

RESEARCH ARTICLE

Diversity of Andrenidae Bees (Hymenoptera: Apoidea) in Arunachal Pradesh, Northeast India

Chihi Umbrey, Nyabin Riso, Amarnath Karmakar, Hiren Gogoi*

Department of Zoology, Rajiv Gandhi University, Rono-Hills, Doimukh-791112, Arunachal Pradesh, India

*Corresponding author: hirengogoi2007@yahoo.co.in

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Abstract

The bees of the family Andrenidae are short tongued and categorized under non-Apidae bee group. For the first time, this study reports Andrenidae bees from the northeastern region of India. A total of three species of bees from Andrenidae family, namely, *Andrena flavipes*, *Andrena rothneyi* and *Andrena savignyi* were recorded during a survey in Arunachal Pradesh and some adjoining areas of Nagaland and Assam from 2018 to 2020. They were found foraging on six forage plants, namely, *Brassica nigra* (Brassicaceae), *Coriandrum sativum* (Apiaceae), *Geranium* sp. (Geraniaceae), *Persicaria* sp. (Polygonaceae), *Anaphalis* sp. (Asteraceae), *Bidens pilosa* (Asteraceae). The *Andrena flavipes* and *Andrena rothneyi* were documented from West Kameng whereas *Andrena savignyi* was documented from Namsai district, Arunachal Pradesh and all the three species were observed rare.

Keywords: *Andrena flavipes*; *Andrena rothneyi*; *Andrena savignyi*; Andrenidae; Forage Plant; Northeast India

1. Introduction

The family Andrenidae are categorized under the order Hymenoptera which includes bees, wasps, ants, and sawflies. Bees are incredibly diverse, with around 20,000 species found across the world. They are organized into seven families: Andrenidae, Apidae, Colletidae, Halictidae, Megachilidae, Melittidae and Stenotritidae. The bees of the family Andrenidae are considered as short-tongued due to the presence of four short, similar segments in their labial palp. They are known for a distinct feature: two subantennal sutures situated below each antenna. However, in species with a black face and coarse punctation, these sutures may be difficult to recognize. Andrenidae is divided into four subfamilies: Alocandreninae, Andreninae, Panurginae, and Oxaeinae (Michener, 2007; Danforth et al., 2013; Ramos et al., 2022). All species within the Andrenidae family of bees are known for their nesting habits - they exclusively nest in soil. They construct their own burrows and create one or a short series of cells at the end of each lateral burrow. Due to these burrowing behaviours, they are often referred to as "mining bees". These bees are typically solitary and have a preference for collecting pollen from only a small range of plant species, which is known as being oligolectic in nature. The Andrenidae family of bees has a recorded number of 3,077 species found across the world. In India, 21 species have been identified, all belonging to the genus *Andrena*. However, there have been no recorded instances of any Andrenidae species found in Arunachal Pradesh, India (Gusenleitner and Schwarz, 2002; Dubitzky, 2006; Michener, 2007; Danforth et al., 2013; Ascher and Pickering, 2021; Bossert et al., 2021; Pisanty et al., 2022; Ramos et al., 2022).

The subfamily Andrenidae is predominantly represented by the genus *Andrena* across various regions worldwide. While Andrenidae can be found on all continents except Australia, they are relatively scarce in tropical areas of Asia. A distinguishing characteristic of *Andrena* is the conspicuous presence of large, flattened, and velvety facial foveae in female individuals, setting this genus apart from others in the family. The hind basitarsus is typically more than half the length of the hind tibia, and the stigma is wider than those found in other genera within the same subfamily.

In females, the scopa on the ventral side of the hind trochanter is a dense mass of long, curled, and branched hairs that cover the base of the femoral corbicula. This structure is known as the floccus, which can be classified as complete if all the hairs on the trochanter are long and curled. Alternatively, when the basal half of the trochanter hairs are nearly straight and short, while the distal hairs are long and curled, the floccus is considered incomplete. The basal area of the labrum is elevated. The male genitalia are usually recognized by the dorsal preapical lobe of the gonocoxite, which is not found in other genera (Bingham, 1897; Michener, 2007).

In light of limited existing documentation on the Andrenidae family of bees in Arunachal Pradesh, India, the present study was undertaken to investigate the diversity and distribution patterns of these bees in the region. The study sought to shed light on the previously unexplored status of Andrenidae bees in Arunachal Pradesh, India.

2. Materials and methods

2.1. Study area

Arunachal Pradesh, located in the Himalaya biodiversity hotspot also shares borders with the Indo-Myanmar biodiversity hotspot (Myers et al., 2000; Marchese 2015, CEPF 2023). It is the largest among the eight northeast Indian states, with an area of 83,743 km². It is bordered by the Indian states Assam and Nagaland in the south, the neighbouring country Bhutan to the west, China to the north and northeast and Myanmar to the east and southeast (www.arunachalpradesh.gov.in). The climate of Arunachal Pradesh varies with elevation. The humid subtropical climate prevails at the lower altitude of 100-1500 m from mean sea level. Higher altitude region extending from 3500-5500 m from mean sea level meets sub-tropical highland and alpine climate. Likewise, the mountain and hill slopes are covered by alpine, temperate, tropical and subtropical forests (Singh et al., 2002).

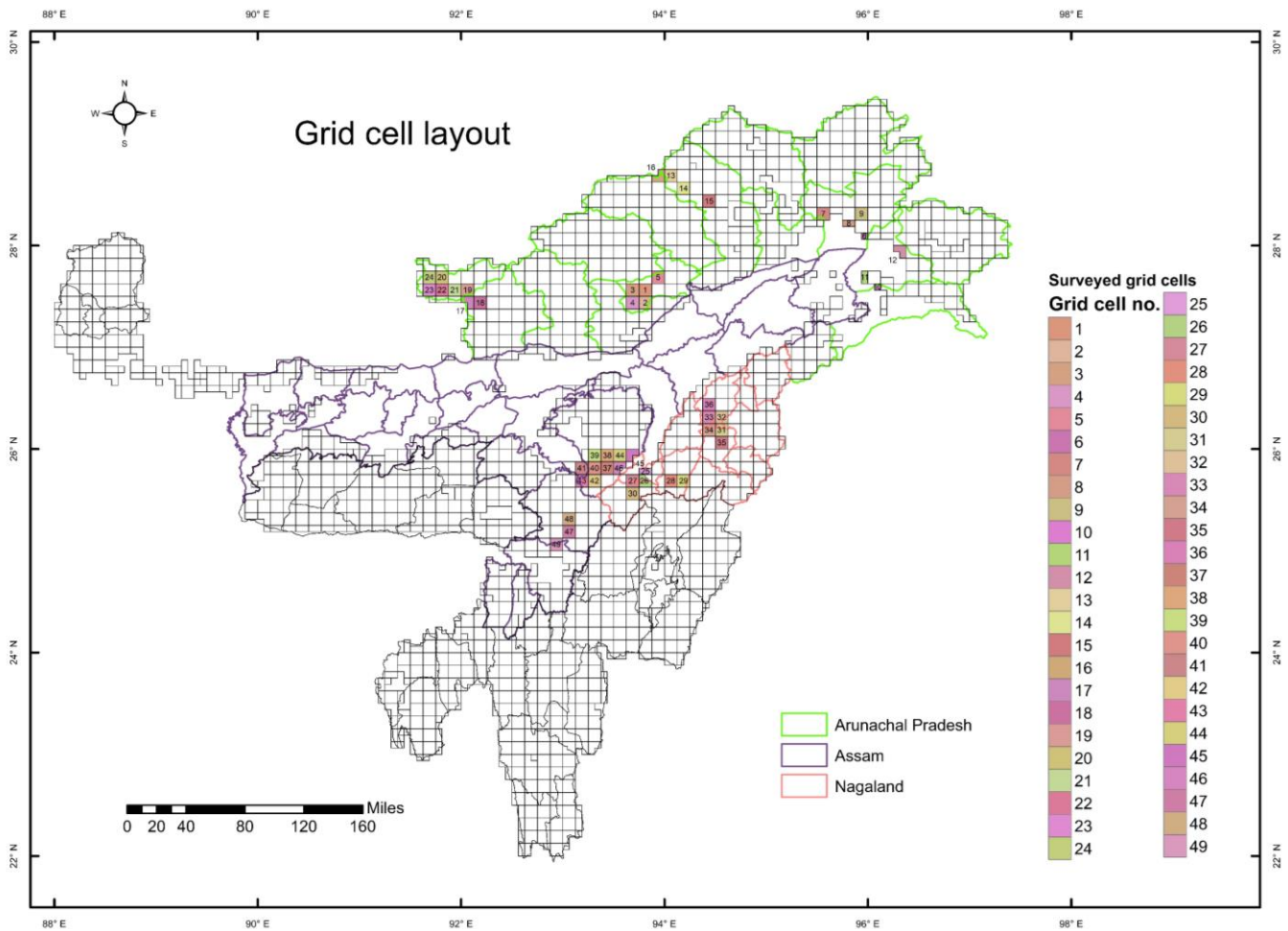


Figure 1. Grid cell layout in northeast India and the surveyed grid cells

Table 1. Distribution of the recorded bees of family Andrenidae

SN	Species	Distribution	References
1	<i>Andrena flavipes</i> Panzer, 1799	India: Punjab World: Afghanistan, Albania, Armenia, Azarbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, China, Croatia, Denmark, Egypt, Europe, France, Georgia, Germany, Greece, Guernsey, Iran, Iraq, Ireland, Israel, Italy, Jordan, Kazakhstan, Kyrgyzstan, Latvia, Lebanon, Libya, Macedonia, Malta, Moldova, Mongolia, Morocco, Nepal, Netherlands, North Africa, Norway, Pakistan, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Spain, Sweden, Syria, Tajikistan, Tunisia, Turkey, Turkmenistan, U.S.A, Ukraine, United Kingdom, Uzbekistan	Cameron (1909), Batra (1967), Tadauchi and Matsumura (2007), Varnava et al. (2020), Ascher and Pickering (2021)
2	<i>Andrena rothneyi</i> Cameron, 1897	India: Uttarakhand, Himachal Pradesh	Bingham (1897), Tadauchi and Matsumura (2007), Ascher and Pickering (2021)
3	<i>Andrena savignyi</i> Spinola, 1838	India: Uttarakhand, Punjab, Haryana, Rajasthan, Gujarat, Delhi World: Afghanistan, Pakistan, United Arab Emirates, Saudi Arabia, Iraq, Israel, Egypt, Libya, Tunisia, Algeria, Morocco, Spain, Malta, Italy, France	Cameron (1907 and 1909), Batra (1967), Ahmed et al. 2020, Ascher and Pickering (2021)

2.2. Sampling plan

To conduct a comprehensive survey of the Andrenidae bee family in Arunachal and adjoining areas, the study area was divided into five zones viz. eastern, central and western Arunachal Pradesh, Nagaland and the Karbi Hills of Assam and the grid cells for the survey were chosen accordingly. Grid cells of $\sim 6.3 \times 6.3$ km, planned by the Ashoka Trust for Research in Ecology and the Environment (ATREE) in collaboration with the Department of Biotechnology (DBT), Govt. of India in the year 2018 for long term monitoring of the biodiversity and habitat parameters of the northeastern region of India were used in this study. Inside each of these grid cells, 5-10 transects of 25×1 m were monitored for sampling purposes (Pollard, 1977). A total of 49 grid cells were monitored during the period from April 01, 2018 to March 31, 2020 (Figure 1).

2.3. Data collection

The bees were collected using sweep nets between the hours of 6:00 am and 4:00 pm. Geo-coordinates and elevation were recorded using a Montana Garmin GPS. The collected specimens were processed for preservation and identification in the Laboratory of Entomology, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh, India. The specimens were studied and photographed using Zeiss Stemi 508 microsystem and Canon EOS 80D with macrolens Canon EFS 18-135mm. Maps were prepared using ArcGIS version 10.4.

2.4. Taxonomic identification

The bee species were identified based on morphological characters by consulting standard literatures (Bingham 1897, Michener 2007,

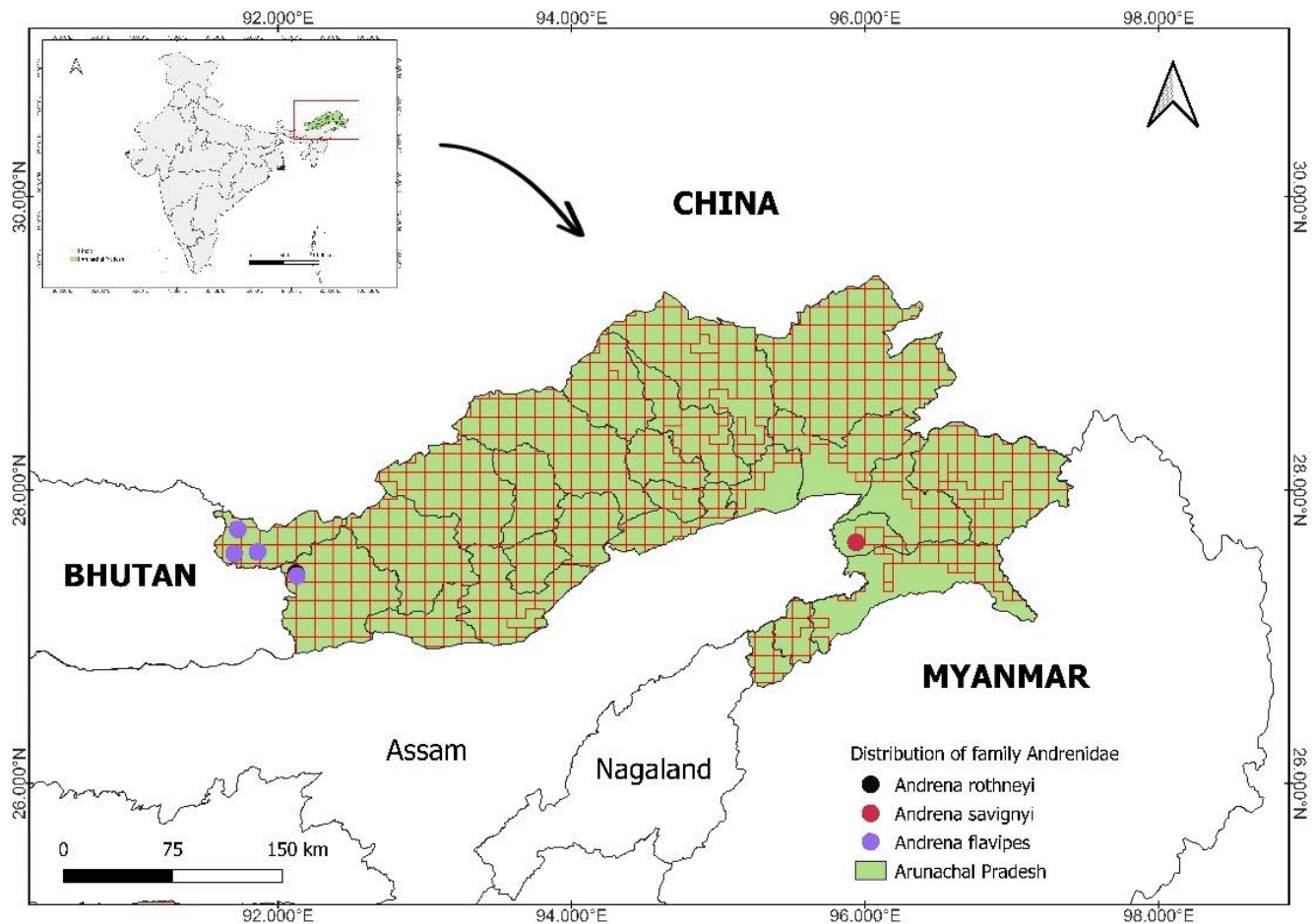


Figure 2. Distribution of family Andrenidae from Arunachal Pradesh

Tadauchi and Matsumura 2007, Ascher and Pickering 2021). Voucher specimens of all the forage plants were collected and processed into mounted herbarium sheets following Bridson and Forman (1998) and Das (2021). Plants were identified based on local floras (Kanjilal et al., 1934 – 1940; Hajra et al., 1996; Giri et al., 2008) and the accepted names were verified from www.plantsoftheworldonline.org (POWO, 2019).

3. Results

The present study documented first three new records of Andrenidae species viz. *Andrena rothneyi*, *Andrena flavipes* and *Andrena savignyi* from Arunachal Pradesh (Table 1; Figure 2, 3 & 4).

Taxonomy

Family- Andrenidae
Subfamily- Andreninae
Genus- *Andrena*

Subgenus: *Oreomelissa* Hirashima and Tadauchi, 1975

Diagnosis: The area from antennal fossae to vertex strongly convex. The 1st m-cu vein of the forewing connects to second submarginal cell beyond the centre or at the end of the cell. Narrow and deep facial fovea. Corbicula poorly developed in females.

***Andrena (Oreomelissa) rothneyi* Cameron, 1897**

Andrena simlaensis Cameron, 1902

Diagnosis

Female: Size 9-10 mm. Facial fovea covered with greyish felted pubescence. Mandible reddened apically. Clypeus strongly convex. Smoky wing membranes. Floccus on the hind trochanter is whitish, long, dense and curled. Metasomal terga 1 and 2 and lateral part of T3 ferroginous. Terga 2-4 with white integumentary bands.

Material examined: Arunachal Pradesh, West Kameng district (27.43571°N, 92.12051°E): 1 female, 2380 m.

Floral Association: Unknown.

Remarks: New report for Arunachal Pradesh (West Kameng).

Subgenus: *Suandrena* Warncke, 1968

Diagnosis: Absence of spines on the hind femora, hind tibial spur strongly broadened at the base, lateral face of propodeum has scattered punctures without any ridges. Males have inflated penis valve and gonostyli, tergites have blue metallic reflections.

***Andrena (Suandrena) savignyi* Spinola, 1838**

Andrena bipartita Brullé, 1840

Andrena bicolorata Smith, 1853

Andrena uromelana Costa, 1888

Andrena antilope Pérez, 1895

Andrena ilerda Cameron, 1907

Andrena ferozeporensis Cameron, 1909

Andrena ilerda inglisi Cockerell, 1920

Andrena bipartita aswanica Cockerell, 1938

Diagnosis

Female: Size 13-14 mm. Head wider than long. Mandibles long, bidentate and apically reddened. Facial fovea covered with white felted pubescence. Integument and hairs of legs are fulvous. Tergite 1 and 2 reddish. T1- T4 with white integumentary bands.

Material examined: Arunachal Pradesh, Namsai district (27.64517°N, 95.93695°E): 2 female, 138 m.

Floral Association: *Brassica nigra* (Brassicaceae), *Coriandrum sativum* (Apiaceae).

Remarks: New report from Arunachal Pradesh (Namsai)

Subgenus: *Zonandrena* Hedicke, 1933

Diagnosis: Medium sized bees. Head broader than long. Broad space between facial fovea and inner margin of the eye. Clypeus black and punctate, short malar area. Genal area broad. Propodeal corbicula well developed. Posterior hind tibial spur broad moderately. Three submarginal cells. Metasomal tergites punctate densely and with complete hair bands.

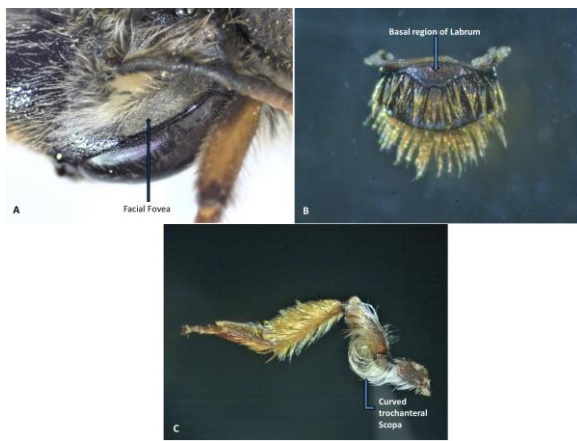


Figure 3. Genus *Andrena*. A: Facial fovea, B: Labrum, D: Hing leg

Andrena (*Zonandrena*) *flavipes* Panzer, 1799

Apis sordida Gmelin, 1790
Melitta fulvicrus Kirby, 1802
Melitta contigua Kirby, 1802
Andrena quadricincta Brullé, 1832
Andrena tricincta Brullé, 1832
Andrena fasciata Imhoff, 1832
Andrena puber Erichson, 1835
Andrena mactae Lepeletier, 1841
Andrena fulvicrus Dufour, 1841
Andrena cinerascens Eversmann, 1852
Andrena capitalis Smith, 1853
Andrena interrupta Schenck, 1869
Andrena problematica Pérez, 1903
Andrena levilabris Cameron, 1908
Andrena punjaubensis Cameron, 1909
Andrena interruptula Viereck, 1916
Andrena quadricinctula Viereck, 1916
Andrena kraussei Strand, 1921
Andrena kengracensis Cockerell, 1930
Andrena flavipes alexandrina Warncke, 1965
Andrena (*Zonandrena*) *flavipes ibizensis* Warncke, 1984
Andrena (*Zonandrena*) *flavipes* Panzer, 1799

Diagnosis

Female: Black integument. Clypeus, supraclypeal, frontal, genal and thorax region covered by long fulvous hairs. Basitibial plate complete. Scopa constitutes both black and white branched hairs. Tergite 1-4 with apical yellow bands. Tergite 5 with fulvous prepygidial fimbriae.

Material examined: Arunachal Pradesh, Dirang (27.417 °N, 92.12672 °E): 1 Female, 2114 m. Tawang (27.57972 °N, 91.85929 °E): 11 Female, 2831 m, (27.56624 °N, 91.69891 °E): 1 Female, 2183 m (27.73448 °N, 91.72471 °E): 4 Female, 2543 m.

Floral Association: *Anaphalis* sp. (Asteraceae), *Bidens pilosa* (Asteraceae), *Geranium* sp. (Geraniaceae), *Persicaria* sp. (Polygonaceae).

Remarks: New report for Arunachal Pradesh (West Kameng and Tawang).

4. Discussion

4.1. Diversity and distribution

All the species recorded during the study were found belonging to a single genus *Andrena* which is also reported as predominant genus in many regions across the world (Michener, 2007; Ascher and Pickering, 2021).

Andrena rothneyi, which had previously been documented in Uttarakhand and Himachal Pradesh, India (Tadauchi and Matsumura, 2007; Ascher and Pickering, 2021), has now been collected from the West Kameng district of Arunachal Pradesh, an area located in the eastern Himalayas with comparable climatic conditions to Uttarakhand. It is possible that this species is also present in neighbouring countries such as Nepal, Bhutan, Myanmar, and China.

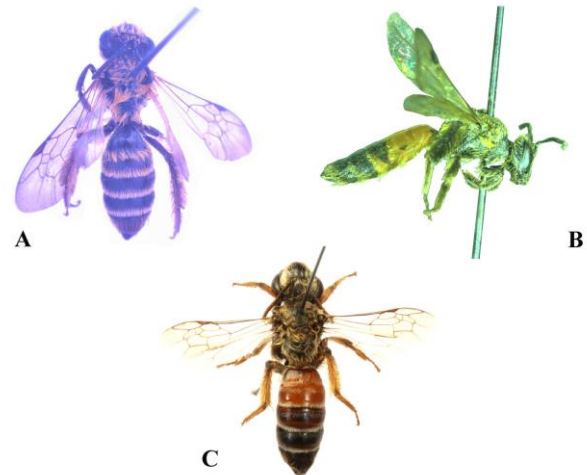


Figure 4. A: *Andrena flavipes*, B: *Andrena rothneyi*, D: *Andrena savignyi*



Figure 5. Forage plants. A: *Brassica nigra* (Brassicaceae), B: *Coriandrum sativum* (Apiaceae), C: *Geranium* sp. (Geraniaceae), D: *Persicaria* sp. (Polygonaceae), E: *Anaphalis* sp. (Asteraceae), F: *Bidens pilosa* (Asteraceae).

Andrena savignyi is a cosmopolitan species with a wide range of distribution. Although it has been recorded in several Indian states, including Gujarat, Rajasthan, Delhi, Haryana, Uttarakhand, and Punjab (Ascher and Pickering, 2021), the new observation in Arunachal Pradesh marks the first time this species has been recorded in northeastern India, expanding its range in the country. The distribution of *Andrena flavipes* was found to be clustered, with an average altitude of 2417 m from sea level. Previous studies also reported the presence of this species at similar high elevations (2685 m above sea level) in India and Nepal (Tadauchi and Matsumura, 2007), indicating that this species may be well adapted to high altitude climates.

4.2. Forage resources

According to Wood and Sánchez (2022), all documented bees belonging to the subgenus *Suandrena* are known to forage from Brassicaceae plants. *Andrena savignyi* has been observed foraging from *Brassica* spp. (*Brassica campestris* and *Brassica napus*), accounting for 52.17% of all floral visitors in cultivated fields of *Brassica campestris* (Kratochwil et al., 2014; Mahmoud and Shebl, 2014; Akram and Sajjad, 2022). The present study also recorded the species to forage from *Brassica* sp. (*Brassica nigra*). *Andrena flavipes* were observed to forage on plants of the family Asteraceae sp. (*Bidens pilosa*) which is presented in Figure 5. Previous reports also noted the species of the genus *Andrena* to forage on *Bidens pilosa* (LaBerge, 1978; Budumajji and Raju, 2018).

5. Conclusion

For the first time, present study recorded evidence of Andrenidae bee species in Arunachal Pradesh and other parts of northeast India. Over a period of three years, only three species were discovered, indicating the rarity of this family in the region. Considering the effectiveness of Andrenidae bees as pollinators and their low population in the area, there is a pressing need for conservation efforts to safeguard these vital insects.

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Authors' contributions

Chihhi Umbrey: Collection and Identification of the specimens; drafting of manuscript.

Nyabin Riso: Collection of the specimens.

Amarnath Karmakar: Collection of the specimens.

Hiren Gogoi: Designed the project and arranged funding, collection and study of the specimens; finalization of manuscript.

Conflict of interests

Authors declares that there is no conflict of interests

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