

Ecological and morphological characterisation of two rare and endemic wild edible *Cucumis* species (Cucurbitaceae) of Western Ghats of India

K. Joseph John · Y. C. Roy · M. V. Krishnaraj ·
V. A. M. Nissar · M. Latha · K. V. Bhat

Received: 5 December 2014 / Accepted: 29 October 2015 / Published online: 26 November 2015
© Springer Science+Business Media Dordrecht 2015

Abstract *Cucumis silentvalleyi* (Manilal, T. Sabu et P.J. Mathew) Ghebretinsae et Thulin and *Cucumis indicus* Ghebretinsae et Thulin are two rare narrow endemics of Western Ghats of India. Both have morphological resemblance but distinguishable by a few key characters like shape of the leaf, ovary and fruit, and chromosome number. While both are edible and non-bitter, their distribution is mutually exclusive, but overlapping with *Cucumis sativus* var. *hardwickii* (Royle) Alef. (the wild and feral form of *C. sativus* L.). Interspecific crossability studies indicate that both are related to each other and to a lesser extent to *Cucumis setosus* Cogn. and *Cucumis melo* L. Being incompletely described, a comparative account of their morphology, phenology, distribution, ecology and conservation are provided.

Keywords *Cucumella* · *Cucumis indicus* · *Cucumis silentvalleyi* · Genetic resources of *Cucumis* · Taxonomy · Western Ghats

Introduction

The genus *Cucumis* L., as revised by Kirkbride (1993) in his Biosystematic Monograph of *Cucumis*, comprises 32 species and subsequently as a sequel to the monograph, the genus *Cucumella* Chiov. was also revised to include 11 species including two new entities (Kirkbride 1994). Following the observations of Kocyan et al. (2007) that Kirkbride's (1993) circumscription of *Cucumis* in its traditional concept is highly unnatural, molecular phylogenetic studies (Ghebretinsae et al. 2007a; Renner et al. 2007) reinvestigated the species relationships, suggesting inclusion of few more genera under the broad generic concept of *Cucumis* L. As corollary to the phylogenetic studies, Ghebretinsae et al. (2007b) and Schaefer (2007) re-circumscribed the genus by transferring the entities under *Cucumella* Chiov., *Dicoelospermum* C.B.Clarke, *Mukia* Arnott, *Myrmecosicyos* C. Jeffrey and *Oreosyce* Hooker f. to make the genus monophyletic. Under this broader concept, *Cucumis* includes 65 species (Schaefer and Renner 2011) and the section *Cucumella* comprises of 12 species, ten of them African and two Indian (Schaefer 2007).

Kirkbride (1994) states that the Indian entities *C. indicus* Ghebretinsae et Thulin and *C. silentvalleyi*

K. J. John (✉) · Y. C. Roy · V. A. M. Nissar · M. Latha
ICAR-National Bureau of Plant Genetic Resources,
Regional Station, Thrissur, Kerala 680656, India
e-mail: josephjohnk@rediffmail.com

M. V. Krishnaraj
Department of Botany, Baselius College, Kottayam,
Kerala 686001, India

K. V. Bhat
ICAR-National Bureau of Plant Genetic Resources, Pusa
Campus, New Delhi 110012, India

(Manilal, T. Sabu et P.J. Mathew) Ghebretinsae et Thulin are known only by their types and because of the poor knowledge of their distribution, no distribution map is available for them. Further, he stressed the need for additional collections from the Indian subcontinent to clarify their specific limitations and distribution. Even while provisionally accepting both as distinct species, Kirkbride (1994) feels that the interspecific difference between the two are less prominent than the infraspecific variation in the African taxa of *Cucumis* (*Cucumella* series). As he could not examine the live specimens of both, his descriptions were not complete. A perusal of the literature, herbarium survey in the Indian herbaria and passport data of live collections indicate that the section *Cucumella* with two endemic taxa in India has been under-collected and have not been studied in the field. This prompted us to investigate the comparative morphology, ecology and crossability relationship of *C. indicus* and *C. silentvalleyi*, both endemic to Western Ghats with restricted distribution and niche specificity.

Materials and methods

Herbarium survey was carried out at Central National Herbarium, Kolkata (CAL), Calicut University Herbarium, Kozhikode (CALI), Botanical Survey of India, Pune (BSI), Botanical Survey of India, Eastern Circle, Shillong (BSISH) and Madras Herbarium, Coimbatore (MH) and a total of 123 sheets of *Cucumis* including erstwhile *Cucumella* Chiov. were examined.

Type localities of both species were visited. Seeds of *Cucumis silentvalleyi* were collected from Silent Valley National Park, Malakkapara range (Thrissur), Cheruthoni (Idukki), Kailasa Nadu (Idukki), Gavi (Pathanamthitta) and Nelliampathy (Palakkad) of Kerala State and Sholayar Dam site of Tamil Nadu. Seeds of *Cucumis indicus* were collected from Amboli Ghat and Gaganbowda in Konkan region of Maharashtra and Dandeli forest in Karnataka. The seeds were raised in pots along with all other *Cucumis* taxa of Indian occurrence under insect-proof net house and also in open field during 2009 and 2010 monsoon (June–October) seasons. All the accessions were morphologically characterised using the descriptor and descriptor states developed by NBPGR (Mahajan et al. 2000) and modified following Kirstkova et al. (2003) and Kirkbride (1993).

Intra-specific classification as adopted by Hammer and Gladis (2014), Jeffrey (2001) and Pitrat et al. (2000) was generally followed for cultivated melon classification. However, the Oriental pickling melon of Kerala (with white, non-sugary, firm and non-aromatic flesh with an extended shelf life) used in this study is actually *C. melo* L. subsp. *agrestis* (Naud.) Pangalo var. *conomon* (Thunb.) Makino (in all probability, an introduction from China dating back to pre-colonial times) and not *C. melo* var. *acidulous* Naud. Vegetable type melon cultivated elsewhere in India (Assam plains) having broad resemblance with oriental pickling melon but with round oblong fruits, thin flesh and poor shelf life are probably belonging to the acidulous group.

Direct and reciprocal crosses were attempted with *C. sativus* L. [IC541391, IC539818, IC469576], *C. callosus* (Rottler) Cogn. [IC550180, IC550203], *C. hystrix* Chakrav. [IC612075], *C. melo* L. subsp. *agrestis* (Naud.) Pangalo var. *conomon* (Thunb.) Makino [IC265564, IC265629, IC265679], *C. melo* L. subsp. *agrestis* (Naud.) Pangalo var. *momordica* (Roxb.) Duthie et Fuller [IC536687, IC536705], *C. melo* L. subsp. *agrestis* (Naud.) Pangalo var. *agrestis* (Naud.) [IC5339841, IC572024] besides *C. sativus* L. var. *hardwickii* (Royle) Alef. [IC248151, IC248263], IC248319], *C. prophetarum* L. [IC550189, IC550188, IC550179, IC550178], *C. setosus* Cogn. [IC583551] and between *C. indicus* [Collector number JJK/Misc/10-74] and *C. silentvalleyi* [IC612079]. Bagged female flowers were hand pollinated in the morning, tagged and again covered. Hybrid fruit set and growth were monitored and seeds were raised for germination in Petri plates. Reaction to various biotic and abiotic stresses like spider mite infestation, fruit fly, leaf miner, pumpkin caterpillar, downy mildew, powdery mildew, and susceptibility to high rainfall and low sunshine hours were recorded under natural epiphytic conditions in the characterisation plot.

Results and discussion

Kirkbride (1994) depended heavily on Chakravarty (1952, 1959) for his description of both taxa and especially measurements are based on his drawings. As Kirkbride (1994) has expressed scepticism on the validity of retention of Indian components of *Cucumella* as distinct species, a key is provided to

differentiate between the two species. He further acknowledges inadequacies of his description, for example, colour of mature fruit, number of seeds per fruit and discrepancy in male flower stalk length due to obvious reasons. Incorporating the missing information as highlighted by him in his revision of *Cucumella*, a detailed technical description of both species is provided based on literature, herbarium and field studies. Kirkbride (1994) stressed on seed pubescence to distinguish between the two species, but seed hairs being deciduous on storage and microscopic we have given more emphasis on visual macromorphology. Earlier descriptions were not complete as many characters could not be derived from the lone herbarium specimen available for the study. As taxonomic history of both species are complex, involving merger and splits and nomenclatural changes, nomenclatural citations and details of specimen examined are also given.

Key to differentiate *C. silentvalleyi* and *C. indicus*

Leaves broadly round, thick, petioles long, more than 6.5 cm, fruits ovate, faintly rostrate at both ends, hispidulous, seeds hairy (*C. silentvalleyi*)
 Leaves deeply angular, membranous, petioles short, less than 6 cm, fruits narrowly cylindrical, highly rostrate (snout like) at both ends, puberulous, seeds non hairy (*C. indicus*)

A perusal of comparative morphology of vegetative and reproductive parts (Table 1; Figs. 1, 2) indicates that both species vary for leaf and fruit shape, besides other characters.

Technical description of the plants

Cucumis silentvalleyi (Manilal, T. Sabu, et P.J. Mathew) Ghebretinsae et Thulin, Novon, 17(2):178.2007. *Cucumella silentvalleyi* Manilal, T. Sabu, et P.J. Mathew, Acta Bot India 13: 283. 1985. TYPE: Sabu SV 10662 (Holo CAL n v) India, Kerala, Palakkad District, Silent valley NP, Poochapara. 1370 m, 20.10.1982.

Annual vines, pubescent throughout, green, monoecious; rooting at nodes. Tap root non tuberous. Leaves green, villous; petiole up to 7.5 cm long, sparsely

pilose; leaf blade broadly round or very shallowly 5-angular, broadly ovate to reniform in outline, 3.8–5 × 5.5–7 cm, margin denticulate, ciliate, cordate at base with a basal sinus, broader than longer, hirsute on upper and lower surface throughout, on veins as well as leaves, base narrow emarginate, cordate. Tendrils simple, up to 17 cm long or more. Male inflorescence in fascicles of 5 flowers, pedunculate, peduncle up to 2 mm or more. Male flowers-yellow, 1.3 cm in diameter, pedicellate of 1.8–2.1 cm, slender, long, hirsute. Hypanthium light green, campanulate, pubescent. Calyx lobes green, narrowly triangular or linear, hirsute throughout, ca 1 mm long. Corolla bright yellow; petals 0.6 × 0.4 cm, acuminate at apex, ovate or broadly ovate, hirsute on lower surface. Anthers 3, yellow, 1–1.5 mm long, pubescent; anther thecae straight without bends, pubescent; filaments below 1 mm long, connective extended, pistillode 0.2–0.5 × 0.2–0.3 mm, shallowly 3-lobed, smooth. Female flowers solitary produced at nodes, pedicellate-1.5 cm. Hypanthium light green, 3.5–5 mm long, lower part fused with the ovary; calyx lobes light green, linear or triangular in outline up to 3 mm long, pubescent. Corolla yellow, broadly ovate, 0.7–0.9 × 0.3–0.6 cm, acuminate at apex. Ovary ovate, 2–4.5 mm long, tomentose, stigma 1–2 mm with three finger-like projections. Style up to 0.9 cm long. Fruits 3 × 1–1.3 cm, globose to ovate in outline, shortly rostrate at both ends, not aculeate, whitish green with dark green stripes, dark green stripes prominent over young fruits and stalk end of the mature fruits and turns whitish green towards blossom end, mesocarp soft, mealy, granular, shining, edible, non bitter, thin up to 1 mm. Fruit cavity filled with seeds. Fruit weighs around 5 g. Rupturing of epicarp starts at the middle of the fruit and exposes the seeds. The seeds come out one by disintegration of the mesocarp. The beaks more or less similar at both ends, around 2.8 mm. Stalk of the fruit ca 7 mm or more. The number of seeds in a fruit ranges from 12 to 32. Seeds 3–4 × 1–2 mm, oblong, ovate, pubescent or puberulous.

Specimens examined C. N. Mohanan, 152881 (CAL) 08.11.1981 Microwave Hill Station, Idukki, Kerala; V.S. Rajan 136755 (CAL) 08. 11. 1981 Microwave Hill Station, Idukki, Kerala; B.D. Sharma 80906 (CAL) 26.09.1972 Upputhara, Idukki, Kerala; E. Vajravelu 94494 (CAL) 03.11.1976 Below Aiyappan Kovil area, Palakkad, Kerala; N.C. Nair 125225

Table 1 Comparative morphology of *C. silentvalleyi* and *C. indicus*

S. no.	Character	<i>Cucumis silentvalleyi</i>	<i>C. indicus</i>
<i>Qualitative characters</i>			
1	Petiole	Long	Short, fairly thick
2	Leaf apex	Obtuse or broadly acute	Acute
3	Leaf texture	Wrinkled	Smooth
4	Leaf lobing	Generally unlobed or broadly round	5-angled
5	Leaf base	Truncate or slightly emarginate	Broadly emarginate
6	Ovary shape	Globose to ovate	Elliptic-Ovate
7	Ovary pubescence	Tomentose	Puberulent
8	Fruit shape	Oval with short beaks at both ends	Cylindrical with long beaks at both ends
9	Fruit pubescence	Hispidulous	Puberulent
10	Fruit rupturing	At a point in the middle portion	Forming a slit from the centre and extends towards sides
11	Mesocarp	Colourless, shining	Whitish
12	Epicarp colour on ripening	Turns whitish	Turns creamish yellow
13	Seeds	Compressed	Turgid
14	Hilum	Pointed	Curved
<i>Quantitative characters</i>			
1	Petiole length	6.9–7.5 cm	3.6–4.3 cm
2	Leaf length	4.5–7.5 cm	3.8–4.2 cm
3	Leaf width	6–9 cm	5.7–6.9 cm
4	Internode length	4.5–6.0 cm	3.8–4.2 cm
5	Tendrils length	10–17 cm	9.5–15 cm
6	No of male flowers/axil	5	4 (5)
7	Male flower diameter	1.3 cm	1.0 cm
8	Pedicel length	1.8–2.1 cm	1.1–1.5 cm
9	Fruit length	2.5–3.0 cm	3.8–4.8 cm
10	Fruit diameter	10–13 mm	7–8 mm
11	Fruit circumference	2.8–3.2 cm	2.3–2.7 cm
12	Seed length	3.0–4.0 mm	2.7–3.2 mm

(CAL) 10.10.1979 Aruvampara Forest, Palakkad, Kerala; T. Sabu, 10663 (CALI) 20.08.1982 Poochappara, Silentvalley, Palakkad, Kerala; Sathish Kumar 16231 (CALI) 16.08.1986 Koruthode, Periyar, Idukki, Kerala; Jomy A. 16271 (CALI) 12.06.1995 Karadikavala, Periyar, Idukki, Kerala; Jomy A. 13932 (CALI) 28.05.1994 Koruthode Periyar, Idukki, Kerala; A.K. Pradeep 56011 (CALI) 19.09.1997 Olichuchattam, way to Valiyamala, Silentvalley, Palakkad, Kerala.

Cucumis indicus Ghebret. et Thulin, Novon, 17(2): 177.2007. *Melothria ritchiei* Chakravarthy, J. Bombay Nat. Hist. Soc. 50:898. 1952. *Cucumella ritchiei* (Chakravarthy) C. Jeffrey, Kew. Bull. 19: 215. 1965. non *Cucumis ritchiei* (CB Clarke) Ghebretinasae et Thulin.

TYPE: Ritchie 67 (holo E) India—Maharashtra, Savantwadi, Ramghat.

Annual vines, pubescent throughout, green, monoecious; rooting at nodes. Tap root non tuberous. Leaves green, villous, petiolate; petioles up to 3.6–4.3 cm long, terete, with straight and antrorse hairs, leaf blade deeply 5-angular, 3.8 × 4.2–5.7 × 6.9 cm, margin denticulate—serrate, villous, cordate at base with a basal sinus, broader than longer or nearly same, villous hirsute on upper surface and lower surface, throughout on veins as well as leaves, base broadly emarginate, cordate. Tendrils simple, up to 15 cm long. Male inflorescence in fascicles of 4–5 flowers, pedunculate, peduncle <2 mm. Male flowers—yellow, 1 cm in diameter, pedicellate of 1.1–1.5 cm, filiform, slender,

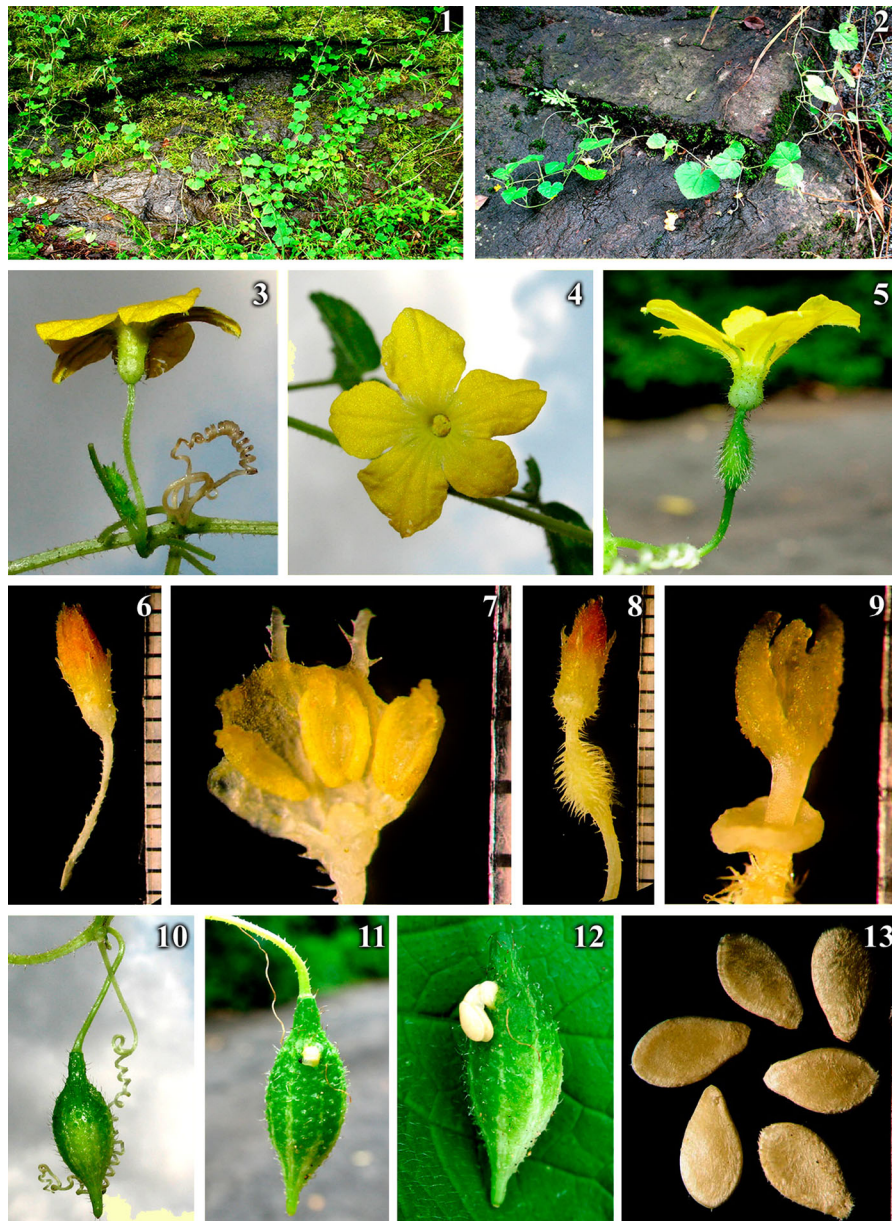


Fig. 1 *Cucumis silentvalleyi*: 1 and 2 habit, 3, 4 and 6 male flower, 5 and 8 female flower, 7 stamen, 9 stigma, 10–12 fruit, 13 seeds

long, hirsute. Hypanthium whitish green, campanulate, pubescent. Calyx lobes green, narrowly triangular or linear villose throughout especially at margins ca 1 mm long. Corolla bright yellow, petals 0.6×0.4 cm in size, acuminate or obtuse at apex, broadly ovate, shining inside, pilose lower surface. Anthers 3, yellow, 2–3 mm long, anther thecae straight without bends, pubescent, filaments below 1 mm, connective extended, pistillode $0.2\text{--}0.5 \times 0.2\text{--}0.3$ mm, shallowly

3-lobed, smooth. Female flowers solitary produced at nodes, pedicellate. Hypanthium whitish green, 3.0–5.0 mm long, lower part fused with the ovary, calyx lobes light green, linear or triangular in outline up to 3 mm long, hispid. Corolla yellow, broadly ovate, $0.6\text{--}0.8 \times 0.4\text{--}0.6$ cm, acuminate at apex. Ovary ovate-ellipsoid of 2.0–2.6 mm long, puberulent, stigma with three finger like projections. Style up to 0.6–1 cm. Fruits 3.8–4.8 cm long, 7.0–8.0 mm in

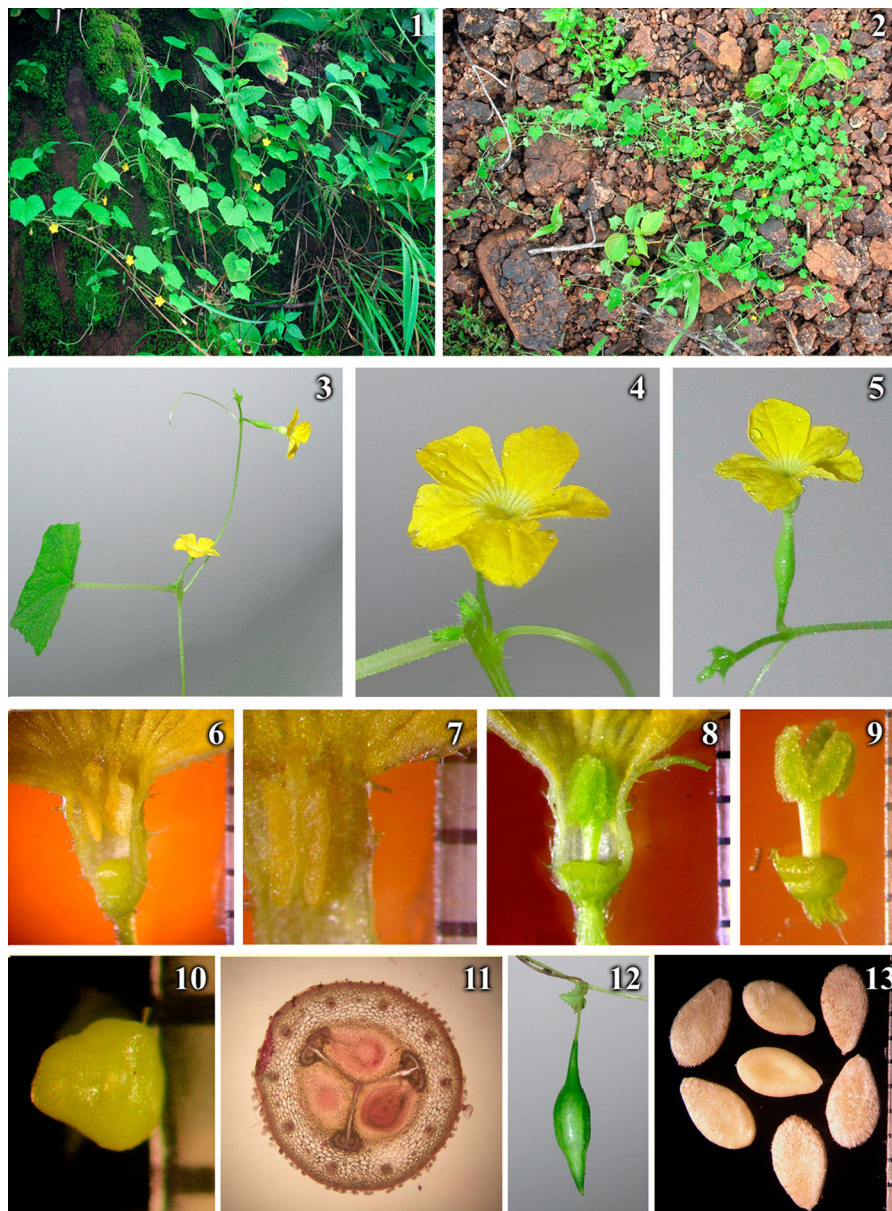


Fig. 2 *C. indicus*: **1** and **2** habit, **3** flowering twig, **4** male flower, **5** female flower, **6** longitudinal section (L.S.) of male flower, **7** stamen, **8** L.S. of female flower, **9** stigma, **10** pistillode, **11** Transverse section (T.S.) of ovary, **12** fruit, **13** seeds

diameter, spindle shaped in outline, rostrate at both ends with long beaks, not aculeate, bicoloured with longitudinal stripes from stalk end to the blossom end, whitish green with dark green stripes, dark green turns whitish green towards blossom end and becomes creamish on ripening. Pericarp thin, pubescent meso-carp soft, mealy, granular, edible, non bitter, thin up to 1 mm, fruit cavity filled with seeds, fruit weighs

around 3 g. beaks of the fruit is around 0.09 cm at stalk end and 0.4 cm at blossom end. Rupturing of epicarp starts at the middle and extends towards sides forming a slit to expose the seeds. The seeds come out one by one by disintegration of the fruit walls through the slits. Stalk of the fruit 2–3.5 mm long. The number of seeds in a fruit is around 40. Seeds 2.7–3.2 × 1.5–1.7 mm, oblong, ovate, glabrous.

Table 2 Crossability of *C. silentvalleyi* and *C. indicus* with related taxa

S. no.	Parents	Number of flowers crossed	No. of fruit set	% of fruit set	Fruit set/seed quality
1	<i>C. silentvalleyi</i> × <i>C. silentvalleyi</i>	102	32	31.37	Filled
2	<i>C. silentvalleyi</i> × <i>C. indicus</i>	24	12	50	Unfilled
3	<i>C. silentvalleyi</i> × <i>C. setosus</i>	46	17	36.95	50 % filled and 50 % chaffy
4	<i>C. setosus</i> × <i>C. silentvalleyi</i>	24	7	29.17	50 % filled and 50 % chaffy
5	<i>C. silentvalleyi</i> × <i>C. melo</i> var. <i>conomon</i>	47	10	21.28	Unfilled seeds
6	<i>C. indicus</i> × <i>C. indicus</i>	16	6	37.5	Filled
7	<i>C. indicus</i> × <i>C. silentvalleyi</i>	18	12	66.67	Unfilled seeds

Specimens examined Raghavan R.S., 100992 (BSI), 15.10.1964, Jog falls, Mysore, Karnataka; Joseph John K. (NHCP), 18.10.2009, Amboli Ghat, Sindhurg, Maharashtra; Joseph John K. (NHCP), 20.10.2009, Gaganbawda, Kolhapur, Maharashtra; Joseph John K., (NHCP) 22.10.2009, Dandeli, Uttar Kannada, Karnataka.

Chromosome number

The basic chromosome number of *C. silentvalleyi* is $2n = 24$ (Rajkumari et al. 2013) and that of *C. indicus* is $2n = 20$ (Sutar et al. 2013). *Cucumis* in general has two basic sets $2n = 24$ for *Cucumis melo*, *C. hystrix*, and majority of the *Cucumis* species. *C. sativus* and its wild form has $2n = 14$. The basic number $2n = 20$ exhibited by *C. indicus* is quite interesting and diverging from that of all other *Cucumis* species. The basic differences in somatic chromosome number is traditionally adopted in plant systematics to bifurcate taxa (Kumar and Rao 2002; Verma and Raina 1983).

Crossability relationship between *Cucumis silentvalleyi* and *C. indicus* and other related taxa of *Cucumis*

Interspecific crossability of both species is given in Table 2. Both the species did not set viable seeds in direct as well as reciprocal crosses with *C. prope-tarum*, *C. callosus*, *C. hystrix*, *C. melo* subsp. *agrestis*, *C. sativus* and *C. sativus* var. *hardwickii* indicating their

genetic divergence. However with *C. melo* and *C. setosus* and between the two, fruit set occurs as indicated below.

Fruit set was observed between *C. melo* and *C. silentvalleyi*. Between *C. indicus* and *C. silentvalleyi* even though there was fruit setting, the size was reduced and most of the seeds were chaffy, indicating embryo abortion and hybrid failure. The filled seeds failed to germinate. Failure of inter-specific hybrid embryo confirms genetic divergence and distinctness of both the taxa. In the crosses with *C. melo*, as the seeds were with aborted embryos both come in the secondary gene pool of *C. melo*.

Evidences from the present crossability study suggests that sequence similarities alone should not be taken as conclusive evidence justifying merger of species described earlier as distinct based on morphological studies. Further, it also underscores the fact that speciation may not be correlated in all instances to sequence differences, as discernible from a restricted number of chloroplast regions commonly used in molecular taxonomy (Sebastian et al. 2010).

Distribution

Cucumis silentvalleyi is occasional on exposed rocky terrain with dripping water at 800 m during rainy season. It was spotted in Sholayar, Kollathirumedu, Anakkayam and Malakkapara range in Sholayar forest, grasslands near Sholayar dam site (Pollachi Taluk, Coimbatore District, Tamil Nadu), Periyar Tiger Reserve and Cheruthoni in Idukki, Vellarimala, Malabar WLS, Waynad WLS, grasslands in

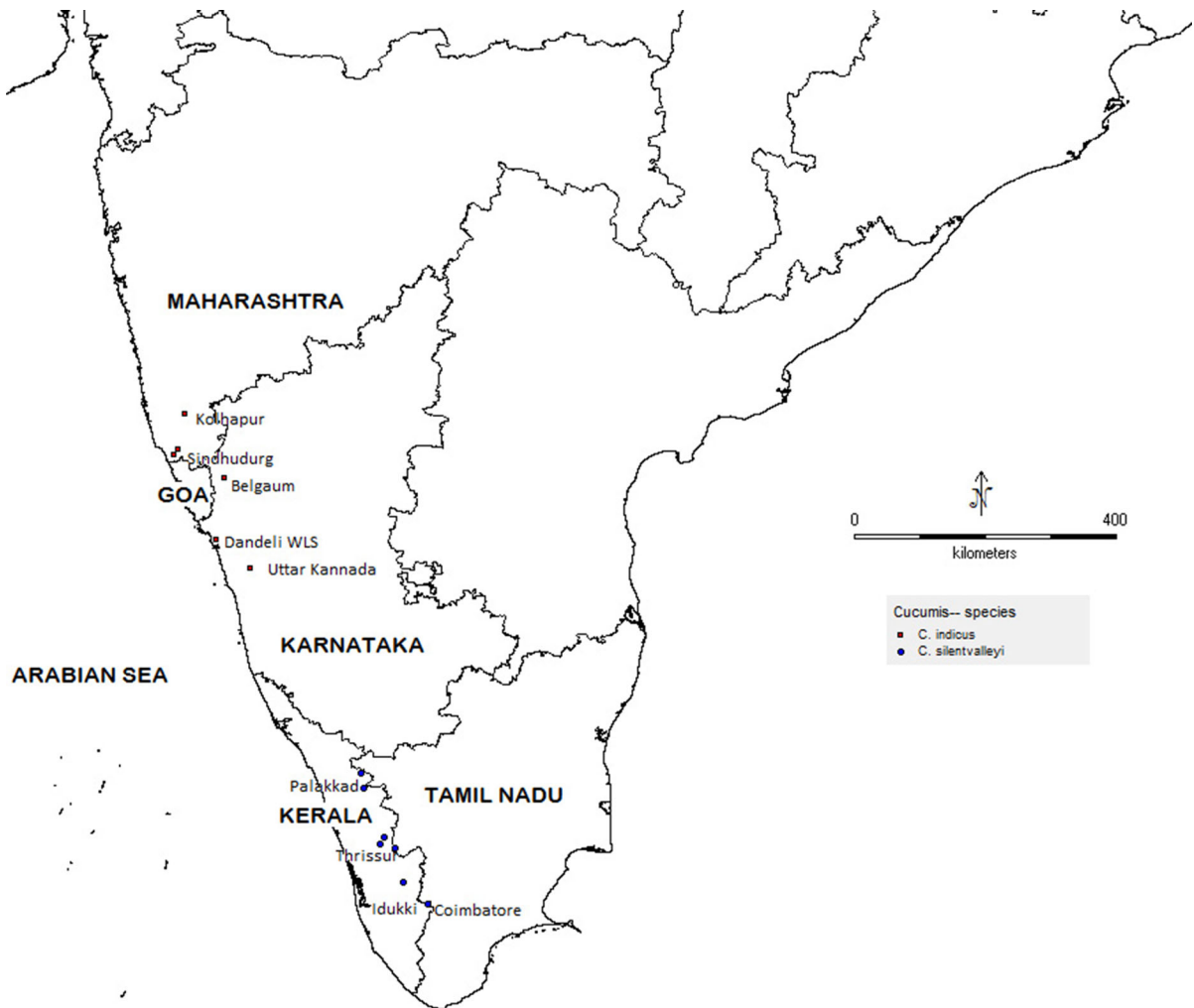


Fig. 3 Distribution map of *C. indicus* and *C. silentvalleyi* in India

Silentvalley National Park (type locality), Myladumpara (Idukki), Gavi & Moozhiyar (Pathanamthitta) and Nelliampathy (Palakkad), all in Southern Western Ghats.

Cucumis indicus occurs rarely in grass lands during rainy season as an ephemeral at 450–700 m. It was spotted on exposed sites in Amboli Ghat, at 2 km stretch in Sindhudurg district of Maharashtra and also in Dandeli Wild life Sanctuary at 250 m near Karwar in Karnataka.

Cucumis silentvalleyi and *C. indicus* are endemic to Western Ghats and their distribution is mutually exclusive but overlapping with *C. sativus* var. *hard-wikii*. Both are narrow endemics, the former restricted to a small stretch of Western Ghats at 400–700 m in

Kerala and adjoining Tamil Nadu and the latter restricted to even a still smaller population in northern end of Southern Western Ghats and southern side (Konkan) of Northern Western Ghats, and the population is with narrow distribution (Fig. 3).

Ecology, phenology and conservation

Both have more or less similar habit and habitat. Both are ephemerals growing near wet-dripping places in partially shaded rocky terrain and grasslands, completing their life cycle by the end of south west monsoon. The plants grow well in rocky crevices during monsoon season where partially decayed debris

and humus accumulates. The seeds germinate with the onset of pre-monsoon rains and establishes well during southwest monsoon. Both are occasional in forest clearings on bushes and thickets and *C. silentvalleyi* is frequent in moist rocks in the grass lands in Silent valley National park. Flowering and fruiting period is July to October and senescence occur by November end.

Cucumis silentvalleyi being a recent discovery, it has not attracted the attention of conservators. However, by virtue of a vast stretch of its habitat including type locality falling in wildlife sanctuaries and protected area network, its in situ conservation is well taken care of. However, in the case of *C. indicus* more studies are warranted. The present indication is that its habitat in Northern Western Ghats is highly vulnerable and needs specific steps for in situ and ex situ conservation.

Stress reaction and economic importance

Both the species were highly susceptible to spider mite and moderately susceptible to cucumber yellow mosaic. To pumpkin caterpillar and serpentine leaf miner also both were susceptible. However both were highly tolerant to heavy rain fall (non water-logged well drained situation) and low sunshine hours.

Local people consume tender fruits of both as salad vegetable. Taste is similar to cucumber and invariably without a tinge of bitterness at any stage of fruit development.

Conclusion

Cucumis silentvalleyi and *C. indicus* are two poorly studied and unconserved (ex situ) rare endemics with niche specificity and narrow distribution. Morphological analysis, different basic chromosome number and interspecific hybrid failure proves their distinctness from each other as separate biological species. Both are having good palatability and are adapted to shade and high rainfall conditions. Being delicate herbs, they may not have any direct domestication potential but may prove useful for melon improvement. Both are narrow endemics with restricted distribution and niche specificity.

Acknowledgments The work was carried out with funding from the National Agricultural Innovation Project (NAIP) on “Biosystematics of the genera *Vigna*, *Cucumis* and *Abelmoschus*”. We profusely thank Head, Germplasm Evaluation Division and Director, National Bureau of Plant Genetic Resources for the support and encouragement. The facilities extended by Dr. Lakshminarasimhan and Dr. V. P. Prasad, CNH, BSI, Kolkata for herbarium consultation and photography of a few sheets is great fully acknowledged.

References

- Chakravarty HL (1952) New finds of Indian Cucurbitaceae. *J Bombay Nat Hist Soc* 50:894–901
- Chakravarty HL (1959) Monograph on Indian Cucurbitaceae. *Rec Bot Surv India* 17(1):1–234
- Ghebretinsae AG, Thulin M, Barber JC (2007a) Relationships of cucumbers and melons unraveled: molecular phylogenetics of *Cucumis* and related genera (*Benincaseae*, *Cucurbitaceae*). *Am J Bot* 94:1256–1266
- Ghebretinsae AG, Thulin M, Barber JC (2007b) Nomenclatural changes in *Cucumis* (Cucurbitaceae). *Novon* 17:176–178
- Hammer K, Gladis T (2014) Notes on infraspecific nomenclature and classifications of cultivated plants in Compositae, Cruciferae, Cucurbitaceae, Gramineae (with a remark on *Triticum dicoccon* Schrank) and Leguminosae. *Genet Resour Crop Evol* 61:1455–1467
- Jeffrey C (2001) Cucurbitaceae. In Hanelt P, Institute of Plant Genetics and Crop Plant Research (eds) Mansfeld’s encyclopedia of agricultural and horticultural crops, vol 3. Springer, Berlin, pp 1510–1521
- Kirkbride JH (1993) Biosystematic monograph of the genus *Cucumis* (Cucurbitaceae). Parkway Publishers, Boone, NC
- Kirkbride JH (1994) Revision of *Cucumella* (Cucurbitaceae, Cucurbitaceae), Melothriaceae, Cucumerinae). *Brittonia* 46(3):161–186
- Kirstkova E, Lebeda A, Katovska J (2003) Response of *Cucumis melo* genotypes MR 1 and P1241 to Czech isolates of cucurbit powdery mildew. *Acta Hort* 588:181–184
- Kocyan A, Zhang LB, Schaefer H, Renner SS (2007) A multi-locus chloroplast phylogeny for the Cucurbitaceae and its implications for character evolution and classification. *Mol Phylogenet Evol* 44:553–577
- Kumar A, Rao SR (2002) Cytological investigations in some important tree species of Rajasthan II. Male meiosis studies in the genus *Anogeissus* (DC.) Guill., and A. Rich. *Caryologia* 55(1):63–72
- Mahajan RK, Sapra RL, Srivastav U, Singh M, Sharma GD (2000) Minimal descriptors (for characterisation and evaluation) of agri-horticultural crops Part I. NBPGR, New Delhi
- Pitrat M, Hanelt P, Hammer K (2000) Some comments on infraspecific classification of cultivars of melon. *Acta Hort* 510:29–36
- Rajkumari K, John KJ, Yadav R, Bhat V, Rao SR (2013) Comparative male meiotic studies in some Indian representative species of *Cucumis* L. (Cucurbitaceae). *Caryologia*. doi:10.1080/00087114.2013.854613

- Renner SS, Schaefer H, Kocyan A (2007) Phylogenetics of *Cucumis* (Cucurbitaceae): Cucumber (*C. sativus*) belongs in an Asian/Australian clade far from melon (*C. melo*). *BMC Evol Biol* 7:58
- Schaefer H (2007) *Cucumis* (Cucurbitaceae) must include *Cucumella*, *Dicoelospermum*, *Mukia*, *Myrmecosicyos*, and *Oreosyce*: a circumscription based on nuclear and plastid DNA data. *Blumea* 52(1):165–177
- Schaefer H, Renner SS (2011) Cucurbitaceae. In: Kubitzki K (ed) *The families and genera of vascular plants, Sapindales, Cucurbitales, Myrtaceae*, vol 10. Springer, Berlin, pp 112–174
- Sebastian P, Schaefer H, Telford IRH, Renner SS (2010) Cucumber (*Cucumis sativus*) and melon (*C. melo*) have numerous wild relatives in Asia and Australia, and the sister species of melon is from Australia. *Proc Natl Acad Sci USA* 107:14269–14273
- Sutar SP, Rajkumari K, Rao SR, Bhat KV, Yadav SR (2013) Chromosome counts in the genus *Cucumis* L. (Cucurbitaceae) from India. *Plant Sci Feed* 3(7):80–82
- Verma RC, Raina SN (1983) Cytogenetics of *Crotalaria* VIII. Male meiosis in 26 species. *Cytologia* 48:719–733