



Short communication

Diversity of bee pollinators and flora in cashew

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ABSTRACT

Seven species of bee that maintained constancy on cashew flowers were identified from coastal Karnataka [(*Pseudapis oxybeloides* (Smith), *Lasioglossum* sp. and *Halictus* sp., Halictidae; *Braunsapis* sp., *Ceratina smaragdula* (F.) and *Ceratina* sp., Apidae)] and four species from coastal Tamil Nadu [(*Ceratina (Pithitis) binghami* Cockerell, *C. smaragdula*, *Braunsapis* sp. and *P. oxybeloides*)]. Time spent by bees for visiting the flowers ranged from 0.8 to 25.1 seconds per flower. Diversity of flora recorded during 2003-08 as floral resources for nectar for all the above bee species during lean and flowering periods of cashew - both at coastal Karnataka and Tamil Nadu - is presented in this paper.

Key words: Diversity of bees, floral resources, cashew

Fruit-set in cashew is mainly influenced by the activity of pollinators (Reddi, 1993; Thimmaraju and Lakshmi Raju, 1993; Freitas and Paxton, 1996). In the East Coast of Tamil Nadu, 32 species of insects visited cashew inflorescences (Ambethgar, 2002). In the West Coast of India, Devasahayam (1986) and Sundararaju (2000, 2003) reported various species of bee such as *Pseudapis oxybeloides* (Smith), *Ceratina smaragdula* (F.), *Apis* spp., *Lasioglossum* sp., *Trigona iridipennis* Smith and one unidentified halictid visiting cashew. Based on the number of free pollen-grains on their bodies, honey bee (*A. mellifera*) and the solitary bee (*Centris tarsata*) were found to be efficient pollinators of cashew (Freitas, 1997; Bhattacharya, 2004). Studies were therefore undertaken to document the diversity of bee pollinators occurring on cashew in the cashew belt of coastal Karnataka and in coastal Tamil Nadu. Simultaneously, information on other flower resources (flora) occurring in cashew plantations during the lean season and flowering period of cashew was collected, in order to suggest methods for conservation and management of pollinators.

Diversity of bee pollinators was assessed by collecting bees that maintained constancy on cashew flowers in the cashew belt of coastal Karnataka and in coastal Tamil Nadu, by undertaking surveys during 2004 – 2006. Bee species were identified using taxonomic keys developed by Batra (1977). Visitation of bee pollinators at fixed hours and on

fixed spots in cashew during the flowering season of 2005-06 was recorded. For this, one square meter of the canopy was marked in early-season (NRCC Selection-2), mid-season (Bhaskara) and late-season (Chintamani- 1) flowering varieties. In each variety, visits of bee pollinators at fixed hour (11.00 hr and 14.00 hr) were observed for a period of 10 minutes continuously for 30 days from initiation of flowering in panicles. Highest population recorded either at 11.00hr or 14.00hr was accounted as population for that day. Role of bee pollinators in fruit-set was observed by caging single trees completely with nylon net (size 40 mesh) similar to that in studies of Freitas and Paxton (1996). Total time spent per flower by some of the bees was recorded with the help of a stop-watch and video-graph. Simultaneous observations were made within cashew plantations on diversity of flora that served as floral resources during lean periods, and additional floral resources during flowering periods of cashew.

Species of bees which visited cashew flowers, and bees carrying pollen grains on their legs and body hairs, were collected and identified. There were seven species from coastal Karnataka *Pseudapis oxybeloides*, *Lasioglossum* sp. and *Halictus* sp. (Halictidae); *Braunsapis* sp., *Ceratina smaragdula* and *Ceratina* sp. (Apidae), and four species from coastal Tamil Nadu: *Ceratina (Pithitis) binghami* Cockerell, *C. smaragdula*, *Braunsapis* sp. and *P. oxybeloides*. These species were observed as mainly

collecting pollen grains, followed by feeding on nectar and were categorized either as pollen-bees native-bees, wild bees or non-*Apis* bees (Batra, 1994). Even though honeybees (*Apis florea* F., *A. cerana indica* and *A. dorsata* F., Apidae) visited cashew flowers in both the regions, these were mainly involved in feeding on nectar and, very rarely, in collecting pollen. Stingless bee (*Trigona iridipennis* Smith, Apidae) alone collected both nectar and pollen grains. However, pollen billets on their corbiculae were loaded in the form of a brownish, slimy mass. Though the occurrence of above species of *Apis*, *P. oxybeloides*, *C. smaragdula* and *Lasioglossum* sp. have already been reported by Devasahayam (1986), Reddi (1995), Sundararaju (2000), Ambethgar (2002) and Bhattacharya (2004), four species viz., *Halictus* sp., *Ceratina* sp., *Braunsapis* sp. and *Ceratina (Pithitis) binghami* in this study have been recorded for the first time from cashew plantations of coastal Karnataka and Tamil Nadu. As per reports of Ambethgar (2002), *Apis mellifera* L. was sighted in coastal Tamil Nadu, but could not be sighted in the repeat survey undertaken during 2004-2006. Similarly, Bhattacharya (2004) reported occurrence of *Bombus* spp. in West Bengal, but it is surprising to note that *Bombus* spp. specific to the cooler high-altitude region (1350m to 8400m above MSL (Abrol, 1997) was seen on cashew. Recently, the extent of pollination in cashew with a maximum of upto 46.8% after the visit of *A. cerana indica*, was documented by Sundararaju (2011).

Total time spent on the flower by bees was accounted for by keeping time with a stop-watch and recording with a video camera (Tables 2 and 3) and was seen to range from 0.8 to 25.1 seconds flower. Whenever pollen alone was collected, the time spent was found to be minimum (0.8 to 5.0 sec flower⁻¹). Combined collection of pollen and nectar, or collection of nectar alone, time spent was maximum (5.0 to 25.1 sec. / flower). This is in contrast to an earlier study by Sundararaju (2000) who observed *P. oxybeloides* as spending 2.0 seconds on pollen collection alone. The abundance of bees on early-(NRCC Selection-2), mid-(Bhaskara) and late-season (Chinthamani - 1) flowering varieties was 0.35, 0.16 and 0.09 bees panicle⁻¹, respectively, in a constant period of 10 minutes, during 2005-06 (Table 1) at Puttur (coastal Karnataka). Under undisturbed video recording, in a canopy area containing 15 panicles during a period of 20 minutes, visit of 2-3 *A. cerana indica* and 1-5 *P. oxybeloides* bees was found to be low in cashew. This is in concurrence with earlier reports of Ohler (1979) and Free (1993).

During 2006-07, a single tree of 'Bhaskara' variety was caged all over with mosquito net, in the centre of a plantation at Puttur and geitonogamous pollination (through gravitational fall of pollen grains) was completely prevented by removing the upper panicles. Every day, the tree was observed between 11.00 and 12.00h. Most of the time, at least twice or thrice, bee species *P. oxybeloides* dashed against the mesh of the cage from outside the of cage and ultimately, could not enter the cage because of its larger body-size, and the close mesh of mosquito net. This type of external attraction may be due to volatiles emanating post-anthesis in cashew flowers. As a result, no fruit-set was observed even upto 45 days from onset of flowering in the particle. And at the same time, normal fruit-set showing various stages of fruit development was observed on all the surrounding un-caged trees. Subsequently, in the caged tree, belated fruit-set was spotted after 45-60 days from of flowering. By this time, all the surrounding un-caged trees

Table 1. Visitation by bees on different varieties of cashew trees

Bee species	Visit of bee within 10 minutes (no./panicle/day) during 30 observational days		
	NRCC Selection-2 (E)	Bhaskara(M)	Chintamani(L)
Stingless bee (<i>Trigona iridipennis</i>)	0.280(30)	0.003(3)	0.036(8)
<i>Apis cerana indica</i> (honey bee)	0.027(14)	0.026(10)	0.014(11)
<i>A. florea</i>	0.025(17)	0.007(3)	0.000
Non- <i>Apis</i> spp.	0.021(9)	0.136(26)	0.036(16)
Total	0.353(30)	0.162 (26)	0.086(27)

Figures in parentheses are no. of days sighted out of 30 observational days; E, M, L: Early-, mid- & late-season flowering variety, respectively

Table 2. Time spent by different species of bees* per cashew flower

Name	Mean± S.D (seconds)**	Range (seconds)
<i>Apis cerana indica</i>	2.31 ± 1.35	0.8 - 9.0
<i>Apis florea</i>	8.25 ± 2.61	1.2- 22.2
<i>Ceratina (Pithitis) binghami</i>	13.62 ± 1.30	5.0- 25.1
<i>Braunsapis</i> sp.	9.43 ± 1.36	2.0- 22.0

*Recorded with a stop-watch; ** Mean of minimum 10 observations

Table 3. Visitation of bees on cashew flowers as recorded on video camera

Bee species	No. of bee visits on 15 panicles within a period of 20 minutes			Time spent / flower (seconds)	
	Day1	Day2	Day3	Mean± S.D.	Range
<i>Apis cerana indica</i>	3	2	2	3.6±1.0	2-5
<i>Pseudapis oxybeloides</i>	1	5	4	4.1±3.9	1-18

had panicles at an advanced stage of fruiting and were on in the verge of cessation of flowering. Since the caged tree had no panicles bearing fruits, flowering was to be observed continuous, without any cessation. Therefore, the caged tree was critically observed. Finally, through visual observation, entry of *Lasioglossum* sp. through the mesh of the cage was confirmed especially at the site where flower panicles touched the mesh of the cage. Also visit to new flowers of the caged tree, by bee species already present inside the cage, was seen. Since the caged tree maintained active flowering while all the surrounding trees were on the verge of cessation of flowering, bees must have been attracted to flower panicles touching the mesh of the cage. Subsequently, through the mesh of the cage, these bees may have made a forced entry. As a result, a final fruit-set in 71.2% of panicles with a mean of 1.2 nuts/panicle was recorded. Whereas, in the surrounding un-caged trees that showed activity of bees of the above-mentioned species (since onset of flowering), final fruit-set was observed in 81.3% of panicles, with a mean of 2.1 nuts/panicle. This level of fruit-set on the caged tree was possible mainly due to involvement of smaller bees that entered through the mesh of the cage. This is in contradiction with earlier studies by Freitas and Paxton (1996) who reported meager fruit-set in a completely caged tree (since larger bees were excluded and smaller bees were not involved in pollination of cashew).

Diversity of flora recorded during 2003-08 as floral resources for all the above bee species in lean periods at coastal Karnataka included of *Lindernia antipoda* L. *L. crustacean* L. and *L. ciliata* (Colsm.) (Scrophulariaceae), *Spermacoce hispida* L. and *S. ocymoides* Burm. (Rubiaceae), *Mimosa pudica* L. and *Acacia pennata* L. Willd (Mimoceae), *Rungia repens* Nees (Acantheceae), *Leucas aspera* Willd. (Labiatae) and *Muntingia calabura* L. (Tiliaceae). Whereas, during the flowering period of cashew, *Blumea lacera* L. and *B. oxydonta* D.C. (Asteraceae), *Rungia parviflora* (Retz.) Nees and *Muntingia calabura* were observed as additional floral resources. In coastal Tamil Nadu, *Ocimum americanum* L. and *O. adscendens* Willd. (Labiatae), *Cleome viscosa* L. (Capparidaceae), *Oldenlandia umbellata* L. (Rubiaceae) and *L. aspera* were found to be floral resources during the lean period. *Cleome viscosa*, *O. adscendens*, and, *L. aspera* and *Celosia* sp. (Amaranthaceae) were observed as additional flower resources during the flowering period.

Even though *P. oxybeloides*, *Lasioglossum* sp. and *Braunsapis* sp. visited cashew and *B. lacera*, *B. oxydonta* and *R. parviflora*, the respective bees maintained with specific parallel-exclusive constancy pattern on cashew alone. But, at Vridhachalam (coastal Tamil Nadu), during the flowering period of cashew, exclusive constancy by *Ceratina (Pithitis) binghami*, *Braunsapis* sp. and *P. oxybeloides* was also observed on *Cleome viscosa* and *L. aspera*, common weeds in cashew plantations. Similar level of exclusive parallel-constancy by these species of bees was not seen on other varieties of cashew except 'Bhaskara'. Thus, the high-yielding variety Bhaskara, was found to be a bee-pollinator attractant variety in coastal Tamil Nadu. This can be further popularised all over coastal Tamil Nadu. Existence of the above floral resources during both lean and flowering periods of cashew in coastal Karnataka and Tamil Nadu, can help conserve/manage these bees whenever any recommended insecticides (used for management of cashew pests) caused a depression in bee population. All the same, use of existing recommended insecticides has not affected pollination in cashew in the past (Sundararaju, 2000, 2003 and 2004). This is because non-*Apis* bees do not have any scope for contact with insecticide-treated cashew flowers, except on the day of insecticide application. Growth of *B. lacera* and *O. adscendens* at the respective regions was noticed only in limited locations and, therefore, needs to be spread to other locations for conservation. It is also interesting to note that most of above-mentioned flora are native weeds in cashew plantations, excepting *Mimosa pudica*. These native weeds are fairly non-invasive and are capable of growing under partial shade of the cashew canopy. However, *Muntingia calabura* is an exotic fruit tree and cannot be recommended for growing within cashew plantations as it has been recorded as a refugee-host for an important, key pest of cashew, *Helopeltis* spp. (Miridae: Heteroptera) (Sundararaju *et al*, 2002).

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