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SHORT NOTE

Exploring the Diverse Range of Bee Pollinators Associated with the Medicinal Plant *Vitex negundo* (Lamiaceae) in West Bengal, India

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Abstract
Chinese chaste tree, *Vitex negundo* L., (family Lamiaceae) is an important medicinal plant. The present study focused on the floral morphology and the diversity of bees pollinating its flowers in three different geographical regions of West Bengal, identifying 56 species from 20 genera across four families of Apoidea.

Vitex negundo L., commonly known as the Chinese chaste tree, is a woody, aromatic shrub in the Lamiaceae family that typically bears tri- or penta-foliate leaves on quadrangular branches and bluish-purple flowers. It is native to South and Southeast Asia, including the Indian subcontinent, and thrives in humid regions or near water bodies in wastelands and open forests (Vishwanathan & Basavaraju, 2010). *V. negundo* has significant medicinal value and is widely employed for treating various health disorders in folk and traditional medicine, such as Ayurveda and Unani. The plant, including its fruits, leaves, roots, and stems, has been utilized for remedies through pastes, decoctions, and dried fruits since ancient times. Several secondary metabolites extracted from *Vitex* include terpenes, steroids, flavonoids, and phenolic compounds, which are recognized for exhibiting anti-inflammatory, antifungal, analgesic, tonic, and antimicrobial properties. Additionally, several other compounds show anti-proliferative properties, cytotoxic activity, and a dopaminergic effect. Numerous supplement companies have successfully commercialized *Vitex*-based products. In India, plant extracts assist women postpartum, enhance lactation, and alleviate childbirth stress. Decoctions of the root, bark, and flower have also been used to treat gastrointestinal disorders, and leaves are employed to relieve headaches. Plant juices are effective in treating respiratory disorders like cough and sore throat. Root tincture and leaf extracts are utilized for rheumatism (Kamal et al., 2022). Leaf pastes and juice are beneficial for skin infections such as cellulitis, hives, and carbuncles through topical application (Saikia et al., 2006). It is commercially cultivated in several tropical and subtropical regions across Africa, Asia, and Australia (Vishwanathan & Basavaraju, 2010). Functionally, the reproductive structures of this plant exhibit entomophilous characteristics, and bees (Hymenoptera: Apiformes) play a crucial role in its pollination (Kumar et al., 2017). In West Bengal, India, this plant grows wild and is locally known as “nishinda.” Here, it flowers from March to October and attracts several bee species that aid in its pollination. This study has documented the diversity of bees visiting and pollinating *Vitex negundo* flowers.

Surveys were conducted in five districts of West Bengal, representing three unique geographical regions. These include the Alipurduar and Cooch Behar districts that are located at the foothills of the great Himalayas; the Bankura and Purulia districts, part of the Chhota Nagpur Plateau; and the South 24 Parganas district, encompassing the diverse Sundarbans. These three regions have radically different agro-climatic situations, with the sub-Himalayan terai region characterized by high humidity and rainfall; the Chhota Nagpur Plateau is a dry tract; and the Sundarbans has a tropical coastal saline belt, resulting in an extensive variation in the floral and faunal diversity among these three regions. Three locations with flowering patches of *V. negundo* plants were chosen from each district and observed between 09:00 am and 05:00 pm during March-October of 2023-2024 for bee visitation. Field photographs of bees were captured using a Samsung S21FE mobile phone and a Nikon D5600 digital camera. Representatives were collected using an aerial insect net and preserved in 70% ethanol. Collected samples were dried, pinned, observed under a Nikon SMZ25 stereo-zoom microscope, and identified up to family, genus, subgenus, and species level using appropriate taxonomic keys and corresponding literature (van der Vecht, 1952; Lieftinck, 1962; Hirashima, 1969; Engel, 2007; Michener, 2007; Pauly, 2009; Ascher et al., 2016; Nidup & Dorji, 2016; Saini et al., 2018; Falswal et al., 2022). Voucher specimens are deposited at the National Zoological Collection (NZC), Zoological Survey of India.

The inflorescence in *Vitex negundo* is a terminal panicle (Figure 1a), and anthesis occurs in acropetalous order. Flowers are purple coloured, hermaphroditic, zygomorphic, gamosepalous, gamopetalous, and partially herkogamous (Figure 1b-e). The calyx is green, campanulate with bluntly pointed lobes. The corolla is tubular basally with a small amount of concentrated nectar and bilabiate, with one bilobed upper lip and four lower lips (lateral lips larger, median lips smaller) covered in dense hairs. Androecium is epipetalous, didynamous, with dithecous anthers that dehisce through longitudinal slits to release white, ellipsoidal, sticky pollen (Figure 1f-i). Gynoecium with a superior globose ovary with four locules having one ovule each, carpel surrounded by stamens, stigma bifid and situated above the level of anthers (Figure 1j-l). Fruits are spherical drupes with the basal portion enclosed by the persistent calyx and turn brown upon ripening (Figure 1 m-n). Several insect species, mainly bees, were observed to visit the flowers at different times of the day (Figure 2). A total of 784 bee specimens belonging to 56 species from 20 genera across four Apoidea families (Table 1) have been observed visiting *V. negundo* flowers. Within Apidae, 20 species belonging to 07 genera; within Halictidae, 19 species belonging to 08 genera; within Megachilidae, 15 species belonging to 04 genera; and two species belonging to one genus within Andrenidae were found to be effective pollinators of *V. negundo*.

This comprehensive documentation of bee diversity pollinating *V. negundo* in West Bengal, particularly the presence of certain pollinators in specific regions, contributes significantly to our understanding of plant-pollinator interactions and the preferences of bee species. Among these four families, Apidae had the maximum number of representatives (35.71%), whereas only two species of *Andrena,* representing Andrenidae, were documented visiting the chaste tree flowers. The pollinator species composition varied across the five districts, with the Cooch Behar district having the highest bees species richness (50 species). In contrast, South 24 Parganas has the lowest species richness (43 species).

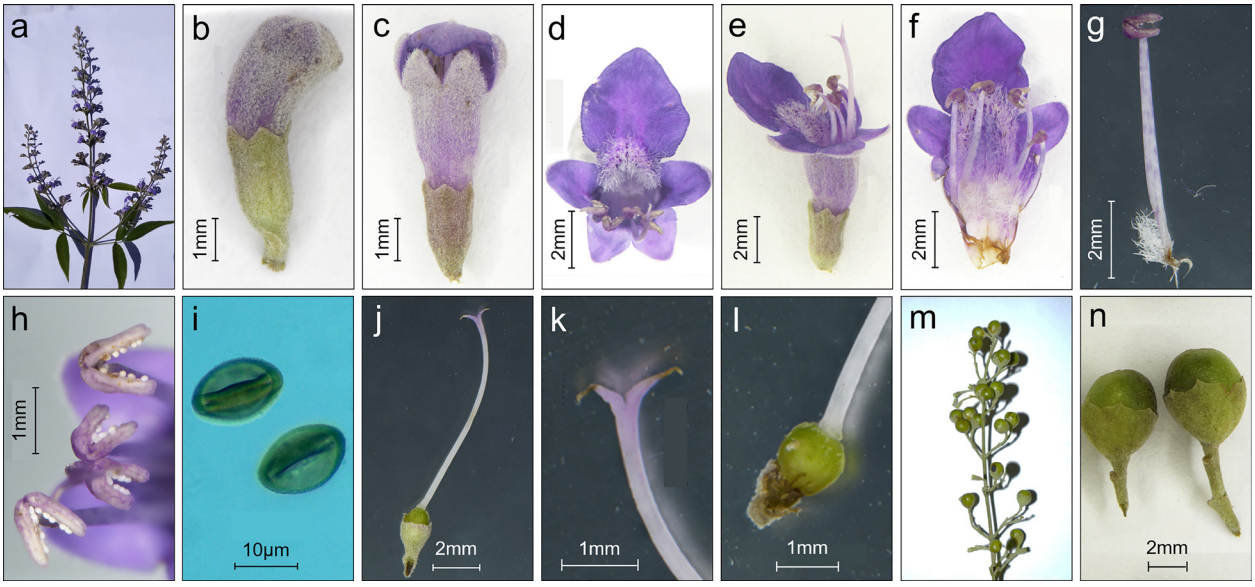

Fig 1. *Vitex negundo* floral and fruit structures. (a) Flowering inflorescence; (b) Mature flower bud; (c) Initiation of flower opening; (d) Fully opened flower; (e) Bifid stigma extended beyond stamen height; (f) Epipetalous and didynamous stamens; (g) Detached stamen; (h) Dehisced anthers;(i). Pollen; (j) Pistil; (k) stigma; (l) Ovary; (m) Fruiting inflorescence; (n) Mature fruits with attached calyx.

Fig 2. Field photographs of bee pollinators visiting nishinda flowers. (a) *Amegilla violacea*; (b) *Amegilla cingulifera*; (c) *Amegilla* nr. *zonata*; (d) *Apis cerana*; (e) *Apis dorsata*; (f) *Apis florea*; (g) *Braunsapis* sp.; (h) *Ceratina binghami*; (i) *Ceratina compacta*; (j) *Ceratina lieftincki*; (k) *Ceratina simillima*; (l) *Tetragonula bengalensis*; (m) *Thyreus himalayensis*; (n) *Thyreus histrio*; (o) *Xylocopa fenestrata*; (p) *Xylocopa aestuans*; (r) *Curvinomia fulvata*; (s) *Curvinomia iridescens*; (t) *Gnathonomia thoracica*; (u) *Hoplonomia elliotii*; (v) *Hoplonomia westwoodi*; (w) *Lasioglossum albescens*; (x) *Lasioglossum cavernifrons*; (y) *Pseudapis oxybeloides*; (z) *Seladonia* sp.; (aa) *Coelioxys confusus*; (ab) *Coelioxys* nr. *capitatus*; (ac) *Euaspis carbonaria*; (ad) *Heriades* sp.; (ae) *Megachile bicolor*; (af) *Megachile conjuncta*; (ag) *Megachile laticeps*; (ah) *Megachile disjuncta*; (ai) *Megachile lerma*; (aj) *Megachile umbripennis*; (ak) *Megachile fraterna*; (al) *Megachile* sp. 1; (am) *Megachile* sp. 2; (an) *Megachile vigilans*.

Some bee species, like *Apis florea* Fabricius, *Tetragonula bengalensis* (Cameron), *Pseudapis oxybeloides* (Smith), *Megachile fraterna* Smith, and *M. vigilans* Smith, have not been recorded to pollinate *V. negundo* in the sub-Himalayan terai, indicating their preference for this plant exclusively in the southern part of West Bengal. Conversely, species like *Xylocopa aestuans* (Linnaeus), *Austronomia* nr. *pilitrochanter* Pauly, *A. pseudoscutellata* Pauly, *Curvinomia fulvata* (Fabricius), *Gnathonomia thoracica* (Smith), and *Lipotriches ceratina* (Smith) have only been recorded from the sub-Himalayan terai, representing the variation in pollinator species composition with a strong preference for *V. negundo* across the different geographical regions of West Bengal.

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Authors' Contribution

RN: Collection, data resources, identification, photography, manuscript preparation, and editing.
SS: Collection, photography, manuscript preparation.
SD: Identification and imaging.
BM: Identification and imaging.
SS: Identification, manuscript preparation, and editing.
PD: Collection, photography, and manuscript preparation.
AR: Conceptualization, identification, manuscript preparation, and editing.

Table 1. Region-specific richness of different bee pollinator species in *Vitex negundo* L.

Sl. N°	Family	Bee species	Material examined	District-wise Species Richness				
				Sub-Himalayan Terai		Chota Nagpur Plateau		Sundarban
				Alipurduar (S = 47)	Cooch Behar (S = 50)	Bankura (S = 49)	Purulia (S = 48)	South 24 Parganas (S = 43)
1	Apidae	*Amegilla* (*Glossamegilla*) *violacea* (Lepeletier)	4♂, 4♀	A	A	P	P	A
2		*Amegilla* (*Zonamegilla*) *cingulifera* (Cockerell)	5♂, 1♀	P	P	P	P	P
3		*Amegilla* (*Zonamegilla*) nr. *zonata* (Linnaeus)	4♂, 2♀	P	P	P	P	P
4		*Apis* (*Apis*) *cerana* Fabricius	25♀	P	P	P	P	P
5		*Apis* (*Megapis*) *dorsata* Fabricius	31♀	P	P	P	P	P
6		*Apis* (*Micrapis*) *florea* Fabricius	27♀	A	A	P	P	P
7		*Braunsapis* sp.	5♂, 9♀	P	P	P	P	P
8		*Ceratina* (*Ceratinidia*) *compacta* Smith	19♂, 17♀	P	P	P	P	P
9		*Ceratina* (*Ceratinidia*) *lieftincki* van der Vecht	12♂, 11♀	P	P	P	P	P
10		*Ceratina* (*Ceratinidia*) *simillima* Smith	11♂, 7♀	P	P	P	P	P
11		*Ceratina* (*Pithitis*) *binghami* Cockerell	23♂, 16♀	P	P	P	P	P
12		*Ceratina* (*Pithitis*) *smaragdula* (Fabricius)	16♂, 17♀	P	P	P	P	P
13		*Tetragonula* (*Tetragonula*) *bengalensis* (Cameron)	13♀	A	A	P	P	A
14		*Thyreus callurus* (Cockerell)	5♂, 5♀	P	P	P	P	P
15		*Thyreus himalayensis* (Radoszkowski)	8♂, 6♀	P	P	P	P	P
16		*Thyreus histrio* (Fabricius)	7♂, 4♀	P	P	P	P	P
17		*Xylocopa* (*Biluna*) *auripennis* Lepeletier	4♂, 3♀	P	P	P	P	P
18		*Xylocopa* (*Ctenoxylocopa*) *fenestrata* (Fabricius)	6♂, 4♀	P	P	P	P	P
19		*Xylocopa* (*Maiella*) *aestuans* (Linnaeus)	1♂, 7♀	P	P	A	A	A
20		*Xylocopa* (*Platynopoda*) *tenuiscapa* Westwood	2♂, 1♀	P	P	P	P	P

Table 1. Region-specific richness of different bee pollinator species in *Vitex negundo* L. (Continuation)

Sl. Nº	Family	Bee species	Material examined	District-wise Species Richness				
				Sub-Himalayan Terai		Chota Nagpur Plateau		Sundarban
				Alipurduar (S = 47)	Cooch Behar (S = 50)	Bankura (S = 49)	Purulia (S = 48)	South 24 Parganas (S = 43)
21		*Austronomia capitata* (Smith)	4♂, 2♀	P	P	P	P	P
22		*Austronomia* sp.	3♂, 4♀	A	P	P	A	A
23		*Austronomia notiomorpha* (Hirashima)	3♂, 2♀	P	P	P	P	P
24		*Austronomia* nr. *pilitrochanter* Pauly	5♂, 3♀	P	P	A	A	A
25		*Austronomia pseudoscutellata* Pauly	2♂, 3♀	P	P	A	A	A
26		*Austronomia takauensis* (Friese)	3♂, 2♀	P	P	P	P	A
27		*Curvinomia* (*Acunomia*) *formosa* (Smith)	2♂, 2♀	P	P	P	P	A
28		*Curvinomia* (*Acunomia*) *fulvata* (Fabricius)	2♂, 2♀	P	P	A	A	A
29		*Curvinomia* (*Acunomia*) *iridescens* (Smith)	14♂, 11♀	P	P	P	P	P
30	Halictidae	*Curvinomia* (*Acunomia*) *strigata* (Fabricius)	11♂, 12♀	P	P	P	P	P
31		*Gnathonomia* (*Gnathonomia*) *thoracica* (Smith)	3♂, 2♀	A	P	A	A	A
32		*Hoplonomia* (*Hoplonomia*) *elliotii* (Smith)	11♂, 12♀	P	P	P	P	P
33		*Hoplonomia* (*Hoplonomia*) *westwoodi* (Gribodo)	14♂, 11♀	P	P	P	P	P
34		*Lasioglossum* (*Ctenonomia*) *albescens* (Smith)	9♂, 6♀	P	P	P	P	P
35		*Lasioglossum* (*Ctenonomia*) *cavernifrons* (Blüthgen)	7♂, 13♀	P	P	P	P	P
36		*Lasioglossum* sp.	5♂, 5♀	P	P	P	P	P
37		*Lipotriches* (*Rhopalomelissa*) *ceratina* (Smith)	5♂, 2♀	A	P	A	A	A
38		*Pseudapis* (*Pseudapis*) *oxybeloides* (Smith)	13♂, 5♀	A	A	P	P	P
39		*Seladonia* sp.	6♂, 2♀	P	P	P	P	P
40		*Coelioxys confusus* Smith	11♂, 5♀	P	P	P	P	P
41		*Coelioxys* nr. *capitatus* Smith	8♂, 4♀	P	P	P	P	P
42		*Coelioxys* sp.	3♂, 2♀	P	P	P	P	P
43		*Euaspis carbonaria* (Smith)	7♂, 9♀	P	P	P	P	P
44		*Heriades* sp.	6♂, 2♀	P	P	P	P	P
45		*Megachile* (*Amegachile*) *bicolor* (Fabricius)	8♂, 6♀	P	P	P	P	P
46		*Megachile* (*Aethomegachile*) *conjuncta* Smith	13♂, 9♀	P	P	P	P	P
47	Megachilidae	*Megachile* (*Aethomegachile*) *laticeps* Smith	12♂, 15♀	P	P	P	P	P
48		*Megachile* (*Callomegachile*) *disjuncta* (Fabricius)	15♂, 11♀	P	P	P	P	P
49		*Megachile* (*Callomegachile*) *lerma* Cameron	6♂, 11♀	P	P	P	P	P
50		*Megachile* (*Callomegachile*) *umbripennis* Smith	7♂, 8♀	P	P	P	P	A
51		*Megachile* (*Creightonella*) *fraterna* Smith	3♂, 2♀	A	A	P	P	P
52		*Megachile* (*Eutricharaea*) sp.1	9♂, 6♀	P	P	P	P	P
53		*Megachile* (*Eutricharaea*) sp.2	4♀	P	P	P	P	P
54		*Megachile* (*Megachile*) *vigilans* Smith	6♂	A	A	P	P	P
55	Andrenidae	*Andrena* sp.1	7♀	P	P	A	A	A
56		*Andrena* sp.2	4♀	P	P	P	P	P

Note: S = Number of species; P = Presence; A = Absence.

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