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Nesting Biology and Seasonality of Long-Horned Bee *Eucera nigrilabris* Lepeletier (Hymenoptera: Apidae)

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Abstract

We provide information on the nesting behavior, seasonality and nest soli type characteristics of *Eucera nigrilabris* Lepeletier, 1841 in Egypt. A nest was discovered in a canal bank in Abbis Village, Alexandria, Western Egypt. The species is protandrous, univoltine, ground nesting species. The bees built deep nests about 85cm under the ground and consisted of lined, branched tunnel with many cells. The bees start fly by end of January until end of March and active in winter seasons. The soil of the nest has yellow color, sandy loam texture, low salinty and sodicity, and low calcium carbonate content. The bee distrbiution was influnced by the soil with high content of sodium carbonate. The bees forage on the wild flora of the family Asteraceae carriyng a yellow pollen load. There is no any record of a cleptoparasitism around the nesting area.

Introduction

The main objective of the current contribution is documenting some biological and ecological aspects of the nesting of the genus *Eucera* Scopoli in the Mediterranean region. The bees of the widespread tribe Eucerini are notorious for their large numbers of similar species, with the distinctions even between genera being subtle and challenging for pollination biologist (Alqarni et al., 2012). Eucera is a large genus that is widespread in Eurasia and the New World and is often abundant in its habitat (O'Toole & Raw 1999). Eucera bee species are common and important pollinator in the Mediterranean region (Nachtigall, 1994; Sapir et al., 2005). There are approximately 300 total species, long tongued, ground nesting solitary bees and having one generation per year (Amiet et al., 2007).

Nests and larvae of *Eucera* are unknown, burrows in the ground, each cell is at the end of a rather long lateral burrow, and the cells are vertical and elongate. They line their brood cells with a waxlike material that they secrete (Michener, 2007). There are some few publications of *Eucera* and *Tetralonia* nesting biology in the world (Malyshev, 1924; 1929; Linsley et al., 1952; Michener & Lange 1958; Rozen, 1969; 1974), (Wafa & Mohamed 1970; Miliczky, 1985; Popova, 1990). The bee distribution is influenced by the plant community, plant diversity, canopy cover, land use and nesting suitability. In particular soil properties can play an important role in the distribution and diversity of ground nesting bees (Grundel et al., 2010).

Eucera nigrilabris Lep. (Eucerindae) is a common species in the Mediterranean region (Ne'eman et al., 2007). This species is important for pollination of some wild plants like *Ophrys tenthredinifera* (Kullenberg et al., 1984; Glaubrecht, 2010) and *Alkanna strigosa* (Ne'eman et al., 2007). The species is well abundant in Egypt distributed in Fayiuom, Cairo and north coast, the flight activity started from January to March and the nesting biology and behavior is unknown.

We hypothesized that the bee diversity influences by not only climate and vegetation, but also soil type and characteristics. Here we try to examine the nesting biology of *Eucera nigrilabris* and their soil preference for building their nest.

Material and Methods

Specimens collection and identification

Several specimens of *E. nigrilabris* were collected by sweep net from natural nests and wild flowers from Abbis Village, Alexandria, NW Egypt. Bees were killed in normal cyanide jars, pinned and stored in wooden boxes at the Dep. of Plant Protection, Fac. of Agriculture, Suez Canal University. Labels containing the collecting time and date, area of collection and scientific name of the host plant were attached to the specimens. Examinations of male genitalia were carried out. Male terminalia were cleared with 10% KOH (potassium hydroxide) for at least half a day then transferred to distilled water for dissection. The bee species identified based on a reference collection at Ain Shams University and the species identification confirmed by Dr. Nicolas J. Vereecken Liberal University of Brussels, Belgium.

Field nesting site

The bee nest was discovered during field collection of bees around Alexandria governorate (western part of Egypt). The nest found at Abbis I Village (N45''82'31' E57''23'29') in the main high way between Alexandria – Cairo Agricultural Road. The nest was in a small canal bank surrounded by some blooming flowers like *Brassica napus* L., *Urtica dioica* L. and other wild plants. At the same nesting site some other bees had been found nesting very close to our nesting site like *Andrena vetula* Lepeletier, 1841 and *Andrena fuscosa* Erichson, 1835.

Weekly observations of the nest and the bees were conducted from February until end of March. Nest excavation had been carried out by digging above the soil surface for observing the nest architecture. The seasonal and daily abundance of bees was recorded at three times of the day 11am, 1pm and 3pm.

Soil characteristic analysis

The soli characteristics analysis was conducted at Dept. of Soil and Irrigation, Faculty of Agriculture, Suez Canal University.

1- Hydraulic conductivity: saturated hydraulic conductivity was determined using Darcy's law in the form $Ks= QL/ \Delta\Psi At$ where Q was the volume of fluid, that moves through a soil per unit cross-sectional area (A), and time (t), is directly proportional to the total potential gradient ($\Delta\Psi$), which drives the fluid flow and indirectly proportional to the length (L) of the soil column through which the fluid moves, according to Hill & James (1995).

2- Bulk density: Bulk densities of the calcareous, alluvial and sandy soils were determined according to Blake and Ha rtge (1986).

3- Electrical conductivity: of the saturated soil paste extract expressed as (dSm-1) were measured using conductivity meter model Jenway 3310 according to Richards (1954).

5- Soil pH: the pH of soil samples was determined by bench type Beckman glass electrode pH meter, in 1:2.5 soil-water suspensions according to Page et al. (1982).

6- Soluble cations and anions: the saturated soil paste extract was analyzed for soluble anions and cations. Sodium and K+ were determined flamephotometerically, Ca2+, Mg2+, were volumetrically determined by titration with ethylene diamine tetra acetic acid (versinate), Cl- was determined by titration with silver nitrate, HCO3- was determined by titration with standard sulphuric acid according Page et al. (1982).

Results and Discussion

Nest description

A nest of *E. nigrilabris* was found at Abbis Village, Alexandria (Western part of Egypt). The species fly during winter season (January – March), the males were started flying before females. The length of the tunnel was very deep about 70 to 80cm (n3), the diameter of the cell entrance was ranged between 0.7-0.8 cm (n3) and diameter of the cell end was ranged between 0.8 to 1cm (n3) (Fig 1). It seems that the whole subfamily of Anthophorinea dig a deep nests and other species could be found with the same nest like *Eucera* and *Tetralonia*. A compound nest of *Tatrealoina* has been discovered during 1976 with 70 cm soil surface combined with *Nomia* sp. nest (Ibrahim, 1976; Malyshev, 1929). There were are a few exception of the subfamily building shallow cavity nesting such as *Anthophora waltoni* Cockerell (Shebl et al., 2014).

During the nest excavation some cells were found empty specially those on the first third of the tunnel during the searching for the eggs. The insect eggs were whitish laid over the pollen ball. Each tunnel has 4 to 6 cells the first cells were empty or false cells, below the first cells some cells were found contains the old body of the laid females by then the main basic cells as shown in Fig 1. The female could used more than one entrance because the tunnels were branched and connected with each other under the soil surface. The cell chambers of species of the genus *Eucera* were constructed as short branches from the main burrow, often two or three cells per nest (Amiet et al., 2007). So some females were used entrance but during excavating the nest some females found in another tunnel. The whole tunnel was lined by wax. *Eucera longicornis* (Linnaeus, 1758) used to nest in a large aggregations and constructed burrows in the ground that branches into up to seven polished brood chambers filled with liquid pollen mass in which the egg is laid. Sometimes two nesting females share the same entrance of nest (Westrich, 1989).

Fig 1. Nest Architecture of *Eucera nigrilabris* Lepeletier, 1841.

Mating behavior

The males were emerged several days before the females, the males easily distinguished from the females by the long antennae and the yellowish clypeus on the head. The males were started flying during the third week of January for almost one moth until the third week of February. Two shapes of male were recognized differing in color and activity. At the beginning the males were reddish with slow movements around the nesting sites without any flight, they moved their legs and antennae from time to time. They remained without flight activities for several hours.

The other shape of male was grey with very active movements around the nests or on the resting sites. The reddish males were the immature males and once they became mature their color changed. Moreover, more than two or three males were recognized following each other at the same tunnel entrance (old tunnels), they seems that they were working probably helping the female for emergence or defending the nests. However, the individual on the surface keep moving their abdomen until leaving the entrance for several minutes. They enter theentered their nests by head but sometimes got out by abdomen and other times by head.

The female was emerged several days after the male and was remained active for almost two months until end of March. The new emerged female was remained inactive for one minute more or less then flying around the nest. The males were fighting with each other before mating. The mating took place over the nesting sites. The mating time took about 3 to 6 minutes or longer. The receptive female female did not accepted other males for another mating so the mating occurred only once a time during the whole lifecycle. Therefore, it is expected that the mated females laid few eggs (Fig 2).

Digging the new tunnel

After the mating the female were started digging her new tunnel. The females were started digging the soil with her head and legs and building a branched and curved tunnels and the whole process remained for several days. The females were dug only one tunnel during the whole life cycle with four to six cells. Then the female were started foraging and collecting pollen, the collected pollens are dry, yellow and the average weight during one trip was about 0.015gm. The number of cells varied from one to another species of ground nesting bees (Fig. 1-2). Most of soil burrowing bees makes only one nest and very few make several nests with very few cells (Stephen et al., 1969; Kamel, 1981; Coville et al., 1983; Norden, 1984; Neff & Simpson, 1992; Semida, 2000; Shebl et al., 2014).

Bee seasonal and daily abundance

Bees were started flying at the third week of January and remain until mid of March so the bees is protandrous and univoltine. The daily activity of the insect were started at 9 or 10am but the maximum activity of the bees was during the midday day hours 12-1pm. The males started flying before females few days for reaching their maturation. The bees were more active during midday hours around 11pm to 1pm and the bees were fewer active during early morning and late afternoon which was noticed in most solitary bee (Fig 3) (Shebl et al., 2014; Shebl & Farag, 2015).

Soil characteristics of the nest

The soil of the nest is too hard from the surface (very dry seems like soft rock) and becomes more softer by going depper due to high moisture. The soil of the nest has a yellow color with sandy loam texture, low salinty and sodicity and low calcium carbonate content (Table 1).

Fig 2. A. Nesting site area; B. Nest entrance; C. Mature male of the resting site; D. Mating, E. Nesting activities, F. The eggs.

The sand, silt and clay were 70.6, 22.3 and 8%, respectively. The EC, SAR, and $CaCO_3$ were 1.5 dSm^{-1}, 2.52, and 3.14 %, respectively. The soluble Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} were 4.9, 3.1, 5.0 and 2.0 meq l^{-1}, while soluble HCO^{-}_3, Cl^{-} and $SO4^{-}_2$ were 3.5, 7.7 and 3.8 meq l^{-1}, respectively (Table 1). During another field survey of bees in Canal Region (Shebl et al., 2013) *E. nigrilabris* were not collected from that area. The type of the soil at that area was sand mainly desertic areas. Our assumption that the bees composition could be affected not only by their floral resources but also by their nesting resources suitability (Pots et al., 2005; Cane et al., 2007). So some species could have a limited distribution due to their nesting resources and the soil characteristics of that nest. Bee community composition is related to plant richness, soil characteristics potentially related to nesting suitability, and canopy cover. Suitability for nesting can be related to soil and soil cover characteristics for example percent of organic content, sand, silt, and clay in the soil (Grundel et al., 2010). The amount of organic matter, organic carbon and bulk density of surface layers are important factors in selection of nesting sites by solitary bees. Many species of ground nesting bees of *Colletes*, *Andrena*, *Halictus* and *Osmia* preferred well drained areas with a good surface flow and a plant stand of sparse to intermediate density (Osgood, 1972). Choosing the site of the nest by bees depend on several intrinsic and extrinsic factors such as morphology, mechanical structure, moisture, presence

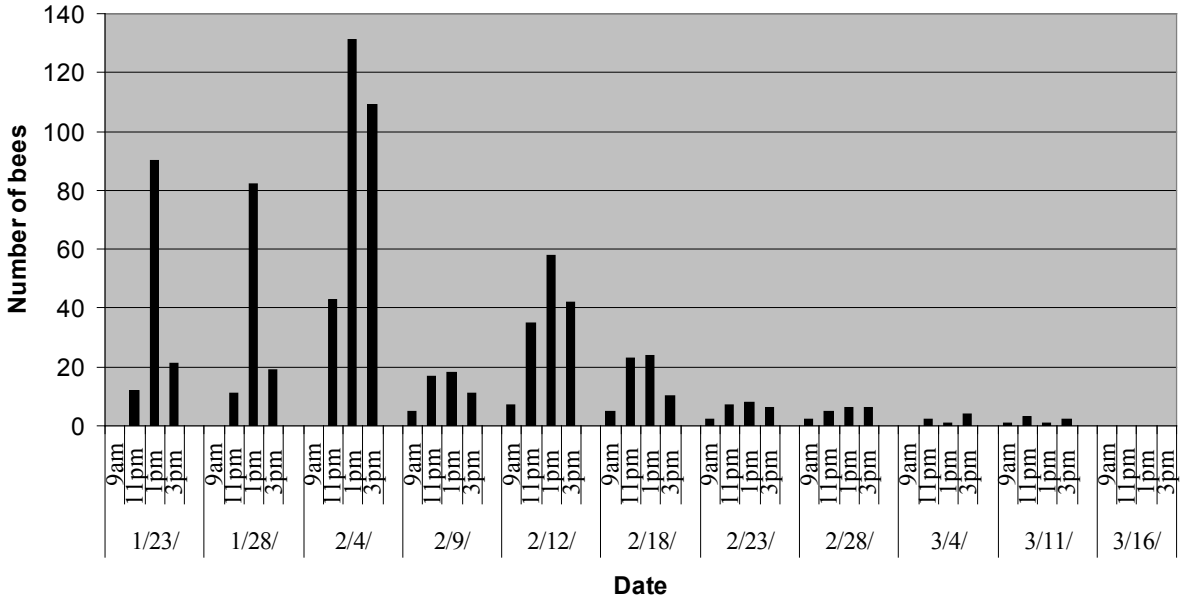

Fig 3. Seasonal and daily abundance of *E. nigrilabris*.

of food and physical properties of the soil (Semida, 2000). The nest of E. nigrilabris was very deep and this could be related to the soil structure. The nest architecture is characterized of the species with different individual variations. Some females dig the nest deep or quite near ground because of the soil conditions (Stephen et al., 1991; Semida 2000).

Table 1. The soil charactersitics of the nesting sites.

Parameter	Soil
Physical Properties	
Soil particles (%)	
Sand	70.62
Silt	22.30
Clay	8.00
Texture	Sandy Loam
Bulk density (g cm^{-3})	1.40
Hydraulic conductivity (cm h^{-1})	1.01
Chemical Properties	
pH (1:2.5)	7.55
EC (dSm^{-1})	1.50
Soluble cations, (meq l^{-1})	
Ca^{2+}	4.90
Mg^{2+}	3.10
Na^{+}	5.04
K^{+}	2.00
SAR	2.52
Soluble anions, (meq l^{-1})	
CO_3^{2-}	N.D*
HCO^{-}_3	3.46
Cl^{-}	7.72
SO_4^{2-}	3.82
$CaCO_3$ (%)	3.14

N.D.: Not detected.

Imapct of human interefrenc on the E. nigrilabris

The decline of plant pollinators particularly bees (Hymenoptera: Apoidea) is well known worldwide. There are many research papers indicated that many solitary bees are threatened by the human interference such as fragmentation of natural habitats, lack of floral resources and extensive use of pesticides (Shebl et al., 2013). The whole nesting are of *E. nigrilabris* area was eliminated due to national project of covered drainage. The whole area is not longer active, the same case was noticed with a number of leafcutting bees (Kamel, et al., 2007). Such studies encourage conservation strategies for protection natural biodiversity resources which has a great impact on our environment.

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