*J. Adv. Sci. Edu. Res.* **2022: 3: 229-239,** ISSN: 2583-0155 (ONLINE)
https://doi.org/10.56253/JASER.3.1.2022.229-239
**Published: 25.12.2023 (http://jaser.rkmvccrahara.org/)**

# An illustration on the foraging activity of *Nomia sp.* (Family Halictidae) and *Apis* (*Megapis*) *dorsata* (Family Apidae) on *Acanthus ilicifolius* at Kanaichatta, Purba Medinipur

Durga Pal[1], Dhrubajyoti Pahari[1], Tania Chatterjee[2], Sudip Mondal[3],
Dibyajyoti Ghosh[4], Punarbasu Chaudhury[2], Bulganin Mitra[5]

[1]Department of Zoology, Prabhat Kumar College, Vidyasagar University
[2]Department of Environmental Science, University of Calcutta
[3]Department of Biotechnology, Maulana Abul Kalam Azad University of Technology
[4] Southern Regional Centre, Zoological Survey of India, Chennai
[5] Centre for Insect Taxonomy & Pollinator Research, RKMVC College, Rahara

***For Correspondence:** bulganinmitra@gmail.com*

**Abstract**

Numerous scientific studies have been conducted on diverse facets of reproductive biology, specifically focusing on the anatomical elements in relation to the pollination biology of mangroves. The symbiotic relationship between insects and the mangrove ecosystem in terms of pollination is a highly significant phenomenon within the realm of natural sciences. The investigation of foraging behaviour shown by insect flower visitors is crucial for gaining a comprehensive understanding of the intricate relationship between plants and their visiting insects. This current communication offers a pictorial demonstration of the foraging behaviour exhibited by two species of pollinators (*Nomia* sp. and *Apis dorsata*) on the reproductive structures of a plant species (*Acanthus ilicifolius*) found in mangrove ecosystems. The study was conducted in Kanaichatta, Purba Medinipur, West Bengal. Among these, *Nomia* sp. is the first documented instance of being a consumer of nectar and pollen from *Acanthus ilicifolius* in Indian mangroves.

## 1. Introduction

*Acanthus ilicifolius* L. (Acanthaceae) is an evergreen non-viviparous mangrove associate, native to Asiatic countries and Pacific islands and is commonly found in moderately saline inter-tidal areas (Chatterjee et al., 2023). The name '*Acanthus'* is derived from a Greek word meaning 'spiny' and the genus is also known as 'Bear's Breeches' due to the spiny nature of the plant (Patel *et al*, 2020). As per IUCN category, *Acanthus*

*ilicifolius* is coming under Least concern (LC) category (Gowthami *et al.,*2021). All the parts of this plant have been used to cure several ailments in various traditional systems. Numerous pharmacological studies done using different types of extracts of plant are antimicrobial, anti-inflammatory, antiviral, antidiabetic, antioxidant, cytotoxic and anticancer activities, antinociceptive, hepatoprotective, leishmanicidal and osteoblastic activity which contributed to the use of *Acanthus ilicifolius* in ethnomedicine (Patel *et al*, 2020).

*Acanthus ilicifolius* is a spiny semi-woody, bushy, evergreen shrub with a height of 0.6 to 1.5 m on average (Plate-1a). It has spines on the margins on its leaves (Plate-1b) and at stem nodes (Santhiavalli and Jayanthi 2016). This plant has a very dense growth, bears shallow tap roots, but stilt roots also can be seen occasionally (Verma and Shah 2020). The flowers of *A. ilicifolius* are arranged in raceme inflorescences (Plate-1c). This plant has large gullet shaped flowers with green calyx and violet corolla (Plate-1d,e &f). Flowers are about 50 mm long and 32 mm in diameter. Flowers are usually sessile, 2-lipped, hairy outside (Chatterjee et al., 2023). The pollen grains are monosiphonous, dispersed as single grains, aperturate, tri-colporate, yellow, powdery, and 49.8 µm in size (Solomon Raju et al., 2017). The configuration of sex organs (Plate-1g &h) and the differential maturation of stamens and stigma were found to prevent self-pollination within the flower but not within the plant and it is further supplemented by strong protandry.

The ring of dense hairs presents at the base of the stamens where the floral tube narrows, points upward and outward; this arrangement prevents insects from crawling into the floral tube (Solomon Raju et al., 2017). Fruits kidney shaped, grey (Plate-1i), 2.5 cm - 3.0 cm long, 1.0 cm diam (Solomon Raju et al., 2017). The flowering season of this plant in the Sundarbans is from May to August (Chakrabarty et al. 2022). But in Kanaichatta, the flowering season was observed from 02.05.23 to 08.07.23. The flowers usually last two days while some fall off after three to four days.

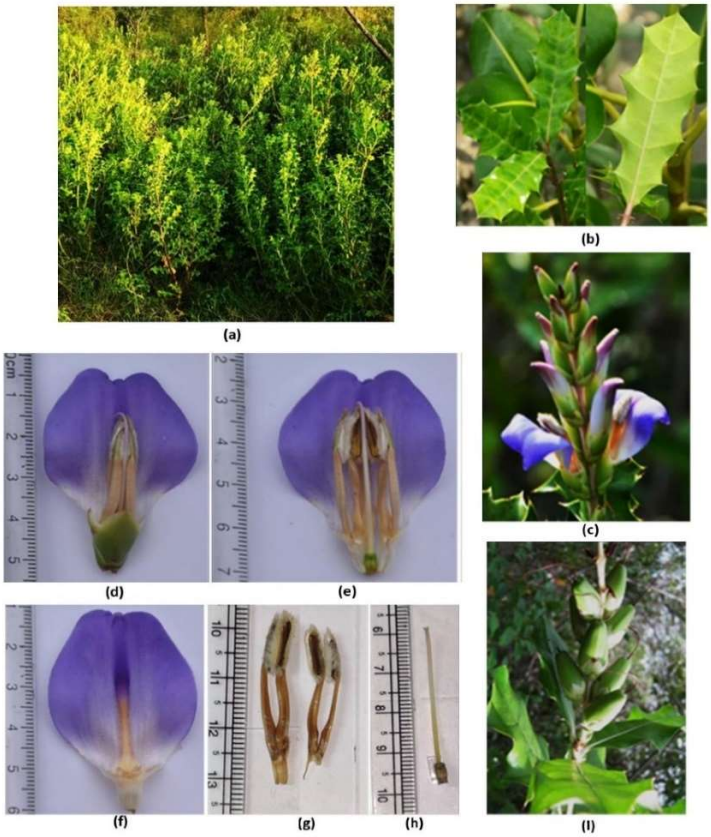


**Plate:1.** a) Whole plant, b) leaves, c) inflorescence, d) flower, e) L.S. of flower, f) petal, g) androecium, h) gynoecium i) fruit

## 2. Materials and Methods

### Study sites

Purba Medinipur District was formed on 1st January 2002 after the partition of Midnapur into Purba Medinipur and Paschim Medinipur which lies at the northern and western border of it. The state of Odisha is at the southwest border; the Bay of Bengal lies in the south; the Hooghly River and South 24 Pargana District to the east; and Howrah district to the north-east (Fig.1).

The Coastal belt of Purba Medinipur district represents 27% of West Bengal of coastal tract. It starts from the mouth of Rasulpur river near Hijli Sarif of Khejuri extended upto the Udoypur of Digha border and about 68 km distance. This belt lies between 21°51′27′′ N to 21°36′50′′ N latitude and 87°29′88′′ E to 88°12′40′′ E longitude (Das et al., 2015).


Fig.1. Map showing the Purba Medinipur district and the study area

Kanaichatta is situated in between 21° 47' 52.0764" N to 87° 53' 12.678" E, 10-12 km away from Junput on the bank of Hooghly estuary (Fig.1). The mangrove patch of Kanaichatta is more than 1 km long stretch along the coast of Hooghly river (Fig.2). This area is with Clay-Loamy and sandy soil and partially submerged during high tide (Fig.3).


Fig.2. Green line marking the mangrove zone of Kanaichatta

Fig.3. Inside the mangrove forest of Kanaichatta

The study area is covered with 12 types of mangrove species, of which, predominant species are *Aegiceras corniculatum, Avicennia marina, Avicennia officinalis, Exoecaria agallocha, Ceriops decandra* and *Bruguiera gymnorhiza*. A highly dense vegetation of *Acanthus ilicifolius* is also found here along with mangrove associated species like, *Clerodendrum inerme, Suaeda nudiflora, Suaeda monoica, Sesuvium portulacastrum* and *Ipomoea pes-caprae*.

**Collection Methodology**

The insects were collected from the flowers by insect net and then kill it by using Ethyl Acetate, after this procedure, the insects were enveloped as per dry preservation technique. The collected and preserved insects brought to the laboratory and identified by the help of experts in Zoological Survey of India, Kolkata.

**3. Result and Observation**

Present communication records the visual foraging activities of two hymenopteran species of two families, *Nomia* sp. (Halictidae) and *Apis* (*Megapis*) *dorsata* Fabricius, 1793 under the superfamily Apoidea on *Acanthus ilicifolius* L. in the mangrove of Kanaichatta, Purba Medinipur.

*Nomia* is a cosmopolitan genus of sweat bees in the family Halictidae and represented with 09 species in the Indian mangroves (Rajmohana & Kumar, 2019). *Nomia* species are moderate-sized, solitary ground nesting bees and an effective pollinator of angiosperms (Rajmohana & Kumar, 2019). These species are distinguished by their round shaped marginal cell and the second submarginal cell being shorter than the first and third. The basal vein is not as curved as other members of the family Halictidae. In the course of the current study, it was observed that *Nomia* sp. exhibited consistent visitations to *Acanthus ilicifolius* during its flowering season, which spanned from May 2nd to July 8th, 2023. However, the quantity and actions of the individuals were seen to be more prominent throughout the months of May in Kanaichatta. The observed species exhibited temporal variation throughout the duration of the study, spanning from 6 am to 6 pm. The findings of the present study indicate that *Nomia* sp. initiates its foraging behaviour in the late morning, specifically at 9 am, with a subsequent steady decline in activity observed from 10.30 am onwards. The individuals were predominantly observed in a collective consisting of seven to eight members or in a larger group. These insects are mostly observed to exhibit flight patterns from ground level to vegetation' s comparatively higher heights, making them challenging to capture with standard insect nets. This difficulty can be attributed to their remarkable speed and the presence of spiky leaves on the *Acanthus ilicifolius* plant. This study observed that the bees exhibited a preference for the plant, initiating their approach rapidly (Plate-2a).

Upon reaching the plant, the insects exhibit a characteristic behaviour of hovering around the blooms in a zigzag pattern, as depicted in Plate-2b and 2c. The bees were promptly placed on the androecium, or male reproductive organs, of the flower (Plate-2d). Typically, the anthers of *Acanthus* plants are externally visible and extend beyond the surrounding structures. The pollen grains are organised in longitudinal patterns along the ventral lips of each anther in the *Acanthus* flower (Plate- 2e). Subsequently, the bees attempted to access the anther lobes in order to extract the pollen (Plate-2f). All of these events were executed within a time frame of 2 to 5 seconds, after which they transitioned to the subsequent event.

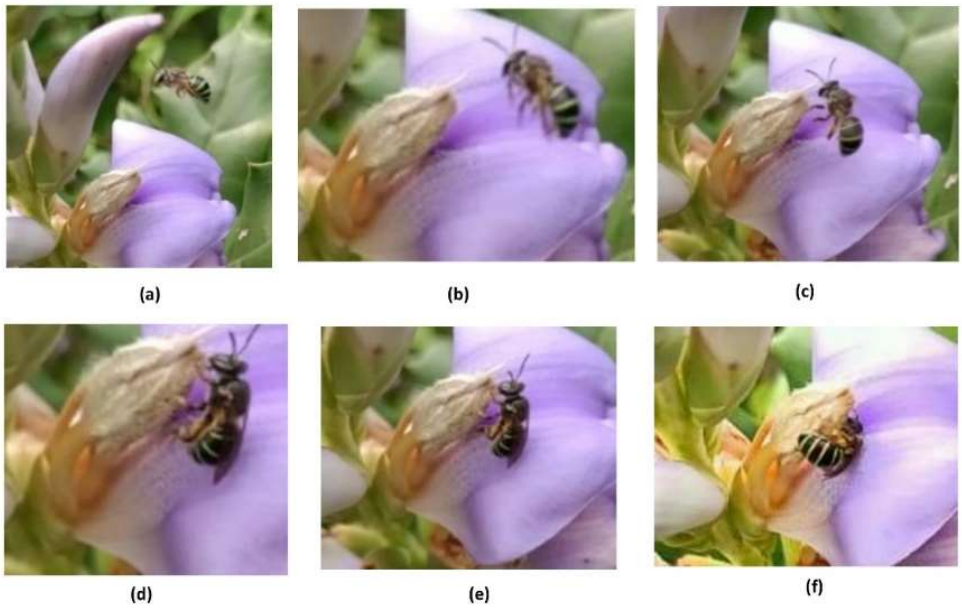


**Plate:2.** a) Sweat bees approaching to Plant, b) close to flower head, c) hovering on the flower, d &e) landed on the flower, f) tried to open the anther lobes.

The second pollinator of *Acanthus ilicifolius* was identified as *Apis (Megapis) dorsata*, often known as the Rock bee or Giant bee (Plate-3a-f). The bee under consideration is one of the largest known species within the bee taxonomic group, characterised by specific measurements of body length ranging from 17 to 20 millimetres, and forewing length ranging from 12 to 15 millimetres. In addition to other honeybee species, *Apis dorsata* has a notable variability in hue, which is contingent upon the specific race and is also associated with its geographical range. These organisms are distributed extensively from the urban ecosystem to several sub-mountainous regions in India.

The hind wing exhibits a discernible distal abscissa in vein M, along with an expansion of the radial vein. The forewings exhibit a fuscous coloration. The basitarsus possesses a copious pad of robust, bifurcated hair. The drone possesses an endophallus consisting of four pairs of elongated and slender structures, accompanied by small bulbed cornua. The scutellum of workers is characterised by a brownish-black colour, whereas queens and drones have a reddish-brown hue. The metasomal segments of the worker have a coloration ranging from black to dark brown, specifically in the T3–T4 segments. The workers have elevated ocelli. The sting apparatus of the organism in question is composed of 11 lancet barbs and 2-4 pairs of stylet barbs. According to Jayasvasti and Wongsiri (1993), the distance from the tip of the lancet to the first barb measures 77.92 µm. The drones possess meta- and mesotarsi that are equipped with condensed frond-like setae.

The findings of the current investigation indicate that the foraging period of *Apis dorsata* occurred within the time frame of 8:30 am to 11:00 am. However, the period of highest visitor activity occurred during the time frame of 9-10am. The observed behaviour of these organisms consistently involved their presence within a collective, which had a notable impact on the foraging behaviours of smaller members of the bee and fly species.

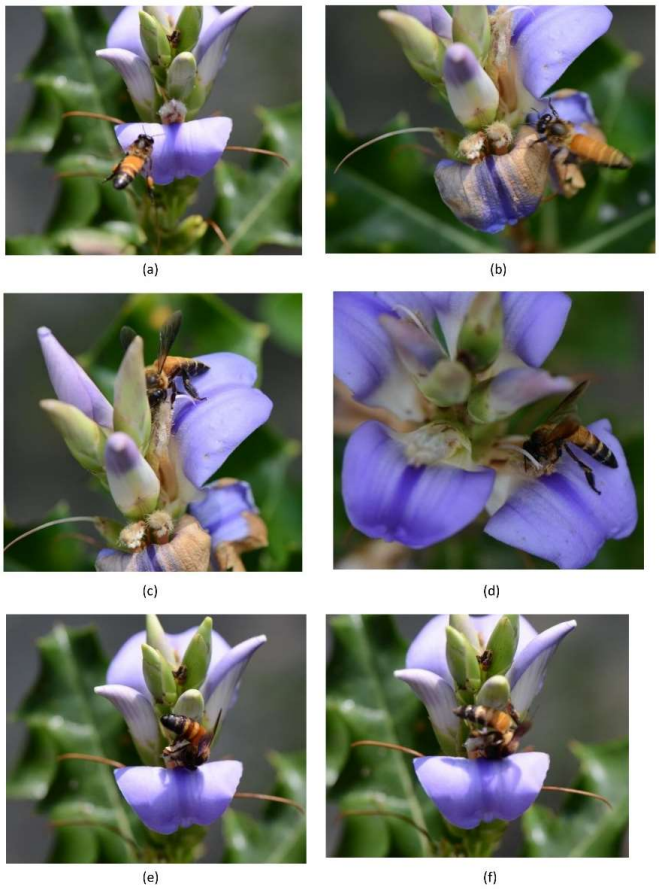


**Plate:3.** a &b) Approaching to flower, c & d) scooping the pollen, e &f) searching for nectar

The observation reveals that the bees exhibited a direct approach towards the reproductive organs of the flower, as depicted in Plate-3a and 3b. Upon alighting on the flower, the bees promptly commenced the process of extracting pollen from the anther (Plate-3c & d). Subsequently, the bees immersed themselves within the depths in order to obtain nourishment from the nectar (Plate-3e & f). The findings of this study indicate that the duration of time spent by *A. dorsata* on flower heads is dependent upon the quantity of flowers that have bloomed within the designated study region. The findings indicate that when the study area exclusively consists of *A. ilicifolius* flowers, *A. dorsata* bees exhibit a significantly longer duration of visitation to the flower head, ranging from 120 to 240 seconds. However, when the study area includes additional flowering plants in addition to *A. ilicifolius*, the average time spent by *A. dorsata* bees decreases substantially, ranging from 50 to 60 seconds.

**4. Discussion**

*Acanthus ilicifolius* is a plant species that exhibits hermaphroditism, with a robust protandrous reproductive system. It is capable of self-compatibility and has the ability to engage in facultative xenogamy. Additionally, this species displays temporal dioecy and relies on pollination by bees (Solomon Raju et al. 2017). They have stated that, the floral mechanism exhibits a high degree of specialisation and is well-suited for pollination by bees with huge body sizes. This study aims to illustrate the foraging behaviours of two prominent hymenopteran species through the utilisation of photographic documentation. The focal point of this investigation is the foraging behaviours seen on *Acanthus ilicifolius*, a plant species, located at Kanaichatta in the Purba Medinipur region.

The initial documentation of an unnamed species of *Nomia* in a mangrove habitat was reported by Solomon Raju *et al*. (2006). That report identified the *Nomia* species as a pollinator of *Ceriops decandra* in the Coringa Mangrove
Wetland, Andhra Pradesh, India. Subsequently, Solomon Raju & Karyamsetty (2008) documented the discovery of an additional unidentified species of *Nomia* serving as a pollinator for *Ceriops decandra* in the Krishna and
Coringa mangrove forests of Andhra Pradesh. Afterwards, an unidentified species of *Nomia* was reported as pollinator of *Avicennia alba* Bl from the Godavari mangrove forests of Andhra Pradesh by Solomon Raju *et al.* (2012). In another study in Coringa mangrove forests, Solomon Raju *et al*. (2014) reported *Nomia* sp. as a pollinator of *Lumnitzera racemosa*. Afterwards, Solomon Raju & Kumar (2016) documented an unidentified species of *Nomia* as a pollinator of a perennial woody climber, *Derris trifoliata* from the Godavari mangrove wetland.

This present communication reports *Nomia* sp. as a pollen and nectar feeder of *Acanthus ilicifolius* for the first time from the mangrove ecosystem of India with a particular focus on Kanaichatta in Purba Medinipur, West Bengal. Numerous scholarly publications have been dedicated to documenting the foraging behaviour and pollination contribution of *Apis dorsata* in the mangroves of India. Several studies have documented the presence of *Apis dorsata* in various plant species, including *Avicennia officinalis* and *Rhizophora mucronata* (Chatterjee *et al*., 2008). Additionally, Pandit and Choudhury (2001) and Pandey and Pandey (2014) have recorded the occurrence of *Apis dorsata* in *Aegiceras corniculatum*. Solomon Raju (2014) has observed *Apis dorsata* in *Avicennia alba* and *A. officinalis*, as well as in *Lumnitzera racemosa*. Moreover, *Apis dorsata* was

documented by Solomon Raju and Kumar (2016) in their study, where they observed its presence in *Derris trifoliata* and *Suaeda monoica*. Additionally, Chakraborti *et al.* (2019a, 2019b, and 2021) revealed the occurrence of *Apis dorsata* in *Avicennia officinalis, Avicennia marina*, *Aegiceras corniculatum,* and *Aegialitis rotundifolia* from mangrove ecosystems of Sundarban Biosphere Reserve. In a recent study conducted by Chatterjee *et al.* (2023), it was documented for the first time that *Apis dorsata*, often known as the giant honey bee, serves as a floral visitor of *A.ilicifolius* in the Indian Sundarbans region. The present observation is the second documented instance of *Apis dorsata* as a flower visitor and pollinator of *A.ilicifolius* in the region of West Bengal.

The state of West Bengal comprises two coastal districts, namely the South 24 Parganas, which is characterised by the presence of the Sundarban mangrove ecosystem, and Purba Medinipur, which has recently witnessed the development of a new mangrove patch. The current investigation is the initial scholarly report on the pollination of mangroves in Kanaichatta, Purba Medinipur, subsequent to the Sundarban Biosphere Reserve in West Bengal, as documented by Mitra et al. (2014).

**5. Acknowledgement**
The authors would like to express their sincere thanks to Swami Kamalasthananda, Principal, Ramakrishna Mission Vivekananda Centenary College, Rahara, Principal Prabhat Kumar College, Contai, Purba Medinipur, Divisional Forest officer and staffs of Forest Department, Govt. of West Bengal. Director, Zoological Survey of India, Kolkata for their necessary support and giving us opportunity to complete this work.

**6. References**

Buchmann, S.L. 1983. Buzz pollination in angiosperms. In: Jones CE, Little RJ (Eds) Handbook of Experimental Pollination Biology. Van Nostrand-Reinhold, Pronceton, 73–113.

Cane, J.H. 1979. The hind tibio-tarsal and tibial spur articulations in bees (Hymenoptera: Apoidea). *J. Kans. Entomol*., **52**: 123-137

Cardale, J.C. 1968. Nest and nesting behaviour of *Amegilla* (*Amegilla*) *pulchra* (Smith) (Hymenoptera: Apoidea: Anthophorinae). *Aust. J. Zool*, 16: 689–707.https:// doi.org / 10.1071/zo9680687

Chakrabarty, S., Chatterjee, T., Gaine, T., Bhattacharjee, S. and Chaudhuri, P. 2022. Vegetative and reproductive phenology of dominant mangrove species: a multi-parametric approach from Indian Sundarbans. **Unpublished Manuscript.**

Chakraborti, U., Mitra, B. and Bhadra, K. 2019a. Foraging Behaviour of *Apis* (*Megapis*) *dorsata* on two Mangrove Plant Species. *Ambient Science*, 06(2); 1-4. Online DOI:10.21276/ambi.2019.06.2.ra02

Chakraborti, U., Mitra, B. and Bhadra, K. 2019b. Diversity and ecological role of insect flower visitors in the pollination of mangroves from the Indian Sundarbans. *Current Science*, 117(6) :1060-1070.

Chakraborti, U., Mitra, B. and Bhadra, K. 2021. Island Based Assemblage Pattern and Foraging Profile of Insect Flower Visitors on *Aegialitis rotundifolia* —a Near Threatened Mangrove Plant from Indian Sundarban. *Neotrop. Entomol*. 51(1), 32-42. https://doi.org/10.1007/s13744-021-00911-0

Chatterjee, D., Remadevi, O.K. and Latheef, A. 2008. Insect-mediated pollination in three major mangrove species on the Karnataka coast, India. Proc. FORTROP II: Tropical forestry change in a changing world. Bangkok, Thailand. Pp.117-131.

Chatterjee, T., Chakrabarty, S., Roy, S., Biswas, O., Mitra, B. and Chaudhury, P. 2023. Spatial and temporal variation of floral visitors and their visitation pattern on *Acanthus ilicifolius* L.: a case study from the mangrove ecosystem of Indian Sundarbans. *J. Insect Conserv.*, 1- 11. https://doi.org/10.1007/s10841-023-00472-0.

Das, D.C., Pati, M., Mahato, G. and Das, M. 2015. Study of tidal vegetation of Purba Medinipur district of West Bengal, India. *Int. J. Bioassays*, 4 (05), 3915-3921

Dollin, A., Batley, M., Robinson, M., and Faulkner, B. 2000. Native Bees of the Sydney Region, a Field Guide. Richmond: Australian Native Bee Research Centre.

Engel, M. S. 2018. A new genus of anthophorine bees from Brunei (Hymenoptera: Apidae). J. *Melittol*., 78: 1–13.

Gowthami, R., Sharma, N., Pandey, R. and Agrawal, A. 2021. Status and consolidated list of threatened medicinal plants of India. *Genet. Resour. Crop Evol.,* 68: 2235–2263.

Gupta, R.K. 2004. The diversity of bees (Hymenoptera, Apoidea) in India. In Gupta, R. K. (Ed.), Advancements in insect biodiversity. *Agrobios* (India). Pp. 53-77.

Jayasvasti, S. and Wongsiri, S. 1993. Scanning electron microscopy analysis of honey bee -. stings of six species (*Apis florea, Apis dorsata, Apis cerana, Apis koschevnikovi, Apis florea,* and *Apis andreniformis*). *Honeybee Sci*., 14: 105-109.

Leijs, R., Batley, M. and Hogendoorn. K. 2017. The genus *Amegilla* (*Hymenoptera*, *Apidae*, *Anthophorini*) in Australia: A revision of the subgenera *Notomegilla* and *Zonamegilla*. Zookeys. 2017; (653): 79–140.

Mitra, B., Biswas, O., Roy, S. and Chakraborti, U. 2014. Pollinators of Mangroves in the perspective of Indian Sunderbans. *ENVIS Newsletter*, Zoological Survey of India, 21:6-11

Pandey, R. and Pandey, C.N. 2014. Reproductive strategy of., (Blanco.)-A Mangrove species, in MNP&S, Gujarat, India., 3(1):35-55.

Pandit, S. and Choudhury, B.C. 2001. Factors affecting pollinator visitation and reproductive success in Sonneratia caseolaris and Aegiceras corniculatum in a mangrove forest in India. J. Trop. Ecol., 17: 431-447.

Patel, R., Patel, N., Patel, K., Patel, M., Patel, K., Verma, P. and Shah, M. 2020. Acanthus ilicifolius: a true mangrove with biomedical potential. World J Pharm Pharm Sci., 9(11):471–489. https://doi.org/10.20959/wjpps202011-17428

Rayment, T. 1935. A Cluster of Bees. Endeavour, Sydney, 752 pp.

Rajmohana, K. and Girish Kumar, P. 2019. Insecta : Hymenoptera–Wasps, Bees and Ants. In: Faunal Diversity of Mangrove Ecosystem in India : 347-372. (Published by the Director, Zool. Surv. India, Kolkata)

Saini, J., Sharma, S.L. and Gupta, R.K. 2016 Taxonomy of the bee genus Amegilla Friese (Apoidea, Apidae: Anthophorini) with eight species first ever recorded from Rajasthan, India with a dichotomous key and a complete distribution record. J. Environ. Biosci., 30, 567–572.

Santhiavalli, P. and Jayanthi, G. 2016. A study on the anatomical characteristics of Acanthus illicifolius Linn. European j. pharm, 3(9):354–361. https://www.ejpmr.com/home/abstract_id/1483

Solomon Raju, A. J. 1990. Observation on the floral biology of certain mangroves. Proc Natl Acad Sci India Sect B Biol Sci. 56(4):367-374.

Solomon Raju A. J., Jonathan, K.H., Lakshmi, A.V. 2006. Pollination biology of Ceriops decandra (Griff.) Ding Hou (Rhizophoraceae), an important true viviparous mangrove tree species. Current Science91: 1235–1238

Solomon Raju A. J., Karyamsetty H.J. 2008. Reproductive ecology of mangrove trees Ceriops decandra (Griff.) Ding Hou and Ceriops tagal (Perr.) C.B. Robinson (Rhizophoraceae). Acta Bot. Croatica, 67: 201-208.

Solomon Raju, A.J., P.V.S. Rao, Kumar, R., Mohan, S.R. 2012. Pollination biology of the crypto-viviparous Avicennia species (Avicenniaceae). Journal of Threatened Taxa, 4(15): 3377–3389.

Solomon Raju, A.J., Kumar, R., Rajesh, B. 2014. Pollination Ecology of Lumnitzera racemose willd. (combretaceae), a non-viviparous mangrove tree. TAPROBANICA, 06 (02):100–109.

Solomon Raju, A.J., Kumar, R. 2016. Pollination ecology of Derris trifoliata (Fabaceae), a mangrove associate in Coringa Mangrove Forest, Andhra Pradesh, India. Journal of Threatened Taxa 8(5): 8788–8796.

Solomon Raju, A.J. and Kumar, R. 2016. On the reproductive ecology of Suaeda maritima, S. monoica and S. nudiflora. JoTT, 8: 8860-8876

Solomon Raju, A. J., Bethapudi, R. and Chappidi, P. R. 2017. Reproductive Ecology of Acanthus ilicifolius L., a Non-Viviparous Mangrove Associate in Coringa Mangrove Forest, Andhra Pradesh (India). Transylv. Rev. Syst. Ecol. Res., 19(3): 17-28.

Verma, P. and Shah, M. 2020. Acanthus Ilicifolius: a true mangrove with biomedical potential. World J Pharm Pharm Sci, 9:472–489. https://doi.org/10.20959/wjpps202011-17428