SALVATORE BELLA^a - ROBERTO CATANIA^a - COSIMO BAVIERA^{b*}FIRST RECORD OF THE GENUS *SERANGIUM* BLACKBURN, 1889
(COLEOPTERA COCCINELLIDAE) IN ITALY^a(CREA) Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria - Centro di Ricerca Olivicoltura, Frutticoltura e Agrumicoltura. Corso Savoia, 190, 95024 Acireale (CT), Italy salvatore.bella@crea.gov.it; robertocatania1995@gmail.com^bDepartment of Chemical, Biological, Pharmaceutical and Environmental Science, Messina University. Viale Stagno D'Alcontres, 31, 98164 Messina, Italy* Corresponding Author: cbaviera@unime.it (C. Baviera)Bella S., Catania R., Baviera C. – First record of the genus *Serangium* Blackburn, 1889 (Coleoptera, Coccinellidae) in Italy.

During a recent survey of ladybirds in a citrus orchard in Sicily, a specimen of the genus *Serangium* (Coleoptera, Coccinellidae) was found. This genus is recorded here for the first time from Italy. Species of this genus was used as an agent of biological control against aleyrodids, and stable populations were previously reported from Europe (France and Corsica) and in the Caucasian area. Literature of this genus recorded for Europe two species: *Serangium montazerii* Fürsch, 1995 and *S. parcesetosum* Sicard, 1929. The single specimen collected unable us to a specific attribution.

KEY WORDS: Ladybeetle; *Serangium*; Citrus; alien predator; Italy

INTRODUCTION

Numerous alien coccinellids introduced as classical agents of biological control have spread rapidly from countries where they were deliberately introduced to many other countries across Europe. Twelve species of alien coccinellids in Europe have been recorded as intentionally released as biological-control agents of pest insects, mainly in Mediterranean regions including France, Portugal and Italy. Furthermore, the commercial production of coccinellids by biological control companies led to a rapid increase in distribution in recent decades (ROY and MIGEON, 2010; GERBER and SCHAFFNER, 2016; SOARES *et al.*, 2018). To date, 11 species are effectively considered introduced in Europe like *Chilocorus kuwanae* Silvestri, 1909, recently synonymized with *C. renipustulatus* Scriba, 1791, described in Europe, *Hyperaspis pantherina* Fürsch, 1975, introduced only in the island of St. Helena, formerly British island of the southern Atlantic Ocean, and *Delphastus catalinae* (Horn, 1895) that was recently confirmed as present in Italy (NUGNES *et al.*, 2020) (Table 1).

The large genus, *Serangium* Blackburn, 1889, firstly described for Australia, to date contains more than 50 species and is distributed mainly in oriental regions (WANG *et al.*, 2011) with several species in Africa and Australia (ŚLIPIŃSKI and BURCKHARDT, 2006; SZAWARYN and SZWEDO, 2018). Most species of rich extant faunas of *Serangium* occur in China (13 species) (WANG *et al.*, 2011), and Australia (12 species) (ŚLIPIŃSKI and BURCKHARDT, 2006; ŚLIPIŃSKI, 2007), four species are recognized in India, Japan, Madagascar, and the Philippines (POORANI, 2002; ŚLIPIŃSKI and BURCKHARDT, 2006). *Serangium clauseni* Chapin, 1940,

was introduced to Cuba from Indonesia to control the citrus blackfly *Aleurocanthus woglumi* Ashby (CHAPIN, 1940; GORDON, 1977). Three fossil species described from Baltik amber, however, suggest that the modern distribution of the genus *Serangium* is only part of a broader former distribution (SZAWARYN and SZWEDO, 2018; SZAWARYN, 2019).

Like other Coccinellidae widely purchase for biological control, *Serangium* species used in biological control is also often mistakenly identified alternatively as *S. montazerii* Fürsch, 1995 or *S. parcesetosum* Sicard, 1929 (BOOTH and POLASZEK, 1996; DUVERGER, 1998; POORANI, 1998; BIEŃKOWSKI, 2018).

MATERIALS AND METHODS

Field studies were conducted in Sicily (Italy) at the experimental citrus field of CREA (Council for Agricultural Research and Economics), located in the suburban area of the town of Acireale (Catania province) (37°37' N, 15°09' E) at 206 metres above sea level, in an orchard of 4 hectares, characterized by the presence of different species and variety of *Citrus* L. genus, with organic management.

A single specimen was collected from 12:00 to 16:00 with the beating technique and preserved in 70% alcohol in plastic vials. In the laboratory, it was prepared for identification and glued on label. The specimen was identified using the taxonomic keys by FÜRŠCH (1995), POORANI (1998), and BIEŃKOWSKI (2018). The examined material was deposited in the collection of the authors.

Table 1 – Coccinellids species introduced in Europe. With (*) the species never, or not recently, recorded in Italy.

Biocontrol target group	Biocontrol target species	Species	Introduction year	Source country	Introduction country
Coccids	<i>Icerya purchasi</i> Maskell, 1878	<i>Rodolia cardinalis</i> Mulsant, 1850	1898	Australia	Portugal
	<i>Saissetia oleae</i> (Olivier, 1791)	* <i>Rhyzobius forestieri</i> (Mulsant, 1853)	1980	Australia	Greece, Italy, and France
		<i>Rhyzobius lophanthae</i> (Blaisdell, 1892)	1973	Australia	Europe
	<i>Planococcus citri</i> Risso, 1813	<i>Cryptolaemus montrouzieri</i> Mulsant, 1850	1907/1908	Australia	Italy
	Diaspididae	* <i>Chilocorus nigritus</i> (Fabricius, 1798)	1985	SE Asia	France, Great Britain
	<i>P. citri</i> , <i>Nipaecoccus viridis</i> (Newstead, 1894), <i>Pseudococcus viburni</i> (Signoret, 1875)	* <i>Nephus reunioni</i> (Fürsch, 1974)	1974	Isle de La Réunion	France
Aphids		<i>Harmonia axyridis</i> Pallas, 1773	1980	Asia	Portugal
		* <i>Hippodamia convergens</i> Guérin-Méneville, 1842	1990/2000	North America	Belgium, Sweden, Denmark, Albania, Czech Republic
Psyllids	<i>Acizzia uncatoides</i> (Ferris & Klyver, 1932)	* <i>Harmonia conformis</i> (Boisduval, 1835)	1998	Australia	France
Aleyrodids	<i>Dialeurodes citri</i> (Ashmead, 1885)	<i>Serangium montazerii</i> Fürsch, 1995 / <i>Serangium parcesetosum</i> Sicard, 1929	1985	Iran/India	France
		<i>Delphastus catalinae</i> (Horn, 1895)	2020	Tropical America	Italy

NEW RECORD

Subfamily **Microweiseinae** Leng, 1920Tribe **Serangiini** Blackwelder, 1945***Serangium*** Blackburn, 1889

GENERAL DISTRIBUTION: Africa (Madagascar), Australia, Palaearctic (especially in the Oriental regions).

EXAMINED MATERIAL: (Fig. 1) Sicily – Catania (province), Acireale, 15.IX.2019, 1 ♂, on a mandarin tree, *Citrus reticulata* Blanco, infested by *Aleurothrixus floccosus* (Maskell, 1895), S. Bella leg., C. Baviera det..

SERANGIUM SPECIES REPORTED FROM EUROPE:

Serangium parcesetosum Sicard, 1929

This species was described from Southern India, by SICARD (1929), in original description there are no drawings nor description of genitalia. Its color is reported as fawn and elytra described as “not punctured even in lateral”. *S. parcesetosum* was introduced into the Caucasian Black Sea coast of Georgia in 1973 (TIMOFEEVA and NHUAN, 1978) and thereafter to the south of France and Corsica from Georgia in 1985 for biological control of Aleyrodidae (ANTADZE and TIMOFEEVA, 1975; TIMOFEEVA and NHUAN, 1978; MALAUSA *et al.*, 1988). This species also was found in the East Black Sea coast of Turkey and introduced into the East Mediterranean region of the country in 1990 (YİĞİT, 1992; YİĞİT and CANHİLAL, 2005). In Turkey, it has successfully adapted in areas where citrus are grown (ULUSOY *et al.*, 1996; UYGUN *et al.*, 1997). In India this species was reported to be a very host specific on the cotton whitefly, *Bemisia tabaci* (Genadius, 1889) (KAPADIA and PURI, 1992) and on the sugarcane whitefly, *Aleurolobus barodensis* (Maskell, 1895).

Fig. I - *Serangium montazerii* Fürsch. (1-2): Male. Sicily, Acireale, 15.IX.2019.

(SHAH *et al.*, 1986; PATEL *et al.*, 1996). Many other species of whiteflies were recorded as prey of this ladybird like *Aleurocanthus woglumi* Ashby, 1915, *Aleurolobus barodensis*, *Aleurothrixus floccosus*, *Bemisia afer* (Priesner and Hosny, 1934), *Parabemisia myricae* (Kuwana, 1927), and *Paraleyrodes minei* Iaccarino, 1990 (EVANS, 2007). *S. parcesetosum* was found very common in citrus grove usually followed the whiteflies populations trends as observed in two orchards in Turkey (YİĞİT *et al.*, 2003).

Serangium montazerii Fürsch, 1995

This species was described from specimens collected in Iran on *Salvia* L., and *Citrus* plants (Fürsch, 1995). In original description male genitalia was reported and the colour is recorded as yellowish-brown and elytra was described as “bearing a row of brown dots at both sides of the suture, separated from it by about 8 times their diameter”. Like *S. parcesetosum* this species has been collected on citrus, olive, pomegranate, and sage; it is a predator of the psyllid *Euphyllura olivina* (Costa, 1839) and of the aleyrodid species *Dialeurodes citri* (Ashmead, 1885), and *Bemisia tabaci* (HAJIZADEH *et al.*, 2003; MODDARRES-AWAL, 2012). Some aleyrodid known as prey of *S. parcesetosum* now were considered prey of *S. montazerii* (*Aleurocanthus woglumi*, *Aleurolobus*

barodensis, *Aleurothrixus floccosus*, *Bemisia afer*, *Parabemisia myricae*, and *Paraleyrodes minei*) (EVANS, 2007).

Unfortunately, these two species was often confused one with the other. In 1996 BOOTH and POLASZEK, reported that *Serangium montazerii* and *S. parcesetosum* are very similar and can be differentiated mainly by genitalia and also by few morphological characters. They reported, for the first time, the male genitalia of the two species, but there are some problems to be consider: 1) they designated a female lectotype of *S. parcesetosum* by a female paratype preserved in British Museum of Natural History, but they didn't explained the origin of the male genitalia reported by them; 2) they re-drew the male genitalia of a paratype of *S. montazerii*, but it seem quite different that the one of the holotype of FÜRSCH (1995); 3) *S. montazerii* is “considered native from India and Pakistan” and considered as only “recently recorded in Iran and Syria”. The authors considered that this species, and not *S. parcesetosum*, as introduced into the Caucasian Black Sea coast of Georgia in 1973 and from there to France and Corsica (MALAUSA *et al.*, 1988) and after in Israel from France (HALPERIN *et al.*, 1995). Furthermore, BOOTH and POLASZEK (1996), don't considered elytral punctuation, different in the two species in the original descriptions, with the punctations more prominent in *S. montazerii*.

POORANI (1998) follows BOOTH and POLASZEK (1996) considered *S. montazerii* and *S. parcesetosum* as very similar species both present in India (the first at North and the second at South) reporting the genitalia and morphological characters of the two species, but without give the localities of the examined specimens.

DUVERGER (1998) follows BOOTH and POLASZEK (1996), replaces *S. parcesetosum* with *S. montazerii* as present in France and Corse.

Subsequently, *S. parcesetosum* was rehabilitated for France and Corse by COUTANCEAU (2006) who studied the specimens collected from 1986 to 2000 in Corse.

Serangium listed by the “EPPO list of biological control agents widely used in the EPPO Region” (EPPO, 2020) is recorded as *S. parcesetosum*. It was considered as introduced in Europe in 1985 for the biological control of *Dialeurodes citri*, and *Bemisia tabaci* (Hemiptera, Aleyrodidae) (ANTADZE and TIMOFEEVA, 1975, 1976; TIMOFEEVA and NHUAN, 1978; MALAUSA *et al.*, 2008; FOTUKKIAII *et al.*, 2013; ORLOVA-BIENKOWSKAJA and BIENKOWSKI, 2017; SOARES *et al.*, 2018).

If we considered the elytra punctuation as absent in *S. parcesetosum* and constituted by a row of brown dots at both sides of the suture, separated from it by about 8 times their diameter in *S. montazerii*, the two species seems morphologically very different in elytral sculpture, moreover *S. montazerii* was described on specimens from Iran and there are no published data about specimens collected in northern India, or Pakistan.

Serangium purchased for biological control probably belonged to at least two different species: one near to *S. parcesetosum*. These two species was very probably erroneously linked the released and established in the Caucasian regions (Abkhazia, Azerbaijan, and Georgia), in

Fig. II - Photos from Natural History Museum, London: (1-2) *Serangium montazerii* Fürsch. Non-type USA; (3-4) *S. montazerii* Fürsch. Paratype Iran; (5-6) *S. montazerii* Fürsch. Non-type Corsica; (7-8) *S. parcesetosum* Sicard. Paratype India.

southern Russia (Sochi) and also in France, Turkey, Israel, and Syria (IZEVSKY, 1990; POORANI, 1998; KOVÁŘ, 2007; MODDARRES-AWAL, 2012; BIRANVAND *et al.*, 2016; BIENKOWSKI and ORLOVA-BIENKOWSKAJA, 2020).

The specimen collected in Sicily seem very similar, by elytra punctuation, to the one figured from Sochi National Park (Western Caucasus at the Black Sea Shore), which seems more similar to *S. parcesetosum* than to *S. montazerii* for the presence of two rows of large punctures along elytral suture (ORLOVA-BIENKOWSKAJA and BIENKOWSKI, 2017). These specimens seem to be far from another specimen figured from Palestine which seems very near to *S. parcesetosum* for the absence of large punctuation on elytra (NAJAJRAH *et al.*, 2019).

Specimens actually preserved in Natural History Museum, London allows to identify the Sicilian specimens very similar to a singleton specimen from a laboratory population came from USA (Fig. II, 1-2) identified as "*S. montazerii*", but very different from the paratype specimen of this species from Iran and from the non-type specimen from Corsica, which show elytra dull and rusty without dots (Fig. II, 3-6). The paratype specimen from India attribute to *S. parcesetosum*, preserved in the same collection have a row of big punctures at both sides of the elytral suture (Fig. II, 7-8). Furthermore, the paratype specimen from Iran (Fig. III) preserved in the Zoologische Staatssammlung München, shows a single row of big punctures at both sides of the suture.

CONCLUDING REMARKS

The presence of a species of the Oriental coccinellid *Serangium* is documented for the first time in Italy. A single specimen was collected in September 2019, in a Sicilian citrus orchard with organic management. In Europe, *S. montazerii* and/or *S. parcesetosum* were considered to be released to control Aleyrodidae on citrus trees in France and Corsica, establishing and continuing to spread spontaneously. The collected specimens seem didn't belonged to no ones of this two species, even if more similar to *S. parcesetosum* while *S. montazerii* seems very probably not present in Europe.

Climatic areas of possible acclimatization for *Serangium* spp. are numerous along the Italian peninsula and in Sicily, and after this first discovery further investigations are recommended for monitoring the diffusion of this allochthonous predator. Even if the larvae and adults of *S. parcesetosum* tended to avoid *Bemisia tabaci* pupae parasitized by *Eretmocerus mundus* Mercet, 1931 (Hymenoptera, Aphelinidae) (AL - ZYOUN, 2007), more studies will be needed to verify the real environmental interactions of this new coccinellid species with indigenous ones in Sicily and the effective interaction with other predators and parasitoids (CIACCIA *et al.*, 2019; BELLA *et al.*, 2021; RONDONI *et al.*, 2021) already present in citrus agroecosystems (BELLA, 2020).

Fig. III - *Serangium montazerii* Fürsch. Paratype Iran, (1-2). Photos from Zoologische Staatssammlung München

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