

Reproductive ecology of *leucas aspera* (wild) link (Lamiaceae)

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ABSTRACT

Leucas aspera is commonly known as Thummi chettu. The plants flower once in a year during September – February. The flowers are white sessile small zygomorphic, bilabiate, gullet shaped produced in verticils of terminal or axillary whorls and oriented horizontally to the axis. The flowers open each day during 6.00-7.30 hours. The open flowers are abundantly visited by honey bees, ants and butterflies for pollen and/ or nectar. The honey bees *Apis florea*, *A.C indica*, the digger bee *Amegilla sp.* *Megachile sp.* *Anthophora zonata* are the principal pollinators. During foraging visits of bees gains contact by their notaeum with essential organs and thus promote nototribic pollination. The small bodied *Trigona*, *Ceratina*, *Apis florea* collected pollen sternotribically.

Key words: *Leucas aspera*, *Amegilla sp.* *Apis floreae*, *A.C indica*, *Megachile sp.* Noto tribic, Sternotribic.

INTRODUCTION

Lamiaceae, known as mint family, comprising ca.210 genera and 3500 species is cosmopolitan in distribution abundant in Mediterranean. The lower lip or labia is characteristic and responsible for conserved family name, labiates. The family is represented in India by 64 genera and 350 species.

Different modes of pollination are correlated with complex syndromes of floral features. The functional aspects of these features related to the plant family Lamiaceae have been reviewed and discussed by Vander pijil. The available pollination literature of the family documents that different genera and different species with in a particular genus radiated with regard to their pollination relationships. *Leucas aspera* is an annual weed and is commonly known as the Thumbai. It is almost distributed throughout India. During growing seasons, it adds considerable biomass to the soil. The paper describes the breeding and pollination mechanisms of *Leucas aspera* in relation to its weed status.

MATERIALS AND METHODS

Leucas aspera occurs in waste lands, agricultural fields and road sides in Addanki, Prakasam Dt .Andhra Pradesh. The studies were carried out in 2012-13 through systematic and regular visits to three sites, the flowering of three different populations were recorded. Flower production on a daily basis was recorded on 25 randomly selected inflorescences. The time of daily anthesis and anther dehiscence in relation to prevailing weather were also recorded. Pollen number per anther was determined from 10 flowers distributed over different plants. Pollen-ovule ratio was

computed after Cruden (1977). The sugars in the nectar were differentiated by paper chromatography (Harborne 1973). The presence of amino acids and proteins in nectar was demonstrated as described by Baker and Baker (1973). Hand pollinations were used to ascertain the prevalent mode(s) of reproduction. Also tests through emasculation were performed for apomixes. Five hundred flowers were observed for fruit development after their natural pollination, and the resulting fruit set, seed set and fecundity were calculated following Cruden (1976).

RESULTS AND DISCUSSION

Flowering phenology: *Leucas aspera* plants show up during September – February, grow vegetatively for a month, then flower for three months; sometimes even up to mid March provided the soil is sufficiently wet. A plant flowers for an average period of 70 days (Range 60-110). Average number of flowers produced per day in one plant is 67 (R31 -128) during flowering season and flowers produced per plant in a one flowering season is 1569 (Range 545-2,572).

Inflorescence phenology: In *Leucas aspera*, the verticillate inflorescence lasts for 16- 30 days, producing an average 53 (range 20-112) flowers. Each day the number of newly opened flowers of an inflorescence varies from 1-6 flowers (average 3 flowers). Flower production ceases in February /March then the plants starts to dry up and wither.

Verticells produced at each node: 80 % of the nodes consist of one verticel, 9.3 % of the nodes consist of set of two verticells without spacing, 9.6% of the nodes consist of set of two verticells with a distance of 5-10 cm and 0.2% of nodes consist of three verticells.

Flower morphology: The flowers white, sessile small, produced in verticils of terminal or axillary whorals and oriented horizontally to the axis. Flowers 20 mm long, gullet shaped. Calyx is green, tubular 8-12 mm; tube curved. Corolla is 13- 18 mm long, tube 5mm long and pubescent above, annulate in the middle. Upper lip 5 mm long, densely white wooly, the lower lip is broader, obviates, and rounded. The stamens are epipetalous, didynamous and almost appressed to the inner surface of the upper corolla lip. The ovary is superior, bicarpellary, syncarpous and tetralocular with four ovules. The style is gynobasic with a bifid stigma.

Anther dehiscence and anthesis: Flowers open each day during 600- 7.30 hours with a peak at 6.30 hours. Anthers dehisce by longitudinal slits in the bud stage about 30 minutes before anthesis. In association with a temperature range of 19- 25 °C and RH 70- 85 %.

Pollen characters: Pollen grains are oval / spheroidal, white in colour, powdery, tricolpate with a smooth exile. The size of the grain is 16.6 μm -24.9 μm . Output of grains per anther 1572 \pm 150 (n=10) and the pollen ovule ratio is approximated to 1179 pollen output per flower 4716.

Flower life time: The stigma attains receptivity soon after anthesis and remains receptive for 30 hours. Thereafter, within 2-3 hours, the corolla, stamens and stigma drop off. The pollen grains remain viable for 48 hours after anther dehiscence.

Breeding behaviour: The results of breeding tests show that the plant is not apomitic, but reproduces through xenogamy, geitonogamy and autogamy; the first mode being most fruitful (Table-4).

Natural fruiting: The natural fruiting varies from 60-71 % (Average 64 %). 40 % of fruits contain 4seeds, 12.6% of the fruits have 3 seeds, 9.1% of the fruits have 2 seeds, 3% of the fruits have only one seed and 36% of fruits have no seed.

Nectar characters: Nectar production begins with anthesis of the flower. A single flower produces 1 μl . In bagged flowers with a total sugar concentration of 25 – 30%. The nectar sugar analysis indicates the presence glucose, sucrose and fructose.

Flower visitors: We recorded 18 species of flower visitors on *Leucas aspera* (Table 2 &3). The flower visitors include bee's ants and butterflies. The bees were digger bee, honey bees and other small bees. Of the total spectrum of foragers some bee species are rather regular to their visits to *Leucas aspera*. *Amegilla sp.* *Apis florea*, *Apis cerana indica*, *Megachile sp.*

Anthophora sp. are the common foragers throughout the flowering season. The bees made 96 %, ants 1% and the butterflies 3% of the total visits. Of the total bee foraging visits, the *Amegilla sp.* constituted 52 %, followed by honey bees (*A.florea*, *A.c indica*) 25.7% *Megachile sp.* 6.5 % *Anthophora sp.* 5.86 % *Apis dorsata* 2.2%, *Ceratina* and *Trigona* 3.2%. Of these visitors honey bees visited for pollen and nectar. *Trigona* and *Ceratina* foraged for pollen only. *Amegilla Camponotus*, *Anthophora* visited for nectar only. All these visitors were found to be active during day time from 7.00 – 1600 hr. The bees *Amegillasp.* and *Apis florea* were more mobile in that they spent less time per flower and visited more flowers per unit time.

Foraging behavior: The lower corolla lip served as the landing place. When *Amegilla sp.*, honey bees and *Anthophora sp.* probed the flowers for nectar, the reproductive parts brushed against their dorsal surface. *Apis florea*, *Ceratina*, *trigona* and *Megachile sp.* while collecting pollen and /nectar, alight on the lower side of the reproductive parts contacting them with their ventral body surfaces. The ant *camponotus* probed the flower from side or front without contacting stigma or anthers. The flower visitors were most active and vigorous between 800- 1200 hr.

Observations on the behavior of different foragers suggested that except for butterflies, all other visitors' effect pollination to a greater or lesser degree. Correlation and integration of the data on the number of flowers visited by different flower visitors per unit time and length of time they spent at the flowers. The number of pollen grains deposited on the stigma in a single visit and successive visits and pollen deposition on stigmas under the forager supported by observations on the foraging behavior of different foragers proved that the bees *Amegillasp.*, *Apis florea*, *Apis cerana indica*, *Megachile sp.* could be effective pollinators of *Leucas aspera*. *Amegilla sp* and honey bees are the major pollinators to use the terminology of Baker et al. (1971). The little bee *Apis florea* may also reckoned as the major pollinator. The digger bee *Amegilla sp.* is very effective in bringing about pollen transfer, it constituted 52% of the total visits.

The medium sized *Apis florea*, *Amegilla sp.* and *Megachile sp.* mediated nototriby while probing for nectar and sternotriby when collecting pollen. Such foraging behaviour with bumble-bees was reported in *Pedicularis sudetica* and *P. grayi* by Macior (1973), who attributed it to the flower behaviour and forager's body as well as to the kind of forage collected. The small bodied *Trigona*, *Ceratina* being unable to reach

at the concealed nectar because of short tongues, collected pollen by inverting their bodies; they thus transferred pollen sternotribically.

The plant species of *Leucas aspera* studied occur in temporary habitats. The adaptation of their floral mechanism for pollination by nectar and pollen

collecting insects, together with the flexibility in breeding systems with a provision for viable seed production through self (spontaneous) and cross pollinations were assure their survival in changing environments where the availability of insects is unreliable.

Table.1.Flowering phenology of *Leucas aspera*

| Date | Place | No. of plants observed | No. of inflorescences (verticells) | Total no.of flower on the day | Total no. of flowers produced during the flowering one season |
|------------|------------------------|------------------------|------------------------------------|-------------------------------|---|
| 12/10/2013 | Dornala fields | 10 | 279 | 644; Avg. 64 | 14268; Avg. 1426 |
| 17/12/2013 | Ramnagar Area | 10 | 119 | 316; Avg. 31. | 5452; Avg. 545 |
| 02/01/2014 | Nagulapadu road fields | 22 | 457 | 876; Avg. 40 | 31990; Avg. 1454 |
| 02/02/2014 | Nagulapadu road fields | 8 | 299 | 1014; Avg. 128 | 20583; Avg. 2572 |
| 08/02/2014 | Near GJC Addanki Area | 15 | 417 | 1077; Avg. 72 | 27,735; Avg. 1849 |



A. *Apis dorsata* collecting nectar



B. *Anthophora* sp. collecting the nectar nototribically

Figure.1. Photographs of foraging insects on flowers of *Leucas aspera*



C. *Junona almona* sp. collecting the pollen sternotribically



D. *Amegilla* sp. Porbing the flower nototribically for nectar

Table.2. Spectrum and census of flower visitors on *leucas aspera*

| Name o Visitor | Dornala fields 15/10/2013 | Near GDC fields Addanki 22/11/2013 | Ramanagar Area 03/11/2013 | SingaraKonda fields 13/01/2014 |
|-----------------------------------|------------------------------|---------------------------------------|------------------------------|-----------------------------------|
| Bees | | | | |
| <i>Amegilla Sp.</i> | 1552 | 1408 | 539 | 1299 |
| <i>Apis cerana indica</i> | 164 | 248 | 300 | 249 |
| <i>Apis florea</i> | 356 | 409 | 477 | 173 |
| <i>Apis dorsata</i> | 70 | 96 | 54 | - |
| <i>Megachile sp.</i> | 214 | 156 | 100 | 136 |
| <i>Anthophora sp.</i> | 134 | 147 | 120 | 140 |
| <i>Polistis sp.</i> | - | - | 33 | 62 |
| <i>Junona almona</i> | 88 | - | - | 109 |
| <i>Trigona sp.</i> | 18 | 57 | 40 | 49 |
| <i>Ceratina sp.</i> | 27 | 23 | 30 | 54 |
| <i>Un identified</i> | 47 | - | - | 50 |
| Ants | | | | |
| <i>Camponotus sp.</i> | 21 | 29 | 38 | 22 |
| Butterflies | | | | |
| <i>Danaus chrysippus</i> | 16 | 15 | 07 | 45 |
| <i>D. limniae</i> | - | - | 05 | - |
| <i>Atrophaneura aristolochiae</i> | - | 22 | 07 | 26 |
| <i>Papilioplytes</i> | 36 | - | - | -- |
| <i>Eupleocore</i> | 24 | 34 | 10 | -- |
| <i>Acreo violae</i> | - | - | - | 11 |
| <i>Borbo bevani</i> | - | 20 | - | - |
| Total visits | 2767 | 2644 | 1760 | 2425 |

Table.3. Flower visitors on *Leucas aspera*, their forage type and body parts of pollen deposit

| Name of the forager | Forage type | | Region of pollen deposit |
|-----------------------------------|-------------|--------|-----------------------------|
| | Pollen | Nector | |
| Hymenoptera | | | |
| APIDAE | | | |
| <i>Apis cerana indica</i> | + | + | Dorsal thorax |
| <i>Apis florea</i> | + | + | Head, legs and ventral side |
| <i>Apis dorsata</i> | + | + | Dorsal thorax |
| <i>Trigona sp.</i> | + | - | Head, legs and ventral side |
| <i>Camponotus sp.</i> | - | + | - |
| <i>Ceratina sp.</i> | + | - | Head, legs and ventral side |
| <i>Amegilla sp.</i> | - | + | Dorsal thorax |
| <i>Megachile sp.</i> | - | + | Dorsal thorax |
| <i>Anthophora sp.</i> | - | + | Dorsal thorax |
| <i>Junona almona</i> | + | + | Head, legs and Ventral side |
| <i>Polistis sp.</i> | + | + | Head, legs and Ventral side |
| LEPIDOPTERA | | | |
| <i>Danaus chrysippus</i> | - | + | Proboscis |
| <i>Danaus limniace</i> | - | + | Proboscis |
| <i>Atrophaneura aristolochiae</i> | - | + | Proboscis |
| <i>Papiliopolytes</i> | - | + | Proboscis |
| <i>Epleocare</i> | - | + | Proboscis |
| <i>Acreoviola</i> | - | + | Proboscis |



E. *Apis cerana indica* collecting nectar nototribically



F. *Apis florea* collecting nectar nototribically



G. *Camponotus* sp. Moving round the flowers



H. Flowering phenology of *Leucas aspera*



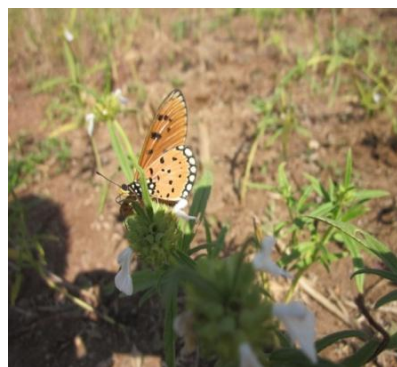
I. *Leucas aspera* – inflorescences (flowering verticells)



J. *Apis florea* collecting pollen sternotribically



K. *Danaus chrysippus* probing the flower



L. *Acreeo violae* probing the flower for nectar

Table.5. Number of flower visits per unit time and length of a visit at *leucas aspera* flowers by different flower foragers

| Species | Length of a visit (in seconds) | | | | No of flower visits/minute | | | |
|-----------------------------------|--------------------------------|-----|-----|------|----------------------------|-------|------|------|
| | n | R | X | S.D | N | R | X | S.D |
| <i>Apis cerana indica</i> | 10 | 5-9 | 6 | 1.41 | 10 | 6-12 | 9.5 | 2.32 |
| <i>Apis florea</i> | 10 | 4-6 | 4.3 | 1.19 | 10 | 6-10 | 7.4 | 1.17 |
| <i>Apis dorsata</i> | 10 | 5-8 | 6.3 | 0.94 | 10 | 7-12 | 9.2 | 1.76 |
| <i>Trigona sp.</i> | 10 | 5-7 | 6.1 | 0.87 | 10 | 8-15 | 10.7 | 2.49 |
| <i>Ceratina sp.</i> | 10 | 5-7 | 6.1 | 0.87 | 10 | 8-15 | 10.7 | 2.49 |
| <i>Amegilla sp.</i> | 10 | 2-5 | 3.2 | 1.05 | 10 | 12-30 | 16.5 | 5.39 |
| <i>Megachile sp.</i> | 10 | 4-7 | 6.1 | 1.33 | 10 | 8-20 | 11.7 | 3.91 |
| <i>Anthophora sp.</i> | 10 | 4-7 | 5.5 | 2.04 | 10 | 7-20 | 12.1 | 4.50 |
| <i>Junona almona</i> | 10 | 5-8 | 6.3 | 2.56 | 10 | 7-12 | 8.9 | 2.43 |
| <i>Polistis sp.</i> | 10 | 5-8 | 6.3 | 0.95 | 10 | 8-14 | 10.5 | 2.34 |
| <i>Danaus chrysippus</i> | 10 | 3-6 | 4.2 | 1.03 | 10 | 7-13 | 9.6 | 1.83 |
| <i>Danaus limniace</i> | 10 | 3-6 | 4.3 | 0.94 | 10 | 6-14 | 9.9 | 1.91 |
| <i>Atrophaneura aristolochiae</i> | 10 | 4-7 | 5.2 | 0.94 | 10 | 9-18 | 12.1 | 2.89 |
| <i>Papilio polytes</i> | 10 | 5-7 | 5.8 | 0.78 | 10 | 8-17 | 12.3 | 2.59 |
| <i>Eupleocore</i> | 10 | 4-7 | 5.7 | 0.94 | 10 | 8-15 | 11.3 | 2.57 |

Table.6. Deposition of number of pollen grains on stigmas in first visit by different flower visitors on *leucas aspera*

| Name of the Species | Mean number of pollen on a stigma after the visit |
|---------------------------|---|
| <i>Amegilla sp.</i> | 96 |
| <i>Apis florea</i> | 65 |
| <i>Apis cerana indica</i> | 106 |
| <i>Megachile sp.</i> | 58 |
| <i>Anthophora sp.</i> | 70 |
| <i>Junona almona</i> | 64 |

Number of flowers sampled = 05

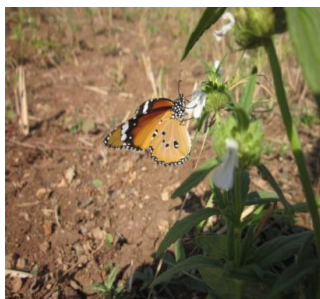


M. *Camponotus sp.* Moving round the flowers



N. Flowering phenology of *Leucas aspera*



O. *Leucas aspera* – inflorescences (flowering**P. *Apis florea* collecting pollen sternotribically****Q. *Danaus chrysippus* probing the flower****R. *Acreeo violae* probing the flower for nectar****CONCLUSION**

Reproductive ecology of *Leucas aspera* was studied along with the morphology of the plant and the flower. Butterflies and bees play a major role in the pollination of *Leucas aspera*. Further research is to be conducted for chemical constituents and medicinal uses of the plant.

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