



CHECKLIST OF BEES (HYMENOPTERA: APOIDEA) IN THE MAAMORA CORK OAK FOREST IN NORTH-WEST OF MOROCCO

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ABSTRACT

Wild bees play a crucial role in the functioning of natural ecosystems and in agricultural production through their pollination services. However, information on these bees and their distribution remains insufficient at the scale of Moroccan ecosystems. For this purpose, an inventory was carried out for a year (2021), in three stations in the Maamora forest, using different trapping techniques. This led to collection of 209 individuals, representing 21 species (including 2 endemics to Morocco) belonging to 5 families of the group *Anthophila*. These results will help to improve scientific knowledge on the distribution of these species and enable their protection.

Key words: Inventory, biodiversity, wild bees, Apoidea, *Anthophila*, geographic distribution, cork oak, Maamora forest, Morocco, checklist, endemic species

Bees play a crucial role in the pollination process, which is a key link in the vital cycle of most plants (IBPES, 2019). Indeed, pollinating insects, including bees, provide ecosystem services to more than 80% of the world's flowering plants, including cultivated crops (Nath et al., 2023). These pollinating insects are responsible for 35% of global agricultural production (Klein et al., 2007). Their role in maintaining natural ecosystems and agricultural systems is therefore paramount. However, bee populations have been declining in recent years (Chagnon, 2008; Jactel et al., 2020). The decline of pollinating insects, a notable consequence of the intensification of modern agriculture, is largely attributed to the simplification of landscapes and the disappearance of natural habitats (Sánchez-Bayo and Wyckhuys, 2019). Pollinating insects are among the groups most affected by human activities, pollution, biological invasions and the effects of climate change (Chagnon, 2008; Nieto et al., 2014; Jactel et al., 2020). Studying the status of bee populations, their diversity and their densities can therefore serve as an indicator of the general state of biodiversity (Zayed and Packer 2005). Morocco hosts a flora and fauna of great biodiversity, including a bee fauna rich in species, approaching 1000 species (Lhomme et al., 2020). However, this Moroccan apian diversity remains very poorly studied, due to the wide spatial distribution of the species and the diversity

of their habitats in the country (Wood, 2023). Despite the wealth of Moroccan bee diversity, comprehensive inventories of bee populations in the country remain to be completed, particularly in certain regions such as the Maamora forest. It is therefore important to better understand and monitor the distribution of bees, which plays an essential role in the functioning of ecosystems and agriculture in Morocco, as elsewhere in the world. In this context, the present study will provide new data and information on the bees of the Maamora forest. A one-year inventory was conducted in 2021, using various active and passive trapping techniques. The main objective of this study was to identify the bee species present in this forest ecosystem. The results obtained will also make it possible to propose appropriate management measures, to preserve this important community of pollinating insects within the Maamora forest.

MATERIALS AND METHODS

The Maamora forest is located on the Atlantic coast of Morocco, between Salé and Kenitra in the northwest of the country. From north to south, it extends over an area of 40 km wide and 70 km long towards the east (Belghazi and Mounir, 2016). This forest covers approximately 135,000 ha, including 71,000 ha of commercial plantations and 64,461 ha of cork oak woodlands (Belghazi and Mounir, 2016), representing

17% of the total area of cork oak forests in Morocco and 25% of the area of Atlantic cork oak forests (Aafi, 2007). Three sampling stations were chosen according to their location in the forest, their distance from the sea, and whether the plots were fenced. Fencing prevents pruning and wood cutting by the local population, and prevents cattle grazing in the undergrowth, which preserves the herbaceous and low shrub cover: Station S1 (Kenitra): Located in the western part of the forest (34°12'33.34"N; 06°35'54.78"W), at an elevation of 37 m, it belongs to the warm sub-humid bioclimate with maritime influences. Station S2 (Sidi Larbi Bouhali): Located in the middle part of the forest (34°04'57.73"N; 06°24'38.31"W), at an elevation of 134 m, it belongs to the warm sub-humid bioclimate with maritime influences. Station S3 (Zemmour Touriza): Located in the eastern part of the forest (34°09'36.1"N; 06°07'04.34"W), at an elevation of 164 m, it belongs to the semiarid bioclimate with temperate winters and continental influences.

Several sampling methods were used: Sweep net technique whilst undertaking trap checks. Pitfall traps (Barber traps): The traps were made with plastic cups with a top diameter of 60 mm, placed with the opening at the ground level, and covered with wooden branches to prevent them from being trampled by animals. Pitfall traps allow for the capture of soil-dwelling invertebrates (Nageleisen and Bouget, 2009). The distance between the traps was 20 m. Coloured bowls: These traps consisted of coloured bowls (yellow, orange, white, and

blue) with a diameter of 15 cm and a height of 13 cm. They were filled halfway with a preservation mixture (soapy water + salt) and placed at a height of 1.5 m above the ground level, in cork oak clearings to attract flower visitors. The different traps were installed at three stations in stations 1, 2, and 3. In each station, 12 traps were set up at distance ranging from 15 to 20 metres apart (8 Barber traps, 4 coloured traps one of each of the following yellow, white, orange, and blue). Traps were checked every 3 weeks for a period of 7 months (April to October) during the year 2021. The collected specimens were spread out and classified into genera and families. They were then carefully grouped into collection boxes and sent to the Zoology Laboratory at the University of Mons in Belgium for identification. The species-level identification was carried out by a group of taxonomists: Simone Flaminio, Thomas James Wood, Guillaume Ghisbian, Michael Terzo, Pierre Rasmont, and William Flordaliso. The material collected was deposited in the insect collection of the Centre for Innovation, Research, and Training - Rabat (Morocco).

RESULTS AND DISCUSSION

The bee inventory conducted during 2021, at different sampling stations within the Maamora forest in Morocco, yielded in 209 individuals belonging to 5 families comprised of 21 species, including 2 endemics to Morocco. These belong to the superfamily: Apoidea (Table 1).

Table 1. List of species collected in the Maamora forest at sites S1, S2 and S3

Families	Species	S1	S2	S3
Andrenidae	<i>Andrena morio</i> Brullé, 1832		*	*
	<i>Andrena discors</i> Erichson, 1841		*	*
	<i>Andrena insignis</i> Warncke, 1974		*	
Apidae	<i>Apis mellifera intermissa</i> (Buttel-Reepen, 1906)	*	*	*
	<i>Bombus terrestris</i> (Linnaeus, 1758)		*	*
	<i>Ceratina albosticta</i> Cockerell, 1931	*	*	*
	<i>Ceratina cucurbitina</i> (Rossi, 1792)	*	*	
	<i>Ceratina maghrebensis</i> Daly, 1983	*		
	<i>Eucera nadigi</i> (Friese, 1924)		*	
	<i>Xylocopa pubescens</i> Spinola, 1838	*	*	
Halictidae	<i>Lasioglossum leucozonium</i> (Schränk, 1781)	*	*	
	<i>Lasioglossum prasinum</i> (Smith, 1848)		*	*
	<i>Lasioglossum punctatissimum</i> (Schränk, 1853)	*	*	
	<i>Lasioglossum virens</i> (Erichson, 1835)		*	*
Megachilidae	<i>Hoplitis saundersi</i> (Vachal, 1891)	*	*	
	<i>Osmia notata</i> (Fabricius, 1804)	*	*	
	<i>Pseudoanthidium scapulare</i> (Latreille, 1809)	*	*	
Melittidae	<i>Dasypoda cingulata mamorensis</i> Warncke, 1973	*	*	
	<i>Dasypoda dusmeti</i> Quilis, 1928	*	*	
	<i>Dasypoda maura</i> Perez, 1895	*	*	
	<i>Dasypoda visnaga</i> (Rossi, 1790)	*	*	

A. Family Andrenidae

1. *Andrena morio* Brullé

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 06.IV.2021; Samih. A, leg. 4 spec.; yellow, and white coloured traps; Cork oak; 28.V.2021; Habbaz. H, leg. 3 spec.; Barber trap; Cork oak. Zemmour Touriza, 34°09'36.1"N, 06°07'04.34"W; alt.164 m; 30.IV.2021; Habbaz. H, leg. 3 spec.; sweep net; *Glebionis coronaria*.

Distribution. Palearctic (Lhomme et al., 2020)

2. *Andrena discors* Erichson, 1841

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 06.IV.2021; Samih. A, leg. 2 spec.; yellow-colored trap; *Glebionis coronaria*; 30.IV.2021; Habbaz. H, leg. 1 spec.; Barber trap; Cork oak. Zemmour Touriza, 34°09'36.1"N, 06°07'04.34"W; alt.164 m; 30.IV.2021; Habbaz. H, leg. 5 spec.; yellow, orange, and white coloured traps. Cork oak.

Distribution. Western Palearctic (Lhomme et al., 2020)

3. *Andrena insignis* Warneke, 1974

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 06.IV.2021; Samih. A, leg. 3 spec.; yellow-colored trap. Cork oak.

Distribution. Morocco (Lhomme et al., 2020)

B. Family Apidae

4. *Apis mellifera intermissa* (Buttel-Reepen, 1906)

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 30.IV.2021; Habbaz. H, leg. 6 spec.; sweep net; Cork oak; 05.VIII.2021; Habbaz. H, leg. 5 spec.; blue, orange, and white coloured traps; Cork oak. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 02.VII.2021; Maatouf. N, leg. 3 spec.; yellow, and white coloured traps; Cork oak. Zemmour Touriza, 34°09'36.1"N, 06°07'04.34"W; alt.164 m; 30.IV.2021; Habbaz. H, leg. 7 spec.; yellow, orange, and white coloured traps. Cork oak.

Distribution. Tunisia, Algeria and Morocco (Lhomme et al., 2020)

5. *Bombus terrestris* (Linnaeus, 1758)

Material examined. MOROCCO – Sidi Larbi

Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 02.VII.2021; Samih. A, leg. 2 spec.; white-colored trap; Cork oak. Zemmour Touriza, 34°09'36.1"N, 06°07'04.34"W; alt.164 m; 28.V.2021; Habbaz. H, leg. 3 spec.; yellow- and orange-coloured traps; Cork oak; 02.VII.2021; Habbaz. H, leg. 1 spec.; sweep net; *Andryala integrifolia*.

Distribution. Palearctic (Lhomme et al., 2020)

6. *Ceratina albosticta* Cockerell, 1931

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 05.VIII.2021; Samih. A, leg. 2 spec.; orange, and white coloured traps; Cork oak. Zemmour Touriza, 34°09'36.1"N, 06°07'04.34"W; alt.164 m; 02.VII.2021; Habbaz. H, leg. 3 spec.; white-, and blue-coloured traps; Cork oak. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 30.IV.2021; Habbaz. H, leg. 5 spec.; sweep net; *Leontodon maroccana*; 28.V.2021; Samih. A, leg. 7 spec.; yellow, and white coloured traps; Cork oak.

Distribution. Morocco, Algeria, Tunisia, Spain (Lhomme et al., 2020).

7. *Ceratina cucurbitina* (Rossi, 1792)

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 02.VII.2021; Samih. A, leg. 8 spec.; sweep net; Cork oak; 05.VIII.2021; Samih. A, leg. 2 spec.; yellow-colored trap; Cork oak. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 30.IV.2021; Habbaz. H, leg. 3 spec.; blue, orange, and white coloured traps; Cork oak; 28.V.2021; Habbaz. H, leg. 2 spec.; sweep net; *Leontodon maroccana*.

Distribution. Palearctic (Lhomme et al., 2020).

8. *Ceratina maghrebensis* Daly, 1983

Material examined. MOROCCO – Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 02.VII.2021; Maatouf. N, leg. 3 spec.; yellow, and white coloured traps; Cork oak; 30.IV.2021; Habbaz. H, leg. 2 spec.; orange, and white coloured traps. Cork oak.

Distribution. Tunisia, Algeria and Morocco (Lhomme et al., 2020).

9. *Eucera nadigi* (Friese, 1924)

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 05.VIII.2021; Habbaz. H, leg. 2 spec.; orange, and white coloured traps; Cork oak.

Distribution. Morocco (Lhomme et al., 2020).

10. *Xylocopa pubescens* Spinola, 1838

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt. 134 m; 05.VIII.2021; Habbaz. H, leg. 3 spec.; yellow-colored trap; Cork oak. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 02.VII.2021; Maatouf. N, leg. 3 spec.; orange, and white coloured traps; Cork oak.

Distribution. Palearctic; Sub-Saharan Africa (Lhomme et al., 2020).

C. Family Halictidae

11. *Lasioglossum leucozonium* (Schrank, 1781)

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt. 134 m; 05.VIII.2021; Habbaz. H, leg. 8 spec.; blue, orange, and white coloured traps; Cork oak. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 02.VII.2021; Maatouf. N, leg. 2 spec.; yellow, and white coloured traps; Cork oak.

Distribution. Palearctic (Lhomme et al., 2020) Western Palaearctic (Pauly, 2016a).

12. *Lasioglossum prasinum* (Smith, 1848)

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt. 134 m; 02.VII.2021; Samih. A, leg. 2 spec.; yellow-colored trap; Cork oak. Zemmour Touriza, 34°09'36.1"N, 06°07'04.34"W; alt. 164 m; 28.V.2021; Habbaz. H, leg. 7 spec.; sweep net; *Leontodon saxatilis*; 29.IX.2021; Habbaz. H, leg. 5 spec.; yellow, orange, and white coloured traps; Cork oak.

Distribution. Western Palaearctic (Lhomme et al., 2020; Ascher and Pickering, 2023).

13. *Lasioglossum punctatissimum* (Schenck, 1853)

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt. 134 m; 06.IV.2021; Habbaz. H, leg. 3 spec.; sweep net; *Leontodon saxatilis*. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 30.IV.2021; Maatouf. N, leg. 3 spec.; yellow, and white coloured traps; Cork oak.

Distribution. Palearctic (Lhomme et al., 2020) Western Palaearctic (Pauly, 2016b).

14. *Lasioglossum virens* (Erichson, 1835)

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt. 134 m; 02.

VII.2021; Samih. A, leg. 2 spec.; sweep net; *Leontodon saxatilis*; 05.VIII.2021; Samih. A, leg. 2 spec.; yellow-colored trap; 16.IX.2021, 1 spec.; white colored trap; Cork oak. Zemmour Touriza, 34°09'36.1"N, 06°07'04.34"W; alt. 164 m; 02.VII.2021; Habbaz. H, leg. 4 spec.; sweep net; *Leontodon saxatilis*; 05.VIII.2021; Habbaz. H, leg. 1 spec.; yellow-colored trap; Cork oak; 16.IX.2021; Habbaz. H, leg. 7 spec.; blue, orange, and white coloured traps. Cork oak.

Distribution. Western Palearctic (Lhomme et al., 2020).

D. Family Megachilidae

15. *Hoplitis saundersi* (Vachal, 1891)

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt. 134 m; 05.VIII.2021; Habbaz. H, leg. 9 spec.; yellow, orange, and white coloured traps; Cork oak. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 02.VII.2021; Maatouf. N, leg. 3 spec.; sweep net; *Scolymus hispanicus*.

Distribution. Western Palearctic (Lhomme et al., 2020).

16. *Osmia notata* (Fabricius, 1804)

Material examined. MOROCCO – Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 06.IV.2021; Maatouf. N, leg. 2 spec.; orange, and white coloured traps; Cork oak. Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt. 134 m; 30.IV.2021; Samih. A, leg. 1 spec.; yellow-colored trap; Cork oak.

Distribution. Western Palearctic (Lhomme et al., 2020).

17. *Pseudoanthidium scapulare* (Latreille, 1809)

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt. 134 m; 05.VIII.2021; Habbaz. H, leg. 3 spec.; orange, and white coloured traps; Cork oak. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 28.V.2021; Maatouf. N, leg. 1 spec.; yellow coloured trap; Cork oak.

Distribution. Western Palearctic (Lhomme et al., 2020).

E. Family Melittidae

18. *Dasypoda cingulata mamorensis* Warncke, 1973

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt. 134 m;

30.IV.2021; Samih. A, leg. 4 spec.; yellow-colored trap; Cork oak; 28.V.2021; Samih. A, leg. 2 spec.; yellow-colored trap; Cork oak; 02.VII.2021; Habbaz. H, leg. 5 spec.; sweep net; *Scolymus hispanicus*; 05.VIII.2021, 1 spec.; white coloured trap; Cork oak. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 06.IV.2021; Maatouf. N, leg. 4 spec.; orange, and white coloured traps; Cork oak.

Distribution. Western Palearctic (Lhomme et al., 2020).

19. *Dasypoda dusmeti* Quilis, 1928

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 30.IV.2021; Habbaz. H, leg. 2 spec.; yellow-colored trap; Cork oak; 28.V.2021; Maatouf. N, leg. 6 spec.; sweep net; *Scolymus hispanicus*. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 02.VII.2021; Samih. A, leg. 2 spec.; blue, and white coloured traps; Cork oak.

Distribution. Western Palearctic (Lhomme et al., 2020).

20. *Dasypoda maura* Perez, 1895

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 02.VII.2021; Samih. A, leg. 4 spec.; blue, orange, and white coloured traps; Cork oak; 05.VIII.2021; Samih. A, leg. 1 spec.; yellow-colored trap; Cork oak. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 02.VII.2021; Habbaz. H, leg. 7 spec.; sweep net; *Scolymus hispanicus*; 05.VIII.2021; Habbaz. H, leg. 3 spec.; yellow-colored trap. Cork oak.

Distribution. Morocco, Algeria (Lhomme et al., 2020).

21. *Dasypoda visnaga* (Rossi, 1790)

Material examined. MOROCCO – Sidi Larbi Bouhali, 34°04'57.73"N, 06°24'38.31"W; alt.134 m; 28.V.2021; Samih. A, leg. 2 spec.; yellow-colored trap; Cork oak; 02.VII.2021; Samih. A, leg. 5 spec.; blue, orange, and white coloured traps; Cork oak. Kénitra, 34°12'33.34"N; 06°35'54.78"W; alt. 37 m; 28.V.2021; Habbaz. H, leg. 3 spec.; sweep net; *Scolymus hispanicus*; 02.VII.2021; Habbaz. H, leg. 1 spec.; yellow-colored trap; Cork oak; 05.VIII.2021; Habbaz. H, leg. 2 spec.; white-colored trap. Cork oak.

Distribution. Western Palearctic (Lhomme et al., 2020)

Morocco is distinguished by an exceptional terrestrial biodiversity, particularly in terms of flora, due to its geographical position and the diversity of its climates and natural habitats. This biological richness makes it one of the "hotspots" of global biodiversity (BLI, 2017). The Moroccan bee fauna (Apoidea) is represented by 961 species belonging to 6 families: Andrenidae, Apidae, Colletidae, Halictidae, Megachilidae and Melittidae, of which the Rabat-Salé-Kénitra region is home to 253 species, and only 4 species are mentioned in the Maamora forest (Lhomme et al., 2020). This study recorded 209 specimens in a single year, 2021, of which 21 species were identified, representing 8.3% of the region's bee fauna. Two species are endemic to Morocco (*Eucera nadigi* (Friese, 1924); *Andrena insignis* Warncke, 1974), two species are endemic to the Maghreb region (*Apis mellifera intermissa* (Buttel-Reepen, 1906); *Ceratina maghrebensis* Daly, 1983), and only one species is endemic to Morocco and Algeria (*Dasypoda maura* Perez, 1895). However, 19 species were found for the first time in the Maamora Forest, and four species were mentioned for the first time in the region (*Lasioglossum leucozonium* (Schrank, 1781); *Lasioglossum punctatissimum* (Schenck, 1853); *Lasioglossum virens* (Erichson, 1835); *Pseudoanthidium scapulare* (Latreille, 1809)). Although the number of species recorded remains very low compared to the total number of species in the country, this remains an encouraging result and encourages further exploration of this bee fauna.

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AUTHOR CONTRIBUTION STATEMENT

All authors contributed to the study conception and design. HH, SA and SA compiled the species records and background data, taxonomic revisions of the species names, and drafted the original manuscript. NM revised the taxonomy, contributed to the analysis, and reviewed the literature. LR drafted and revised the manuscript. All authors reviewed the manuscript.

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CONFLICT OF INTEREST

No conflict of interest.

REFERENCES

- Aafi, A. 2007. Etude de la diversité floristique de l'écosystème de chêne-liège de la forêt de la Mamora (Unpublished Ph.D. Dissertation), Institut Agronomique et Vétérinaire Hassan II, Rabat.
- Ascher J S, Pickering J. 2023. Discover Life bee species guide and world checklist (Hymenopter: Apoidea: Anthophila).
- Belghazi B, Mounir F. 2016. Analyse de la vulnérabilité au changement climatique du couvert forestier. Forêt de la Maâmora (Maroc). FAO, rapport technique, 124 p.
- BirdLife International (BLI). 2017. Ecosystem profile: Mediterranean basin biodiversity hotspot. Disponible à partir de : www.cepf.net/sites/default/files/mediterranean-basin-2017-ecosystem-profile-english_2.pdf.
- Chagnon M. 2008. Causes et effets du déclin mondial des pollinisateurs et les moyens d'y remédier. Fédération Canadienne de la Faune. Bureau régional du Québec.
- IPBES, Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, IPBES secretariat, 2019. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (eds).
- Jactel H, Imler J-L, Lambrechts L, Failloux A-B, Lebreton J-D, Le Maho Y, Duplessy J-C, Cossart P, Grandcolas P. 2020. Insect decline: immediate action is needed. *C R Biologies*, 343, n° 3. pp 267-293.
- Klein A M, Vaissière B E, Cane J H, Steffan-Dewenter I, Cunningham S A, Kremen C, Tscharntke T. 2007. Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B: Biological Sciences* 274: 303-313.
- Lhomme P, Michez D, Christmann S, Scheuhl E, El Abdouni I, Hamroud L, Ihsane O, Sentil A, Chrif Smaili M, Schwarz M, Dather H H Straka J, Pauly A, Schmid-Egger C, Patiny S, Terzo M, Müller A, Praz C, Risch S, Kasperek M, Kuhlmann M, Wood T J, Bogusch P, Ascher J, Rasmont P. 2020. The wild bees (Hymenoptera: Apoidea) of Morocco. *Zootaxa* 4892(1): 1-159.
- Nageleisen L M, Bouget C. 2009. L'étude des insectes en forêt: méthodes et techniques, éléments essentiels pour une standardisation. Synthèse des réflexions menées par le groupe de travail "Inventaires Entomologiques en Forêt" (Inv.Ent.For.). ONF, 144 p, 978-2-84207-343-5. hal-00539120.
- Nath R, Singh H, Mukherjee S. 2023. Insect pollinators decline: an emerging concern of Anthropocene epoch. *Journal of Apicultural Research* 62(1): 23-38.
- Nieto A, Roberts S P M, Kemp J, Rasmont P, Kuhlmann M, García Criado M, et al. 2014. European red list of bees. Luxembourg: Publication Office of the European Union.
- Pauly A. 2016a. Le genre *Lasioglossum*, sous-genre *Lasioglossum* Curtis, 1833 en Europe et le Bassin Méditerranéen. Atlas Hymenoptera. Mons, Gembloux.
- Pauly A. 2016b. Le genre *Lasioglossum*, sous-genre *Evylaeus* Robertson, 1902, de la région Paléarctique. Atlas Hymenoptera. Mons, Gembloux.
- Sánchez-Bayo F, Wyckhuys K. 2019. Worldwide decline of the entomofauna: A review of its drivers. *Biological Conservation* 232: 8-27.
- Wood T J. 2023. Bee species newly recorded for the Moroccan fauna, including two new species of *Ammobatoides* and *Thyreus* (Hymenoptera: Anthophila). In *Annales de la Société entomologique de France (NS)* 59(3): 177-203. Taylor and Francis.
- Zayed A, Packer L. 2005. Complementary sex determination substantially increases extinction proneness of haplodiploid populations. *Proceedings of the National Academy of Science of the United States of America* 102: 10742-10746.

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