Hemicrambe* and *Nesocrambe*) perhaps indicates that they are remnants of this extinct Miocene flora of the Mediterranean coasts and represent the relicts of an earlier Miocene radiation. The East-West disjunction of genera such as *Hemicrambe* suggests great antiquity and supports this hypothesis. A recent evolutionary radiation centred on NW Africa as a response to the drying out during the Pliocene has given rise to most other extant taxa. It seems likely then that *Nesocrambe* is a relict of the old Miocene flora, which has survived in a small, moist refugium on Soqotra.

Conservation status. – It is remarkable that *Nesocrambe* has managed to survive in its small refugium with a total estimated area of occupancy of less than 10 km². At present the rapid development of the island poses no immediate threat to this unique habitat: the area is inhospitable, inaccessible by road and there is a lack of potable water. However, its restricted distribution and the very limited extent of the niche which it occupies means that it is vulnerable to both environmental and man-induced change. We strongly suspect that this marginal habitat is threatened by the long-term trend of lower rainfall in the region and would be particularly vulnerable to the effects of global warming (Miller & Morris 2000). This trend threatens the survival of several of the remarkable endemics of the Soqotra Archipelago including as yet undescribed species of *Begonia* and *Pelargonium*. These plants all occupy small humid niches on low mountains in otherwise dry areas and so, with increasing aridification, have no possibility of mitigating the effects of gradual drying by migrating upwards in altitude. We recommend placing *Nesocrambe socotrana* under the IUCN category “Critically Endangered” (IUCN 2001), because the estimated area of occupancy is less than 10 km² and it is only known from a single locality. It is recommended that seeds should be collected and stored in a seed bank.

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