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New records, distribution and phenology of hoverflies (Diptera: Syrphidae) in semi-arid habitats in northeastern Algeria

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Faunistic analysis of a bioindicator group of insects (Diptera: Syrphidae) across semi-arid habitats in northeastern Algeria

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Abstract

Hoverflies (Diptera: Syrphidae) pollinate plants, predate other insects, and feed on vegetal and decay materials, being used as bioindicators of different ecosystem conditions and processes. The main aim of the present paper is to enhance the bioindicator potential of hoverflies in Algeria (North Africa) by studying the hoverfly communities of six sites with different vegetation and conditions, in the semi-arid Northeast of Algeria: unpolluted riverbank, plant nursery, polluted riverbank, olive orchard (*Olea europaea*), prickly pear plantations (*Opuntia ficus-indica*), and a cypress hedge (*Cupressus sempervirens*).With an entomological net, hoverflies were sampled fortnightly from December 2016 to November 2017. In total 37 species were identified, predominating by the subfamily Erisalinae. The unpolluted and polluted riverbanks, and the plant nursery had the highest species richness with 26, 24, and 23 species respectively, whereas, the lowest species numbers were detected in the prickly pear plantations, the cypress hedge and the olive orchard with 16, 14, and 10 species respectively. One species was new to North Africa (*Eumerus etnensis*) and other three species new to Algeria (*Eupeodes nuba*, *Paragus vandergooti* and *Eumerus obliquus*). The results of the present paper suggest the need for further hoverfly surveys in other unexplored regions and habitats of Algeria.

Key words: Algerian ecosystems, Diptera, faunistics, species inventory, species distribution, Syrphidae.

1. Introduction

The Syrphidae (Diptera), commonly known as ‘hoverflies’ in Europe and ‘flower flies’ in North America, are true flies with about 6000 species and 202 genera distributed almost worldwide (Rotheray and Gilbert 2011). Hoverflies play multiple ecosystem

services, particularly as efficient pollinators and predators of other insects (Petanidou et al. 2011; Ricarte et al. 2011; Inouye et al. 2015). Generally, they are divided into the following functional groups: phytophages, mycophages, saprophages, saproxylics and zoophages (Sommaggio 1999; Rotheray et al. 2000, 2001; Rojo et al. 2003). Hoverflies are used as bioindicators thanks to their widespread distribution, availability of identification keys and diverse larval requirements (Sommaggio 1999). For example, hoverflies with predatory larvae indicate the presence of their preys nearby and hoverflies with saproxylic larvae the maturity of trees where they find their breeding sites (rot holes or sap runs) (Rotheray 1993). Nonetheless, the very basic premises to use hoverflies as bioindicators is to know the habitats (adults) and microhabitats (larvae) they associate with (and depend on) in their geographic range (Speight and Castella 2001).

In North Africa, the degree of knowledge of the hoverflies varies greatly from one country to another. In many cases, hoverfly knowledge does not reflect the real dimension of each hoverfly biocenosis, as a result of insufficient exploration of the various regions of the countries concerned. For example, the number of species listed in Tunisia, Egypt and Libya is 61, 43, and 33 species, respectively (El-Hawagry and Gilbert 2019). The hoverfly community in these countries apparently remains to this day poorly known. In contrast to the three previous countries, the hoverfly fauna of Morocco is apparently much better known, with 131 species recorded (e.g. Kassebeer 1995a, 1995b, 1999a, 1999c; Sullivan and Sutherland 2000; Reemer et al. 2004, Pârvu et al. 2006; Vujić et al. 2015).

The total data on the hoverfly fauna of Algeria is limited mainly to a few species lists derived from occasional surveys in the 20th century (Becker 1907; Séguy 1961; Peck 1988; Hurkmans 1993; Djellab and Samraoui 1994). However, there are some recent

investigations carried out in humid and semi-arid regions of Algeria (Djellab et al. 2013; Haffaressas et al. 2017; Djellab et al. 2019).

North Africa and particularly Algeria has an uneven and poor knowledge of their hoverflies as stated above. This fact reduces the bioindicator potential of this insect group in a world region where they could be used in habitat management and conservation (Speight and Castella 2001), as well as in other applied fields such as the control of pest insects (Raymond et al. 2014).

Algeria presents a great climatic diversity, since one meets there all the Mediterranean bioclimatic stages going from wet to Saharan, which gives the country a great faunistic and floristic diversity. According to the size and habitat diversity of Algeria, the hoverfly fauna (currently 76 spp) (El-Hawagry and Gilbert 2019) and communities at different Algerian habitats seem to be far to be fully understood. Thus, this study aims at enhancing the bioindicator potential of hoverflies in Algeria by surveying and studying them in six sites with different vegetation and conditions, in the steppe rangelands from the Northeast (an unpolluted riverbank, a polluted riverbank, a plant nursery, an olive orchard, a prickly-pear plantation and a cypress hedge). This is then a new step towards a definitive checklist of the Algerian hoverflies, with findings relevant to North Africa.

2. Material and Methods

2.1. Study area

The study was conducted in the region of Hammamet, located at 18 km northwest of the city of Tebessa (northeastern Algeria) (Fig. 1). Based on data provided by the meteorological station of Tebessa located within study area (latitude: 35°4'N, longitude: 8°13'E, altitude: 813m, WMO station code: 604750) available at 'tutiempo' climate data base (https://fr.tutiempo.net/climat/ws-604750.html), for the period 1972-2016, the study

area is characterized by a semi-arid climate (De Martonne aridity index=14.1). September was the rainiest month with 40.93 mm, while July was the driest month with 14.95 mm. Annual rainfalls averaged 372.08 mm and the annual average of mean temperature was 16.37°C with a maximum in July (26.26 °C) and minimum in January (7.67°C). Gaussen and Bagnouls diagram represented in Figure 1 shows that the dry period lasted more than five months a year, from mid-May to late October.

Field work covered six sites representing different vegetation and conditions from the steppe rangelands of Algeria shown in Table 1.

2.2. Sampling methods and identifications of species

Fieldwork lasted one year round from December 2016 to November 2017. The sampling of Syrphidae was carried out fortnightly with a regular sampling effort at each of the six sites described above. Adult hoverflies were collected using an entomological net. Each sampling session per site lasted two continuous hours. Sampling method consisted of line transects with four transects of 30 m established, 120 m at each study habitat.

In the lab, hoverflies were killed by putting them in a freezer during 24 hours. After that, they were pinned through the thoracic dorsum and the wings and legs were well spread. Each specimen was labeled and assigned with information of the sampling site, and date of capture. Adults were identified under a binocular stereomicroscope using the following literature: Sack (1928-1932), Séguy (1961), Goeldlin de Tiefenau (1976), Marcos-García (1986), Verlinden (1994), Stubbs and Falk (2002), Nielsen (2004), Smit et al. (2004), Marcos-García et al. (2007), Smit and Vujić (2008), Bartsch et al. (2009), Van Veen (2010), Speight et al. (2016a), Smit et al. (2017), and Van Steenis et al. (2017). Specimens were identified in first stage by Nadjoua Mebarkia and Sihem Djellab, and then confirmed or reidentified by Antonio Ricarte. The identified specimens are deposited in the insect collection at in laboratory of Tebessa University

(Algeria) and at the 'Colección Entomológica de la Universidad de Alicante', deposited in the 'Centro Iberoamericano de la Biodiversidad' (CIBIO) (Spain).

Adults of some species were illustrated with photos produced as stalks of individual images made with a camera (Leica DFC 450) attached to a binocular stereomicroscope (Leica M205 C). Stalks were made in Leica Application Suite X (LAS X) ®, v. 3.0.4.16529.

2.3. Determination of biological and ecological attributes

For each recorded species, the following information is provided: localities were it was recorded in Tebessa province in our study ('Localities'); Algerian and world distribution ('Distribution') [based on Dirickx (1994), Van Veen (2010), Speight (2017) and other specific references cited in the text]; trophic habits and biology of larvae ('Larval trophic habits') [based on Speight (2017) and other specific references cited in the text].

3. Results

3.1. Annotated list of recorded species

Overall, the present survey yielded 37 species of Syrphidae. The list included Four species new to Algeria, of which one was new to North Africa. The species collected in the study area are shown in Table 2, which compares the results of this study with those of other studies dealing with the Algerian hoverfly fauna.

Subfamily Syrphinae

1. *Chrysotoxum intermedium* (Meigen, 1822)

Material examined. (19ex)11 m, 8 f, S1, 16. III. 6-20. IV. 01. VI. 2017; (11ex) 6 m, 5 f, S2, 16. II. 02. III. 20. IV. 04. 18. V. 2017; (10ex)7 m, 3 f, S3, 03-17. III. 21. IV. 05. V. 2017; (6ex) 3 m, 3 f, S5, 08-22. IV. 2017; (9ex) 5 m, 4 f, S6, 04. III. 08-22. IV. 06-20. V. 2017; leg, N Mebarkia, det. S Djellab, A Ricarte.

Distribution. Central and Southern Europe, east to Afghanistan (Van Veen 2010). North Africa: known from Morocco to Tunisia (Dirickx 1994). In Algeria *C. intermedium* is reported from Tebessa, El-Kala and Guelma (Djellab 2013; Djellab et al.2013; Haffaressas et al. 2017; Djellab et al. 2019)

Larval trophic habits: Larvae of *Chrysotoxum* spp. seem to be associated with ant nests, probably feeding on ant-attended root aphids (Burgio and Sommaggio 2002; Van Veen 2010). The larvae of *C. intermedium* are aphidophagous (Rojo et al. 2003).

2. *Dasysyrphus albostriatus* (Fallén, 1817)

Material examined. (1ex) 1 m, S2, 06. IV. 2017; leg. N Mebarkia, det. S Djellab, A Ricarte.

Distribution. Fennoscandia, Iberia, Ireland, central and southern Europe, Turkey, Russia, central Asia and Japan (Speight 2017). In North Africa, this species is reported from Tunisia and it was recorded for the first time in Algeria by Djellab et al. (2013). It is a confirmed migratory species (Speight 2017).

Larval trophic habits. Predominantly aphid-feeder (Rojo et al.2003).

3. *Episyrphus balteatus* (de Geer, 1776)

Material examined. (9ex) 5 m, 4 f, S1, 16. III. 06. IV. 19. V. 2017; (22ex) 14 m, 8 f, S2, 02-16. III. 06-20. IV. 04-18. V-21. IX. 2017; (3ex) 2 m, 1 f, S3, 03. III. 07. VI. 06. X. 2017; (1ex) 1 m, S5, 09. IX. 2017; (6ex) 4 m, 2 f, S6, 08. IV. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Ubiquitous and migratory. The distribution includes Australia and the Palearctic region; for North Africa, this species is reported from Morocco to Egypt (Dirickx 1994; Djellab 2013; Djellab et al. 2013; Haffaressas et al. 2017; Djellab et al. 2019).

Larval trophic habits. Larvae predate not only on aphids, but also on a wide range of soft-bodied insects (Rojo et al. 2003).

4. *Eupeodes corollae* (Fabricius, 1794)

Material examined. (2ex) 2 f, S1, 06-20. IV. 2017; (4ex) 2 m, 2 f, S2, 16. II. 06-20. IV. 04. V. 2017; (5ex) 3 m, 2 f, S3, 03-17. III. 7-21. IV. 06. X. 2017; (3ex) 1 m, 2 f, S4, 07-21. IV. 05. V. 2017; (3ex) 3 f, S5, 22. IV. 2017; (4ex) 1 m, 3 f, S6, 18. III. 22. IV. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. One of the most widely distributed and common hoverfly species in the Mediterranean Basin. Its range includes several locations in tropical Africa. Present in North Africa, from Morocco to Tunisia and common in northeast Algeria. It is a migratory species (Dirickx 1994; Speight 2017).

Larval trophic habits. Larvae of *E. corollae* feed mainly on aphids, but also on a wide range of other arthropods (Rojo et al, 2003).

5. *Eupeodes nuba* (Wiedemann, 1830)

Material examined. (1ex) 1 f, S3, 07. IV. 2017; (1ex) 1 m, S4, 21. IV. 2017; leg. N Mebarkia, det A Ricarte.

Distribution. Described from Nubia, northern Sudan, the range includes Switzerland in central Europe, south-western parts of Asia, Canary Isles and the Mediterranean Basin. In eastern parts of the Afrotropical region, it occurs from Ethiopia south to South Africa; and also Egypt and Morocco (Dirickx 1994; Speight 2017). This study revealed that the species is also present in Algeria (first record from this country).

Larval trophic habits. Aphidophagous (Rojo et al. 2003).

6. *Melanostoma mellinum* (Linnaeus, 1758)

Material examined. (2ex) 1 m, 1 f, S1, 4-18. V. 15. VI. 06. VII. 2017; (1ex) 1 f, S2, 18. V. 2017; (3ex) 2 m, 1 f, S3, 7-21. IV. 19. 2017; (1ex) 1 m, S6, 22. IV. 2017; leg. N Mebarkia, det. S Djellab, A Ricarte.

Distribution. One of the most common species in the Mediterranean Basin (Dirickx1994). In North Africa, it is present from Morocco to Egypt including Algeria.

Larval trophic habits. Aphid-feeder (Speight, 2017).

7. *Meliscaeva auricollis* (Meigen, 1822)

Material examined. (1ex) 1 m, S1, 06. IV. 2017; leg. N Mebarkia, det. S Djellab, A Ricarte.

Distribution. Fennoscandia, the Faroes, south Iberia, the Mediterranean Basin (including Cyprus, Malta and Crete), Canary Isles, Turkey, Ireland, and most of Europe (Speight 2017). In North Africa, the species is known from Morocco to Egypt, including Algeria from Tebessa and El-Kala (Dirickx 1994; Haffaressas et al. 2017).

Larval trophic habits. Aphid predators, it has also been found feeding on psyllids (Rojo et al. 2003; Speight 2017).

8. *Paragus bicolor* (Fabricius, 1794)

Material examined. (11ex) 9 m, 3 f, S1, 4-18. V. 15. VI. 06. VII. 2017; (6ex) 3 m, 3 f, S2, 20. IV. 01. 01. VI. 06. VII. 21. IX. 2017; (13ex) 8 m, 5 f, S3, 05-19. V. 07-21. VII. 2017; (4ex) 2 m, 2 f, S4, 07. IV. 05-19. V. 02. VI. 2017; (4ex) 2 m, 2 f, S5. 06-20. V. 03. VI. 06. VII. 2017; (8ex) 6 m, 2 f, S6. 18. III. 08-22. IV. 20. V. 08. VII. 2017; leg. N Mebarkia, det. S Djellab, A Ricarte.

Distribution. From southern Sweden and Denmark, south to the Mediterranean and North Africa; from France eastwards through central and southern Europe to Mongolia; Iran and Afghanistan; North America (Speight 2017).

Larval trophic habits : Aphidophagous (Rojo et al.2003).

9. *Paragus quadrifasciatus* Meigen, 1822

Material examined. (9ex) 5 m, 4 f, S3, 17. III. 5-19. V. 21. VII. 18. VIII. 2017; (2ex) 1 m, 1 f, S6, 04. III. 06. V. 2017; leg. N Mebarkia, det. S Djellab, A Ricarte.

Distribution. Central, Southern Europe and Maghreb (from Morocco to Tunisia) (Dirickx 1994; Van Veen 2010). *P. quadrifasciatus* was recorded in Algeria from Guelma (Haffaressas et al.2017).

Larval trophic habits. Aphidophagous (Rojo et al.2003).

10. *Paragus tibialis* (Fallén, 1817)

Material examined. (3ex) 3 m, S1, 18. V. 2017; (2ex) 2 m, S4, 07. IV. 2017; (1ex) 1 m, S6, 04. III. 2017; leg. N Mebarkia, det. S Djellab, A Ricarte.

Distribution. It is present in southern Norway, Sweden, Denmark, the Mediterranean coast of Europe, the Canary Isles, Britain, Turkey, North America and North Africa (from Morocco to Egypt) **(**Dirickx 1994; Speight 2017). In Algeria, *P. tibialis* has been recorded from Tebessa and El-Kala (Djellab 2013; Djellab et al. 2013).

Larval trophic habits : Aphidophagous (Rojo et al.2003).

11. *Paragus vandergooti* Marcos-García, 1986 (Fig. 2)

Material examined. (6ex)5 m, 1 f, S1, 18. V. 01. VI. 06. VII. 2017 ; (5ex)3 m, 2 f, S2, 1-15. VI. 06. VII. 03. VIII. 2017 ; (3ex)3 m, S3, 05. V. 07. 21. VII. 2017 ; (1ex)1 m, S5, 06. V. 2017 ; (4ex)3 m, 1 f, S6, 06. 20. V. 03. VI. 2017 ; leg. N Mebarkia, det M.A. Marcos García, A Ricarte.

Distribution. Southern France, Portugal and central Spain (Speight 2017). In North Africa, this species was recorded only from Morocco (Dirickx 1994). This species is new to the fauna of Algeria.

Larval trophic habits. not described, but probably an aphid predator.

12. *Platycheirus albimanus* (Fabricius, 1781)

Material examined. (1ex)1 m, S2, 16. III. 2017; leg. N Mebarkia, det A Ricarte.

Distribution. Spread across Greenland, Iceland, the Faroes, Fennoscandia, the Mediterranean Basin, most of Europe, Turkey, Russia, Siberia, Philippines and North America (Speight 2017). North Africa, this species was reported only once from Morocco (Dirickx 1994), whereas in Algeria, Djellab et al. (2013) recorded *P. albimanus* for the first time in El-Kala.

Larval trophic habits. Aphid-feeders (Rojo et al.2003).

13. *Platycheirus ambiguus* (Fallén, 1817) (Fig. 3)

Material examined. (2ex) 2 m, S1, 16. III. 2017; (1ex) 1 m, S2, 02. III. 2017; leg. N Mebarkia, det A Ricarte.

Distribution. Uncertain due to confusion with other species, supposedly from Fennoscandia south, central Spain, Ireland eastwards, through most of Europe, the Pacific coast (Nielsen 2004; Speight 2017).

Larval trophic habits. Aphidophagous (Rojo et al. 2003).

14. *Scaeva dignota* (Rondani, 1857)

Material examined. (1ex) 1 m, S6-03. VI. 2017; leg. N Mebarkia, det A Ricarte.

Distribution. Central and southern Europe, Morocco and Algeria (Dirickx 1994; Van Veen 2010). This species has not been reported in recent inventories in Algeria (Djellab 2013; Djellab et al. 2013; Haffaressas et al. 2017)

Larval trophic habits. Aphidophagous (Rojo et al. 2003).

15. *Sphaerophoria rueppellii* (Wiedemann, 1830)

Material examined. (4ex) 2 m, 2 f, S1, 04-18. V. 01. VI. 2017; (4ex) 3 m, 1 f, S2, 04-18. V. 2017; (3ex) 2 m, 1 f, S3, 19. V. 18. VIII. 2017; (1ex) 1 f, S5, 20. V. 2017; (11ex) 8 m, 3 f, S6, 06-20. V. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Entire Palearctic region and eastern parts of the Afrotropical region. It is the most widespread and common species of the genus *Sphaerophoria* in the Mediterranean Basin ; in North Africa, it is present from Morocco to Egypt (Dirickx 1994). *S. rueppellii* was reported from Algeria only in Tebessa and Guelma provinces (Djellab 2013 ; Haffaressas et al. 2017).

Larval trophic habits. Aphidophagous (Rojo et al. 2003).

16. *Sphaerophoria scripta* (Linnaeus, 1758)

Material examined. (80ex) 38 m, 42 f, S1, 20. IV. 04-18. V. 01. VI. 17. VIII. 07. IX. 2017; (38ex) 28 m, 12 f, S2, 20. IV. 4-18. V. 01-15. VI. 2017; (21ex) 6 m, 15 f, S3, 07. IV. 05-19. V. 02. VI. 2017; (14ex) 4 m, 10 f, S4, 03. III. 07-21. IV. 05-19. V. 2017; (8ex) 5 m, 3 f, S5, 22. IV. 06-20. V. 03-17. VI. 08. VII. 2017; (48ex) 37 m, 11 f, S6, 08. IV. 06-20. V. 03-17. VI. 2017; leg. N Mebarkia, det. S Djellab, A Ricarte.

Distribution. A highly migratory species, its range includes southwest Greenland, Iceland, south Fennoscandia, the Pacific coast and the Palearctic; this species in North Africa is reported from Morocco to Egypt (Dirickx 1994; Speight 2017).

Larval trophic habits. Predators of different aphid species, it has also been found feeding on some species of Psyllidae and Lepidoptera (Rojo et al. 2003).

17. *Xanthogramma marginale* (Loew, 1854)

Material examined. (1ex) 1 m, S1, 20. VII. 2017 ; (2ex) 1 m, 1 f, S3, 19. V. 08. IX. 2017 ; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Portugal, central and southern Spain (Ricarte 2008), southern France, Italy and North Africa (Morocco and Algeria) (Dirickx 1994; Speight 2017).

Larval trophic habits. Unknown, but probably aphidophagous. Larvae of *Xanthogramma* spp. seem to be associated with nests of *Lasius* ants, probably feeding on ant-attended root aphids.

Subfamily Eristalinae

18. *Ceriana vespiformis* (Latreille, 1804)

Material examined. (3ex) 3 m, S1, 18. V. 07. IX. 2017; (3ex) 2 m, 1 f, S2, 01. VI. 06. VII. 03. VIII. 2017; (2ex) 1 m, 1 f, S3, 02. VI. 05. X. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution: Spain, the Mediterranean Basin, and various Mediterranean islands (Speight 2017). In North Africa, it is known from Morocco, Egypt and Algeria.

Larval trophic habits. Saproxylic (Rotheray et al. 2006).

19. *Eristalinus aeneus* (Scopoli, 1763)

Material examined. (7ex) 5 m, 2 f, S1, 03-18. VIII. 21. IX. 2017; (21ex) 11 m, 10 f, S2, 02-16. II. 02-16. III. 06. IV. 01. VI. 06. VII. 2017; (42ex) 25 m, 18 f, S3, III. IV. V. VI. VII. VIII. IX. X. 2017; (1ex) 1 m, S4, 07. IV. 2017; (39ex) 19 m, 20 f, S5, III. IV. V. VI. VII. VIII. IX. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Cosmopolitan: Afrotropical region, central and southern Europe, North America, Australia and the Gilbert and Ellis islands in Australasia, Southern Sweden and Canary Isles (Speight 2017). In North Africa, it occurs from Morocco to Egypt (Dirickx 1994; Djellab 2013; Djellab et al. 2013; Haffaressas et al. 2017).

Larval trophic habits. Aquatic saprophagous (Rotheray 1993).

20. *Eristalinus taeniops* (Wiedemann, 1818)

Material examined. (32ex)18 m, 14 f, S1, 06. IV. 01-15. VI. 03-17. VIII. 07-21. IX. 2017 ; (15ex)7 m, 8 f, S2, 01. VI. 06. VII. 03-17. VIII. 07. IX. 2017 ; (48ex)30 m, 18 f, S3, 02-16. VI. 04-18. VIII. 08-22. IX. 2017 ; (1ex)1 m, S5, 06. V. 2017 ; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Portugal, Spain, round the Mediterranean Basin, Canary Islands, in eastern parts of the Afrotropical region down to South Africa (Speight 2017). In North

Africa,*E. taeniops*is present from Morocco to Egypt (Dirickx 1994; Djellab 2013; Djellab et al. 2013; Haffaressas et al. 2017).

Larval trophic habits. Aquatic saprophagous (Pérez-Bañón et al. 2013).

21. *Eristalinus megacephalus* (Rossi, 1794)

Material examined. (15ex) 10 m, 5 f, S1, 01-15. VI. 06. VII. 03-17. VIII. 2017; (5ex) 3 m, 2 f, S2, 03. VIII. 07-21. IX. 2017; (20ex) 9 m, 11 f, S3, 02. VI. 21. VII. 04-18. VIII. 08-22. IX. 06. X. 2017; (10ex) 8 m, 2 f, S5, 04. VIII. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Southern Spain, France and coastal areas of Italy, the Mediterranean Basin, the Afrotropical region and South Africa (Speight 2017). In North Africa, this species occurs from Morocco to Egypt, including Algeria where it was reported in El-Kala (Djellab et al.2013).

Larval trophic habits. Aquatic saprophagous (Speight 2017).

22. *Eristalinus sepulchralis* (Linnaeus, 1758)

Material examined. (1ex)1 f, S1, 03. VIII. 2017 ; (13ex)6 m, 7 f, S3, 02. VI. 18. VIII. 08. IX. 2017 ; (2ex)2 f, S5, 22. IX. 2017 ; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Throughout the Palearctic region. *E. sepulchralis* is less common in the Mediterranean Basin compared to *E. aeneus*. In North Africa, this species occurs from Morocco to Egypt (Dirickx1994).

Larval trophic habits. Aquatic saprophagous (Rotheray 1993).

23. *Eristalis arbustorum* (Linnaeus, 1758).

Material examined. (40ex) 24 m, 16 f, S1, 02. III. 04-18. V. 01-15. VI. 06-20. VII. 03-17. VIII. 07. IX. 2017; (99ex) 43 m, 56 f, S2, II–VIII. 2017; (127ex) 46 m, 81 f, S3, III–X. 2017; (2ex) 2 f, S4,19.V.2017; (47ex) 19 m,28 f, S5,II–VIII.2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Throughout the Palearctic region and North America. This species is recorded in the North Africa from Morocco to Tunisia (Dirickx1994; Speight 2017).

Larval trophic habits. larvae are aquatic saprophagous (Speight 2017).

24. *Eristalis similis* (Fallén, 1817)

Material examined. (2ex) 2 f, S1, 20. IV. 01. VI. 2017; (6ex) 2 m, 4 f, S3, 21. IV. 05-19. V. 02. VI. 07. VII. 2017; (1ex) 1 m, S4, 05. V. 2017; (4ex) 2 m, 2 f, S5, 08-22. IV. 03. VI. 2017; leg. N Mebarkia, det S Djellab, A Ricarte

Distribution. Migratory species (Nielsen et al. 2012); Finland, Britain, central and southern Europe, Asia, and the Mediterranean Basin (Speight 2017).

Larval trophic habits. Aquatic saprophagous found in streams rich in organic matter (Pérez-Bañón et al. 2013).

25. *Eristalis tenax* (Linnaeus, 1758)

Material examined. (5ex) 2 m, 3 f, S1, 06. IV. 04-18. V. 01-15. VI. 2017; (8ex) 3 m, 5 f, S2, 02-16. II. 16. III. 06-20. IV. 04. V. 05. X. 2017; (34ex) 13 m, 21 f, S3, 07-21. IV. 05-19. V. 02-16. VI. 04. VIII. 08. IX. 2017; (4ex) 4 f, S4, 07-21. IV. 2017; (4ex) 2 m, 2 f, S5, 08-22. IV. 06. V. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Migratory and cosmopolitan species, it is the most widely distributed Syrphidae species in the world. It is known from all regions except the Antarctic, found throughout Europe except in the far north. It occasionally reaches offshore islands of northern Europe (Speight 2017).

Larval trophic habits: Aquatic saprophagous (Pérez-Bañón et al. 2013).

26. *Eumerus amoenus* Loew, 1848

Material examined. (1ex) 1 m, S3, 07. IV. 2017; leg. N Mebarkia, det. A Ricarte.

Distribution. Central France, Portugal, Spain, southern Germany and Switzerland, and central Europe (Speight 2017). *E.amoenus* is one of the most common species of the

genus *Eumerus* in the Mediterranean region (Dirickx 1994). In Algeria, it is recorded from Guelma (Haffaressas et al. 2017).

Larval trophic habits. Phytophagous, feeding on bulbs, tubers, rhizomes and fruits (Ricarte et al. 2017).

27. *Eumerus barbarus* (Coquebert, 1804)

Material examined. (1ex) 1 m, S1, 06. IV; (10ex) 5 m, 5 f, S2, 20. IV. 01-15. VI. 06. VII. 21. IX. 2017; (4ex) 2 m, 2 f, S6, 04-18. III. 2017; leg. N Mebarkia. det. A Ricarte.

Distribution: Portugal, Spain, France, Italy, Mediterranean islands, North Africa; from Morocco to Egypt (Speight 2017). In Algeria, the latest report of this species is by Van Steenis et al. (2017) who in addition, described a new species of the *Eumerus barbarus* group from this country.

Larval trophic habits. Phytophagous (Ricarte et al. 2017).

28. *Eumerus etnensis* Van der Goot, 1964

Material examined. (1ex)1 m, S2, 15. VI. 2017; leg. N Mebarkia. det. A Ricarte.

Distribution. Known from Portugal, Spain, southern France, Sicily and Malta (Speight 2017). *E. etnensis* is a new addition to the Algerian and North African hoverfly fauna. This species is similar to *Eumerus purpurariae* Báez, 1982 which is endemic to the Canaries and the specimen studied in the present paper is according to the characters stated in Smit et al. (2004) to separate it from *E. purpurariae*.

Larval trophic habits. Phythophagous (Ricarte et al. 2017).

29. *Eumerus obliquus* (Fabricius, 1805) (Fig. 4)

Material examined. (1ex) 1 m, S2, 21. IX. 2017; leg. N Mebarkia. det. A Ricarte.

Distribution: Balearic and Canary Islands, Corsica, southern France, Italy, Sicily, Malta and the Afrotropical region. In North Africa, the species is reported only from Egypt (Speight 2017). It is then a new addition to the entomofauna of Algeria.

Larval trophic habits: Phytophagous; reared from a wide range of decaying plants including fruits and vegetables (Ricarte et al. 2017).

30. *Helophilus trivittatus* (Fabricius, 1805)

Material examined. (3ex) 2 m, 1 f, S2, 19. V. 2017; (3ex) 2 m, 1 f, S3, 21. IV. 22. IX. 2017; (1ex) 1 m, S5, 08. VII. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Highly migratory species (Nielsen et al. 2010); Fennoscandia, from Ireland eastwards through Eurasia to the Pacific, Iran and Afghanistan and the Mediterranean Basin. In North Africa, *H. trivittatus* occurs from Morocco to Tunisia (Dirickx 1994; Speight 2017).

Larval trophic habits. *Helophilus* spp. larvae are semi-aquatic filter feeders, feeding on detritus and bacteria. The larva of this species has been collected in liquid mud with a high organic content but it remains undescribed (Speight 2017).

31. *Merodon clavipes* (Fabricius, 1781)

Material examined. (2ex) 1 f, 1 m, S1, 06. IV. 18. V. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Portugal, Spain, central and southern Europe, Romania, Ukraine, Turkey and North Africa (Speight 2017). In Algeria, *M. clavipes* is recorded only in Tebessa (Djellab 2013).

Larval trophic habits. Unknown, but supposedly phytophagous, as larvae of other congeneric species (Ricarte et al. 2017).

32. *Merodon serrulatus* Wiedemann *in* Meigen, 1822

Material examined. (1ex)1 m, S1, 06. IV. 2017; leg. N Mebarkia, det. Ricarte.

Distribution. Iberian Peninsula, southern France, Italy, southern parts of the former Yugoslavia; Greece, Romania, Turkey, Syria, Jordan, the Ukraine eastwards into

western Siberia and Mongolia. In North Africa, it is present in Algeria and Morocco (Speight 2017).

Larval trophic habits: Unknown, but supposedly phytophagous, as larvae of other congeneric species (Ricarte et al. 2017).

33. *Myathropa florea* (Linnaeus, 1758)

Material examined. (2ex) 1 m, 1 f, S1, 20. IV. 21. IX. 2017; (1ex) 1 f, S3, 17. III. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Fennoscandia, Eurasia, Pacific coast, Canary Isles and the Mediterranean Basin. In North Africa, *M. florea* is recorded from Morocco to Egypt except Libya (Dirickx 1994; Speight 2017).

Larval trophic habits. Saproxylic (Speight 2017).

34. *Platynochaetus rufus* Macquart, 1835

Material examined. (1ex)1 f, S3,17. III. 2017; leg. N. Mebarkia, det. A. Ricarte, A. Vujić.

Distribution. Maltese islands, In North Africa, the species is reported from Algeria (Speight, 2017).

35. *Psilota innupta* Rondani, 1857

Material examined. (1ex)1 m, S6, 08. IV. 2017; leg. N Mebarkia, det. A Ricarte.

Distribution. Sweden, central Germany, Slovakia, Austria, Hungary, Spain, Italy, Serbia, Croatia, Greece, Romania, southern parts of European Russia, Siberia and North Africa (Speight 2017).

Larval trophic habits. Unknown, but supposedly saproxylic, as the larvae of other congeneric species (Speight 2017).

36. *Syritta pipiens* (Linnaeus, 1758)

Material examined. (47ex) 24 m, 23 f, S1, IV–IX. 2017; (58ex) 28 m, 30 f, S2, III–IX. 2017; (85ex) 50 m, 35 f, S3, III–IX. 2017 ; (6ex) 4 m, 2 f, S4, 07-21. IV. 05-19.V. 2017; (15ex) 11 m, 4 f, S5, 06. V. 03. VI. 2017; (12ex) 8 m, 4 f, S6, 18. III. 08. IV. 06-20. V. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. Cosmopolitan, known from most of the Palearctic, North America, SouthAmerica and Oriental region (Speight 2017).

Larval trophic habits. Saprophagous (Magni et al. 2013).

37. *Volucella liquida* Erichson,1841

Material examined. (2ex)1 m, 1 f, S1, 20. VII. 2017; leg. N Mebarkia, det S Djellab, A Ricarte.

Distribution. *V. liquida* has been noted in two Maghreb countries, Algeria and Morocco (Dirickx1994; Djellab et al. 2013).

Larval trophic habits. Unknown.

3.2. Phenology of the species recorded in the study area

The flight period for some species such as *Eristalinus aeneus*, *Eristalis arbustorum*, *Eristalis tenax, Sphaerophoria scripta* and *Syritta pipiens* was spread over three seasons, spring, summer and autumn except November, December and January. Certain species have a short flight period, for example *Episyrphus balteatus*, *Eupeodes corollae, Helophilus trivittatus, Melanostoma mellinum*, *Merodon clavipes, Myathropa florea*, *Paragus bicolor*, *Paragus quadrifasciatus*, *Paragus tibialis, Paragus vandergooti* and *Eristalis similis*. Some other species have been reported only during a month: *Dasysyrphus albostriatus*, *Eumerus amoenus*, *Eumerus etnensis*, *Eumerus obliquus*, *Eupeodes nuba, Meliscaeva auricollis, Merodon serrulatus*, *Platycheirus albimanus*, *Platycheirus ambiguus*, *Platynochaetus rufus*, *Psilota innupta, Scaeva dignota* and *Volucella liquida*; these species were restricted to a very short flight period. Finally, it

should be noted that almost all species were absent during winter (December, January) and November in autumn. The species with the longest flight periods were all Eristalinae (*E. aeneus*, *E. arbustorum*, *E. tenax*, *S. pipiens*), while all species of Syrphinae had shorter flight periods (Fig. 5).

Discussion

The geographical position of Algeria, as a transition area between the Palearctic and Afrotropical regions, gives it a great importance in terms of animal diversity (Chenchouni 2012). In spite of this fact, in general, few studies on animal groups have been carried out in this country, in particular those devoted to Syrphidae. The data provided in previous investigations on this insect family are widely dispersed and difficult to access. For example, Kassebeer (1999b) revised the historical collection of Syrphidae caught and published in 1849 by Lucas, and thereby referred to the presence of 30 species in Algeria. Other faunistic inventories compiled by Séguy (1961), Peck (1988) and Dirickx (1994) indicated 34, 58 and 62 species, respectively.

The sampling conducted out in our study over a year indicates the presence of 37 species. During the period 1996-2010 and within the same climatic region of Algeria, Djellab et al. (2013) reported the presence of 34 species, whereas a total of 73 species were listed under humid climate in the El-Kala region during 1991-1992, and 31species under the subhumid climate (Haffaressas et al. 2017).

It is noteworthy mentioning that this study provides one species new to North Africa (*Eumerus etnensis*) and three new to Algeria (*Eupeodes nuba*, *Paragus vandergooti* and *Eumerus obliquus*).

The unpolluted and polluted riverbank and the plant nursery have the greatest species numbers; at the opposite, the prickly pear plantations, cypress hedge and olive orchard have the lowest species numbers. The unpolluted and the polluted riverbanks are

diversified with grass, trees, shrub, mud and water that attract more Syrphidae due to the availability of trophic resources both for adults and larvae. The richness of any species in a specific habitat is related to availability of breeding places and hosts. When the habitat cover is diverse, this influences then positively the biodiversity of the Syrphidae (Ouin et al. 2006; Ricarte et al. 2011; Djellab et al. 2019). This situation does not apply on prickly pear plantations, cypress hedge and olive orchard characterized by low plant diversity, which negatively affects that of hoverflies. Thus, hoverflies are adept fliers that interact directly with the vegetation for their dietetics requirements (D'Amen et al. 2013).

Larvae belonging to the subfamily Eristalinae, were saprophagous, with the exception of some species are phytophagous. Species of subfamily Eristalinae were abundant throughout the whole study period, with higher diversity than the Syrphinae (20 spp vs 17spp). The Syrphinae are primarily aphidiphagous, some are generalists, others specialize in just a few species of aphids, and they lay their eggs in or near the aphid colonies on the plants (Rojo et al. 2003), and the most members of the Eristalinae proliferate in marshes, wet places, and rotting materials (Sommaggio 1999; Speight 2017).

Under the semi-arid climatic conditions of North Africa, the determination of species phenologies during a year round sampling showed that there are species with a long flight period, such as *S. pipiens* and other species with the flight period restricted to a few months, such as *E. amoenus*. This can be explained by the number of generations each species can perform following the local ecological conditions (mainly climate) of the region (Chafaa et al. 2013a; Idder-Ighili et al. 2015). Indeed, hoverfly species can be univoltine, bivoltine or even polyvoltine (Raymond et al. 2014; Ball and Morris 2015). The long flight periods of certain species are also associated with the availability of

feeding resources not only for the adults but also for their larvae. For example, *E. tenax*, a species with one of the longest activity periods, is an antropophilic hoverfly capable of breeding in a wide range of saprophagous media that are also present all the year round. The presence of Syrphidae species in the spring, summer and autumn and their absence during winter can be explained by the fact that hoverflies are mainly present during warmer and sunny days. Janzen (1973), Wolda (1988) and De Groot and Bevk (2012) point out that seasonal weather conditions can have a strong influence on insect activity. Climate variables are also known to be good predictors of population behavior in ecosystems where the distinction between the rainy and dry seasons is clear (Chafaa et al. 2013b; Idder-Ighili et al. 2015).

The present study increases the knowledge of the hoverflies from the steppe rangelands of Algeria, as well as that at the regional level within this country. A better knowledge of the hoverfly community associated with these habitats and the hoverfly diversity of the Tebessa region enhances the bioindicator potential of hoverflies in this world region, and provides further grounds to start designing a conservation tool such as 'Syrph the Net, the database of European Syrphidae' (Speight et al. 2016b). The new species reported at the regional scale reflect the particularities of North African semi-arid environments. Therefore, we agreed that time is ripe to put more efforts in developing integrated research on the Syrphidae fauna in different regions of Algeria.

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No potential conflict of interest was reported by the authors.

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Table 1. Sampling localities in Tebessa northeastern Algeria.

Table2. List of hoverfly species collected in different sites within the steppe rangelands of Tebessa Province in northeastern Algeria. The list includes the findings of the present study and those of other studies carried out in Tebessa (*Djellab, 2013), El-Kala (**Djellab et al. 2013), and Guelma (***Haffaressas et al. 2017). Legend: + (presence), — (absence).

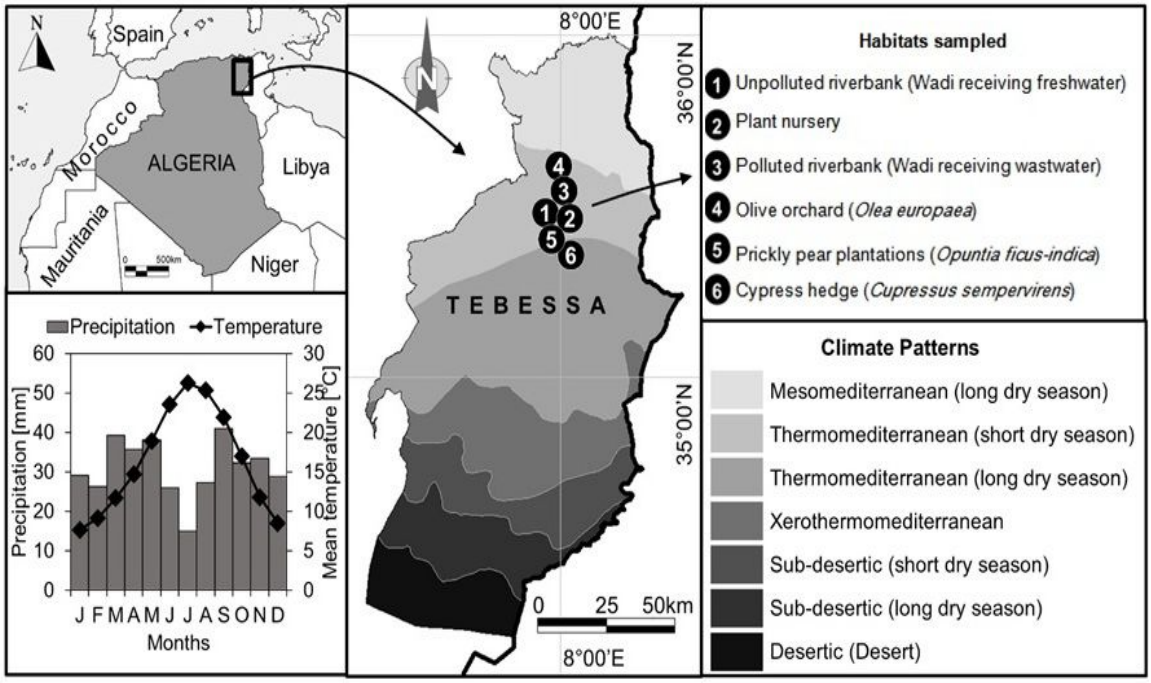
Figure 1. Geographic location and climatic map of the study area and sampled localities (circles) in Tebessa, northeastern Algeria. The bottom-left plot represents Gaussen and Bagnouls climatic diagrams of Tebessa applied for the period 1972–2016.

Figure 2. *Paragus vandergooti*, male from the region of Tebessa, Algeria. Dorso-lateral view.

Figure 3. *Platycheirus ambiguus*, male from the region of Tebessa, Algeria. Lateral view.

Figure 4. *Eumerus obliquus*, male from the region of Tebessa, Algeria. Dorso-lateral view.

Figure 5. Phenogram of the hoverfly species recorded during 2016-2017 in different sites within the steppe rangelands of northeastern Algeria. Legend: Fine grey lines= absence, thick black lines = presence.



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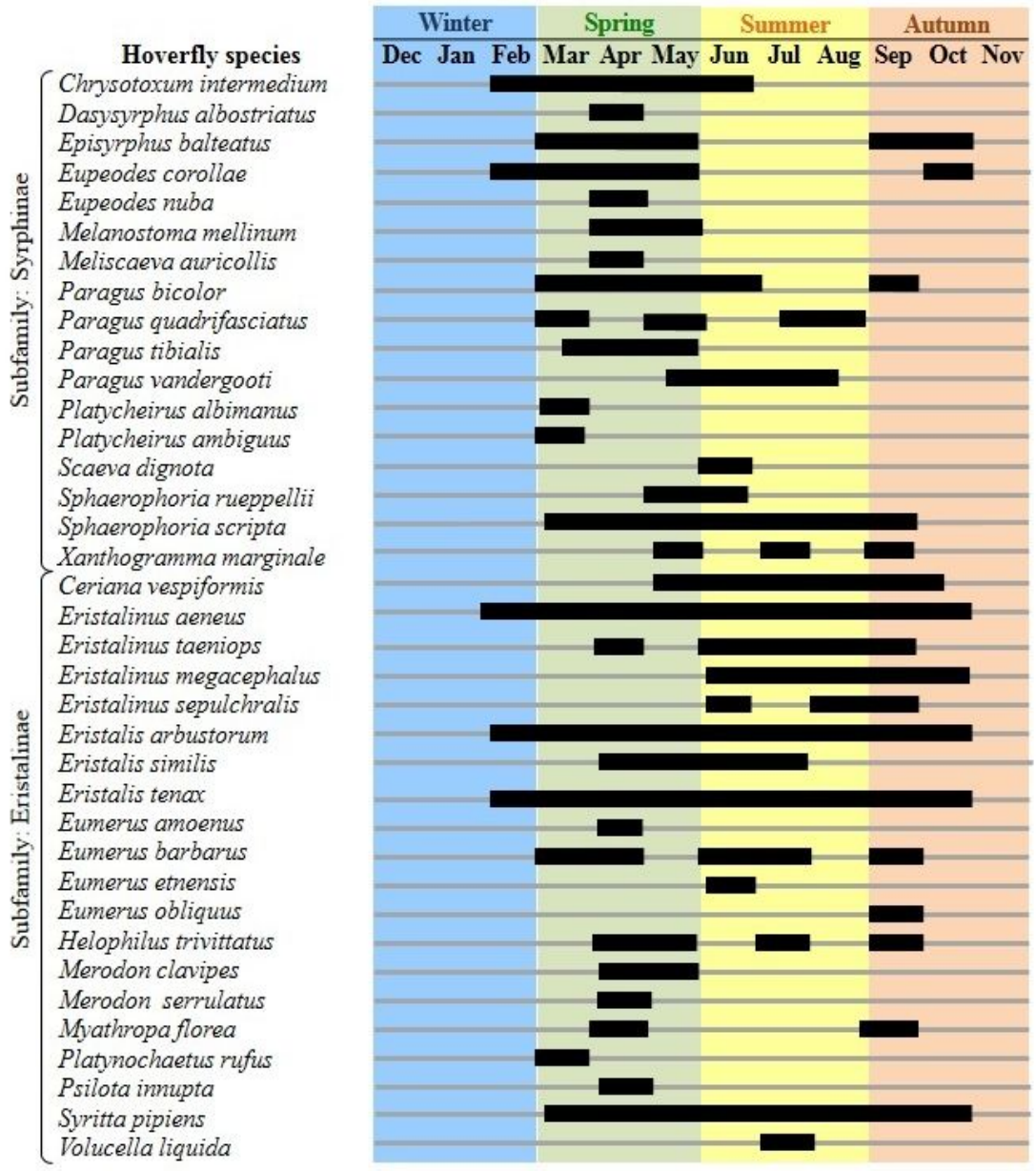

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Table 1. Sampling localities in Tebessa northeastern Algeria.

Stations	Code	Latitude(N)	Longitude(E)	Altitude(m)	Vegetation
Unpolluted riverbank	S1	35º25'01.65"	07º57'46.66"	965	Tree, shrub, and grass habitats around
Plant nursery	S2	35º44'89.38"	07º95'77.72"	886	Ornamental plants and vegetable crops
Polluted riverbank	S3	35º27'33.39"	07º57'32.92"	856	Shrub and grass habitats, dominated by *Mentha rotundifolia*
Olive orchard	S4	35º28'00.07"	07º58'08.68"	832	Composed entirely of fruiting trees*Olea europea* and with a smaller contribution of grass habitats
Prickly-pear plantations	S5	35º27'58.06"	07º58'40.32"	782	Composed entirely of *Opuntia ficus-indica*, and grass habitats around
Cypress hedge	S6	35º26'39.31"	08º00'20.43"	785	Grasslands around

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Hoverfly species (Current study)	Previous records from Algeria		
	Tebessa (*)	El-Kala (**)	Guelma (***)
Subfamily: Syrphinae			
Chrysotoxum intermedium (Meigen, 1822)	+	+	+
Dasysyrphus albostriatus (Fallen, 1817)	+	—	—
Episyrphus balteatus (De Geer, 1776)	+	+	+
Eupeodes corollae (Fabricius, 1794)	+	+	+
Eupeodes nuba (Wiedemann, 1830)	—	—	—
Melanostoma mellinum (Linnaeus, 1758)	+	+	+
Meliscaeva auricollis (Meigen, 1822)	+	—	+
Paragus bicolor(Fabricius, 1794)	+	+	+
Paragus quadrifasciatus Meigen, 1822	—	—	+
Paragus tibialis (Fallén, 1817)	+	+	—
Paragus vandergooti Marcos-García, 1986	—	—	—
Platycheirus albimanus (Fabricius, 1781)	—	+	—
Platycheirus ambiguus (Fallen, 1817)	—	—	—
Scaeva dignota (Rondani, 1857)	—	—	—
Sphaerophoria rueppellii (Wiedemann, 1830)	+	—	+
Sphaerophoria scripta (Linnaeus, 1758)	+	+	+
Xanthogramma marginale (Loew, 1854)	—	+	—

Subfamily: Eristalinae

Ceriana vespiformis (Latreille, 1804)	+	+	+
Eristalinus aeneus (Scopoli, 1763)	+	+	+
Eristalinus taeniops (Wiedemann, 1818)	+	+	+
Eristalinus megacephalus (Rossi, 1794)	—	+	—
Eristalinus sepulchralis (Linnaeus, 1758)	+	+	—
Eristalis arbustorum (Linnaeus, 1758)	+	+	+
Eristalis similis (Fallén, 1817)	—	+	+
Eristalis tenax (Linnaeus, 1758)	+	+	+
Eumerus amoenus Loew, 1848	—	—	+
Eumerus barbarus (Coquebert, 1804)	—	—	—
Eumerus etnensis van der Goot, 1964	—	—	—
Eumerus obliquus (Fabricius, 1805)	—	—	—
Helophilus trivittatus (Fabricius, 1805)	+	+	—
Merodon clavipes (Fabricius, 1781)	+	—	—
*Merodon serrulatus*Wiedemann *in* Meigen, 1822	—	—	—
Myathropa florea (Linnaeus, 1758)	+	+	—
Platynochaetus rufus Macquart, 1835	—	—	—
Psilota innupta Rondani, 1857	—	—	—
Syritta pipiens (Linnaeus, 1758)	+	+	+
Volucella liquida Erichson, 1841	—	+	—