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Pest and pollinator diversity in *Momordica cymbalaria* Hook (Fenzl.)

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Abstract
Momordica cymbalaria (Fam.: Cucurbitaceae) vernacularly called as Athalakai in Tamil is an under-utilized, non-cultivated, season-bound vegetable harvested from wild sources. The plant is confined to Virudhunagar district and parts of Tirunelveli, Tenkasi, Thoothukudi, Madurai, and Theni districts of Tamil Nadu and a few parts of Karnataka, Andhra Pradesh, and Telangana. However, Tamil Nadu holds more than 65 percent of the area. The plant prefers well-drained black and red soil with an annual rainfall of at least 5 cm. A good rainfall followed by a dry climate is favourable. Hadda beetle, cotton aphid, and cucurbit fruit fly are the major pests and Yellow Mosaic Vir us is found to be the important disease which is carried to subsequent seasons through infected tubers. Interestingly, scorpion nymphs are found to co-exist in large numbers on the tubers in the fields which might be due to the presence of an attractant chemical. Solitary bees such as Lassioglossum sp. and Amegilla sp. are the major pollinators. The plant is so unexplored and is not given the position of a crop as it is not cultivated. As the plant is in the vague of extinction, researchers need to carry out studies aiming to improve seed viability, enhancing tuber germination and multiplication, developing crop cultivation protocol, and improving fruit shelf-life.

Keywords: distribution, *Momordica cymbalaria*, plant protection, pollinator ecology, scope for exploitation, topography

Introduction
Momordica cymbalaria (Fam.: Cucurbitaceae) is an under-utilized, non-cultivated, season-bound, vegetable harvested from wild sources. It is vernacularly called as *Athalakai* (Tamil), *Kasarakaee* or *Kasarakaya* or *Kasarakai* (Telugu), *Karchikai* (Kannada) and *Kadavanchi* (Marathi) (Rekha, 2015) [7]. Fruits are mainly used for culinary purposes (Parwathi and Kumar, 2002) [3]. The plant possess antioxidant (Prashanth *et al.* 2013) [4], anti-diabetic and hypolipidemic (Rao *et al.* 1999; Koneri *et al.* 2006) [6] anti-helminthic, anti-microbial (Ramnath and Kumar, 2012) [5] and wound healing properties (Kolluru *et al.* 2016) [2]. Tubers and leaf decoction are widely used in traditional medicinal preparations. Fruits have abortifacient properties. Although attention has been given on the pharmacological aspects of the plant, no published work has been done so far on the production, protection, and pollination biology.

Botanical Description and Distribution
It is a creeper-climber capable of spreading on the ground (from 1.5 m to 3 m) and climbing using tendrils when provided with supporting structures (Fig. 1). Leaves are glabrous, leathery, dark green, and reniform possessing five to seven lobes in a deep cordate base and a spine like structure at the margin where the veins meet up. The petiole length varies from 50 to 75 mm. Flowers are pale yellow, monoecious, and pentamerous. Flowering happens usually 30 days after shoot emergence. Male flowers (Fig. 2) borne on simple stalks emerge first, and female flowers (Fig. 3) with miniature fruit-like swellings at the base follow two weeks later. The peduncle length of male and female flowers ranges from 15 to 43 mm and 25 to 50 mm respectively. The male and female flowers start blooming at 0900 and 0930 hours and reach full bloom at 0930 and 0945 hours respectively. The flowers close in the evening from 1730 to 1800 hours. Peak flowering occurs during October.

Fruits (Fig. 4) are ribbed, pyriform, grow to a length of 20 to 30 mm, and possess eight sharp ridges attenuated at the apex and the base. 0.5 to 1 mm thick pericarp holds fibrous pulp and seeds. The fruits are found singly all over the vein where a leaf, tendril, and flower emerge on the same node. Fruit on full maturity burst out (Fig. 5) expelling three to eight, small (4.6 mm), ovoid, smooth, and shiny seeds. 40 to 75 percent of seeds lack endosperm, a major reason for their non-viability. The seeds (Fig. 6) with shiny brownish black seed coat possess endosperm and those with creamy white seed coat do not possess endosperm or possess partially filled endosperm. Fruits are harvested mainly from November to January. The plant also flowers during May and fruits are available during June - July.

The plant is confined to Virudhunagar district and parts of Tirunelveli, Tenkasi, Thoothukudi, Madurai, and Theni districts of Tamil Nadu and parts of Bengaluru district of Karnataka (Ramnath and Kumar, 2012) [5], Chitoor district of Andhra Pradesh, Anantapur and Kurnool districts of Telengana (Srinivasalu *et al.* 2017) [8], and few parts of Maharashtra and Madhya Pradesh. However, Tamil Nadu holds more than 65 per cent of the area under the plant (Fig. 7).

Table 1: Systematic position of *M. cymbalaria*

Kingdom	Plantae
Super-division	Spermatophyta (Seed Plants)
Division	Magnoliophyta (Flowering plants)
Class	Magnoliopsida (Dicotyledons)
Order	Cucurbitales
Family	Cucurbitaceae (Cucumber family)
Sub-Family	Cucurbitoideae
Tribe	Jolifficae
Genus	*Momordica*
Species	*cymbalaria* Hook (Fenzl.)

Fig 1: *Momordica cymbalaria* plant

Fig 2: Male flower

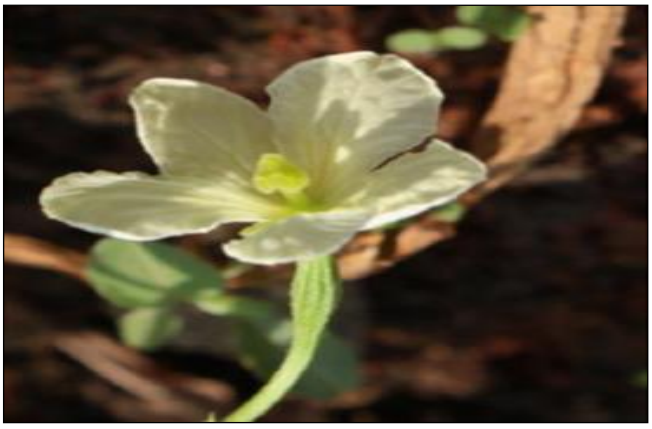

Fig 3: Female flower

Fig 4: Fruits

Fig 5: Fruits bursting out

Fig 6: Seeds

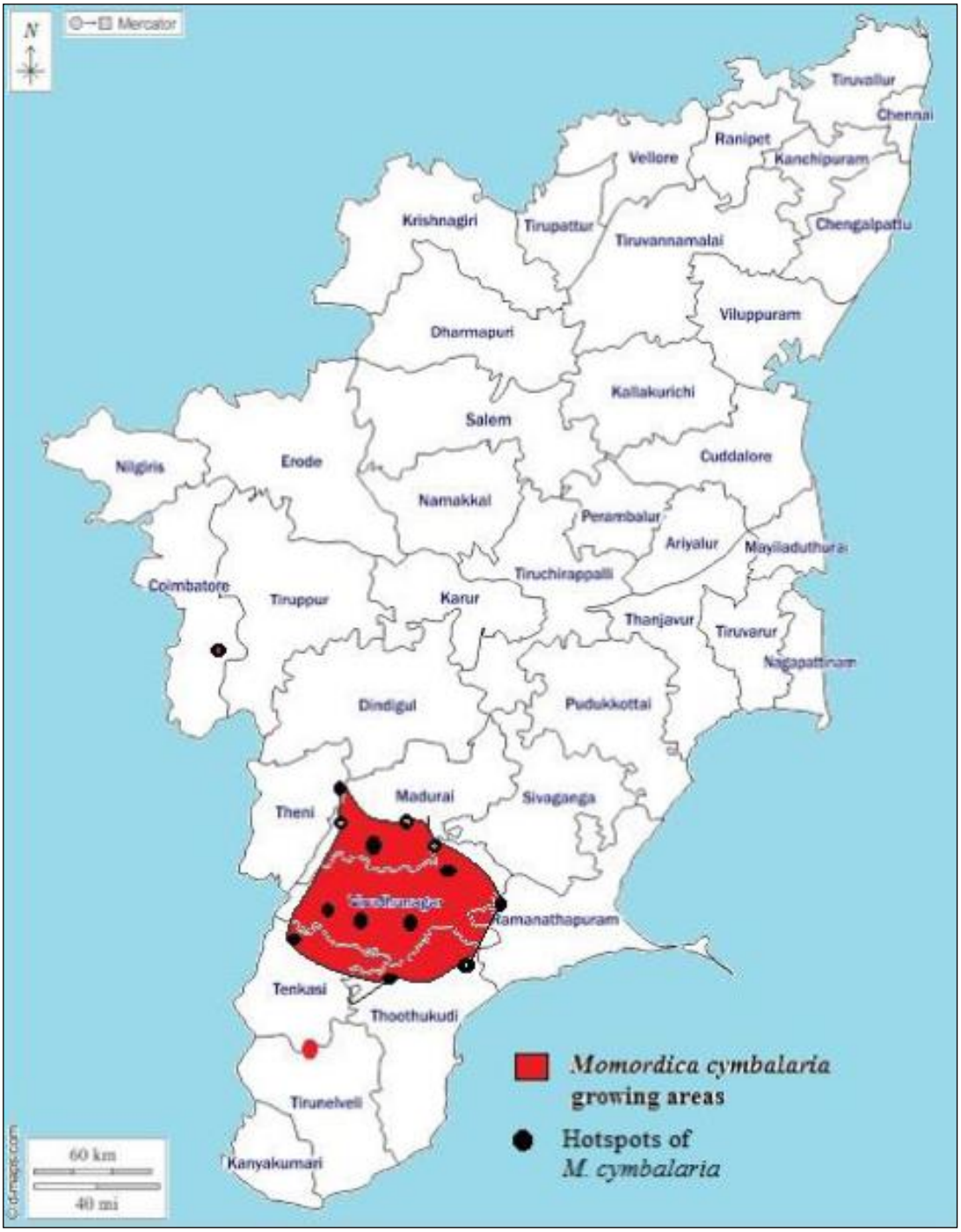

Fig 7: Map of *M. cymbalaria* growing areas in Tamil Nadu

Crop Husbandry

Propagation

Unlike other cucurbits the plant is propagated through tubers (Fig. 8), which live in soil for up to 30 years. The tuber weighs 100 g on an average and ranges from 3 to 265 grams with a size of 2.5 cm x 3 to 8 cm x 10 cm. It stores enough water and germinates with the onset of the rain.

Fig 8: Tubers

Topography and Climate

The plant prefers well-drained black and red soil. Annual rainfall of at least 5 cm is required. A good rainfall followed by a dry climate is favourable. Its growth varies with topography. Germination of the tubers is good under dry, arid conditions. It also germinates under extreme cold conditions in high altitudes.

No specific crop management practice is followed. However, clipping of more than two climbers is followed.

Plant Protection

As *M. cymbalaria* grows in the dry belts - Southern districts of Tamil Nadu, where rainfed pulses and millets are predominant crops, pests and diseases attacking pulses tend to attack *M. cymbalaria*.

Hadda beetle (Fig. 9) a major pest of cucurbitaceous plants is found to attack the leaves severely. Cotton aphid (Fig. 10) is found to occur on veins and suck the sap. Eight to ten fruit flies (Fig. 11) larvae were found per fruit. Fruit fly infestation makes the fruits unpalatable, and invites bacteria and other saprophytic organisms, severely affecting the marketability. Black gram Yellow Mosaic Virus (Fig. 12) vectored by aphids is found to be an important disease and is carried to subsequent seasons through infected tubers.

Spiders were found waiting on the underside of the leaves for preying on floral visitors. Nymphs of a hemipteran bug, *Probergrothius sanguinolens* was also found associated with the plants. These nymphs are reported to prefer dead materials to seeds.

Interestingly, scorpion nymphs are found to co-exist in large numbers on the tubers in the fields. The possible reason might be the presence of an attractant chemical.

Table 2: List of arthropods associated with *M. cymbalaria*

S. No.	Common Name	Scientific Name	Role in the Ecosystem
1.	Epilachna beetle	*Henosepilachna septima* Dieke	Pest
2.	Fruit fly	*Bactrocera cucurbitae* Coquillett	Pest
3.	Aphids	*Aphis gossypii* Glover	Pest
4.	Spiders	*Oxyopes javanus* Latreille	Predator
5.	Bug	*Probergrothius sanguinolens* Amyot & Serville	Saprophyte
6.	Scorpion	-	Not known
7.	Indian bee	*Apis cerana indica* Fab.	Flower visitor/ Pollinator
8.	Little bee	*Apis florea* Fab.	Flower visitor/ Pollinator
9.	Stingless bee	*Trigona* sp.	Flower visitor/ Pollinator
10.	Sweat bee	*Lasioglossum* sp.	Flower visitor/ Pollinator
11.	Blue banded bee	*Amegilla zonata* Linn.	Flower visitor/ Pollinator
12.	Yellow sweat bee	*Nomia* sp.	Flower visitor/ Pollinator
13.	Blue banded bee	*Amegilla cingulata* Fab.	Flower visitor/ Pollinator
14.	Sweat bee	*Colletes* sp.	Flower visitor/ Pollinator
15..	Sweat bee	*Andrenia* sp.	Flower visitor/ Pollinator
16.	Ctenoplectid bee	*Ctenoplectra* sp.	Flower visitor/ Pollinator
17.	Sweat bee	*Halictus* sp.	Flower visitor/ Pollinator
18.	Leaf cutter bee	*Megachile* sp.	Flower visitor/ Pollinator
19.	Cuckoo wasp	*Chrysis smaragdula* Lepeletier & Serville	Flower visitor/ Pollinator
20.	House fly	*Musca* sp.	Flower visitor/ Pollinator
21.	Blow fly	*Caliophorid* sp.	Flower visitor/ Pollinator
22.	Gnat	*Lophodiplosis trifida* Gagne	Flower visitor/ Pollinator
23.	Red ant	*Dorymyrmex* sp.	Flower visitor/ Pollinator
24.	Stripped ant	*Technomymex albipes* Smith	Flower visitor/ Pollinator
25.	Trap ant	*Monomorium minimum* Buckley	Flower visitor/ Pollinator
26.	Black ant	*Camponotus pensylvanicus* De Geer	Flower visitor/ Pollinator

Fig 9: Hadda Beetle in *M. cymbalaria*

Fig 10: Aphis gossypit

Fig 11: Fruit fly larvae in *M. cymbalaria*

Fig 12: Yellow Mosaic Virus in *M. cymbalaria*

Harvesting and Post-harvest care

Each plant yields approximately one and a half kilograms of fruits and are picked by hand when matured. Collection of fruits is a tedious job, and a maximum of three kg can be picked per day. The fruits can be stored under ventilated conditions for two days at room temperature. Poor ventilation will lead to fungal growth and a foul smell, making fruit unfit for consumption. However, its shelf life can be increased to seven days under refrigerated conditions. The fruits harvested during September-November exhibit extreme bitterness than those harvested during June – July months.

Pollinator ecology

The flowers are visited by a wide range of insect pollinators (Fig. 13 & 14). Insects belonging to Hymenoptera, Diptera, Hemiptera, and Coleoptera orders have been recorded to provide pollination services to *M. cymbalaria*. However, hymenopteran pollinators play a predominant role. Among them, solitary bees such as *Lassioglossum* sp. and *Amegilla* sp. are the major pollinators. Social bees do not tend to visit, as they usually prefer pulse crops, the predominant one in the ecosystem. If the plant is cultivated on a commercial scale, there are chances that social bees overtake the solitary bees. Being a weed plant, the pollinator range falls in line with the pollinators of the crop ecosystem where it grows.

Pollinators start foraging once the flowers start blooming and the peak foraging activity is from 0900 to 1200 hours. After that, a fallback in the activity of bees was recorded. The flowers close at 1800 hours and the pollinators' visit continued till 1730 to 1830 hours. Ants are permanent visitors from 0900 to 1830 hours. Few social bees like *Apis florea* and *Trigona* sp. were found to visit the flowers till 1600 hours. Pollinator identification was supplemented by theses from Agricultural College and Research Institute, TNAU, Madurai (Yogapriya, 2019) [9] and Anbil Dharmalingam Agricultural College and Research Institute, TNAU, Trichy (Anandhabhairavi, 2017) [1].

Fig 13: Nomia sp. in *M. cymbalaria*

Fig 14: Lassioglossum sp. in *M. cymbalaria*

Commercial value and scope for exploitation

People (including farmers) of other districts than the ones where it is distributed are unaware of the plant and its uses. However, in its area of natural distribution, the plant is allowed to grow amidst cropped areas for fruits. Although not commercially cultivated, the fruits fetch a maximum of Rs. 240 per Kg in the Madurai district and fetch Rs. 120 to Rs. 165 per Kg in the Virudhunagar district where it is available in plenty.

The plant is so unexplored and is not given the status of a crop as it is not cultivated. As the plant is in the vague of extinction, researchers need to carry out studies aiming to improve seed viability, enhance tuber germination and multiplication, develop crop cultivation protocol, and improve fruit shelf-life. Such concerted research efforts may transform the plant into a crop and lead to its commercial exploitation.

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