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Leucospidae of Morocco with a comparison to the other countries of North Africa

Khadija Kissayi [1,3*], Fatiha Bentata [2], Mustapha Labhilili[2], Mohammed Ibriz[3]

[1] Department of Forest Development, National Forest Engineers School, 11 000, Salé, Morocco

[2] National Institute of Agronomic Research, 10 000, Rabat, Morocco

[3] Department of Biology - Health - Environment" Laboratory, Biodiversity - Environment" Research Unit, Ibn Tofaïl University, Faculty of Sciences, University campus, 14 000, Kénitra, Morocco

* Corresponding author: Kissayi_k@yahoo.fr

Abstract: This paper presents, for the first time, a complete list of the Moroccan Leucospidae (Hymenoptera: Chalcidoidea). Six species have been identified in Morocco to date, placed in a single genus, *Leucospis* Fabricius, 1775. The geographical distribution of each species in Morocco is compiled along with its global distribution, biology and associated plants. Additionally, a comment with a comparison for countries in the North African region was illustrated with a map.

Keywords: Chalcidoidea, Leucospidae, new data, biogeographical distribution, Morocco, North Africa

Introduction

The family Leucospidae Walker constitutes a monophyletic group within the superfamily Chalcidoidea. Thus far, 151 species have been described in four genera, with the most diverse genus, *Leucospis* Fabricius, accounting for over 87% of these species. According to Noyes (2023), the remaining three genera are *Micrapion* Kriechbaumer, 1894 (12 species), *Neleucospis* Bouček, 1974 (Bouček 1974a) (1 species), and *Polistomorpha* Westwood, 1839 (7 species). Additionally, a fossil species known as *Leucospis glaesaria* Engel, 2002 has been identified from Early Miocene amber exclusively found in the Dominican Republic (Engel 2002).

The Leucospidae family was systematically revised by Bouček (1974a), and the biology is provided by Clausen (1940) and Habu (1962). Most members of this family are cited as primary parasitoids (Bouček 1959; Fry 1989), gregarious (Grissell & Cameron 2002), parasitoids of larvae or nymphal, pupae, prepupae (Matthews 2000; Gazola & Garofalo 2003), and include hyperparasitoids (Baur 2005, Hesami *et al.* 2005), cleptoparasitoids (Pauly *et al.* 2003), or associated with galls (Peck 1963). They are recognized as common ectoparasitoids of bees (Ye *et al.* 2017; Lucia *et al.* 2019). Furthermore, Leucospidae exhibit a degree of specialized in their host interactions, developing as parasitoids within the nests of Aculeate Hymenoptera (Schmid-Egger 2010). The primary insect hosts are mainly comprised of Coleoptera: Bostrichidae, Cerambycidae; Hymenoptera: Apidae, Vespidae, and Lepidoptera: Tortricidae (Bouček 1959, 1961, 1974a, Peck 1963, Medler 1964, Baker *et al.* 1985, Narendran 1986, Fry 1989, Grissell & Cameron 2002, Gazola & Garofalo 2003, Baur 2005, Hesami *et al.* 2005). These insects typically mimic stinging bees or wasps, and often display coloration that is predominantly black accented with yellow, red, or white markings, occasionally exhibiting metallic hues (Bouček 1974a, Cardinal & Darling 2003, 2005, Darling & Cardinal 2005).

The Leucospidae fauna is poorly known in Morocco, comprising only six valid species. The purpose of this article is to present, for the first time, the data of all species of Leucospidae from Morocco.

Material and methods

The material presented during this work was reviewed on specimens deposited at the MNHN and the MNHN-IS during museum visits conducted by K. Kissayi in November 2019, supplemented by a bibliographic search as exhaustive as possible.

The revision, identification and data were done using the keys in Bouček (1956, 1959, 1974a, 1974b); Nikol'skaya (1960, 1978); Bouček & Narendran (1981); Pagliano (1988); Madl (1989, 1990, 2014, 2015); Bürgis (1996); Baur & Amiet (2000); Schmid-Egger (2010); Lotfalizadeh & Fakhrzadeh (2012); Madl & Schwarz (2012, 2014); Ye *et al.* (2017); Lima & Dias (2018); Sankararaman *et al.* (2019).

Abbreviations used:

BZOL: Biology Centre of the State Museum of Upper Austria, Linz, Austria.

CIRAD: Center for International Cooperation in Agricultural Research for Development, Montpellier, France.

CU: Cornell University, New York, United States of America.

GDPC: Gérard Delvare, Personal Collection.

MHNG: Museum of Natural History, Geneva, Switzerland.

MNHN: National Museum of Natural History of Paris, France.

MNHN-IS: National Museum of Natural History of the Scientific Institute of Rabat, Morocco.

MCSN: Natural History Museum of Genova, Italy.

NHM: Natural History Museum British Museum, United Kingdom.

Results

The are just six Leucospidae species known to exist in Morocco, and they are all belonging to the genus *Leucospis*.

The faunal list for each species is provided by the distribution in Moroccan region, followed by its distribution in the world (the general distribution of the studied species was based on Noyes (2023) complemented by a bibliographical search as exhaustive as possible), its biology, associated plants, and finally a remark if there is further information as well as the distribution in North Africa.

Note that all identifications are checked for the specimens deposited in the museums visited by K. Kissayi.

List of Moroccan species Leucospidae

Hymenoptera Linnaeus, 1758

Chalcidoidea Latreille, 1817

Leucospidae Walker, 1834

Leucopsidae Walker, 1834: 13; Type-genus: *Leucopsis* Duméril, 1832 (= *Leucospis* Fabricius, 1775).

Leucospidae Walker; Haliday 1839: ii. [Justified emendation].

Leucaspoidae Walker; Förster 1856: 18, 20, 29. Type-genus: *Leucaspis* Burmeister (= *Leucospis* Fabricius).

Leucospinae Walker; Howard 1886: 197.

Leucospididae Walker; Cameron: 1907: 204; Brues & Melander 1932: 485.

Leucospidae Walker: Habu 1962: 165; Bouček 1974a: 9; Schmid-Egger 2010.

Genus *Leucospis* Fabricius, 1775

Leucospis Fabricius, 1775: 361. Type-species: *Leucospis dorsigera* Fabricius, by monotypy.

Coelogastev Schrank, 1780: 303-306, pl. 8, fig. 4. Type-species: *Leucospis dorsigera* Fabricius, by subsequent monotypy (first subsequently included species).

Metallopsis Westwood, 1839: 264, 265 [as subgenus of *Leucospis* Fabricius]. Type-species: *Leucospis cayennensis* Westwood, by monotypy.

Exochlaenus Shipp, 18946: 245. Type-species: *Leucospis anthidioides* Westwood, by original designation.

Parexoclaenus Girault, 1915: 355. Type-species: *Parexoclaenus vespoides* Girault, by original designation.

Exoclaenoides Girault, 1915: 356. Type-species: *Exoclaenoides uncinctus* Girault, by original designation.

Epexoclaenoides Girault, 1915: 357. Type-species: *Epexoclaenoides bicinctus* Girault, by original designation. Syn.

Leucospis is a genus of wasps belonging to the family Leucospidae. Most species are brightly coloured with yellow and black patterning and with a length of about 0.5 to 2 cm. They have characteristically enlarged femora on the hind leg with the lower margin toothed. The wings have a longitudinal fold and the long ovipositor is bent upwards and forwards over the metasoma (Bouček 1974a, Peters *et al.* 2018). *Leucospis* Fabricius currently consists of 131 described species in the world (Noyes 2023).

***Leucospis biguetina* Jurine, 1807**

Leucospis biguetina Jurine, 1807: Bouček 1956: 251 (tax., Morocco without exact locality).

Material examined. *Marrakech-Safi:* Road of Marrakech-Safi, 1 ♀, 31.V.1928, coll. R. Benoist (MNHN).

Geographical distribution. Algeria, Austria, Bosnia-Hercegovina, Croatia, Czech Republic, France, Hungary, Iran, Israel, Italy, Montenegro, Morocco, Russia, Serbia, Slovakia, Slovenia, Spain, Switzerland, Turkey (UCD Community 2023).

Biology. *Leucospis biguetina* Jurine is cited as a primary parasitoid of Hymenoptera: Megachilidae, Sphecidae: *Isodontia mexicana* (Saussure, 1867) (Le Goff 1997, Baur & Amiet 2000, Bogusch *et al.* 2022).

Associated plants. Apiaceae, Euphorbiaceae (Baur & Amiet 2000).

Remark. In North Africa, this species is recorded in Algeria (Bouček 1956) and Morocco.

***Leucospis brevicauda* Fabricius, 1804**

Leucospis brevicauda Fabricius, 1804: Masi 1935: 35 (tax., descr. ♂, Morocco).

Leucospis brevicauda Fabricius, 1804: Bouček 1974a: 141 (tax., type design., Morocco), 160 (key).

Leucospis brevicauda Fabricius, 1804: Baur & Amiet 2000: 384 (tax., Morocco).

Distribution in Morocco. *Souss-Massa:* 70 km N Agadir, Tamri, 1 ♂, 8.V.1995, coll. Mi. Halada; Oued Tiznit, Massa, 3 ♂ ♂, 8.V.1995, coll. M. Snižek; 10 km S Taroudant, 1 ♂, 22.IV.1990, coll. M. Halada (Madl & Schwarz 2014: 1572); 70 km N Agadir, Tamri, 4 ♀ (MHNG); 100 km E Bouzakame, Icht, 1 ♂ (BZOL) (Baur & Amiet 2000: 384) (Fig. 1).

Tanger-Tétouan-Al Hoceïma: Tangier (MCSN, Genova) (Bouček 1974a: 142); same locality, 4 ♀, 3 ♂ (BZOL) (Baur & Amiet 2000: 384); *Rabat-Salé-Kénitra:* Séhoul (MNHN) (Bouček 1974a: 142); 1 ♀, Arbaoua 12 km S Ksar el Kébir 18.IV.1995, coll. H. Tussac; 1 ♀, road Tangier-Meknes 18 km N Souk El Arba du Gharb, 34°50'34"N 05°57'36"W, 14.V.2000, coll. G. Delvare (GDCP) (G. Delvare, pers. comm., March 01, 2024).

Moreover, Morocco, without exact locality, 4 ♀ (MHNG) (Bouček 1956: 251, Baur & Amiet 2000: 384).

Material examined. *Tanger-Tétouan-Al Hoceïma:* Tangier, 1 ♀, 1901, coll. G. Buchet; 1 ♀, 1914, coll. E. André (MNHN); same locality, 1 ♀, 1914, coll. E. André (MNHN-IS); *Rabat-Salé-Kénitra:* Séhoul (MNHN).

Fig. 1. *Leucospis brevicauda* Fabricius. ♂, habitus in lateral view (photo by C. Villemant).

Geographical distribution. France, Spain (Madl & Schwarz 2014), Portugal (Bouček, 1959), Algeria, Italy, Morocco, Tunisia (Baur & Amiet 2000), Turkey (Öncüer 1991).

Biology. Unknown.

Remark. In North Africa, this species is recorded in Algeria (Fabricius 1804), Tunisia (Baur & Amiet 2000), and Morocco where it has been reported by Masi since 1935.

Leucospis dorsigera Fabricius, 1775

Leucospis dorsigera Fabricius, 1775: Schletterer 1890: 185 (tax., descr. ♂ ♀, Morocco).

Leucospis dorsigera Fabricius, 1775: Weld 1922: 11 (key), 32 (Morocco), pl. 3 (fig. 16).

Leucospis dorsigera Fabricius, 1775: Maidl 1933: 128 (Morocco).

Leucospis dorsigera Fabricius, 1775: Bouček 1974a: 142 (tax., biol., Morocco without exact locality), 159 (key).

Leucospis dorsigera Fabricius, 1775: Madl 1989: 199 (tax., Morocco).

Leucospis dorsigera Fabricius, 1775: Madl 1990: 82 (tax., Morocco).

Distribution in Morocco. *Tanger-Tétouan-Al Hoceïma:* Tangier, 2 ♂, 1 ♀ (CU, NY, USA) (Weld 1922: 32); same locality, 1 ♂ 1 ♀ (Madl 1989: 200); *Rabat-Salé-Kénitra:* Rabat, 1 ♂, 1.VI.1934 (Jourdan & Rungs 1934: 212); *Souss-Massa:* Oued Issene E Agadir, 1 ♀, 13.IV.1988, coll. J. Gusenleitner (Madl 1990: 83); *Guelmim-Oued Noun:* 30 km NNW Goulimine,1 ♂, 26.III.1987, coll. J. Gusenleitner (Madl 1990: 83); *Oriental:* Debdou-Taourirt, 1 ♂, 14.V.1930, coll. R. Ebner (Madl 1989: 200); Figuig: Meridja, 13.V.1930 (Maidl 1933: 128).

Material examined. *Tanger-Tétouan-Al Hoceïma:* Tangier, 3 ♀ 1 ♂, 1919, coll. J. De Gaulle; same locality, 6 ♀ 4 ♂, 1914, coll. E. André; surroundings of Tangier, 2 ♀ 2 ♂, 1857, coll. C. Favier (MNHN); same locality, 1 ♀, 1914, coll. E. André (MNHN-SI); *Fèz-Meknès:* Meknes, 550 m, 1 ♀, 1919, coll. R. Benoist (MNHN).

Geographical distribution. Afghanistan, Algeria, Australia, Austria, Bosnia-Herzegovina, Bulgaria, Caucasus, Croatia, Cyprus, Czech Republic, former Czechoslovakia, Egypt, France, Germany, Greece, Hungary, India, Iran, Israel, Italy, Jordan, Kazakhstan, Lebanon, Libya (Madl 2015), Macedonia, Moldova, Montenegro, Morocco, Pakistan, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Switzerland, Syria, Tunisia (Madl & Schwarz 2014), Turkey, Turkmenistan, Ukraine (Noyes 2023, UCD Community 2023).

Biology. *Leucospis dorsigera* Fabricius is quoted as a primary parasitoid of Hymenoptera: Apidae (Erdös 1955, Bouček 1959, 1961, 1977, Fry 1989, Le Goff 1999), ectoparasitoid of Megachilidae (Renneson 2005). Also, it's known as hyperparasitoid of Hymenoptera: Ichneumonidae (Hesami *et al.* 2005), and Coleoptera: Bostrichidae (Herting 1973) and Cerambycidae colonized by bees of the genus *Eriades* [= *Osmia*] according to Grandi (1961) (in Baur & Amiet 2000) and *Xorides corcyrensis* Kriechbaumer (Hymenoptera: Ichneumonidae) (Baur 2005). In addition, this species has been cited as a parasitoid host of *Melittobia acasta* (Walker, 1839) (Hyminoptera: Eulophidae) (Domenichini 1966).

Associated plants. Apiaceae (Baur & Amiet 2000), Asteraceae, Fabaceae, Poaceae and Rosaceae (Askew *et al.* 2001), Liliaceae and Rubiaceae (Bouček 1959).

Remark. Although Schletterer 1890 cited Morocco without an exact locality for *Leucospis dorsigera* Fabricius, it is only according to Bouček (1974a) that this species has been mentioned for all countries in the North African region [Algeria (Fabricius 1804), Egypt (Spinola 1838) and Tunisia (Madl & Schwarz 2014)], excluding Mauritania in the Maghreb region.

***Leucospis gigas* Fabricius, 1793**

Leucospis gigas Fabricius, 1793: Schulz 1905: 18 (Morocco).

Leucospis gigas Fabricius, 1793: Berland 1934a: 173 (biol., Morocco).

Leucospis gigas Fabricius, 1793: Bouček 1974a: 49 (tax., biol., Morocco), 156 (key).

Distribution in Morocco. *Fèz-Meknès:* Timahdit region, Atlas Mountains (NHM) (Bouček 1974a: 153); 1 ♀, Moulay Idriss Volubilis ruins, 03.VI.1992, coll. G. Delvare (GDPC); 1 ♀, Taza Djebel Tazekka 1500 m, 29.VI.1996, coll. H. Tussac (GDPC); *Béni-Mellal-Khénifra:* 1 ♀, road from Bin El Ouidane to Ouarzazate, 23.V.1985, coll. Maldès J.-M. (GDPC) (G. Delvare, pers. comm., March 1, 2024); *Tanger-Tétouan-Al Hoceïma:* Tangier (Berland 1934a: 173).

Geographical distribution. Afghanistan, Albania, Algeria, Armenia, Austria, Bosnia-Herzegovina, Caucasus, China, Croatia, former Czechoslovakia, Egypt, France, Germany, Gibraltar, Greece, Hungary, India, Iran, Israel, Italy, Jordan, Kazakhstan, Kirgizia, Lebanon, Libya, Macedonia, Malta, Montenegro, Morocco, Pakistan, Romania, Russia, Slovakia, Slovenia, Spain, Switzerland, Syria, Tadzhikistan, Tajikistan (Ye *et al.* 2017), Tunisia, Turkey, Turkmenistan, Ukraine, USA, Uzbekistan.

Biology. *Leucospis gigas* Fabricius is cited as a primary parasitoid of Hymenoptera: Apidae (Fry 1989, Bouček 1959), Megachilidae (Bouček 1974a), Vespidae (Fateryga & Ivanov 2009).

Associated plants. Crassulaceae [*Sedum album* Linnaeus] (Baur & Amiet 2000).

Remark. *Leucospis gigas* Fabricius is cited so far in all countries of the North African region [Algeria (Lucas 1849); Egypt, Libya and Tunisia (Bouček 1974a)], excluding Mauritania in the Maghreb region.

Leucospis intermedia (Illiger, 1807)

Leucospis intermedia Illiger, 1807: Berland 1934b: 66 (key ♀), 67 (key ♂), 68 (biol., Morocco).

Distribution in Morocco. *Fèz-Meknès:* Meknes, 25.VI.1928, coll. R. Benoist (Berland 1934b: 68; *Drâa-Tafilalet:* 1 ♀, Dadès gorges, 28.V.1992, coll. G. Delvare (GDPC); 3 ♀, Tizi N' Tinififft, 10.V.1989, coll. H. Tussac (GDPC) (G. Delvare, pers. comm., March 1, 2024).

Material examined. *Fèz-Meknès:* Meknes, 550 m, 1 ♀, 1919, coll. R. Benoist (MNHN).

Geographical distribution. Afghanistan, Albania, Algeria, Armenia, Australia, Austria, , Azerbaijan, Bulgaria, Caucasus, China, Croatia, Cyprus, Czech Republic, Czechoslovakia, Egypt, France, Germany, Greece, Hungary, Iran, Israel, Italy, Jordan, Kazakhstan, Lebanon, Libya, Macedonia, Moldova, Montenegro, Morocco, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Switzerland, Syria, Tadzhikistan, Tajikistan, Transcaucasia, Turkey, Ukraine, Uzbekistan.

Biology. *Leucospis intermedia* (Illiger) was reported as a primary parasitoid of Hymenoptera: Megachilidae [*Megachille* sp., *Osmia emarginata* Lepeletier, *O. mustelina* Gerstäcker] (Bouček 1959, Baur & Amiet 2000, Ye *et al.* 2017). In Morocco, this species was observed on *Euphorbia* sp. (Euphorbiaceae) (G. Delvare, pers. comm., March 1, 2024).

Remark. In North Africa, this species is mentioned in Algeria, Egypt, Libya, and Morocco (Madl 2015, Bouček 1974a).

***Leucospis miniata* Klug, 1834**

Leucospis miniata Klug, 1834: Bouček 1974a: 104 (key), 111 (fig. 158), 133 (Morocco).

Distribution in Morocco. *Dakhla-Oued Ed-Dahab:* Oum Dreyga, 2 ♂, 23.III.2009, coll. A. Foucart (Foucart, pers. comm., February 1, 2022) (Figs 2a, b); *Souss-Massa:* Tamralta, 1 ♂, 1.VI.1945, coll. Ch. Rungs (Bouček 1974a: 133); *Béni-Mellal-Khénifra:* High Atlas, 1900 m, Ouaourioud, numerous specimens ♀ (Fig. 3) and ♂, 20.VI.2022 (L. Kruszelnicki, pers. comm., October 31, 2023), *Laâyoune-Boujdour-Sakia El Hamra:* 1 ♀, 25 km before Guelta Zemour 24°59'53.8"N 12°30'12.7", IV.2009, coll. G. Delvare (DGPC) (G. Delvare, pers. comm., March 1, 2024).

Material examined. *Fèz-Meknès:* Middle Atlas, Ras El Ksar, 900 m, 1 ♀, 12-13.VI.1929, coll. F. Le Cerf (MNHN-SI); *Souss-Massa:* Tamralta, 1 ♂, 1.VI.1945, coll. Ch. Rungs (MNHN); 1 ♀, Aguelman Aberhane, VII.1954 (MNHN-SI).

Fig. 2. *Leucospis miniata* Klug on branches of Nucularia perrinii Battandier. a – ♂; b – ♂ (photo by A. Foucart)

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Fig. 3. *Leucospis miniata* Klug. ♀, habitus in dorsal view (photo by L. Kruszelnicki)

Geographical distribution. Algeria and Israel (Madl & Schwarz 2014), Egypt (Klug 1834), Italy (Caleca *et al.* 1995), Libya (Madl 2015), and Morocco (Bouček 1974a).

Biology. No host record known of *Leucospis miniata* Klug so far. But, in Morocco, this species was observed on *Nucularia perrinii* Battandier, 1903 (Amaranthaceae s.l.) (Chenopodiaceae s.st.).

Remark. In North Africa, this species is recorded west to Morocco and east to Egypt (Klug 1834), and Algeria (Bouček 1974a), but not from Tunisia, and Mauritania in the Maghreb so far.

Discussion

Global results of the current investigations have allowed us to identify only 6 Leucospidae species confirmed for Morocco, represented by only genus, *Leucospis*.

The knowledge of the Leucospidae, especially in countries of North Africa, is still very incomplete and presents several shortcomings. The comparative study of Leucospidae with the rare bibliographic data available on North African faunas indicates a slight difference in the faunal composition. Indeed, some species of Leucospidae are common to almost all North African countries. As a result, the Moroccan Leucospidae family has six binomial species as well as Algeria, and Egypt, respectively, as compared to the fauna of these countries. On the other hand, Libya has five species, followed by Tunisia with four.

Note that Gadallah *et al.* 2018 have only recently discovered the North African endemic species *Leucospis arabica* Gadallah & Soliman, 2018 in Egypt. However, the Leucospidae are mentioned in all countries in the North African region, with the exception of Mauritania for the Maghreb region (Fig. 4).

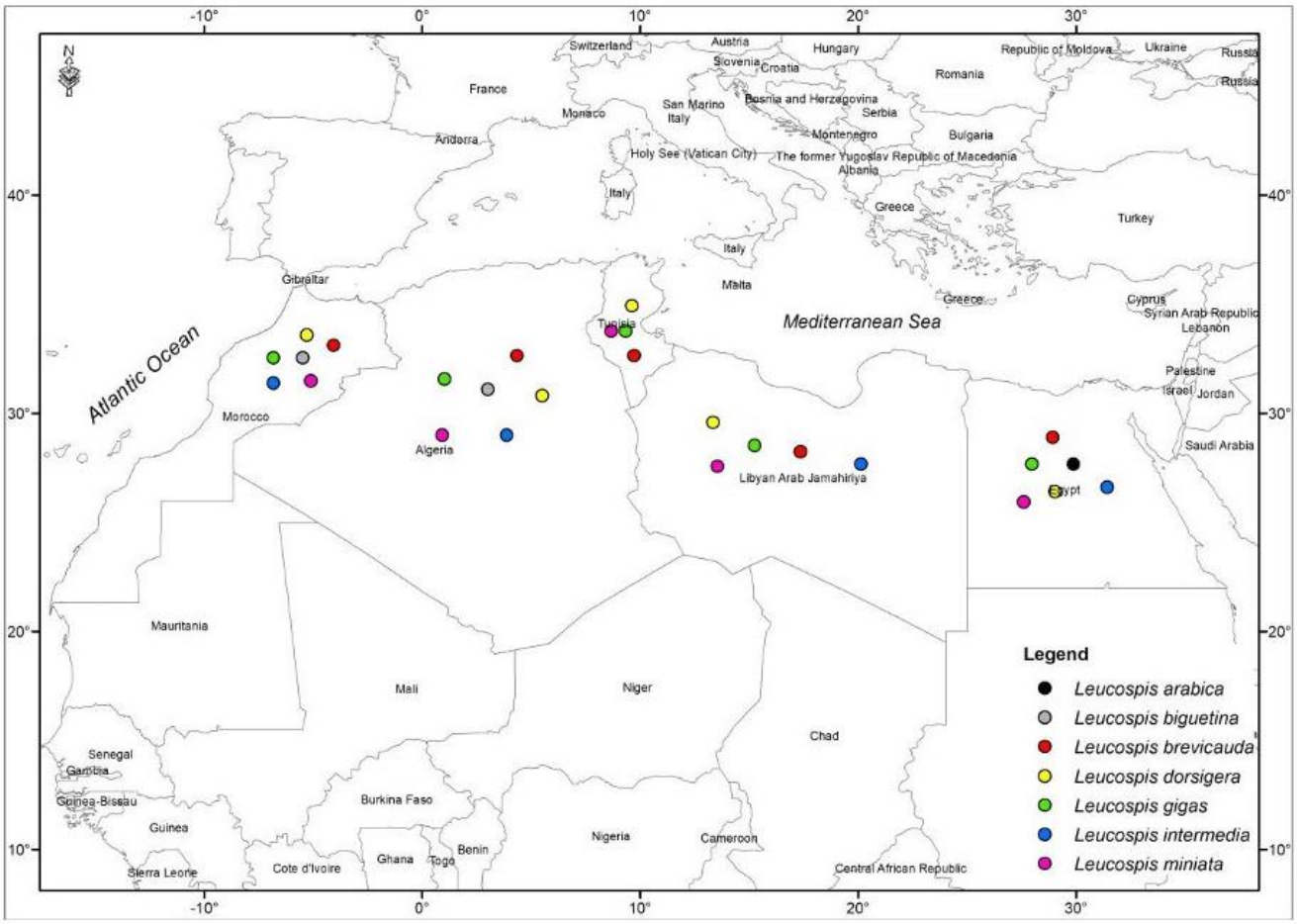

Fig. 4. Synthesis of biogeographic data relating to *Leucospis* species recorded in the North African region.

Being situated in the West-Palaearctic region, Morocco is renowned for its numerous and varied natural environments, which is in principle, ought to accommodate a greater variety of organisms. Research programs on this Hymenoptera group should be carried out in several regions of Morocco to improve our knowledge of the Moroccan heritage. All the countries in the North Africa should be included in this research because they have a lot of biodiversity.

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