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Architectural nesting preferences and parasitism in megachile bees (Hymenoptera: Megachilidae)

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Abstract

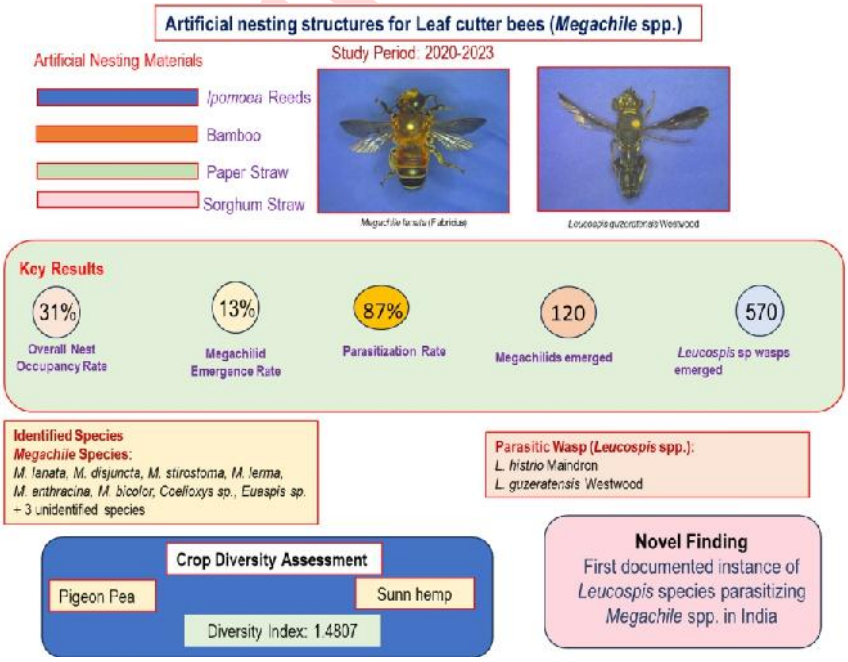
Aim: This study developed artificial nesting structures to facilitate leaf cutter bee habitation and examined their foraging behavior.

Methodology: We deployed 723 Ipomoea reed trap nests across agricultural landscapes at UAS Bangalore and conducted monthly assessments of nest occupancy, emergence, and parasitism from 2020-2023.

Results: Overall occupancy rate was 31.26% with only 12.57% emergence rate due to high parasitism (87.4%). Six Megachile species were identified, with *M. lanata* dominant (39% abundance). Two *Leucospis* species caused most parasitism - first record of *L. histrio* and *L. guzeratensis* parasitizing Megachile in India. Pigeon pea supported higher bee diversity (H'=1.4807) than sunn hemp (H'=1.0114).

Interpretation: High parasitism rates limit artificial nest success, requiring integrated pest management approaches for bee conservation.

Key words: Diversity, *Ipomoea* reeds, Megachilid, Nesting, Occupancy, Parasitization



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Introduction

Numerous crop plants are effectively pollinated by a variety of non-Apis bees, including several ground-nesting species (Cane, 1997). Among the most commonly recognized families of bees contributing to pollination are Halictidae (sweat bees), Megachilidae (leafcutter and mason bees) and Apidae (carpenter bees, bumble bees and *Apis* sp.). Several solitary non-*Apis* bees have been successfully managed for pollination in agricultural systems. For instance, *Megachile rotundata* (alfalfa and canola), *Nomia melanderi* Latreille (alfalfa) and *Osmia lignaria* Say (almond, apple, cherries) are commercially utilized in the United States, where they nest directly within crop fields or controlled environments such as greenhouses (Cane, 2008). These solitary bees are highly effective pollinators, contributing essential diversity to agro ecosystems (Peterson and Artz, 2014). Megachile bees are solitary bees that build nests inside pre-existing cavities, such as hollow stems, logs, or even man-made holes, by cutting leaf pieces or mud or floral petals or plant resins and using them to construct brood cells.

The female bee collects a mixture of pollen and nectar to form a food provision for her offspring, then deposits a single egg and seals the cell before moving on to the next cell in the linear nest. This distinctive nesting behavior, particularly the leaf-cutting activity, makes *Megachile* species easily recognizable in the field and influences their habitat requirements and nest site selection preferences (Pramanik *et al.,* 2025; Sinu and Bronstein, 2018; Sinu *et al.,* 2022; Sinu *et al.,* 2025). The diversity of materials used for cell construction - ranging from leaf fragments to plant resins - reflects the adaptability of different *Megachile* species to local resource availability, making them suitable candidates for artificial nest management programs (Michener, 2007). Many *Megachile* species nest in pre-existing cavities and readily adopt artificial nesting structures, such as "bee hotels" or “trap nests” (Krombein, 1967; MacIvor and Packer, 2015; O’Neil and O’Neil, 2016).These artificial nesting substrates not only support bee populations but also facilitate research into their nesting biology, life cycles, and interactions with associated organisms. Additionally, the contents of trap nests can provide insight into the floral resources utilized by bees to provision their brood (Buschini *et al.,* 2006).

Trap-nest methodologies support research on both native plant pollination and the potential for solitary bees to be managed for commercial crop pollination. Indeed, the use of artificial nesting substrates has significantly advanced our understanding of the biology of key pollinators, notably the economically important alfalfa leafcutter bee, *M. rotundata* (Fabricius) (Pitts-Singer and Cane, 2011). Approximately, 1,500 species of *Megachile* across 70 subgenera have been described world wide (Michener, 2007; Ascher and Pickering, 2025). South-east Asia alone is home to over 150 valid species across a dozen subgenera (Kilpatrick *et al*., 2020), with around 120 of these species documented in India (Gupta, 1993; Veeresh *et al*., 2015; Kilpatrick *et al*., 2020). Despite this diversity, detailed knowledge on their nesting biology, nest architecture, conservation needs and management strategies remains limited. Early investigations into the biology and nesting behavior of *Megachile lanata* date back to the 1970s (Kapil *et al.,* 1970; Chaudhary and Jain, 1978), with numerous subsequent studies focusing on species diversity and their floral associations. More recently, several significant contributions have shed light on the trap-nesting behavior and nesting ecology of various leafcutter and resin/mason bee species from India (Kumar *et al*., 2015; Kunjwal *et al*., 2016; Kumar and Kumaranag, 2018; Udayakumar and Shivalingaswamy, 2022).

Providing artificial nests for leafcutter bees presents a promising conservation approach. However, an encouraging multiple species to co-aggregate within shared nesting sites may inadvertently increase the risk of brood parasitism, as the proximity of brood cells can facilitate the spread of parasitic organisms (MacIvor and Packer, 2015; Kumar *et al.,* 2015). Despite this risk, there has been limited discussion on parasite loads associated with different trap-nest designs in the Indian context. In this study, we explore the artificial nesting materials and dimensions that are most preferred by megachile species in south indian agroecosystems, seasonal patterns of nest occupancy and emergence success, parasitoid species attack megachile nests and the rate of parasitization and *megachile* diversity across different crop ecosystems.

Materials and Methods

Study site: The present study was conducted at Gandhi Krishi Vigyan Kendra (GKVK), University of Agricultural Sciences campus in Bangalore, India (12.97° N, 77.59° E; elevation 924 m above sea level) over a three-year period from 2020-2023. The research site is characterized by moderate climatic conditions, with recorded meteorological data showing a mean maximum temperature of 29.5°C and mean minimum temperature of 18.2°C. The region receives an average annual rainfall of 915.8 mm with relative humidity averaging 68.5% and typical wind velocities of 6.40 km hr^{-1} (Department of Agrometeorology, University of Agricultural Sciences, Bangalore). The research was conducted in three distinct phases: - Phase 1 (October-December 2020-21): Initial substrate selectivity trials with 200 trap nests. Phase 2 (January 2022-December 2022): Intensive monitoring of 723 Ipomoea reed nests. Phase 3 (November 2023): Community structure assessment in crop ecosystems. The experimental area incorporated a mosaic landscape of agricultural ecosystems, including both actively cultivated crop fields and established orchard systems. This heterogeneous habitat matrix supported diverse floral resources that provided continuous foraging opportunities for bee populations throughout the annual cycle. The intermingling of managed agricultural zones with semi-natural vegetation created an ideal setting for studying Megachilid nesting behaviors across varying resource availability conditions.

Substrate selectivity and nesting material preferences among Megachilid bees: Two hundred trap nests with five different types of nesting materials were constructed to assess substrate selectivity among *Megachile* species. The trap nest types included: bamboo sticks (152 cm length × 2.0 cm internal diameter), paper straws (19.5 cm × 0.5 cm), bamboo straws (19.0 cm × 0.6-0.7 cm), *Ipomoea* reeds (16.5 cm × 0.6 cm) and sorghum straws (19.5 cm × 0.7 cm) (Table 1). Each material type consisted of 40 individual nesting tubes to ensure adequate replication. The trap nests were bundled in groups of 8-10 tubes and secured within PVC pipes (10 cm diameter × 25 cm length) to protect them from weather exposure. Bamboo sticks were placed in separate stand arranged both vertically and horizontally. The PVC housing units were mounted on Iron rods at 2-3 m height above ground level to minimize ground predator access and optimize bee visibility. Trap nest stations were positioned 50 m apart across the study site to reduce inter-station competition effects. Each PVC pipe was oriented with a slight downward tilt (5-10°) to prevent water accumulation. The entrance holes faced southeast to maximize morning sun exposure while providing afternoon shade protection. All trap nests were split longitudinally into two halves prior to deployment and secured with removable gum tape to facilitate non-destructive examination of nest contents following bee colonization.

Nest maintenance protocol: Occupied nests were collected monthly and immediately replaced with fresh trap nests to maintain consistent availability. Unoccupied nests were inspected bi-weekly for damage and replaced as needed. Weather-damaged nests were replaced within 48 hours to ensure continuous sampling effort.

Emergence rate calculation: Emergence rate = (Number of adult megachilids emerged / Total brood cells) × 100. Collected nests were maintained at laboratory conditions (25±2°C, 65±5% RH) until adult emergence or mortality.

Nest construction and occupancy of Megachilid bees in *Ipomoea* reeds: Based on initial acceptance rates and nesting preferences to different nesting materials, the experimental protocol was refined in subsequent year 2022 with the most effective trap nest designs being deployed at greater densities to optimize leafcutter bee domiciliation (Veeresh *et al.,* 2015). The research methodology employed 723 *Ipomoea* reed (*Ipomoea* carnea Jacq.) trap nests strategically positioned within PVC pipes at an elevation of 2-3 meters above ground level. The 723 *Ipomoea* reeds were distributed across three sites in GKVK campus *viz.,* National seed project (300 reeds), Bee park (300 reeds), and Organic farming unit (123 reeds). Total study area encompassed approximately 2.5 hectares with trap nests positioned along field borders within 100m of crop fields within the University of Agricultural Sciences campus in GKVK, Bangalore. Trap nest stations were positioned along agricultural field margins with 70% adjacent to leguminous crops (Pigeon pea 40%, Sunn hemp 30%); 20% near mixed vegetable plots (tomato, brinjal, chilli); 10% bordering fallow lands with wild flowering plants. All sites within 200 m of water sources. Each reed was meticulously prepared by splitting it longitudinally into two equal halves, which were subsequently secured together using adhesive tape. This innovative design allowed for non-destructive examination of nest contents following bee colonization. Systematic weekly monitoring was conducted throughout the study period, with newly occupied nests being clearly marked with observation dates to precisely document colonization timing and determine acceptance percentages. Once identified by the characteristic mud/ leaf plugs sealing tunnel entrances, occupied nests were carefully collected and immediately replaced with fresh trap nests to maintain consistent nesting opportunities. The harvested nests underwent comprehensive analysis, including documentation of cell numbers per nest, adult emergence rates and systematic identification of both emerged leafcutter bees and associated parasitic species. Taxonomic identification was conducted using established morphological keys (Michener, 2007) with representative voucher specimens of both the host bees at UAS, Bangalore and their parasitoids at UAS, Bangalore and Zoological Survey of India, Kolkata, India.

Megachilid community structure within Leguminous crop ecosystems: Systematic entomological sampling was conducted within established Pigeon pea (*Cajanus cajan*) and Sunn hemp (*Crotalaria juncea*) cultivation systems during peak flowering periods in November 2023.

Transect sampling: Transects measuring 100m were set through crop fields during peak flowering (0900-1100 hrs). Five replicate transects per crop type were sampled weekly for four weeks. Sweep netting involved 20 sweeps per 10m section, totaling 200 sweeps per transect. Collection events were strategically timed to coincide with optimal foraging conditions during clear, sunny days when pollinator activity reached maximum intensity. The sweep net methodology was implemented using standardized transect sampling to ensure consistent collection effort across habitat types.Field-collected specimens underwent rigorous morphological examination under laboratory conditions using stereo-microscopic analysis. Taxonomic identification to species level was accomplished utilizing established diagnostic keys (Michener, 2007; Batra, 1984), with particular attention to critical morphological characters including mandibular structure, scopal configuration and tergal ornamentation. The resulting distribution and abundance data were subjected to quantitative ecological analysis using the Shannon-Weiner diversity index ('H'). This robust analytical method was selected for its capacity to integrate both species richness parameters and relative abundance distributions, providing a multi-dimensional assessment of community structure. The index calculations revealed distinctive patterns of megachilid diversity between crop systems, offering valuable insights into habitat utilization preferences and potential crop-specific associations within this ecologically significant bee family.

$$\text{Shannon-Weiner Diversity Index } (H') = -\Sigma\,(pi \times \ln(pi))$$

Where, pi is the proportion of the species of pollinator, ln is the natural log with base e.

Results and Discussion

The perusal of data showed varying acceptance rates for different artificial nesting structures (Table 1). Ipomoea reeds with length 16.5 cm, diameter 0.6 cm showed highest acceptance (48.5%) followed by bamboo stick with length 152 cm, diameter 2 cm with moderate acceptance (22.5%). The data revealed that megachilid bees showed preference for specific entrance hole diameters, with moderate (0.6 cm) and large (2 cm) diameters being more acceptable than tiny ones. Paper straw 19.5 cm long, 0.5 cm diameter showed low preference (9%) by megachilid bees (Table 1). Bamboo and sorghum straws showed no preference despite similar dimensions of paper straw. Similarly, different materials (paper, bamboo, sorghum) showed dramatically different acceptance rates, suggesting material composition impacts selection. The preference for *Ipomoea* reeds correlates with the findings by MacIvor (2017), who reported that cavity-nesting bees often select natural plant materials over synthetic alternatives. He found that material origin significantly influenced the nest colonization rates among solitary bees. The variation in acceptance rates based on entrance diameter aligns with Krombein's (1967) observations that different megachili species select specific hole diameters corresponding to their body size. This dimensional selectivity is considered a mechanism to reduce competition and predation. Willmer (2011) documented that many megachile species prefer nesting cavities with specific humidity and temperature regulation properties, which might explain the preference for *Ipomoea* reeds and bamboo sticks over synthetic or processed materials. The complete rejection of bamboo straw and sorghum straw despite similar dimensions to preferable materials supports the findings of Gaston *et al.* (2005) who observed that surface texture and internal cavity characteristics significantly influence the nesting site selection.

The observations revealed consistent utilization of tunnels measuring 5-8 mm in diameter (Table 1). Our field deployment of 723 Ipomoeareed nests yielded 226 successfully colonized structures containing 954 brood cells (Table 2). This 31.26% acceptance rate throughout the annual cycle represents significantly higher colonization success. The observed nest architecture with an average of 5.92±1.79 cells per nest (range: 3-8; n=50) demonstrates remarkable consistency with the findings of Gupta (1993) in the northern India, who reported 5.7±1.2 cells per nest in *Megachile lanata* (Fig. 4). These findings contribute to a growing body of evidence suggesting that while Megachilid nesting preferences show regional variation, fundamental architectural elements remain consistent across biogeographic regions, reflecting evolutionary adaptations to universal challenges in brood protection and resource optimization.

The data reveals a pronounced seasonality in megachilid nesting behavior, with occupancy rates following distinct seasonal patterns (Fig. 1). The highest nesting activity occured during winter months (October-December), showed peak in

Table 1: Substrate selectivity and nesting material preferences among megachilid bees

Artificial nesting structure	Length (cm)	Diameter of entrance hole (cms)	Number of nests provided	% Acceptance (Nest occupancy)
Bamboo stick	152	2	200	22.50
Paper straw	19.5	0.5	200	9.00
Bamboo straw	19.0	0.6-0.7	200	0.00
Ipomoea reeds	16.5	0.6	200	48.50
Sorghum straw	19.5	0.7	200	0.00

Table 2: Seasonal nest occupancy patterns of *Megachile* spp. in *Ipomoea*-reed trap nests and associated parasitism by *Leucospis* spp.

Month	Number of reeds occupied	Number of brood cells	Number of megachilids emerged	Number of parasitoids emerged	% parasitism
May	0	0	0	0	0
June	29	118	12	68	89.83
July	15	51	10	22	80.39
August	6	22	3	15	86.36
September	10	44	6	32	86.36
October	30	133	12	86	90.98
November	35	164	16	96	90.24
December	48	173	35	113	79.77
January	16	66	10	57	84.85
February	12	67	5	29	92.54
March	10	45	4	17	91.11
April	15	71	7	35	90.14
Total	226	954	120	570	87.42

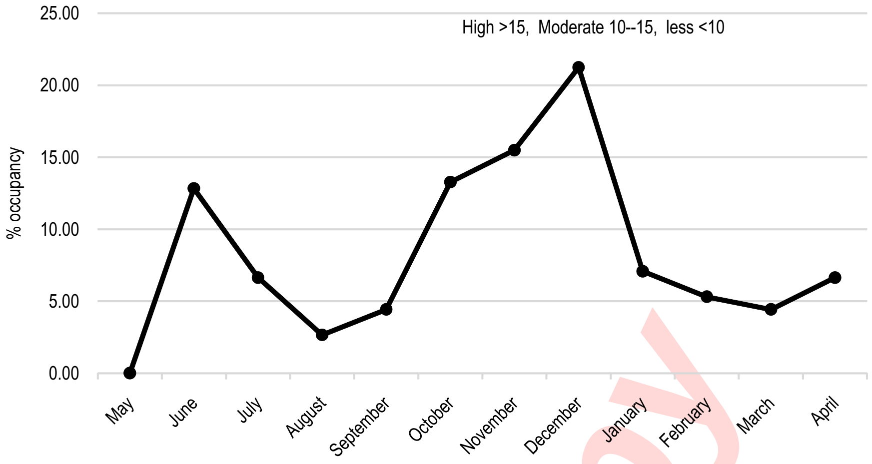


Fig. 1: Frequency of nest occupancy by megachile spp. in *Ipomoea* reeds during 2021-22.

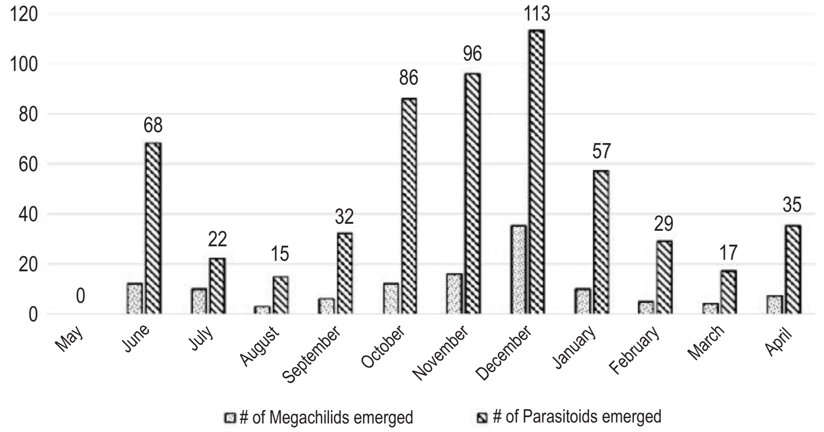


Fig. 2: Parasitization levels of megachilid bees by *Leucospis* spp.

December (21.24%), followed by a significant decrease in January-February, before reaching a secondary, smaller peak in June (12.83%). This bimodal distribution suggests two possible phenomena. One is multiple generations of megachilids with different activity periods and second one is different species of Megachilids with distinct seasonal preferences. The complete absence of activity in the month of May and low occupancy in August correlates with seasonal dynamics documented by Kim *et al.* (2006), who found that many cavity-nesting bee species avoid nesting during periods of heavy rainfall or environmental stress. Zanette *et al.* (2005) also documented that different megachilid species exhibit distinct seasonal preferences, which could explain the bimodal distribution if multiple species are utilizing the *Ipomoea* reeds at different times of the year. The temporal distribution of megachilid occupancy in *Ipomoea* reeds demonstrates clear seasonal preferences, with peak activity during winter months and a secondary peak in early summer. These patterns likely reflect adaptations to local floral resource availability, climate conditions and possibly interspecific competition dynamics among different megachilid species or generations.

The nests occupied with the megachilid bees were observed for the emergence of adults. Unfortunately, only 120 adult megachilids emerged from 954 brood cells contributes to 12.57 per cent bee emergence. The numbers of offspring varied widely among nests, 96 reeds were occupied by *Megachile* spp with the occupancy of 42.48 per cent followed by *M. lanata* (38.50 %) and *M. disjuncta* (19.03 %) (Table 3). This species diversity pattern is significant as it shows a dominance hierarchy within the megachilid community utilizing these artificial nesting structures. The data also documents several non-megachilid hymenopterans using the same hollow trap nests *viz., Rhynchium brunneum* (Eumeninae), *Zethus coelonicus* (Eumeninae), *Trypoxylon petiolatum* (Crabronidae) and

Table 3: Occupancy patterns of *Ipomoea* reed trap nests among diverse nesting taxa

Taxonomic category	Family	Number of *Ipomoea* reed occupied	Percentage	Nature of species
Megachile lanata	Megachilidae	87	38.50	Pollinator
Megachile disjuncta		43	19.03	Pollinator
Megachile spp.		96	42.47	Pollinator
Other Taxa				
Rhynchium brunneum	Vespidae	27	3.73	Predator
Zethus coelonicus		12	1.66	Predator
Trypoxylon petiolatum	Crabronidae	3	0.41	Predator
Ants	Formicidae	35	4.84	Omnivorous

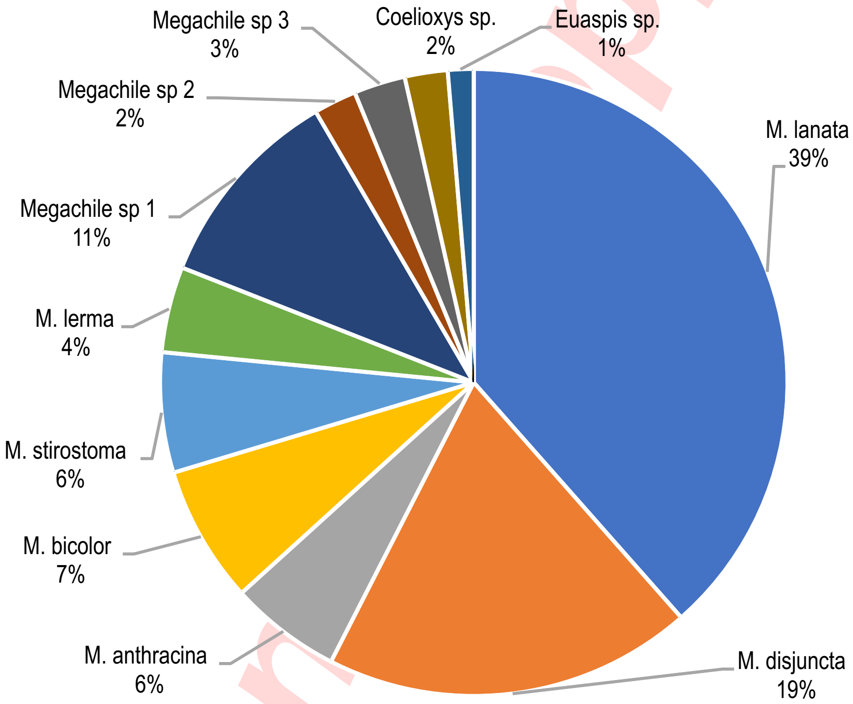


Fig. 3: Relative abundance of megachilid species.

unidentified ant species (Formicidae) (Table 3). This indicates ecological niche overlap and potential competition for nesting resources among different cavity-nesting hymenoptera. The co-occurrence of megachilid bees with potter wasps (Eumeninae) and other hymenopterans corresponds with the observations of Buschini (2006) on niche partitioning among cavity-nesting hymenoptera. The data mentions that majority of cells in the megachilid nests were parasitized, suggesting extremely high parasitism rates that prevented identification of some host species (Fig. 5). This high parasitism rate likely explains the low emergence success rate of only 12.57%. This research noted that parasitism is often the primary limiting factor in population growth for many megachile species. The low emergence rate (12.57%) combined with high parasitism suggests that while artificial nesting structures like *Ipomoea* reeds can attract nesting megachilids, additional conservation strategies may be needed to improve the reproductive success. The presence of multiple hymenopteran taxa utilizing these nests indicates their broader ecological value beyond just supporting megachilid populations. A total of 723 trap nests were deployed, of which 226 nests colonized by megachilid bees were collected and monitored for adult emergence during 2021-22. From these nests, 570 parasitoid individuals emerged, resulting in a parasitism rate of 87.42% (Table 2; Fig. 2). This study confirms that parasitism can reach even higher levels in some ecological contexts. Peak parasitism was observed during the months of October,

Fig. 4: Nest construction and occupancy of *megachilid* bees in *Ipomoea* reed trap nests. (a) Trap nests with I*pomoea cornea* reeds, (b) *Ipomoea cornea* reeds occupied by *Megachile* spp. © *Megachile* spp. occupied tunnel entrances being plugged with mud/disks, (d) Emerged adults of *Megachile lanata* from trap nests of *Ipomoea cornea.*

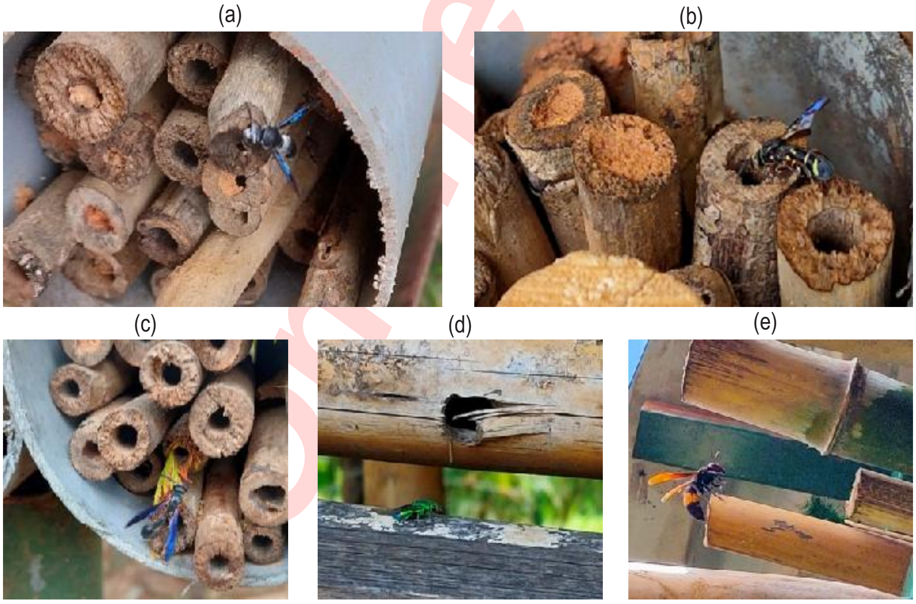


Fig. 5: Presence of parasitoids and predatory/parasitic wasps around *Ipomoea carnea* reeds occupied by *Megachile* species. (a) and (b) *Leucospis* sp. (c) Potter wasps *Zethus coelonicus* (Eumeninae), (d) Cuckoo wasps or emerald wasp (Chrysididae), (e) *Vespa tropica,* the greater banded hornet (Vespidae).

November and December (Fig. 3), indicating a seasonal pattern in parasitoid activity. Two parasitoid species *viz., Leucospis histrio* Maindron, 1878 and *Leucospis guzeratensis* Westwood, 1839 (Hymenoptera: Chalcidoidea: Leucospidae) were identified as the most prevalent natural enemies of megachilid bees at study site (Fig. 6). Notably, *L. histrio* is considered a rare parasitic wasp, previously reported only from Kerala (Girish Kumar and Sureshan, 2016). This study presents the first recorded instances

Table 4: Diversity of *Megachile* spp. in Pigeon pea and Sunn hemp ecosystems during study period

Species	**Frequency of visit 10/min**	
	Pigeon pea	**Sunnhemp**
Megachile lanata	16	3
Megachile sp. 1	8	2
Megachile disjuncta	4	1
Megachile lerma	2	-
Megachile stirostoma	2	-
Coelioxys sp.	3	-
Total number of floral visitors (10 min/5 plants)	35	6
Shannon Weiner diversity index (H)	1.4807	1.0114

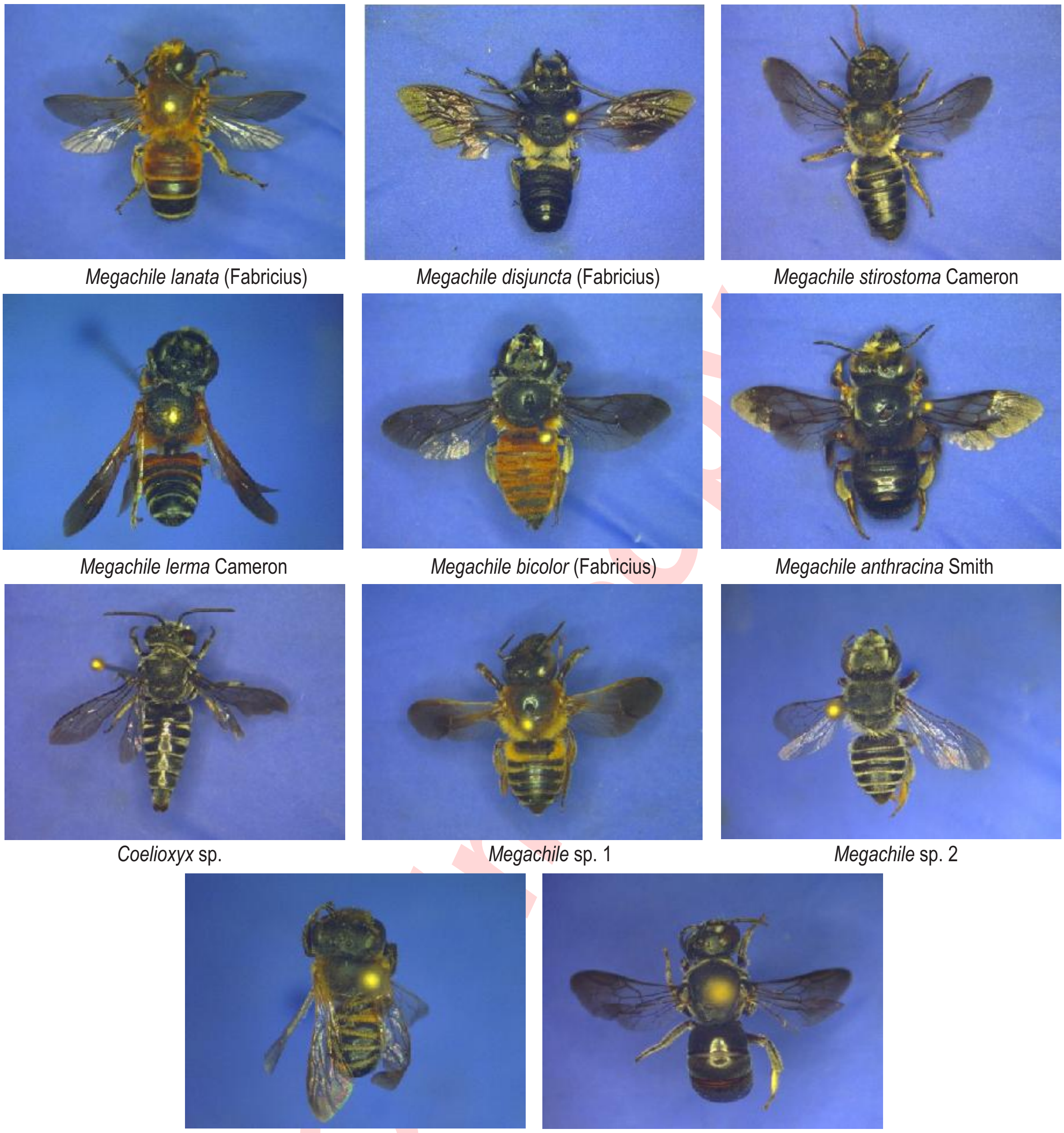
Leucospis histrio Maindron

Leucospis guzeratensis Westwood

Fig. 6: Parasitoids of *Megachile* spp.

of *L. histrio* and *L. guzeratensis* parasitizing *Megachile* spp. in India. Previous global studies have documented *Leucospis* species parasitizing megachilid bees. For example, *Leucospis affinis* Say was found parasitizing seven genera within the family megachilid (Krombein *et al.,* 1967). The nesting behavior of megachilid bees provides accessible brood cells for parasitism by *Leucospis* females, which oviposit directly into the brood cells. *Leucospis* species are also known to parasitize other solitary bees and aculeate hymenoptera, including members of subfamily Eumeninae (Vespidae) and certain Apidae species. Females preferentially target brood cells containing mature larvae at the prepupal stage. Larvae of *Leucospis* can be easily identified on the host. In the present study, observations were limited to nests containing a linear arrangement of brood cells. However, no direct evidence was recorded regarding the oviposition behavior or larval development of *L. histrio* and *L. guzeratensis,* highlighting the need for further detailed investigations into their life cycles and host interactions. Additional brood-parasitic hymenopterans from the family megachilidae were also recorded, including *Coelioxys* sp. (n = 24) and *Euaspis* sp. (n = 13). These species are well-documented cleptoparasites of *Megachile* spp., consistent with the previous reports from various geographical regions (Iwata, 1976; Scott *et al.,* 2000; Rozen and Kamel, 2007; O'Neill and O'Neill, 2016; Soh *et al.,* 2020). Identification of *Coelioxys* as a common cleptoparasite corresponds with the findings of Baker *et al.* (1985) demonstrating that *Coelioxys* species are specialized parasites of megachilid bees, with most species targeting specific host megachile species. Their study found that *Coelioxys* females typically oviposit in partially provisioned cells before the host female completes provisioning and oviposition.

The data reveals distinct patterns in *Megachilid* bee diversity and foraging behavior between pigeon pea and Sunn hemp ecosystems during November 2023 (Table 4). In pigeon pea ecosystem, the total number of 35 visits per 10 min per 5 plants were observed with species richness of 6 and Shannon-Wiener diversity index (H) of 1.4807. In sunn hemp ecosystem the total 6 visits per 10 min per 5 plants were observed with species richness of 3 and Shannon-Wiener diversity index (H) of 1.0114. The dominant species observed was *Megachile lanata* in sunn hemp (3 visits per 10 min, 50% of total visits) and pigeon pea (16 visits per 10 min, 45.7% of total visits). Pigeon pea attracted significantly higher visitation rates (5.8 times more visits per 10 min) than sunn hemp and supported twice as many *Megachile* species (6) compared to sunn hemp (3). Three species (*M. lerma, M. stirostoma* and *Coelioxys* sp.) were exclusively found on



Megachile lanata (Fabricius)

Megachile disjuncta (Fabricius)

Megachile stirostoma Cameron

Megachile lerma Cameron

Megachile bicolor (Fabricius)

Megachile anthracina Smith

Coelioxyx sp.

Megachile sp. 1

Megachile sp. 2

Megachile sp. 3

Euaspis sp.

Fig. 7: Diversity of megachile taxa.

pigeon pea and absent from sunn hemp. All species showed higher visitation frequency to pigeon pea than sunn hemp, with *M. lanata* exhibiting the most pronounced preference (16:3 ratio). The Shannon-Wiener index confirms higher diversity in the pigeon pea ecosystem (1.4807) compared to sunn hemp (1.0114).

The diversity of megachile species was recorded in the University of Agricultural Sciences, GKVK, Bangalore during 2020 to 2023. A total of 11 megachile species were identified during the study period, out of which eight were successfully classified at the species level. These included *Megachile lanata, Megachile disjuncta, Megachile stirostoma, Megachile lerma, Megachile bicolor, Megachile anthracina, Coelioxys* sp. and *Euaspis* sp (Fig. 7). The remaining three species, which could not be conclusively identified to the species level, were provisionally labeled as *Megachile* sp. 1, *Megachile* sp. 2 and *Megachile* sp. 3. Analysis of relative abundance revealed that *M. lanata* was the most dominant species in the sampling area, accounting 39% of the total individuals collected, followed by *Megachile disjuncta,* which contributed 19% to the total population. The remaining species, including both the identified and unidentified *Megachile* species as well as *Coelioxys* sp. and *Euaspis* sp., each represented less than 10% of the total abundance (Fig. 3).

The higher diversity of megachilid bees documented in leguminous crops typically support more diverse bee communities than non-leguminous crops due to their protein-rich pollen and accessible flower morphology. The dominant position of *M. lanata* in both the ecosystems aligns with Michener's (2007) documentation that certain megachilid species often become dominant pollinators in agricultural settings when suitable nesting materials are available nearby. Michener noted that *M. lanata* is particularly adaptable to various agroecosystems across tropical regions. The presence of *Coelioxys* sp. exclusively in the pigeon pea ecosystem correlates with the findings of Rozen and Kamel (2007), who observed that cleptoparasitic bees typically follow their host species' floral preferences and are more likely to be found in habitats with higher host densities floral reward quantity and quality strongly influence megachilid foraging preferences. Leguminous crops with higher protein content in pollen typically attract more bee visitors than crops with lower nutritional rewards.The presence of both common and less frequently encountered species reflects moderate diversity and suggests a stable yet specialized megachilid community within the agroecosystem of the GKVK campus. These findings contribute valuable baseline data for pollinator conservation efforts and support the importance of urban agricultural landscapes in sustaining native bee populations.

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