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WRONG TAXONOMY LEADS TO A WRONG CONCLUSION ON A PUTATIVELY 'INVASIVE' SPECIES TO EUROPE: THE CASE OF *PSEUDACROBASIS NANKINGELLA* (LEPIDOPTERA PYRALIDAE)

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Scalercio S., Slamka F. – Wrong taxonomy leads to a wrong conclusion on a putatively 'invasive' species to Europe: the case of *Pseudacrobasis nankingella* (Lepidoptera Pyralidae).

In this paper the current distribution, biology and ecology of *Pseudacrobasis tergestella* (Ragonot) was revised in the light of the new synonymy with *Pseudacrobasis nankingella* Roesler. The synonymy, established in 2014, falsified the hypothesis of a recent biological invasion of *P. nankingella* in European countries. Furthermore, new records for the Italian Peninsula are provided after 113 years from its description for the type locality near Trieste. Males and females were dissected and their genitalia compared to illustrations in literature for warranting a correct identification. This species is polyvoltine and feeds on seeds of *Quercus* but adults are reported to emerge also from cones of *Pinus*. It was usually found in mild and humid forested habitats, in coastal areas and along rivers. The currently known range of *P. tergestella* includes the westernmost and the easternmost regions of the Palearctic, with a very large disjunction. We plan to submit specimens from as many as possible populations of this species to DNA barcoding analysis in order to investigate the diversification of genetic lineages.

KEY WORDS: *Pseudacrobasis tergestella*, *Pseudacrobasis nankingella*, taxonomic changes, forest insects, Italy, invasive species.

INTRODUCTION

The knowledge on South European species belonging to the subfamily of Phycitinae (Pyralidae) is far from being exhaustive. Many faunistic and taxonomic novelties are every year published and many other are expected in the next years (PINZARI *et al.*, 2010; BALDIZZONE *et al.*, 2013; SCALERCIO *et al.*, 2014).

The discovery of *Pseudacrobasis nankingella* Roesler, 1975 in Europe was one of the most interesting findings because it was described from China (ROESLER, 1975) and it was supposed alien to the European continent where it was firstly reported from Spain (Asselbergs, 1998) and successively from Portugal (CORLEY *et al.*, 2000) then France and Corsica (Asselbergs, 2002). In Far East it is also known from Japan (ROESLER, 1975; Inoue *et al.*, 1982), Korea (PARK J.D., *et al.*, 1998; PARK M.S., *et al.*, 1998) and Russia (BIDZILYA *et al.*, 2010; Streltsov, 2011).

The alien origin of this species was firstly supposed by Asselbergs who stated as follows: "The discovery of *P. nankingella* in N.E. Spain is an enigma because the species was only known so far from China […] and furthermore from Japan" (1998: p. 42). This supposition was supported by the absence of records in Europe before the 1991 and the abundance of European records after this year being this species recorded in France from 1991 to 1993 by five different collectors, and in France, Spain and Portugal from 1991 to 1995 by seven different collectors (ASSELBERGS, 2002).

During 2014 four specimens belonging to this species were collected also in southern Italy, expanding eastwards the known range of the species, with an apparent expansion rate from the site of the first European record consistent with an active spread of the species by flight as observed for other invasive lepidopteran species such as the univoltine *Lymantria dispar* L. (Lepidoptera Lymantriidae) in North America (Liebhold *et al.*, 1992), and the bivoltine pyralid *Cydalima perspectalis* Walker in northwestern Switzerland (LEUTHARDT *et al.*, 2010).

In 2014, at the supposed maximum expansion of the non-indigenous species in Europe, the study of the type specimen of *Pseudacrobasis tergestella* (RAGONOT, 1901) unveiled the synonymy of this species with the Far East *Pseudacrobasis nankingella* ROESLER, 1975 (Vives Moreno, 2014). It is quite curious that both authors derived the name of the species from the type locality which are Trieste, Italy, for the former, and Nanking, China, for the latter. VIVES MORENO (2014) established the name of *Pseudacrobasis tergestella* (RAGONOT, 1901) for this species.

The aim of this paper is to report this species for new Italian localities, and to review its biology, ecology and distribution for the first time along its entire range.

MATERIALS AND METHODS

Field data and bibliographic data were jointly utilized to delineate the current species range and to investigate ecology and biology of the species.

FIELD DATA

Pseudacrobasis tergestella was found in the Fiume Argentino Valley, near the village of Orsomarso, southern

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Italy, at 160 metres altitude (lat.: 39°47'41.58"N; long.: 15°55'22.41"E). This site is located in the Site of Community Importance named "Valle del Fiume Argentino" of the Natura 2000 network, site code IT9310023. The vegetation is dominated by riparian forests and is located in an area characterized by the habitat of alluvial forests with *Alnus glutinosa* (L.) Gaertn. and *Fraxinus excelsior* L., Natura 2000 code: 91E0, and *Salix alba* L. and *Populus alba* L. galleries, Natura 2000 code: 92A0.

Specimens and genitalia slides (gen. slide: CRASAM-035, CRASAM-036) are conserved in the collection of the Unità di Ricerca per la Selvicoltura in Ambiente Mediterraneo, Rende (CRA-SAM).

Bibliographic data

Available records devoted to this species are arranged in Table 1. We found 38 records of species occurrences, 16 in the Asiatic range, 22 in the European range (Fig. I). Only the two most ancient data concern the *Pseudacrobasis tergestella*, whereas the other concern the former *Pseudacrobasis nankingella*.

The bibliography (see references within Table 1) has been comprehensively reviewed in order to describe the current knowledge on biology and distribution of this species.

RESULTS AND DISCUSSIONS

New records for the Italian Peninsula

Two males and two females were collected. Wing pattern of females is fresher than that of the males suggesting an earlier emergence of males (Fig. II). Their genitalia (Figs. III-IV) perfectly match available images in the literature, confirming the species identification. Wingspan is 18mm for males, 18 and 19mm for females.

P. tergestella was also recorded from Borella di Cesenatico, North Italy, where it was collected 16th June 2011 (Gilberto Bonoli leg., www.naturamediterraneo.com/forum/).

These records are the first for Italy after 113 years from the species description.

Pseudacrobasis tergestella is externally more or less similar to *Acrobasis* spp. and therefore it can be overlooked in nature or in Lepidoptera collections. Generally, the moth is smaller and the costal area of forewings is greyish in the medial area. With worn specimens it is necessary to examine the genitalia. The wingspan ranges from 12 to 16mm (N = 17) in the Asiatic area and from 18 to 19mm (N = 6) in European countries.

Male genitalia are generally similar to *Acrobasis* spp., but with a characteristic uncus, which is distally extended to form two lateral lobes (Fig. III). Female genitalia are generally similar to those of *Acrobasis* spp., showing relatively long apophyses, ostium oval, well-sclerotized, ductus bursae membranous, extended at base, corpus bursae oval, signum bursae small and well-sclerotized (Fig. IV).

Biology

According to Roesler (1975) and Asselbergs (1998) the biology of the species is unknown, but this is true only for the European range. In the Asiatic range its biology was investigated in South Korea where *P. tergestella* is known to be a pest in mature acorn of oaks (*Quercus* spp.) (Park J.D., *et al.*, 1998) causing a significant amount of damage to acorns collected on the ground. Adults also emerged from cones of *Pinus* spp. (Park M.S., *et al.*,

Fig. I – Currently known distribution of *Pseudacrobasis tergestella*.

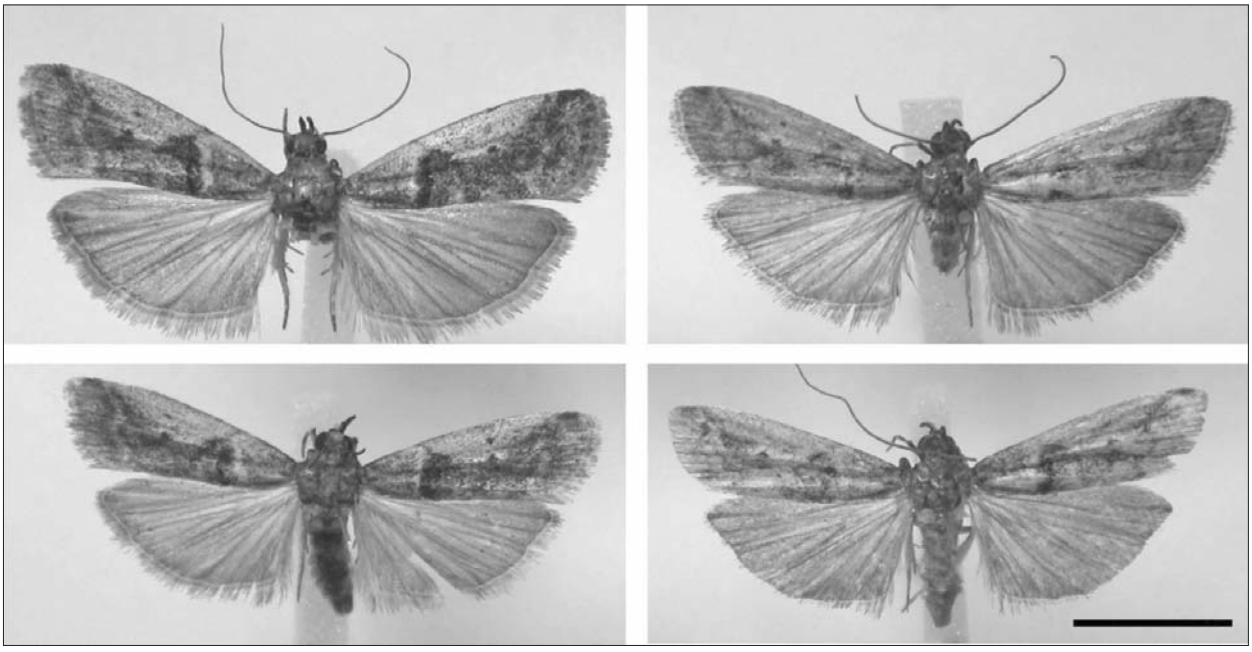

Fig. II – *Pseudacrobasis tergestella*: Fiume Argentino Valley, 160m, 27th August 2014, collection of the Unità di Ricerca per la Selvicoltura in Ambiente Mediterraneo, Rende; females on the left, males on the right. Scale bar 5mm.

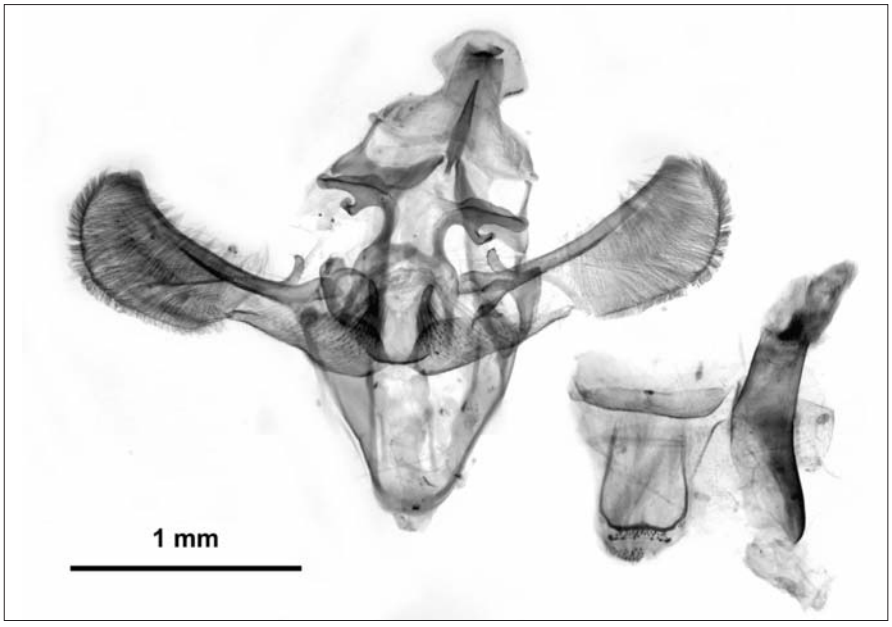

Fig. III – Male genitalia of *Pseudacrobasis tergestella*, Fiume Argentino, Italy, 27th August 2014, gen. slide CRASAM-035.

1998), suggesting that the larvae have a generalist diet on seeds of forest plant species. Many pyraloids feeding on seeds also use dried vegetal matter as an alimentary source (SLAMKA, 2010). This is the case for all the species belonging to the Phycitinae genus *Ephestia* and *Cadra*, which are frequently found in warehouses and on preserved foodstuffs, some of them cosmopolitan and invasive (LOPEZ-VAAMONDE *et al.*, 2010; SLAMKA, 2010). Data available on the phenology of the species in its Asiatic range are identical to those of the European range. Available records of *P. tergestella* in Europe, affect the period from mid-May to the end of September; this time period includes all known collecting dates in the Asiatic range apart from one, taken at the beginning of October (ROESLER, 1975). This pattern, confirmed in Colombaille, France, where it was frequently collected, seems to be the result of some overlapping generations from the mid-spring to the late-summer or of some separate generations, the number of which is defined by local climate. In any case, it seems to be able to have at least three generations per year, perhaps as many as five (ASSELBERGS, 2002).

HABITAT AND DISTRIBUTION

The Asiatic distribution ranges from 26°29'N to 48°37'N, occupying 22 degrees of latitude from Yunnan, China, in the south to Khabarovsk, Russia, in the north.

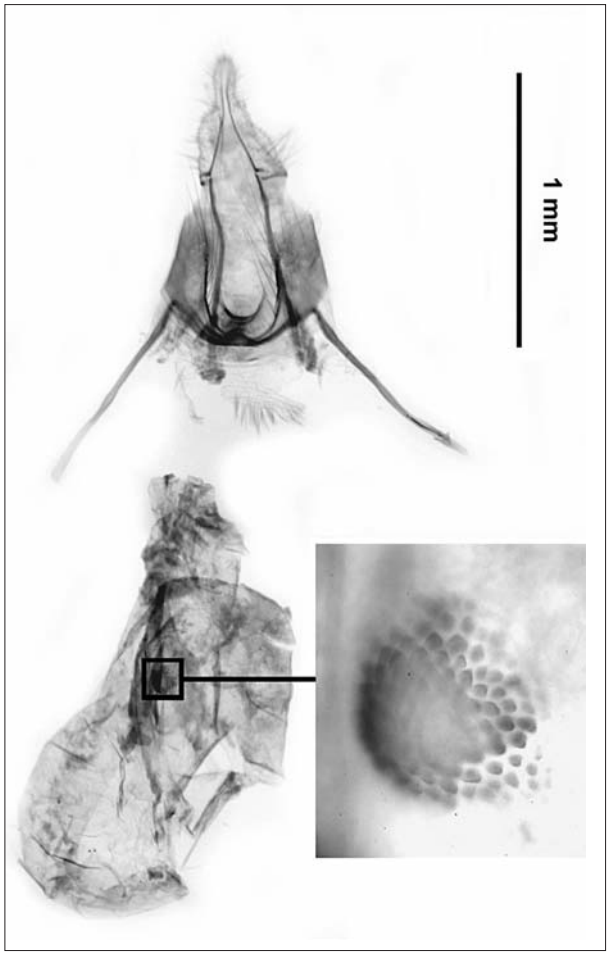

Fig. IV – Female genitalia of *Pseudacrobasis tergestella*, Fiume Argentino, Italy, 27th August 2014, gen. slide CRASAM-036.

These extreme records are far from the core of known Asiatic range, the Yunnan record representing both the most distant from the sea and the highest altitude (Table 1). Other available records from China, Japan and South Korea occupy only eight degrees of latitude (Table 1). European range is entirely compatible with the latitude range within the Asiatic area, varying from 37°12'N for the southernmost record from Portugal and 44°14'N for the northernmost record from France.

All records of *P. tergestella* are fall within the biome of temperate forests, with the exception of Russian records; at their southern border these fall within the coniferous forests belt. We were able to determine the CORINE Land Cover Level 1 of 34 localities where *P. tergestella* was collected. It seems not sensitive to human disturbance because 25 out of 33 localities were located in Agricultural areas and Artificial surfaces in both native and invaded ranges and only height in Forests and semi-natural areas.

In Europe it was recorded in areas with a climate more xeric than those experienced in the native range. In fact sclerophylls dominate the landscape of European countries, with fewer occurrence in coastal areas, wetlands and river beds or in broad-leaved forests, where the humidity is higher than surrounding habitats. It was observed at a higher distance from the sea in the Asiatic range (N = 13; mean =199.8; mediane = 95.0) compared to the European range (N = 21; mean = 22.43; mediane = 20.0).

The species flight at very low altitude in both Asiatic (N = 13; mean = 293.0m; mediane = 55.0m) and European ranges (N = 20; mean = 110.0m; mediane = 60.0m). Exceptions are one Japanese and one Chinese record, both at higher altitude than the highest European locality situated at 525 metres above the sea level, and with the Chinese record at the exceptional altitude of 2300-2500 metres.

CONCLUSIVE CONSIDERATIONS

In this paper the currently known distribution, biology and ecology of *Pseudacrobasis tergestella* was revised in the light of the new synonymy of *Pseudacrobasis nankingella*. The distribution of *P. tergestella* is quite unique with occurrences in the far east and in the far west of the Palearctic region. No records are currently available for Central Asia and East Europe, where suitable habitats are present. The great areal disjunction and the large timespan between old and recent European records generated the erroneous hypothesis of an alien origin of the presence in Europe of *P. nankingella*. In the future it should be interesting to submit as much as possible populations of this species to DNA barcoding analysis in order to investigate the diversification of genetic lineages. If Asiatic and European populations will show a close genetic relationship despite their distance, it is possible to hypothesize a suggestive ancient introduction on this species in Europe or in Asia, for example through the Marco Polo's Route.

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Table 1 – List of available records of *Pseudacrobasis tergestella*. In most cases coordinates, altitude, distance from the sea and CORINE Land Cover Level 1, 2 were only inferred from bibliography. The accuracy of these inferred data depend upon the accuracy of the original description of collecting sites.

Site	Collecting data	Coordinates	Altitude (m a.s.l.)	Distance from the sea (km)	CORINE Land Cover Level 1, 2
China, Jiangsu Province, Lungtan near Nanking (Roesler, 1975)	16.V.1933, 1♀; 25.VII.1933, 1♂; 5♂♂, 1♀: 19.VI.1933, 15.VII.1933, 20.VII.1933, 20.VII.1933, 27.VII.1933, 7.X.1933; H. Höne leg.	32°03'N (±5'); 118°47'E (±5')	10-120	200-230	Urban fabric, Arable land
China, Chekiang Province, West Tien-Mu-Shan (Roesler, 1975)	2♂♂, 3♀♀: 1.IX.1932, 7.IX.1932, 10.IX.1932, 23.IX.1932; H. Höne leg.	30°30'N (±15'); 119°44'E (±15')	80-200	50-150	Forests and semi-natural areas
China, North Yunnan Province, Lijiang (Roesler, 1975)	3♂♂: 30.VII.1935, 10.VIII.1935; H. Höne leg.	26°29'N (±5'); 100°16'E (±5')	2300-2500	950	Urban fabric, Arable land
Japan, Honshu Island, Yokohama (Roesler, 1975)	15.VII.1911, 1♀; H. Höne leg.	35°20'N (±4'); 139°34'E (±3')	5-100	0-7	Urban fabric
Japan, Honshu, Kiso, Nagano, Fukushima (Yamanaka *et al.*, 2002)	10.VIII.1996, 4 specimens	33°48'N (±1'); 132°44'E (±1')	800-900	110-115	Forests and semi-natural areas
Japan, Honshu, Achimantai, Akita (www.jpmoth.org/)	1♀, 15mm; A. Sasaki leg.	39°56'N (±10'); 140°42'E (±10')	-	-	Forests and semi-natural areas
Japan, Honshu, Chiba (www.jpmoth.org/)	-	35°35'N (±1'); 140°08'E (±1')	10-20	1-2	Urban fabric
Japan, Honshu, Ishikawa (www.jpmoth.org/)	-	36°35'N (±1'); 136°37'E (±1')	10-20	3-4	Urban fabric, Arable land
Japan, Honshu, Nagoya, Aichi (www.jpmoth.org/)	-	35°10'N (±1'); 136°54'E (±1')	10	10	Urban fabric
Japan, Honshu, Gifu (www.jpmoth.org/)	-	35°22'N (±1'); 136°43'E (±1')	10	35	Urban fabric
Japan, Kyushu Island (www.jpmoth.org/)	-	32°42'N (±1°10'); 130°51'E (±1°)	-	-	-
Japan, Shikoku, Matsuyama City, Ichitsubo Bridge (Kataoa *et al.*, 2012)	30.VI.2008, 1♀	33°48'N (±1'); 132°44'E (±1')	10	5	Urban fabric, Arable land
Russia, Primorye Region, Lazovsky Nature Reserve (Bidzilya *et al.*, 2010)	30.VIII.1992, 1 specimen	44°50'N (±5'); 136°12'E (±10')	10-100	0-13	Forests and semi-natural areas
Russia, South of Khabarovsk Region (Streltsov, 2011)	-	48°37'N (±1°); 139°05'E (±1°)	-	-	Forests and semi-natural areas
South Korea, Seoul, Forestry Research Institute (Park J.D. *et al.*, 1998)	1993-1994, many adults from larvae feeding on mature acorn	37°35'N (±1'); 127°02'E (±1')	75	30	Urban fabric, Forests and semi-natural areas
South Korea, Kangwon, Chunchon (Park M.S. *et al.*, 1998)	1997, adults from larvae feeding on *Pinus* cones	37°50'N (±10'); 127°45'E (±10')	80-150	80-110	Urban fabric, Forests and semi-natural areas
Italy, Trieste, Miramare (Ragonot, 1901)	29.VII, 1♀; H. Rebel leg.	45°42'09" (±1'); 13°42'47" (±1')	20	0-1	Urban fabric, Forests and semi-natural areas
Italy, Emilia-Romagna, Borella (www.naturamediterraneo.com)	16.VI.2011, 1♀; G. Bonoli leg.	44°11'N (±1'); 12°22'E (±1')	5	3	Urban fabric, Arable land

(continued)

Continued Table 1

Site	Collecting data	Coordinates	Altitude (m a.s.l.)	Distance from the sea (km)	CORINE Land Cover Level 1, 2
Italy, Calabria, Fiume Argentino Valley (original data)	27.VIII.2014, 2♂♂, 2♀♀; S. Scalercio leg.	39°47'41.58"N; 15°55'22.41"E	160	11	Forests and semi-natural areas
Croatia (Klimesch, 1942)	-	-	-	-	-
France, Var, Ollioules (Asselbergs, 2002)	23.V.91, 1♀; 23.V.94, 1♀; 3.VII.95, 1♀; 27.VII.95, 1♀; A. Debourges leg.	43°08'N (±1'); 5°50'E (±1')	60	4	Urban fabric
France, Var, Bois de Prignonet (Asselbergs, 2002)	18.VI.99, 1♂; W. Felder leg.	43°33'N (±1'); 6°35'E (±1')	150-200	15-20	Forests and semi-natural areas
France, Var, Colombaille, near Draguignan (Asselbergs, 2002)	22.V.97; 2.VI.95; 4.VI.95; 19.VI.93; 19.VI.98; 4.VI.94; 12.VII.95; 13.VII.1997; 26.VII.97; 5.VIII.96; 16.VIII.99; 6.IX.95, 1♀; 9.IX.97; 19.IX.98; T. Varenne leg.	43°32'N (±1'); 6°27'E (±1')	300-350	27	Urban fabric, Forests and semi-natural areas
France, Corse, Sainte-Lucie de Porto-Vecchio (Asselbergs, 2002)	12.VIII.91, 1♂; G. Brusseaux leg.	41°42'N (±1'); 9°20'E (±1')	20-50	2-3	Urban fabric, Agricultural areas
France, Alpes Maritimes, Antibes (Asselbergs, 2002)	3.VII.93, 1♀; Cocquempot leg.	43°35'N (±1'); 7°07'E (±1')	0-50	0-1	Urban fabric, Marine waters
France, Pyrénéens Orientales, Amélie-les-Bains (Asselbergs, 2002)	17.VII.93, 1♂, 19mm; C. Tavoillot leg.	42°28'N (±1'); 2°40'E (±1')	220	30	Urban fabric, Forests and semi-natural areas
France, Bouches-du-Rhône, Martigues (Asselbergs, 2002)	20.VIII.98; T. Varenne leg.	43°24'N (±1'); 5°03'E (±1')	10	0-2	Urban fabric, Continental waters
France, Gard, Combe de la Lune, near Nîmes (Asselbergs, 2002)	23.VIII.99; R. Mazel leg.	43°51'N (±1'); 4°22'E (±1')	110-130	40	Urban fabric, Artificial non agricultural vegetated areas
France, Gard, Font du Rossignol, Nîmes (Asselbergs, 2002)	29.VIII.2001, 1♂; R. Mazel leg.	43°50'N (±3'); 4°20'E (±3')	60-150	33-36	-
France, Gard, Carsan (www.naturedugard.org)	-	44°14'N (±1'); 4°35'E (±1')	140-180	83	Urban fabric, Forests and semi-natural areas
France, Gard, Beaucaire (www.naturedugard.org)	-	43°48'N (±1'); 4°38'E (±1')	15	40	Urban fabric, Continental waters
France, Gard, Gajan (www.naturedugard.org)	-	43°53'N (±1'); 4°12'E (±1')	120	37	Urban fabric, Forests and semi-natural areas
France, Gard, Jonquières-Saint-Vincent (www.naturedugard.org)	-	43°49'N (±1'); 4°33'E (±1')	40	40	Agricultural areas
France, Gard, Saint-Gilles (www.naturedugard.org)	31.VII.2012, 1♂; J.-L.Hentz leg.	43°40'N (±1'); 4°25'E (±1')	10	23	Agricultural areas
France, Gard, Sainte-Croix-de-Caderle (www.naturedugard.org)	-	44°04'N (±1'); 3°35'E (±1')	500-550	57	Forests and semi-natural areas
Spain, Girona, Tossa de Mar (Asselbergs, 2002)	19-20.VI.99, 2♂♂; 5-6.VII.95, 3♂♂; 5-6.VII.96, 3♂♂; 17.IX.95, 1♂; 19.IX.95, 1♂; A.L. Cox leg.	41°43'N (±1'); 2°55'E (±1')	0-20	0-2	Urban fabric, Marine Waters
Portugal, Algarve (Asselbergs, 2002)	15. IX.94, 1♀; M.F.V. Corley leg.	37°12'N (±7'); 8°08'W (±40')	-	0-40	-
Portugal, Lisbone, Serra de Portel (Corley *et al.*, 2012)	5.IX.2011, 1♂; E. Marabuto & I. Rodrigues leg.	38°35'N (±1'); 9°09'W (±1')	50-70	3-4	Urban fabric, Artificial non agricultural vegetated areas

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