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Muktipada Panda
Department of Botany,
Regional Institute of Education,
Bhubaneswar (RIE-NCERT,
BBSR), Odisha, India

Field identification and phytochemical uses of *Oxystelma esculentum* (L.f.) Sm.: A rare wetland climber of Odisha State, India

Muktipada Panda

Abstract

This study reports presence of *Oxystelma esculentum* (L.f.) Sm. (Subfamily: Asclepiadoideae), a very rare wetland climber from coastal areas of Odisha state, India. This is the first time report and the species can be identified in the field having characters like, a climber with milky latex, opposite leaves, pointed leaf tip, white (outside) and pink (inside) colored flowers, pointed petal tips with hairy edges, presence of pollinia, smooth follicular fruit with many hairy small seeds. The plant is restricted to abandoned, tide influenced canal and river banks of Subarnarekha River near to Kasaphal estuary, Balasore. The plant is host specific and more frequently found associated with *Ipomoea carnea* Jacq. and rarely with *Ficus hispida* Linn.f., *Vitex negundo* Linn., *Ludwigia octovalvis* (Jacq.) Raven, *Clerodendrum inermi* (Linn.) Gaertn. and *Sesbania bispinosa* (Jacq.) W.F. Wight, etc. This plant has strong phyto-medicinal constituents and used for remedies from cancer, hepatitis, kidney disorders, stress-related disorders and various microbial infections. Habitat degradation and loss of host species are two major causes for the disappearance of *O. esculentum* (L.f.) Sm. Habitat conservation and finding alternative in-vitro technique for its artificial propagation will help for long term conservation of this indigenous flora of the state.

Keywords: Oxystelma, pollination, taxonomy, uses, conservation

Introduction

The family Asclepiadaceae is commonly known as milkweed family of angiosperms. Recently, phylogeny studies like Angiosperm Phylogeny Group III and Angiosperm Phylogeny Group IV had included Asclepiadaceae in the family Apocynaceae which now has five subfamilies: Apocynoideae, Rauvolfioideae, Asclepiadoideae, Periplocoideae, and Secamonoideae (APGIII, 2009; APGIV, 2016; Madani *et al.*, 2017) [25]. Asclepiadoideae is the largest subfamily in Apocynaceae (Rapini 2012) [42] which treated as Asclepiadaceae for almost two centuries. The actual number of species of family is a matter of contention and had been differently assessed. It includes 2000-2100 species in 167 genus (Zomlefer, 1994) [58], 2000 species in 250 genera (Ping-tao *et al.*, 1995; Daniel, 2009) [38, 81] 3400 species in 240 genera (Albers and Meve, 2004) [1] about 1,800 species in 280 genera (Mukherjee, 2011) and 3000 species in 170 genera (Rapini, 2012) [42]. Rahman and Wilcock (1991) [5] recognized occurrence of 327 species from fifty one genera of the family 'Asclepiadaceae' from south-west Asia and Indian subcontinent. Plants of this family are commonly found along tropical and subtropical areas with a few in temperate regions (Zomlefer, 1994; Ping-tao *et al.*, 1995; Mukherjee, 2011) [58, 38]. The family contains more of herbs and shrubs rather than trees (Daniel 2009) [8]. Asclepiads can be distinguished from other angiosperms by the presence of milky latex, corona, gynostegium and pollinaria (Shah and Ahmad, 2014) [49]. The family holds many medicinally valuable floras. Due to the elevated market demand, most of the species are endangered, threatened, rare or critically endangered (Shah and Wani, 2016) [50]. Within the family, 'Oxystelma' is a very poorly reported genus. There are twenty one scientific names listed for it in the web portal of 'The Plant List' but only three names have been accepted, i.e., *Oxystelma bornouense* R.Br., *Oxystelma esculentum* (L. f.) Sm. and *Oxystelma esculentum* var. *alpini* (Decne.) N.E. Br. (The Plant List, 2013) [55]. The latter two represents one species and thus the genus confirms only two living species. From India, only *Oxystelma esculentum* (L.f.) R. Br. ex Schult. has been reported so far.

O. esculentum (L. f.) Sm. (Asclepiadaceae) was first collected on 19 August 1854 by Schimper, W., Kew No# 2305, from Ethiopia and kept in the Royal Botanic Gardens (Kew, London, England, UK, K000234398) (Shahzad *et al.*, 2016) [51]. Literature on this plant argued that it is a very rare species in terms of abundance and distribution (Shahzad *et al.*, 2016) [51]. According to the Royal Botanical Gardens, the species is found in South Africa and some areas of China, India, Sri Lanka, Java, and Shimoga.

Correspondence
Muktipada Panda
Department of Botany,
Regional Institute of Education,
Bhubaneswar (RIE-NCERT,
BBSR), Odisha, India

The plant appears beautiful when it flowers (Naskar, 1990)^[29]. Microscopic study of plant organs showed presence of druses of Calcium oxalate crystals in phloem of root, rhizome, stem, petioles and in spongy parenchyma of leaf tissue (Poornima *et al.* 2009)^[39]. This plant has many potential therapeutic uses which are of vital importance in curing the diseases of the modern world like cancer, hepatitis, kidney disorders, stress-related disorders and microbial infections (Pandya and Anand, 2011^a)^[33]. Each plant part is of great importance for their phyto-medicinal properties.

It was noticed that there is lacking of scientific and taxonomical enumeration for the presence of *O. esculentum* (L.f.) Sm from the Odisha state, India and same as for studies carried in the past. Present work reports first time about presence of this species from Balasore district, Odisha. The objective of this study is to report taxonomic reenumeration and its phyto-medicinal valuation through literatures that will help for implementing both in-field and in-vitro conservation of this critically rare species.

Materials and Methods

O. esculentum (L.f.) Sm is a critically rare flora in India. This species had not been reported from coastal Odisha and study lakes detailed taxonomical enumeration. A seasonal based field survey were conducted in different wetland areas of six coastal districts (i.e. Ganjam, Puri, Jagatsinghpur, Kendrapara, Bhadrak and Balasore) of Odisha state from March, 2016 to August, 2018. These areas include major wetland like Chilika lagoon (First Ramsar site of Odisha) and its periphery; Mangrove wetland of Mahanadi delta & Bhitarkanika Willife Sanctuary (2nd Ramsar site); River basin of major rivers (i.e., Mahanadi, Brahmani, Batarani-Subarnarekha, and Budhabalang) and their distributaries of these coastal districts for the verification of existence of the species. But, the plant was only recorded from Balasore district and the collected specimen was identified using available scientific literature and taxonomic keys. The species was assessed for the wide range of attributes which include habitat with GPS tracking, host flora, vegetative and reproductive morphological characters, pollinating insects and seed dispersal mechanism. In-situ photographs were taken using camera Sony α SLT 58Y (DSLR) and herbarium specimens were preserved for references.

Results and Discussions

Present result identified and reports occurrence of *O. esculentum* (L.f.) Sm., only from Balasore district and along the river basin of Subarnarekha out of visited six coastal districts of the state, Odisha. The district spreads with an area of 3806 sq. km and between 87° 22' E to 87° 28' E longitude and 21° 32' to 21° 36' N latitude. The pioneer work on flora of Odisha state by Hains (1921-1925)^[13] has not reported this species from Odisha but reported its presence from Patna (Bihar) on his book 'The Botany of Bihar and Orissa'. Later, Saxena and Brahmam (1994-1996)^[48] by reviewing literature showed its presence from locations like Bhawanipatna, Kalahandi and northern Ganjam of Odisha but no information was available regarding occurrence from coastal Odisha. Das *et al.* (1994)^[9] studied specifically on wetland plants of coastal Odisha but not recorded this species. Their

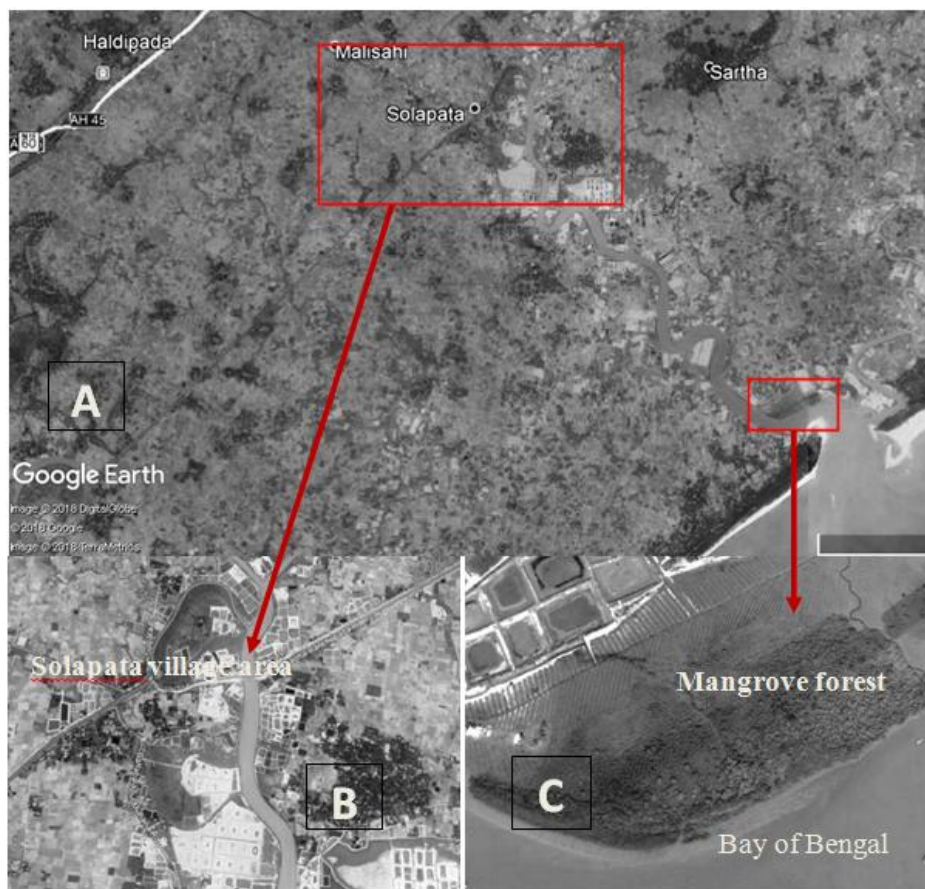
investigations were mostly confined in deltaic areas of river Mahanadi, Brahmani and Baitarani. Recent studies on ethnobotanical and medicinal utility of plants occurring different coastal district of Odisha had not reported existence of this valuable flora (Sahu *et al.*, 2011; Sujana *et al.*, 2015; Mishra *et al.*, 2016; Mohapatra *et al.*, 2018)^[45, 52, 27, 28]. Similarly, Sujana *et al.* (2015) studied diversity and distribution of macrophytes in Balasore district, but they also failed to report its presence. Thus, this is the first time report regarding occurrence this flora from Balasore, a coastal district of Odisha state. The plant has been recorded along the edge of river Subarnarekha and abandoned canals that are in connection with Bay of Bengal near to Kasaphal estuary. The species is a rare one and not equally distributed throughout the district. The plant is a climber and looks very beautiful in the flowering seasons and gives a false appearance like orchid due to its strong showy and peculiar arrangement of flowers in the inflorescence.

Distribution: The plant is worldwide in distribution but more common in coastal countries. Literature showed that it is native to countries like Bangladesh, Cambodia, China (Guangdong, Guangxi, Yunnan), Egypt, Indonesia, Iraq, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand, Viet Nam, NE Africa, SWAsia and India (Lansdown, 2011)^[23]. From India, it has been reported to occur in Gujarat, Maharashtra, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal, Bihar (Patna) and Odisha (Table 1) but these studies lacked a clear taxonomic enumeration. Most of the studies simply listed of its occurrence along with other flora and not emphasized or given any importance towards its valuation and need of any conservation measures.

This particular study found that *O. esculentum* (L.f.) Sm. is rare species and occur in specific abandoned wetlands in coastal locations of Balasore district. It was more common from the roadside canals near from Haldipada road to Kasaphal estuary through Bahalapure (more abundant at Solapata village) (Fig. 1A-B) and rarely on the canal banks flowing from Jamsuli road to Chaumukh through Langaleswar. The habitat experience daily tide water inflow from Bay of Bengal and they are in proximate with mangrove ecosystem of Balasore district (Fig. 1 C). Giesen *et al.* (2006)^[11] for the first time included it as mangrove associate. He described the species as *Oxystelma carnosum* R. Br. which is a synonym of *O. esculentum* (L.f.) Sm. It has been reported to be a mangal associate flora of Southeast Asia (Malaysia, the Philippines, Indonesia and Papua New Guinea) to northern Australia (Giesen *et al.*, 2006)^[11]. Till date, there is no report on occurrence of this plant from any Indian mangals. Thus, for the first time we are including, *O. esculentum* (L.f.) Sm as both a mangrove associate and a normal wetland species. So, Indian mangals now hosts nine species of family Asclepiadaceae as mangrove associates. These species are *Finlaysonia obovata* Wall., *Hoya parasitica* (Roxb.) Wall, *Pentotropis capensis* (L.f.) Bullock, *Sarcobolobus carinatus* Wall., *Sarcobolobus globosus* Wall., *Tylophora fleuxosa* R. Br., *Tylophora indica* (Burm. f.) Merr., *Tylophora tenuis* Blume (Panda *et al.*, 2017)^[32] and *Oxystelma esculentum* (L.f.) Sm (This study).

Table 1: Recent report showing occurrence or uses from India

State	Location	References
Uttar Pradesh	Katerniaghat Wildlife Sanctuary	Kumar <i>et al.</i> , 2015
Maharashtra	Satpuda Range (Khandesh)	Khan and Firdousi, 2015
Gujrat	Barda Hills near Porbandar	Pandya and Anand, 2011 ^d
Tamilnadu	Pudukkottai Narthamalai Hillock	Anandhan and Narayanaswamy, 2011
	Kanyakumari District	Uma and Parthipan, 2015
	Western Ghats	Sarvalingam and Rajendran, 2016
Rajasthan	Kota District	Joshi, 2018
Uttarakhand		Rawat, 2014
West Bengal	Sagar Islands	Naskar, 1990
Bihar	Patna	Hains, 1921-1925
Assam	Subansiri river basin	Buragohain, 2011
Andhra Pradesh	Eastern ghats (Vizianagaram district)	Parijatham, 2016
Odisha	Unknown	Kirtikar and Basu, 1975
	No confirmatory location	Saxena and Brahmam, 1994-1996
	Baghiapada (Boudh district)	Sahu <i>et al.</i> , 2013
	Barkul (Khurda district)	Kar <i>et al.</i> , 2016

**Fig 1:** Existing location the species and its nearby mangrove forest, Balasore, Odisha

Taxonomic key of family Asclepiadaceae (or Subfamily: Asclepiadoideae) and of genus Oxystelma

Key to family Asclepiadaceae: Corolla lobes 5; Pollen in waxy sub-pellucid mass (pollinia); Filaments connate into a tube; Fruit follicular, dehiscent ventrally.

Key to distinguish genus Oxystelma (bolded) from others of family, Asclepiadaceae (Odisha, India)

I. Filaments free. Pollinia granular, 2 in each cell:-

- A. Corona coralline. Twiners: (*Hemidesmus*, *Cryptolepis*, *Cryptostegia*, *Streptocaulon*)
 B. Corona stamina. Prostrate herb: (*Streptocaulon*)

II. Filaments connate into a tube. Pollinia waxy, 1 in each cell:-

A. Anthers with a membranous tip. Pollinia often pedicelled

1. Pollinia pendulous from the corpuscle:-

- a. Erect, leafy: (*Calotropis*, *Asclepias*)
 b. Twiners, or suberect or erect and leafless

i. Corona double. Flowers large

Twiners, Leaf narrow, deciduous. Corolla large. Follicles smooth (*Oxystelma*)

Leaf broad. Inner corona with long appendages. Follicles echinate (*Pergularia*)

- ii. Corona single, staminal, processes discrete: (*Raphistemma*, *Pentatropis*)
- iii. Corona single, staminal, processes united into a lobed or toothed ring or cup: (*Holostemma*, *Cynanchum*, *Sarcostemma*)

2. Pollinia erect on the corpuscle (rarely horizontal or pendulus)

a. Corolla lobes overlapping: (*Sarcolobus*, *Gymnema*, *Telosma*, *Macradenia*, *Dregea*, *Tylophora*)

b. Climbing or epiphytic with fleshy leaves, Corolla valvate. Corona stellately spreading: (*Hoya*)

B. Twining or erect, Corona single or double, Corolla valvate, Anthers without a membranous tip. Pollinia sessile or subsessile (*Leptadenia*, *Ceropegia*, *Boucerosia*).

Taxonomic description of *Oxystelma esculentum* (L.f.) Sm.

The plant is a climber (Plate 1. A; Plate 2. A-D), perennial, grow upto 6 m height (but strongly depends on the type of host species), glabrous except flowers. Roots fibrous emerge from lower node of the stem. Leaves opposite, present at nodes (Plate 1. B), nodal distance 8-14 cm, stem 0.2-1.0 cm in diameter; petiolate, petiole 0.5-1.5 cm long; leaf blade linear or linear lanceolate, 6 - 11 × 0.7 - 2 cm, apex acute, base rounded, lateral veins 9 - 12 pairs, united in intra-marginal loops (Plate 1. C-F). Inflorescences longer than leaves, 5-8 flowered (generally 6), sub-umbellate or racemiform cymes (Plate 1. I). Flower buds 8 - 9 mm, peduncle upto 10 cm long, pedicels are 1-1.5 cm, bracteate and bracts are small (Plate 1. G-I). Flowers actinomorphic, bisexual, hypogynous, pentamerous. Calyx 5-lobed, connate and 3.5 × 1 mm, sepals 5, polysepalous, ovate to lanceolate, acute, sapaloid or slightly pink, imbricate aestivation (Plate 1. G). Corolla is whitish on outer side but purple inside (many purple veins or blotches are on the inner side), 2 - 3 cm in diameter, limb 1.5 - 2 cm; lobes triangular, 1.0 - 1.5 cm, densely hairy near margin, gamopetalous and valvate aestivation (Plate 1. D). Stamens 5, epipetalous, covered with protective layer which is white or slightly brownish, 1.0 - 1.2 cm (Plate 1. H-I). Corona 2 seriate, staminal, outer copular, inner 5-lobed, acuminate, free, filaments connate, anthers bilobed, pollinia pendulous, 1.3-1.8 mm, one in each cell. Carpels 2, bilocular, syncarpous, ovary superior, stigma convex, style short, greenish. Fruit are upto 5 cm long, seeds follicles, small and many, seed coat smooth but numerous white hairs present which help in wind seed dispersal (Plate 1. L-N).

Spot identification: A herbaceous twinner (climber) with milky latex; leaves opposite and arise at internodes, sharply pointed leaf tip; purple veined (inner side) flowers, petal tips are pointed and hairy; pollinia present; fruit follicle; from distance the flowering plant gives a false appearance like orchids.

Phenology and Ecology: The plant is commonly called as an amphibious climber. It grows in marshy areas, on the margins of open water in swamps, ponds and lakes, often rooting in the water and scrambling over emergent vegetation (Lansdown, 2011) [23]. Habitat study showed it occurs in the plains and lower hills of India, including paddy fields and hedges near semi-marshy places (Khare, 2007) [20]. In the riverbank riparian corridor (terrestrial habitat), the plant used to climb on two amphibians plants namely *Tamarix diocia* and *Ipomoeia carnea* which are abundant in the river bank (Buragohain, 2011) [7]. This study recorded occurrence of the species along the river and canal banks of Subarnarekha river basin of coastal district Balasore (Odisha, India). Locally, the plant is known by its vernacular name as Dudhialata and Jala dudhi. The host plants were a few and they were *Ipomoea carnea* Jacq. (most cases), *Ludwigia octovalvis* (Jacq.) Raven, *Ficus hispida* Linn.f. (Vernacular name: Dimiri), *Vitex negundo* Linn. (Vernacular name: Begunia or Nirgundi), *Clerodendrum inermi* (Linn.) Gaertn. (Vernacular name: Guhia, Nutunga) and *Sesbania bispinosa* (Jacq.) W.F. Wight (Plate 2. A-E). The habitat where the plant has been recorded was found as experience ingressions of tidal water of Bay of Bengal and near to mangrove patch of the district. Flowering occurs for a long period of from August to November. Pollination mainly by insects (bees, ants, wasp) (Plate 1. K). Fruiting occurs from October - December. Explosive seed dispersal is another unique feature of this species. Few understory and associate herbs were recorded which frequently occur along with *O. esculentum* (L.f.) Sm. These species are like, *Polygonum pulchrum* Blume, *Polygonum hydropiper* Linn., *Lindernia* spp., *Calotropis gigantea* R.Br., *Ludwigia* spp., *Rotala indica* (Will.) Koehne, *Aeschynomene aspera* Linn., *Aeschynomene indica* Linn. and *Sida* spp. etc. Systematic position (Hassler, 2018) [15]: Kingdom: Plantae; Phylum: Tracheophyta; Class: Magnoliopsida; Order: Gentianales; Family: Apocyanaceae; Genus: Oxystelma.

Species uncertainty of genus *Oxystelma*: The genus 'Oxystelma' holds only two live species (i. e., *Oxystelma esculentum* (L. fil.) Smith. and *Oxystelma bornouense* R.Br.). *O. esculentum* (L. fil.) Smith. has wide distribution and commonly found in Indian subcontinents. The other one, *O. bornouense* R.Br. is strictly confined to African habitat. Recently it had been recorded from the Arly National Park, Tapoa, Burkina Faso (West Africa) and the Djoudj National Park (Senegal) (Ouédraogo *et al.*, 2011; Ngom *et al.*, 2012) [31, 30]. The later one is a critically rare and a restricted species which also lacking strong taxonomic evidence to differentiate it from the former one (Table 2). Geographical isolation may be the reason for evolution into two species.



Plate 1: Morphometric and floral characters of *O. esculentum*

Note: (A) A flowering twig showing climber form; (B) Opposite leaves with prominent petiole at stem node; (C-D) linear leaf showing acute apex, venation with intra-marginal loops (E-F) stem modified to help climbing habit without any modification; (G-H) un opened and opened flower bud with

sepals; petals (I-J) purpled united petals from inside and having pollinia; (K) Was visitation to flower; (L) follicular fruit; (M) un-ripened fruit with haire; (N) ripened fruit with white hairs for seed dispersal



Plate 2: Recorded few host plant species of *O. esculentum* on which it climb

Note: (A) *Ficus hispida* Linn.f.; (B) *Vitex negundo* Linn.; (C) *Ipomoea* spp. & *Vitex negundo* Linn.; (D-E) *Ipomoea carnea* Jacq

Synonyms: The species has been variously named and described throughout the globe and consists of more than twenty vernacular names which are as follows:-

Oxystelma esculentum (L.f.) Smith; *Oxystelma alpini* Decne.; *Oxystelma bifidum* Llanos; *Oxystelma carnosum* R. Br.; *Oxystelma caudatum* Buch.-Ham. ex Wall.; *Oxystelma esculentum* var. *alpini* (Decne.) N.E. Br.; *Oxystelma esculentum* var. *wallichii* (Wight) T. Cooke; *Oxystelma gilliesii* (Hook. & Arn.) K. Schum.; *Oxystelma hooperianum* Blume; *Oxystelma ovatum* P.T. Li & S.Z. Huang; *Oxystelma*

pulchellum (Roxb.) D. Dietr.; *Oxystelma secamone* (L.) H. Karst. var. *wallichii* (Wight) M.A. Rahman & Wilcock; *Oxystelma secamone* K.Schum.; *Oxystelma secamone* H.Karst.; *Oxystelma senegalense* Decne.; *Oxystelma solanoides* (Kunth) K. Schum.; *Oxystelma vailiae* Rusby; *Oxystelma violacea* (Phil.) K. Schum.; *Oxystelma wallichii* Wight; *Oxystelma zippelianum* Blume; *Periploca esculentum* L.f.; *Sarcostemma esculentum* (L.f.) R.W. Holm; *Asclepias rosea* Roxburgh, nom. illeg.; *Asclepias rosea* Kunth (The Plant List 2013; Hassler 2018) ^[55, 15].

Table 2: Comparison between two species of 'Oxystelma' showing data of more similarity

Sl.	Character	<i>Oxystelma esculentum</i> (L. fil.) Smith.	<i>Oxystelma bornouense</i> R.Br.
1	In literature	Common studied species	Rarely studied, data lacking
2	Habitat	River and canal bank, Plants of family Convolvulaceae are commonly host species	River bank and open place
3	Identification	Twiner with white flowers outside & pink from inside	Twiner with white flowers
4	Propagation	Seed	Seed
5	Synonym	≥20	<i>Oxystelma senegalense</i> Decne. fide Fl.
6	Uses	Medicinal	Medicinal
7	Distribution	Australia, Ethiopia, Chad, Sudan, Tanzania, China, Bangladesh, Cambodia, India, Indonesia, Laos, peninsular Malaysia, Nepal, Pakistan, Sri Lanka, Thailand, Vietnam, Java, Egypt, Iraq, Israel, Saudi Arabia, Sinai peninsula, Myanmar	Guinea, Chad, Ethiopia, Kenya, South Sudan, Somalia, Guinea-Bissau, Cameroon, Burkina Faso, Ivory Coast, Mali, Senegal, Benin, Togo.
8	References	Hains, 1921-1925; Albers and Meve, 2004; Giesen <i>et al.</i> , 2006; Khare, 2007; Lansdown, 2011; The Plant List, 2013; Savitha and Balamurugan, 2014; Flowers of India, 2016; Hassler, 2018	The Plant List, 2013; Gnoumou <i>et al.</i> , 2015; West African Plants: a photo guide (Accessed on 8 th Nov. 2018); The Herbarium Catalogue, Royal Botanic Gardens, Kew (Accessed on 9 th Nov 2018)

Phyto-medicinal properties and uses

India has 2.4% of world's area, holds 8% of global biodiversity which includes over 45,000 plant species (Shah and Wani, 2016) ^[50]. The traditional healers use 2500 plant species as medicine for basic preventive and curative healthcare since time immemorial (Boomibalagan *et al.*, 2013) ^[6]. In Asclepiadaceae, the leaves are the most important part use for herbal preparations followed by whole plant, root, stem, latex, tuber and seed (Boomibalagan *et al.*, 2013) ^[6]. The review of literature showed *Oxystelma esculentum* (L. f.) Sm is medicinally valuable and a phytochemically rich flora. The roots, leaves and fruits are known to be eaten by poor people in famine times (Lansdown, 2011) ^[23]. The roots are used ethnomedicinally by the tribes of Orissa in India in throat infections, skin diseases and also in the treatment of hepatitis (Kirtikar and Basu, 1975) ^[21]. Entire plant is edible; decoction is used as gargle in aphthous ulcerations of mouth, stomatitis, sore throat and itches; paste of plant applied in skin diseases; anti-periodic, cancer, menoxenia, and traumatic injury; antiseptic, depurative, galactagogue (Naskar, 1990; Khare, 2007; Quattrocchi, 2012; Boomibalagan *et al.*, 2013) ^[29, 20, 40, 6]. Roots are used in jaundice (Naskar, 1990; Li *et al.*, 1994; Khare, 2007; Lansdown, 2011; Marwat *et al.*, 2012; Quattrocchi, 2012; Parijatham, 2016) ^[29, 24, 20, 23, 26, 40, 37]. Latex has vulnerary properties (Khare, 2007) ^[20] antiseptic (Quattrocchi, 2012) ^[40]. It was found that juice of fruits is used in muscle pain, cough and leucoderma and in gonorrhoea; leaf juice in jaundice.

Trivedi *et al.* (1990) ^[56] isolated a novel pregnane triglycoside, named esculentin from *O. esculentum* and characterized as sarcogenin-3-*O*- β -D-thevetopyranosyl (1 \rightarrow 4)-*O*- β -D-cymaropyranosyl (1 \rightarrow 4)-*O*- β -D-oleandropyranoside (molecular formula: C₄₂H₆₈O₁₇; molecular weight: 844; M.P.: 118-120 °C). Hamed *et al.* (2004) ^[14] isolated three new polyhydroxypregnane glycosides from the leaves. A pregnane ester oligoglycoside (oxysine), a pregnane triglycoside (esculentin), a cardenolide (oxyline), two more

cardenolides, oxystelmoside and oxystelmine, have been isolated from the roots (Khare, 2007) ^[20]. Poornima *et al.* (2009) ^[39] reported occurrence of secondary metabolites like tannins, flavonoids, terpenoids, cardiac glycosides and alkaloids. Ashok Kumar *et al.* (2010) ^[5] suggested that the methanol extract had significant inhibition in lipid peroxidation and possesses good antimicrobial activity. It is one of the few plants to contain cardenolides and pregnane glycosides, which are easily obtained from this plant and can act as precursors of many therapeutically important compounds (Pandya and Anand, 2011^a) ^[33]. The phytochemical petroleum ether extract revealed presence of important classes of bioactive compounds like cardenolides, flavonoides, phenolics, sterols and triterpenoides (Pandya and Anand, 2011^c) ^[35]. Presence of ten different types of secondary metabolites such as alkaloids, anthraquinones, catechins, flavonoids, glycosides, phenolic groups, reducing sugars, saponins, tannins and terpenoids were reported in the various solvent extracts (John Peter Paul *et al.*, 2017) ^[16]. The anti-ulcer property of this plant has been proved by Pandya and Anand (2011^b) ^[34]. They found the petroleum ether extract had the most effective anti-ulcer activity. Savitha and Balamurugan (2016) ^[47] had shown potential antimicrobial activity from the methanol leaf extracts.

Conservative prospective: The quantitative evaluation is lacking and study is needed for evaluation species abundance and its trend. Anandhan and Narayanaswamy (2011) ^[2] and Zoq-ul-Arfeen *et al.* (2015) ^[59] had reported rare distribution of this species from Tamilnadu (India) and Pakistan, respectively. The habitat of this species is threatened by drainage conversion to agriculture and development; it is unlikely to become extinct in the short term (Lansdown, 2011) ^[23]. Due to the elevated market demand of the medicinal plants belonging to family Asclepiadaceae, most of the species are endangered, threatened, rare or critically endangered (Shah and Wani, 2016) ^[50]. The species of the

family are also exploited locally due to their high medicinal value and other ethnobotanical properties (Shah and Wani, 2016) [50]. The habitats in which it occurs are often threatened by drainage, conversion to agriculture and development; it is unlikely to become extinct in the short term (Lansdown, 2011) [23]. Dharmendra *et al.* (2010) [10] worked out on callogenetic propagation route via adventitious shoot development in *O. secamone*, which could be useful for large scale multiplication of this medicinal plant.

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