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The Role of *Apis florea* in the Pollination of some Plant Species in Andhra Pradesh, India

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Abstract

The role of the dwarf honey bee in the pollination of some plant species in Andhra Pradesh has been reviewed. The plant species utilized by the honey bee for pollen and nectar have been evaluated in respect of flower phenology, floral characters, flower sex, etc. Further, the foraging behaviour of the honey bee on different plant species has been observed. The study concludes that the plant species utilized by the bee can be cultivated for promoting bee-keeping.

(Key words : Pollination, *Apis florea*, Dwarf honeybee, Honey plant)

Ⅰ. INTRODUCTION

India is a land of honey bees. Of the different honey bees, the dwarf honey bee, *Apis florea* predominates in the tropical regions. It is commonly found in the plains and extends its distribution upto 900 m above sea level (pers. obser.). It builds a small, single exposed and vertical nest of soft wax on trees or bushes in shaded places (Thakar and Tonapi, 1962; Rajagopal. 1998). It frequently migrates over short distances. Disturbances cause the bee to desert the comb, leaving behind honey, brood and pollen stores (Rajagopal, 1998). As the bee is predominantly tropical in occurrence, its nesting plant species are not a problem because tropical regions are rich in plant diversity.

The bee is valued for its honey because of its medicinal properties (Batra, 1977). It has been considered to be of less importance for crop pollination despite its persistent flower-visiting habit for pollen and nectar. The bee utilizes a variety of floral sources available within a short distance from its colony and it contributes to the success of sexual reproduction in plants.

Ⅱ. MATERIALS AND METHODS

The dwarf honey bee actively probes the flowers of various plant species for pollen and/or nectar. Over the past several years, the foraging activity of this bee in the environment of Visakhapatnam region (17°42′ N and 82° 18′ E), Andhra Pradesh, India has been observed along with the foraging behaviour of other partners of the pollinator guild. The functional aspects of flowers and mating systems of the forage plants of *A. florea* have been studied as per Aluri and Subba Reddi (1994).

Ⅲ. RESULTS AND DISCUSSION

1. FORAGING ACTIVITY OF THE DWARF HONEY BEE

Table 1 gives the forage plants of *A. florea* together with their habit, flower sex and mating systems. These plants represent trees, shrubs, herbs and creepers, and belong to

Table 1. Flower sex and mating system(s) in plant species foraged by Apis florea

FAMILY	PLANT SPECIES	HABIT	FLOWER SEX	MATING SYSTEM
ALNGIACEAE	*Alangium salviifolium*	Tree	Bisexual	Self & Cross
ASTERACEAE	*Tridax procumbens*	Herb	Female(Ray florets) & Bisexual(disc florets) in the capitulum	Self & Cross
ANACARDIACEAE	*Semecarpus anacardium*	Tree	Male & Bisexual on the same plant but trees biased for male or Bisexual	Self & Cross
BIGNONIACEAE	*Spathodea campanulata*	Tree	Bisexual	Cross
CAESALPINIACEAE	*Tarmarindus indica*	Tree	Bisexual	Self & Cross
COMBRETACEAE	*Terminalia catappa*	Tree	Bisexual (at bottom) and staminate (above) in the same inflorescence	Self & Cross
	T. tomentosa	Tree	Bisexual	Cross
EUPHORBIACEAE	*Euphorbia tortilis*	Shrub	Male (central cyathia) and Bisexual (lateral cyathia)	Self & Cross
	Jatropha curcas	Shrub	Male and Female flowers in the same inflorescence	Self & Cross
	J. gossypiifolia	Shrub	Male and Female flowers in the same inflorescence	Self & Cross
FABACEAE	*Pterocarpus santalinus*	Tree	Bisexual	Self(fruit aborts) & Cross
	Derris indica	Tree	Bisexual	Self & Cross
LAMIACEAE	*Anisomeles indica*	Herb	Bisexual	Self & Cross
	Ocimum americanum	Herb	Bisexual	Self & Cross
	O. basilicum	Herb	Bisexual	Self & Cross
LECYTHIDACEAE	*Couroupita guianensis*	Tree	Bisexual	Cross
LINACEAE	*Hugonia mystax*	Shrub	Bisexual (distyly)	Cross
MELIACEAE	*Azadirachta indica*	Tree	Bisexual	Self & Cross
MIMOSACEAE	*Acacia caesia*	Shrub	Bisexual	Cross
MYRTACEAE	*Syzygium cumini*	Tree	Bisexual	Self & Cross
POLYGONACEAE	*Antigonon leptopus*	Creeper	Bisexual	Self & Cross
RHAMNACEAE	*Zizyphus mauritiana*	Tree	Bisexual	Self & Cross
RUBIACEAE	*Morinda tomentosa*	Tree	Bisexual	Cross
SAPINDACEAE	*Allophylus serratus*	Shrub	Male and bisexual (functionally female) in the same inflorescence	Self & Cross
	Cardiospermum halicacabum	Creeper	Male and Bisexual flowers	Self & Cross
	Sapindus emarginatus	Tree	Male and Bisexual	Self & Cross
STERCULIACEAE	*Sterculia foetida*	Tree	Male and Bisexual (Functionally female)	Cross
VERBENACEAE	*Tectona grandis*	Tree	Bisexual	Self (fruit aborts) & Cross
ZYGOPHYLLACEAE	*Tribulus terrestris*	Herb	Bisexual	Self & Cross

species of different genera of different families. *Tridax procumbens* produces female and bisexual flowers (in capitulum) on the same plant. *Semecarpus anacardium, Terminalia catappa, Euphorbia tortilis, Allophylus serratus, Cardiospermum halicacabum, Sapindus emarginatus* and *Sterculia foetida* produce male and bisexual flowers within the same inflorescence or on the same plant; the bisexual flowers are functionally female. *Jatropha curcas* and *J. gossypiifolia* produce male and female flowers in the same inflorescence. The remaining plant species produce only functionally bisexual flowers. The flower sex plays an important role for the operation of different mating systems. The plant species, *Spathodea campanulata, Terminalia tomentosa, Couroupita guianensis, Hugonia mystax, Acacia caesia, Morinda tomentosa* and *Sterculia foetida* are obligate outcrossers, while all others are both self and cross-pollinating. It shows that pollen movement within and between conspecific plants is a must and it requires pollen vectors. The list of forage plants of *A. florea* in dicates that the been seems to have no preference for the floral rewards of any particular plant species. The forage plants have anthese at different times. Most of the plant species open flowers during morning hours and also those that open flowers at other times present floral rewards for availability during daytime. As the floral rewards are available during daytime, the bee, being a daytime forager, profitably utilizes them. As the bee is polylectic in character, it is no wonder to find its foraging activity on diverse plant species. Further, the plant species in tropical latitudes require more than one pollinator species (Faegri & van der Pijl, 1979) and in line with this, the plant species now observed are found foraged by *A. florea* and also by a variety of insects. The flowers of these plant species are of open type with shallow base and easily accessible even to short-tongued anthophilous insects. *Spathodea companulata* is tubular but it is broadly spaced inside and the stamens are placed at the mouth of the tube. It offers both pollen and nectar as floral rewards. Its flowers are primarily adapted for bird-visitation (Aluri & Rao, 2002). However, the dwarf bee utilizes *S. campanulata* as pollen source only.

2. FLORAL CHARACTERS AND HONEY BEE VISITATION

Bee-pollinator class is normally associated with the flower species possessing blue or yellow colour (Kevan, 1983; Scogin, 1983). The flower colours of the plant species foraged by the dwarf bee are white, yellow, green, blue, purple and red (Table 2) and hence, that is in disagreement with the above generalization. Moist of the species produce nectar in trace amount while others secrete nectar ranging from 0.4-11 μl per flower. The nectar sugar concentration varies between 4 and 48% (Table 2). It shows that the bee utilizes even trace amount of nectar and also both dilute and concentrated nectars, if available. This finding does not agree with the generalization that bees utilize nectar with sugar concentration of typically more than 20% (Percival, 1965; Baker, 1975). The forage plants of *A. florea* produce pollen in huge amount at flower level. The pollen production is much more in *Couroupita guianensis*. It shows that these plants are an excellent source of pollen for the bee. The flowering periods of these plant species are spread over the entire period of the year and this flowering sequence enables the bee to obtain pollen and nectar throughout the year. The bee collects both pollen and nectar in the same or in successive foraging visits from all the plant species

Table 2. Flowering and floral details of forage plants of Apis florea

Plant species	Flower colour	Flowering period	Anthesis time(Hr.)	Forage	Pollen output/ flower	Nectar volume (μl)	Nectar sugar conc. (%)
Alangium salviifolium	Dirty White	2-4	24 hrs	P + N	27,3000	no	25-29
Tridax procumbens	Cream	Y1	0600-0700	P + N	420	Traces	n/o
Spathodea campanulata	Red	1-3	2200	P	7,517	5	n/o
Semecarpus anacardium	Light Green	6-8	0600	P + N	M = 2595 B = 2157	M = 2 B = 5	n/o
Tamarindus indica	Dusty White	4-8	2300-0400	P + N	18,600	1	6-8
Terminalia cattappa	Cream	2-3 & 6-8	0300-0500	P + N	1,925	Traces	n/o
T. tomentosa	Greenish White	6-7	0200-0800	P + N	15,000	6	4-18
Euphorbia tortilis	Yellow	12-3	0730-1000	P + N	765	Traces	n/o
Jatropha curcas	Greenish Yellow	7-10	0530-0630	P + N	655	Traces	n/o
J. gossypiifolia	Purplish Red	6-10	0600-0700	P + N	880	M = 1.5 F = 2.5	62-72
Pterocarpus santalinus	Yellow	4-5	2330-0030	P + N	34,800	Traces	n/o
Derris indica	Bluish-violet	3-6	0900-1100	P + N	39,630	Traces	n/o
Syzygium cumini	Light-White	5-6	0700-1700	P + N	8,400	11.26	21-36
Anisomeles indica	Purple	11-1	0530-0730	P + N	7,440	1.6	32-43
Ocimum americanum	White	8-10	0530-1330	P + N	1,402	Traces	n/o
O. basilicum	White	8-10	0730-1300	P + N	1,312	0.4	9
Couroupita guianensis	Rosy Yellow	Y1	0700	P	Abundant	No secretion	-
Hugonia mystax	Yellow	6-9	0500-0800	P + N	18,850	Traces	n/o
Azadirachta indica	White	3-5	0200-1000	P + N	n/o	Traces	n/o
Acacia caesia	White	8-10	0600-0700	P + N	3,000	Traces	n/o
Antigonon leptopus	Purple White	Y1	0600-0800	P + N	1,480	1.5	26-28
Zizyphus mauritiana	White	9-1 & 3-6	0600-1000	P + N	4,900	2.5	30
Morinda tomentosa	White	4-8	1700-1900	P + N	16,410	Abundant	n/o
Allophylus serratus	White	8-9	0200-0500	P + N	4,432	Traces	n/o
Cardiospermum halicacabum	White	6-12	0500-0900	P + N	2,880	Traces	n/o
Sapindus emarginatus	Cream	11-1	0520-0700	P + N	57,775	M-4, B-11	22-48
Sterculia foetida	Greenish Red	1-3	0700-1000	P + N	2,350	Traces	n/o
Tectona grandis	White	5-11	0300-0400	P + N	12,650	Traces	n/o
Tribulus terrestris	Yellow	Y1	0600-0800	P + N	18,000	n/o	n/o

Y1 = Year-long; 1-12 = months; P = pollen; N = nectar; M = male; B = bisexual; n/o = not observed.

except *Spathodea campanulata*. It has the necessary skill to probe variously shaped flowers; this probing behaviour is very important for the bee to harvest floral rewards.

The plant species foraged by *A. florea* are also foraged by other honey bees, and other anthophilous insects. *Anisomeles indica* is foraged also by birds. It is not surprising to note the foraging activity of a variety of insects on a single plant species in tropical regions *sensu* Faegri & van der Pijl (1979). Table 3 gives the percentage of foraging visits of *A. florea* on different plant species relative to the foraging visits of other anthophilous insects on the same plant species. These figures suggest that *A. florea* contributes considerable percentage of visits to most of the plant species, indicating its competitive ability to utilise the same floral resource along with other anthophilous insects by co-existence.

3. FORAGING BEHAVIOUR OF THE DWARF BEE

The dwarf bee approaches the flowers in upright position, collects floral rewards sterno-tribically, and carries pollen on its underside and legs in huge amount. It does only legitimate visiting. Pollination efficiency of a flower visitor is generally assessed by a consideration of the percentage of visits, pollen pick-up, foraging speed, the number of flowers foraged and the intrafloral behaviour. Table 3 & 4 provide some of the information in this line. These data speak of the efficiency of collection of floral rewards by *A. florea* and in the process, effecting pollination. The bee is relatively a slow mover and also has the tendency to stay on the same plant most of the time. Such a tendency of the bee largely accounts for autogamous or geitonogamous pollinations. Since no plant species is exclu-

Table 3. Foraging visits (%) of *Apis florea* relative to other foragers on different plant species

Plant species	Foraging visits (%)					
	Apis florea	Other bees	Wasps	Butterflies	Flies	Birds
Semecarpus anacardium	21	63	14	2	0	0
Tamarindus indica	23	68	7	1	1	0
Terminalia tomentosa	23	37	0	8	32	0
Euphorbia tortilis	43	17	15	0	25	0
Jatropha curcas	22	64	0	0	14	0
Pterocarpus santalinus	11	77	0	12	0	0
Anisomeles indica	12	75	0	1	0	12
Ocimum americanum	36	58	0	5	1	0
O. basilicum	27	61	0	5	7	0
Hugonia mystax	20	78	0	2	0	0
Antigonon leptopus	12	79	2	2	5	0
Zizyphus mauritiana	23	43	26	0	8	0
Allophylus serratus	9	50	38	3	0	0
Cardiospermum halicacabum	31	51	15	3	0	0
Sterculia foetida	3	40	0	4	54	0
Tectona grandis	2	20	20	38	20	0
Tribulus terrestris	25	52	0	5	18	0

Table 4. Foraging efficiency of *Apis florea* on different plant species

Plant species	Average foraging time/flower (sec.)	Averae No. of flowers foraged per min.
Tamarindus indica	6	8
Terminalia tomentosa	13	8
Euphorbia tortilis	4	16
Jatropha curcas	5	12
Pterocarpus santalinus	7	10
Anisomeles indica	3	30
Ocimum americanum	21	11
O. basilicum	28	16
Hugonia mystax	5	7
Antigonon leptopus	5	9
Zizyphus mauritiana	4	15
Allophylus serratus	8	6
Cardiospermum halicacabum	8	7
Steruculia foetida	5	9

No. of observations : 20 on each plant.

sively foraged by it, the depletion of floral rewards by other simultaneously foraging insects compels the bee to make inter-plant movements in quest of floral rewards and in consequence, cross-pollination is also effected by the bee.

The study suggests that the dwarf bee plays an important role in the pollination of plant species foraged by it. The bee is a generalist and utilises the flowers of various species available within its flight distance from the colony. The potential of *A. florea* as a pollinator in our native wild plants and in sustaining plant diversity in both forest and non-forest areas should be evaluated. Further, as the bee is manageable, the possibilities to exploit its potential for pollination, honey-making, and better agricultural economy must be explored. *A florea* should be allowed to perpetuate in its native habitats as its value as pollinator far exceeds the value of the honey.

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