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Chronology of the worldwide spread of a parthenogenetic beetle, *Reesa vespulae* (Milliron, 1939) (Coleoptera: Dermestidae)

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Abstract
Reesa vespulae (Milliron, 1939) is a parthenogenetic synanthropic subcosmopolitan dermestid pest native to the Nearctic region. The chronology (1942–2020) of its spread outside its native range, its general distribution and ecology are summarized and discussed. Its spread is likely to be the result of multiple introductions into the different zoogeographic regions, and secondary translocations therein; the oldest records from outside its native range are: 1942 (Australian region), 1946 (Neotropical region), 1957–1958 (Palaearctic region) and 1986–2010 (Oriental region). *Reesa vespulae* is excluded from the Afrotropical fauna, since the sole available record was based on a misidentification, while it is recorded from central Italy for the first time, moreover its oldest Algerian and Austrian records are provided. The need for preventive measures against dermestid infestations in natural history collections is highlighted.

Key words: museum pests, alien species, urban fauna, global warming, *Attagenus fasciatus*.

Introduction

Reesa vespulae (Milliron, 1939) is a parthenogenetic synanthropic subcosmopolitan pest native to the Nearctic region (Denux & Zagatti 2010). Understanding the drivers of the biological invasions across regions, is important for designing appropriate management interventions, especially in fragile and/or human-altered ecosystems (Scalera et al. 2012); in this framework, the ecology and the chronology (1942–2020) of the spreading of this species outside its native range, is herein summarized and discussed.

Material and Methods

The specimens were identified according to various works (Beal 2003; Háva 2004, 2011). The earliest published and unpublished records for each country are summarized in Table 1. The year of the first observation for a zoogeographical region and continent is in bold. When a first record is relative to a period (e.g. "1986–2006"), it is followed, generally, by two references relative to the older and more recent years. If a country record was originally provided without the year of collection, this latter is indicated (Table 1) as that of the publication of the relative paper but preceded by a "≤".

The terminology of invasion ecology's status follows Wheeler & Hoebeke (2017: 644, Table 21.1). The borders of Asia and Europe, and the main subdivisions of European Russia (Central Territory, North Territory, South Territory) and of Asian Russia (East Siberia, Russian Far East, West Siberia) are according to Löbl & Löbl (2016). Chorotype ranges follow Vigna Taglianti et al. (1999).

Acronyms of specimen depositories:

CFA F. Angelini collection c/o Museo di Storia Naturale dell'Università di Firenze, Sezione di Zoologia "La Specola", Florence, Italy.

CJH J. Háva collection, Prague, Czech Republic.

Results

***Reesa vespulae* (Milliron, 1939)**
Perimegatoma vespulae Milliron, 1939: 570.

Material examined. Austria: Vienna, Ottakring, 10 Jul 1998, O. Caudr leg., 1 ♀ (CJH). **Belarus**: C. [= City of] Vitebsk, 2 May 2002, I.A. Solodovnikov leg., in insect collections [in Russian], 5 ♀♀ (CFA). **Italy**: Lazio region, Rome (city center), 20 Jun 2018, V. Roucka leg., on a window in a hotel, 2 ♀♀ (CJH). **Russia**: [West Siberia,

Kemerovo Oblast,] Kuznetsk hollow, Leninsk-Kuznetsk distr., 5–6 km W Shabanovo vill., 4 Jul 1998, G. Stepanjuk leg., 1 ♀ (CJH). **Algeria**: Biskra, 29–30 May 1971, Hoffer & Horák leg., 1 ♀ (CJH). **Morocco**: Al-Atlas al-Kebir Mts., Oukaimeden env., 2650–2755 m ca, 4–5 Jun 2014, V. Zieris leg., 1 ♀ (CJH).

Chorotype and distribution. This species was described from an old wasp nest from St. Paul, Minnesota (USA) (Milliron 1939), but it is now subcosmopolitan in distribution (Háva 2015, 2020), being recorded from Nearctic region (Canada, Greenland, Mexico, USA) (Böcher 1988; Háva 2002; Beal 2003; Háva & Herrmann 2021a), Palaearctic region (see below), Neotropical region (Argentina, Chile) (Háva 2002; Háva & Herrmann 2020), Oriental region (India) (Drugova & Kapustkin 2011), and Australian region (Australia, New Zealand) (Waller & Watt 1979; Armes 1983; GBIF 2013). A recent record from Sudan in the northern Afrotropical region (Omer 2014, plate 12) is erroneous and refers to *Attagenus* (*A*.) *fasciatus* (Thunberg, 1795) (Háva, unpublished data).

The oldest records of *R. vespulae* outside its native range, are from New Zealand in 1942 (Somerfield 1981) and from Argentina in 1946 (Háva & Herrmann 2020). The species is established in New Zealand (Waller & Watt 1979; Somerfield 1981; Waller 1982; Miller 2019), but is known from only two countries in South America (Table 1).

Reesa vespulae in the Palaearctic region is recorded from: Europe (Armenia, Austria, Belarus, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Moldova, Norway, Poland, Portugal, Romania, Russia (Central, North and South Territories), Slovakia, Sweden, Switzerland, The Netherlands, Ukraine), North Africa (Algeria, Egypt, Madeira, Morocco, Tunisia) and Asia (Afghanistan, China, Japan, Kazakhstan, Mongolia, Russia (East and West Siberia, Russian Far East), South Korea, Uzbekistan) (Háva 2003; Zhang 2004; Telnov et al. 2005; Tsinkevich & Lukashenya 2005; Háva 2007; Süda 2009; Háva & Legalov 2010; Drugova & Kapustkin 2011; Háva et al. 2013; Hong et al. 2014; Audisio et al. 2015; Háva 2015; Gearner 2019; Grosso-Silva 2019; UkrBIN 2020; Háva & Herrmann 2021b; Koutsoukos et al. 2021).
In Europe (Table 1), *R. vespulae* was first collected in 1957–1958 in Germany (Bahr & Nussbaum 1974; Peacock 1993), and in 1959 in Russia, Moscow (Zhantiev 1973; Sellenschlo 1986a) and Denmark (Bunalski & Przewoźny 2009); afterwards it was collected in other European countries, and it is established in most of them (Bergh et al. 2002; Háva 2007).

The undetailed record from Austria (Háva 2007), was based on the above examined specimen that is the first collected in this country (Schuh & Plonski 2010; Kahlen 2011; Degasperi et al. 2014; Mitter 2017), while from Belarus was previosusly known only from Minsk (Tsinkevich & Lukashenya 2005).

This species is widespread in European Russia, where, in detail, is recorded from the following administrative subdivisions: Republic of Adygea (Háva & Herrmann 2014), Belgorodskij rajon (Drugova & Kapustkin 2011), Chechen Republic (Háva et al. 2014), Dagestan (Drugova & Kapustkin 2011), Kaliningrad Oblast (Alekseev & Nikitsky 2008), Leningrad Oblast, Lipetsk Oblast, Moscow, Moscow Oblast, Stavropol, St Petersburg, Krasnodar Kraj, Tambovskij region, and Vologoskyi region (Zhantiev 1976; Tsurikov 2009; Drugova & Kapustkin 2011).

The species is recorded from Moldova (Drugova & Kapustkin 2011), but this record was recently overlooked (Munteanu et al. 2014; Audisio et al. 2015; Timuş 2015).

In Italy, this species was previously known only from a spice and aromatic herb factory located in northern Italy, Emilia-Romagna region (Nicoli Aldini 2003a, 2003b, 2004; Nardi & Háva 2013). The above-mentioned record from Rome is the first from central Italy (Nardi 1997; Nardi & Háva 2013). The available data do not allow us to ascertain if *R. vespulae* is established in this city, or if this record is only due to an interception. However, as this species is parthenogenetic (Milliron 1939; Beal 1967; Peacock 1993), the chances of it becoming established there seem high.

In northern Italy, this species is unrecorded from South Tyrol (Kahlen & Hellrigl 1996), but it is expected in this area since is known from the neighbouring North Tyrol in Austria (Schuh & Plonski 2010; Kahlen 2011; Degasperi et al. 2014). An analogous situation is valid also for Lombardy region, since the species is recorded from a Swiss site very near the Lombard border (CSCF 2020), and it is established in Switzerland (Wittenberg 2005). Fortunately, it is unrecorded from the bordering Veneto region (Bon et al. 2016), where there are important natural history museums (cf. Poggi & Conci 1996; Ruffo & Curri 2005).

In Palaeartic Asia, the species was first collected at Jajal in Afghanistan (Zhantiev 1973), and afterwards it was collected in other countries; unfortunately the precise year of collection of some of the recorded specimens is unknown (Table 1).

Reesa vespulae is widespread in Asian Russia where, in detail, has been recorded from the following areas: Altai (Drugova & Kapustkin 2011), East Russia (Drugova & Kapustkin 2011), Irkutsk (Drugova & Kapustkin 2011), Kemerovo (Háva & Legalov 2010; Drugova & Kapustkin 2011; Polevod 2015, 2016), Krasnojarks (Drugova & Kapustkin 2011), Novosibirsk (Háva & Legalov 2010), Samarskij region, and Sacha-Jakutia (Drugova & Kapustkin 2011). The above examined specimen from West Siberia was already published (Háva & Legalov 2010) but, for a misprint in the relative article, the year of collection was illegible.

The generic record from Algeria (Háva 2003) was based on the above-mentioned specimen from Biskra. The generic record from Morocco (Háva 2003), is here confirmed by a new collection, that is interesting also for the elevation of the site; the presence of the species is probably related to the existence of a ski station.

The available Palaearctic data (Table 1) show that this species was introduced into Europe and Asia at least at the end of the 1950s and it rapidly spread over most of countries. This spread is likely to be the result of multiple introductions into the region, and secondary translocations therein.

Ecology. *Reesa vespulae* is a parthenogenetic species, and in its native area (Nearctic region) is mostly a wild species developing in nests of wasps, solitary bees and birds where larvae feed on the remains of insects and spiders, and pollen; adults are floricolous and feed on pollen and nectar; in this area the species is, generally, a minor pest of wheat storage, homes and insect collections (cf. Beal 1967; Sellenschlo 1986a; Bousquet 1990; Peacock 1993; Beal 2003; Robinson 2005). In Europe, few records of the species are known out-of-doors (Peacock 1993; Kleeberg 1995; Stejskal & Kučerová 1996; Tsurikov 2009), while it lives in synanthropic environments (museums, universities, dwellings, food stores) where its larvae feed on dried plant and animal materials, and can cause serious damage to botanical, mycological, zoological, and entomological collections (Bahr & Nussbaum 1974; Mehl 1975; Hämäläinen & Mannerkoski 1984; Peacock 1993; Hagstrum et al. 2013; Vaucheret & Leonard 2015). The larvae can also infest fungi growing on exposed wood in cellars, but, chiefly, a wide range of dry organic matter: stored seeds (wheat, barley, rye, rice, peas, tomato, capsicum, *Dactylus glomerata*, *Phleum pratense*, etc.), dried fruits, dried milk, flour, dried mushrooms, bread crumbs, and food residues (cf. Peacock 1993; Stejskal & Kučerová 1996; Robinson 2005; Drugova & Kapustkin 2011; Hagstrum et al. 2013; Kadej et al. 2017; Klishina & Drugova 2017). The species has also been recorded from large sea-going passenger vessels (McKirdy et al. 2019).

Being parthenogenetic, *R. vespulae* has the potential to be a very significant pest, and considerable infestations of entomological collections have been observed (Hämäläinen & Mannerkoski 1984; Polevod 2016). Depending on

Table 1 – Chronology of the spread of *Reesa vespulae* outside its native range (Nearctic region). Abbreviations. ! = this paper; AUS = Australian region; NEO = Neotropical region; ORI = Oriental region; PAL = Palaearctic region. The year of the first observation for a zoogeographical region and continent is in bold.

FIRST OBSERVATION	ZOOGEOGRAPHICAL REGION (CONTINENT)	COUNTRY (MAIN REGION)	REFERENCE
1942	AUS (Oceania)	New Zealand	Somerfield 1981
1946	NEO (S America)	Argentina	Háva & Herrmann 2020
1957–1958	PAL (Europe)	Germany	Bahr & Nussbaum 1974
1959	PAL (Europe)	Denmark	Bunalski & Przewoźny 2009
1959	PAL (Europe)	Russia (Central European Territory)	Zhantiev 1973
1963	PAL (Europe)	Norway	Strand 1970
1966	PAL (Europe)	Finland	Mäkisalo 1970
1968	PAL (Europe)	Sweden	Andersson 1973
1971	PAL (Africa)	Algeria	Háva 2003; !
≤1973	PAL (Asia)	Afghanistan	Zhantiev 1973
1973	PAL (Europe)	France	Martinez & Cocquempot 1985
1974	PAL (Europe)	Iceland	Ólafsson 1979
1976	AUS (Oceania)	Australia	GBIF 2013
1977	PAL (Europe)	Great Britain	Adams 1978
1977	NEO (S America)	Chile	Háva 2002
1979	PAL (Europe)	The Netherlands	Van Rossem et al. 1980
1985	PAL (Europe)	Belgium	Coulon 1986
≤1986	PAL (Europe)	Czech Republic	Novák & Verner 1990
1986–≤1992	PAL (Asia)	Russia (Russian Far East)	Lafer 1992; Drugova & Kapustkin 2011
1986–1998	PAL (Asia)	Russia (West Siberia	Drugova & Kapustkin 2011; !
1986–2002	PAL (Europe)	Russia (North European Territory)	Drugova & Kapustkin 2011; Klishina & Drugova 2017
1986–≤2003	PAL (Africa)	Egypt	Háva 2003; Drugova & Kapustkin 2011
1986–≤2003	PAL (Africa)	Morocco	Háva 2003; Drugova & Kapustkin 2011
1986–≤2003	PAL (Africa)	Tunisia	Háva 2003; Drugova & Kapustkin 2011
1986–2006	PAL (Europe)	Russia (South European Territory)	Drugova & Kapustkin 2011; Háva et al. 2014; Háva & Herrmann 2014
1986–2010	ORI (Asia)	India	Drugova & Kapustkin 2011

FIRST OBSERVATION	ZOOGEOGRAPHICAL REGION (CONTINENT)	COUNTRY (MAIN REGION)	REFERENCE
1986–2010	PAL (Asia)	Kazakhstan	Drugova & Kapustkin 2011
1986–2010	PAL (Asia)	Mongolia	Drugova & Kapustkin 2011
1986–2010	PAL (Asia)	Russia (East Siberia)	Drugova & Kapustkin 2011
1986–2010	PAL (Asia)	Uzbekistan	Drugova & Kapustkin 2011
1986–2010	PAL (Europe)	Armenia	Drugova & Kapustkin 2011
1986–2010	PAL (Europe)	Moldova	Drugova & Kapustkin 2011
1986–2010	PAL (Europe)	Russia (South European Territory)	Drugova & Kapustkin 2011
1986–2010	PAL (Europe)	Ukraine	Drugova & Kapustkin 2011
1987	PAL (Asia)	Japan	Hava 2002; Kitano et al. 2011
1993	PAL (Europe)	Greece	Koutsoukos *et al*. 2021
1994	PAL (Europe)	Estonia	Süda 2009
1995	PAL (Europe)	Switzerland	CSCF 2020
1996	PAL (Europe)	Hungary	Merkl 2006
1997	PAL (Europe)	Belarus	Tsinkevich & Lukashenya 2005
1998	PAL (Europe)	Austria	!
1998–1999	PAL (Europe)	Italy	Nicoli Aldini 2003a
2002	PAL (Europe)	Ireland	O´Connor 2003
2002	PAL (Europe)	Slovakia	Háva et al. 2003
2003	PAL (Europe)	Romania	Háva 2004
≤2004	PAL (Asia)	China	Zhang 2004
2004	PAL (Europe)	Latvia	Telnov et al. 2005
2006	PAL (Europe)	Poland	Bunalski & Przewoźny 2009
2010	PAL (Europe)	Serbia	Háva et al. 2013
2011	PAL (N Africa)	Portugal (Madeira Island)	Háva & Herrmann 2021b
≤2013	PAL (Europe)	Lithuania	cf. Ferenca et al. 2018
2013	PAL (Asia)	South Korea	Hong et al. 2014
2016	PAL (Europe)	Luxembourg	Christian 2017
2019	PAL (Europe)	Portugal (mainland)	Grosso-Silva 2019
2020	PAL (Europe)	Bulgaria	Tsvetanov & Háva 2020

conditions, the duration of a complete life cycle varies between three months and three years but the short-lived adults survive only for one or two weeks. Under heated indoor conditions, odd individuals can be seen throughout the year, although they are most commonly encountered between spring and early autumn, with peak abundance in July, often on window sills; larvae may be found at any time (Mäkisalo 1970; Ackery et al. 1999; Robinson 2005). The egg was illustrated by Kučerová et al. (2010).

Adults fly and readily move between infested sites (Robinson 2005), and they can be collected also by light traps (Novák & Verner 1990; Stejskal & Kučerová 1996; Nicoli Aldini 2003a, 2003b, 2004; Háva et al. 2008; Troukens et al. 2017), window sill sticky-traps (Armes 1988), pheromone-baited sticky-traps (Ackery et al. 2016), plastic floor traps and open blunder traps (Vaucheret & Leonard 2011). The DNA barcode sequences of *Reesa vespulae* were deposited in GenBank (Hong et al. 2014).

In Finland, *Laelius pedatus* (Say, 1836) (Hymenoptera, Bethylidae), a Nearctic imported indoor parasitoid, attacks larvae of *R. vespulae* that possibly, in Sweden, are a host also for *L. fumimarginalis* Vikberg, 2005 (Vikberg & Koponen 2005).

Discussion. *Reesa vespulae* is the only species of its genus, so its taxonomic identification (adults and larvae) is relatively easy. Nevertheless, if examined only superficially, it can be confused with some species of *Trogoderma* Dejean, 1821 (cf. Beal 1956, 1967; Zhantiev 1976; Sellenschlo 1986a, 1986b; Lafer 1992; Peacock 1993; Beal 2003; Háva 2004; Weidner & Sellenschlo 2010; Drugova & Kapustkin 2011; Háva 2011; Kadej et al. 2017; Klishina & Drugova 2017). In fact, the photos of *R. vespulae* and *R.* sp. from Chile (McCaffrey 2011a, 2011b), refers to *Trogoderma angustum* (Solier, 1849) (Háva, unpublished data). Nevertheless, there is one undescribed South American species that appears congeneric with *R. vespulae* (Beal 2003: 399).

The world spread of *R. vespulae* is likely to be the result of multiple introductions into the different zoogeographic regions, and secondary translocations therein; in any cases the oldest records (Table 1) from outside its native range are of years 1942 (Australian region), 1946 (Neotropical region), 1957–1958 (Palaearctic region) and 1986–2010 (Oriental region).

The temperate origin (Nearctic region) of the species may explain the scarcity or the lack of records from most of the intertropical areas of the planet (Table 1), so the global warming (Parmesan 2007; Quante 2010), as observed in other beetles (cf. Robinet & Roques 2010; Kwon et al. 2015; Gatti & Nardi 2017; Urbani et al. 2017), probably contrasts the spreading and establishment of *R. vespulae* in warmer areas. On the contrary, other dermestids are favoured by this phenomenon (cf. Walther et al. 2009; Stengaard Hansen et al. 2012, 2015).

Conclusion. Most alien dermestids are synanthropic and associated with animal remains, leathers and skins, dried meats, woollens and furs (cf. Hinton 1945; Denux & Zagatti 2010), so natural history collections (cf. Linnie 1994), insect fairs and entomological bourses (Schuh & Plonski 2010), and the international seed trade (Hämäläinen & Mannerkoski 1984) favour the spread of these species. Unfortunately, this phenomenon occurs also in Europe (e.g. Åkerlund 1995; Rabitsch & Schuh 2002; O'Connor 2003; Herrmann & Háva 2006; Denux & Zagatti 2010; Weidner & Sellenschlo 2010; Stengaard Hansen et al. 2012; Nardi & Háva 2013; Aberlenc & Brustel 2014; Stengaard Hansen et al. 2015; Borowski & Mokrzycki 2017; Háva & Herrmann 2017; Orlova-Bienkowskaja 2017; Nardi & Vomero 2017; Kovalenko 2018; Guariento et al. 2019; Holloway et al. 2019; Nardi & Háva 2019). The records documented and discussed above reaffirm the need to carefully inspect public and private natural history collections, including also new aquisitions and the return of loaned specimens, for signs of infestation, to avoid the further spreading of dermestid pests (cf. Linnie 1994; Rajendran & Hajira Parveen 2005; Wheeler & Hoebeke 2017; Trematerra & Pinniger 2018).

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