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Morphological Notes and Floral Associations of Bees (Hymenoptera: Apidae) in the Benghazi Coastal Plain (Benghazi–Deryana–Tokera), Eastern Libya

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Abstract

Bees of the family Apidae are essential pollinators, yet faunistic data regarding their coastal populations in Libya remain limited. This study aimed to survey the diversity and floral visitation patterns of Apidae in the coastal areas of Benghazi, specifically Deryana and Tokera. Field surveys were conducted over a one-year period from January 2022 to January 2023. Bee specimens were collected, described, and identified to the species level using standard family-level and species-specific taxonomic keys. A total of five bee species were identified: *Anthophora oraniensis* (Lepeletier, 1841), *Anthophora bimaculata* (Panzer, 1798), *Amegilla albegina* (Lepeletier, 1841), *Xylocopa pubescens* Spinola, 1838, and *Ammobates oraniensis* (Lepeletier, 1841). Ecological observations revealed that these bee species actively foraged on flowering plants belonging to three distinct families: Asteraceae, Brassicaceae, and Geraniaceae. These findings provide updated baseline data on the apid bee fauna and highlight key plant-pollinator interactions in the Benghazi coastal region, which is crucial for local biodiversity conservation and ecosystem management.

Keywords: Apidae; Bee Diversity; Floral Visitation; Pollinator-Plant Interactions; Benghazi; Coastal Ecology.

INTRODUCTION

Bees are among the most efficient pollinators due to their behavioral adaptations. The order Hymenoptera, which includes bees, encompasses about 125,000 known species. Bees optimize pollen and nectar collection through refined behaviors, often foraging near their nests and targeting dominant floral species in the landscape (Berenbaum, 2007).

Globally, there are over 20,000 recognized bee species, categorized into seven major families. Social species like honeybees and bumblebees live in colonies, while 90% of bee species, such as mason, carpenter, and leafcutter bees, are solitary (Linsley, 1958). Wild bees are particularly effective pollinators, contributing significantly to crop production and providing an estimated $150 billion in global pollination services annually (Frankie et al., 2019; Lhomme et al., 2020). The Mediterranean basin is recognized as a biodiversity hotspot, characterized by high levels of endemic plant and animal species. This region supports an exceptional diversity of wild bees, particularly along the eastern Libyan coast, which includes Al Jabal Al Akhdar. The area's Mediterranean flora, favorable

rainfall, and sandy habitats provide ideal conditions for bee populations, including families such as Apidae and genera such as Dasypoda, Anthophora, and Andrena (Ascher & Pickering, 2020; Grace, 2010). Wild bees constitute a vast taxonomic group that is extremely rich in terms of biology and ecology, with an estimated 20,507 species existing globally (Michener, 2007). The family Apidae is the largest of these groups, comprising over 5,700 species. Members of Apidae, including bumble-bees, honeybees, and cuckoo bees, are widely distributed and ecologically significant (Cardinal et al., 2010). This study aimed to survey the diversity and floral visitation patterns of Apidae in the coastal areas of Benghazi, specifically Deryana and Tokera.

MATERIALS AND METHODS

A survey study was conducted in the coastal area of Benghazi, specifically in Deryana and Tokera, with the study area divided into three parts. The vegetative cover in the study area is characterized by the presence of various types of trees, shrubs, and seasonal plants.
Bee specimens were collected over an activity period from January 2022 to January 2023. Weekly collections were conducted between 09:00 AM and 05:00 PM.
Bees were collected using aerial sweep nets.

- Specimens were placed in glass killing jars lined with paper.
- Ethyl acetate was added to the jars to kill the bees.
- Specimens were examined using a stereomicroscope.
- Specimens were stored in wooden entomological boxes to ensure their preservation.

During collection, the following data were recorded:

- Time and date of collection.
- Temperature and humidity conditions at the time of collection.
- The type of flower visited by the bees.

Identification:
Bees were identified using family-level and species-specific taxonomic keys (Michener, 2007).

RESULTS

Anthophora oraniensis (Lepeletier, 1841)

The bees were collected from Garyounis at 12:00 PM on 20 March 2023, with 47% relative humidity and 24°C. Visited plant: White and yellow chrysanthemum flowers (Fig. 1).

Figure (1). White and yellow chrysanthemum flowers

DESCRIPTION:

Specimen Examined: ♀ (Female).
Measurements: Body length: 17 mm. General Description: The integument is black (Fig. 2).

Figure (2). Dorsal view of *Anthophora oraniensis* (♀)

Head: Triangular in frontal view, covered in dense white pubescence; the integument is punctate. Compound eyes brown. The lateral ocelli are positioned level with the upper margins of the compound eyes (Fig. 3).

Figure (3). Head of *Anthophora oraniensis* (♀)

Antennae: 12-segmented, with a rounded apex; the scape is brown, and the pedicel is small, black, and rounded (Fig. 4).

Figure (4). Frontal view of *Anthophora oraniensis* (♀)

Clypeus: Trapezoidal, covered in short, white pubescence.
Mandibles: Prominent and black (Fig. 4).
Thorax: Covered in dense, short yellow pubescence; the prothorax is larger than the meso- and metathorax. The metathorax bears long, dense pubescence on its lateral margins. Tegula black and oval (Fig. 4.5).
Wings: Three submarginal cells present; the medial (M) cell is bluntly rounded, and the recurrent vein does not intersect the submarginal cell at the same junction (Fig. 2).
Legs: Coxae short, black, and oval. Forelegs have widened tibiae, an arolium, and dense black pubescence. The middle and hind legs each bear a single tibial spur (Fig. 6)

Figure (5). Lateral view of *Anthophora oraniensis* (♀)

Abdomen (Metasoma): Composed of 5 visible segments, covered in dense, short black pubescence; the apical margins of the terga bear short yellow pubescence. Terga I–III are larger and wider than the remaining terga (Fig. 6).
Sterna: Covered in short black pubescence, with the apical margins bearing similar pubescence (Fig. 7).

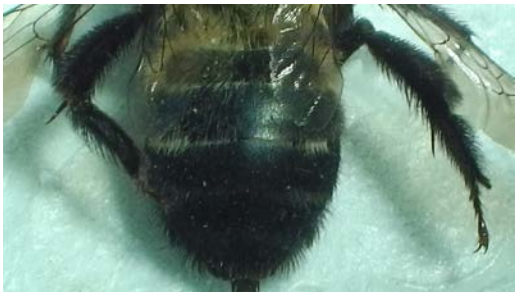

Figure (6). Hind legs and abdomen of *Anthophora oraniensis* (♀)

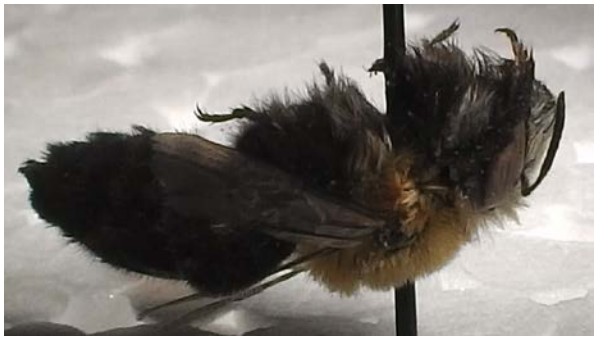

Figure (7). Sternum of *Anthophora oraniensis* (♀)

Anthophora bimaculata (Panzer, 1798)

Specimens were collected in Benghazi on 12 June 2023. Environmental conditions at the time of collection were 25°C and 73% relative humidity. The bees were observed foraging on Brassica rapa (Brassicaceae) (Fig. 8).

Figure (8). *Brassica rapa* flowers

Description:

Specimen Examined: ♂ (Male).
Measurements: Body length: 9 mm (Fig. 9).

Figure (9). Dorsal view of *Anthophora bimaculata* (♂)

Head: Trapezoidal in frontal view, cream-colored, and broad; aligned horizontally with the thorax. Compound eyes green. The lateral ocelli are positioned level with the upper margins of the compound eyes (Fig. 10).
Clypeus and Mouthparts: The clypeus is cream-colored and covered in white pubescence. The mouthparts are prominent; the mandibles are brown (Fig. 10).

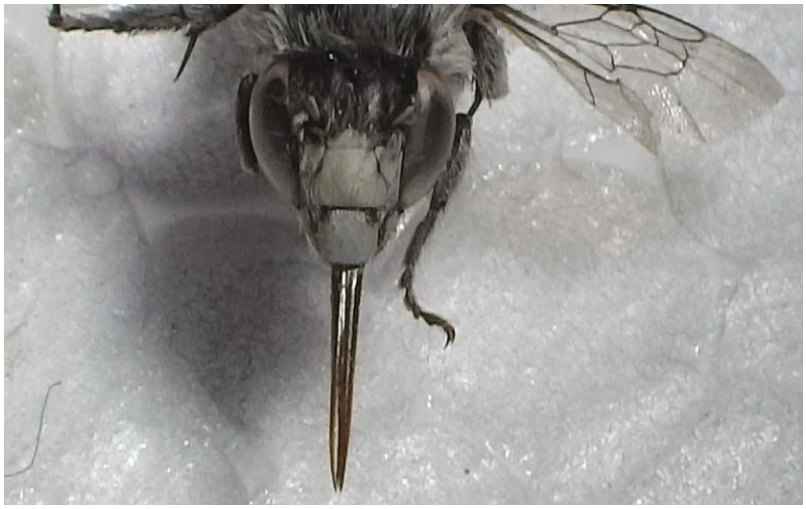

Figure (10). Head, forewing, and foreleg of *Anthophora bimaculata* (♂)

Thorax: Dense white hair; tegula oval and brown.

Wings: Three submarginal cells, transparent with brown venation; D1 and D2 are approximately the same size; the recurrent vein (RV) is not at the junction of the submarginal cells; the M cell is rounded (Fig. 10).
Legs: Forelegs are black with white hairs; middle and hind legs have a tibial spur; the tibiae have dense white hairs, the trochanters lack hairs, and no arolium is present (Fig. 11).
Abdomen: Round, narrow light bands on the terga, 5 segments, punctate; at the tips of the terga there are short, dense, white hairs (Fig. 11).
Sterna: No hairs or setae, except that the tips of the bands bear yellow hairs.

Figure (11). Lateral view of *Anthophora bimaculata*(♂)

Amegilla albegina (Lepeletier, 1841)

The bees were collected from Deryana on 3 August 2023 at 33°C and 50% relative humidity.
Visited plant: Brassica (Brassicaceae) (Fig. 12).

Figure (12). Brassicaceae (Brassica) plant

Description:

Specimen Examined: ♀ (Female).
Measurements: Body length: 13 mm (Fig. 13).

Figure (13). Dorsal view of *Amegilla albigena* (♀)

Head: Triangular in shape and narrower than the thorax. Compound eyes pale brown. The lateral ocelli are positioned level with the upper margins of the compound eyes; the head is covered in yellow pubescence (Fig. 14).

Clypeus and Mouthparts: The clypeus is glabrous (lacking setae), trapezoidal, and black with a median longitudinal brown stripe. The mouthparts are prominent and black. The mandibles are pale brown, each bearing a small subapical tooth (Fig. 17)

Figure (14). Frontal view of *Amegilla albegina* (♀)

Antenna: 12-segmented; the flagellum has a rounded apex, and the pedicel is small and rounded.
Thorax: Slightly broad, bearing short yellow setae, with long yellow pubescence on the lateral margins. The mesothorax is larger than both the prothorax and the metathorax (Fig. 15)

Figure (15). Lateral view of *Amegilla albegina* (♀)

Tegula: Rounded, brown (Fig. 15).
Wings: Wing membrane brown with dark brown venation; three submarginal cells present; the basal vein is arched (Fig. 16).
Legs: Arolium absent; coxae oval and brown. Forelegs covered in white pubescence. The mid and hind legs bear tibial spurs. The hind tibiae possess dense, long, white setae on the lateral surface, while the medial (inner) surface bears short, black pubescence; the hind legs bear two tibial spurs (Fig. 17).
Abdomen (Metasoma): Composed of 5 visible segments; the apical margins of the terga bear bands of white pubescence. Terga I–III are wider than terga IV–V. A scopa is present on the hind legs. The sterna are glabrous (lacking pubescence) (Fig. 17).

Figure (16). Forewing of *Amegilla albegina* (♀)

Figure (17). Hind leg and abdomen of *Amegilla albegina* (♀)

Xylocopa pubescens Spinola, 1838

Specimens were collected in Alhawary, Benghazi, on 7 November 2023 at 17:00 h. Environmental conditions at the time of collection were 25°C and 71% relative humidity. The bees were observed foraging on passion fruit and tomatoes.

DESCRIPTION:

Specimen Examined: ♀ (Female).
Measurements: Body length: 23 mm.
General Description: The integument is entirely black (Fig. 18)

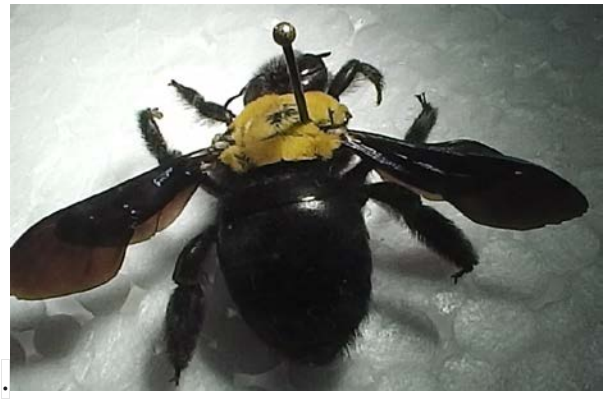

Figure (18). Dorsal view of *Xylocopa pubescens* (♀)

Head: Rounded, slightly narrower than the thorax, and covered in dense white setae; the integument is densely punctate. Compound eyes dark brown, bearing dense, long, black setae between them; the lateral ocelli are positioned below the uppermost margins of the compound eyes (Fig. 19).
Thorax: Prothorax larger than the meso- and metathorax; integument black, covered in dense yellow setae.
Clypeus: Black, bearing long, dark brown setae (Fig. 19).

Figure (20). Frontal view of *Xylocopa pubescens* (♀)

Mandibles: Rectangular, elongate, black, bidentate at the apex, with the apical tooth longer than the other.
Antenna: Scape long, rounded, with a black edge (Fig. 20).
Thorax: Prothorax larger than the meso- and metathorax, black, with dense, long, yellow setae (Fig. 21); tegula clear, large, and dark brown; wings: brown membrane, dark venation, three submarginal cells, the jugal lobe of the forewing is short, 3SMC is larger than 1SMC and 2SMC.
Legs: Coxae triangular, narrower at the base; tibiae have dense black setae; tarsi have five segments; arolium present with short yellow setae (Fig. 22).
Abdomen: 6 segments, black with dark brown bands, punctate; tergum 2 wider than the other terga; tergum 6 triangular, with dense, long, black setae at the edges; sterna: base dark brown, dense black setae at the apical edge (Fig. 22).

Figure (21). Lateral view of *Xylocopa pubescens* (♀)

Figure (22). Hind leg and abdomen of *Xylocopa pubescens* (♀)

Ammobates oraniensis (Lepeletier, 1841)

Specimens were collected in Tokera on 3 August 2023 at 13:22 h. Environmental conditions at the time of collection were 29°C and 73% relative humidity. The bees were observed foraging on Geranium spp. (Geraniaceae) (Fig. 23).

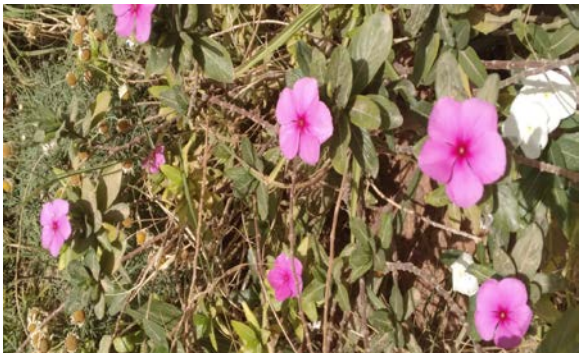

Figure (23). Geraniaceae (Geranium) flowers

DESCRIPTION:
Specimen Examined: ♂ (Male).
Measurements: Body length: 9 mm.
General Description: This species is a cleptoparasitic bee. The integument is shiny and black (Fig. 24)

Figure (24). Dorsal view of *Ammobates oraniensis* (♂)

Head: Integument black, punctate, and covered in black setae. Compound eyes brownish-green; the lateral ocelli are positioned level with the upper margins of the compound eyes (Fig. 25).

Figure (25). Frontal view of *Ammobates oraniensis* (♂)

Clypeus: Black, trapezoidal, and punctate, bearing long, black setae. Mandibles: Prominent, brown, and covered in pale brown setae. Mouthparts: Short and black.
Antenna: 13-segmented, black, with a rounded apex.
Thorax: Punctate and glabrous (lacking setae), with distinct median grooves (sulci). Tegula black and rounded (Fig. 26).

Figure (26). Lateral view of *Ammobates oraniensis* (♂)

Wings: Smoky (infuscate); two submarginal cells present; the medial (M) cell is bluntly rounded (Fig. 27). Legs: Slender and black, bearing white setae directed downwards (deflexed). The midlegs are larger than the forelegs, bearing brown setae and one tibial spur. Coxae black and oval (Fig. 27).
Abdomen (Metasoma): Slender, composed of 5 visible segments; the lateral margins of the terga bear white spots (maculae), and tergum I is convex. Sterna: Glabrous (lacking setae), dark brown, with the apical margins pale brown (Fig. 27).

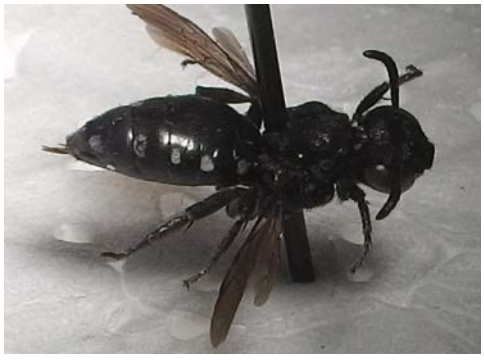

Figure (27). Abdomen of *Ammobates oraniensis* (♂)

DISCUSSION

The survey identified five species belonging to the family Apidae: *Anthophora oraniensis* (Lepeletier, 1841), *Anthophora bimaculata* (Panzer, 1798), *Amegilla albegina* (Lepeletier, 1841), *Xylocopa pubescens* Spinola, 1838, and *Ammobates oraniensis* (Lepeletier, 1841). Although Apidae is the largest bee family globally, comprising over 5,700 species, members of this family—including bumblebees, honeybees, and cuckoo bees—are widely distributed and ecologically significant. These findings align with previous global and regional studies, which highlight the richness of Apidae species across diverse habitats. Reported species richness in the Mediterranean and North Africa includes: Portugal with 74 species (Baldock et al., 2018), [Insert Missing Country] with 49 species (Provine, 2012), Cyprus with 110 species, Turkey with 121 species, Tunisia with 184 species, Algeria with 598 species (Benkheder et al., 2010), Morocco with 241 species, and Malta with 34 species (Vannave et al., 2020). Additionally, previous studies in the Al Jabal Al Akhdar and Derna regions of Libya have also reported members of this family (Elmabruk & Bataw, 2019; Bufliga, 2009). In this study, Anthophora species were observed visiting plants in the Brassicaceae and Asteraceae families. This aligns with findings from Germany and Colorado, where Anthophora species have been reported visiting the Solanaceae family (Mason et al., 2022; Michez et al., 2008). Furthermore, in Algeria, Xylocopa species have been recorded visiting Asteraceae and Brassicaceae (Bendifallah et al., 2018).

The relatively low number of Apidae species recorded in the study area compared to nearby regions like Algeria and Tunisia may reflect differences in sampling effort, habitat diversity, or climatic conditions. However, the observed floral preferences, such as visits to Brassicaceae and Asteraceae, suggest that Apidae provide potential pollination services in the region. These findings underscore the ecological importance of Anthophora and Xylocopa species and their adaptability to diverse floral resources.

CONCLUSION

This study contributes to the growing knowledge of Apidae diversity and their ecological roles in Libya. In summary, five bee species belonging to the family Apidae were successfully recorded, described, and identified to the species level using standard taxonomic keys. Furthermore, the observed foraging behavior highlighted their ecological interactions with flowering plants across three distinct families: Asteraceae, Brassicaceae, and Geraniaceae. Future work should expand sampling efforts, explore additional habitats, and further investigate the specific roles these species play in local pollination networks and overall ecosystem functioning.

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Author contributions: The authors contributed equally.

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