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Agrotis sardzeana Brandt, 1941 (Lepidoptera: Noctuidae) new to Europe.

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Abstract: On the basis of an individual photographed in Seville (Spain), *Agrotis sardzeana* Brandt, 1941 (Lepidoptera: Noctuidae) is mentioned for the first time for the Iberian Peninsula and Europe. Previous citations from Africa and Asia are reviewed in order to outline the geographical distribution range of this xero-thermophilous, deserticolous species. *A. sardzeana* is characterized both in terms of external morphology and genitalia, which is described for the first time. It is compared with other similar species, especially *Agrotis yelai* Fibiger, 1990, highlighting the most important diagnostic features. In the context of the ongoing climate change, a possible expansion northward of its distribution range is argued. The importance of image banks on the Internet and of the photographic entomology is briefly discussed in relation to progress in faunistic knowledge.

Key words: Lepidoptera, Noctuidae, *Agrotis sardzeana*, Europe, Iberian Peninsula, faunistic novelty.

Resumen: *Agrotis sardzeana* Brandt, 1941 (Lepidoptera: Noctuidae) nueva para Europa. Sobre la base de un individuo fotografiado en Sevilla (España), se cita *Agrotis sardzeana* Brandt, 1941 (Lepidoptera: Noctuidae) por primera vez para la Península Ibérica y para Europa, repasándose las citas previas de África y Asia para delimitar el área de distribución de esta especie xerotermófila de afinidades desérticas. Se caracteriza tanto en cuanto a su morfología externa como en cuanto a su genitalia, que se describe por primera vez. Se compara con otras especies parecidas, especialmente con *Agrotis yelai* Fibiger, 1990, destacándose los rasgos diagnósticos más importantes. Se argumenta sobre la posibilidad de que esta especie esté expandiendo su área de distribución hacia el norte, en el contexto del cambio climático en curso. Se discute brevemente la importancia de los bancos de imágenes en Internet y de la entomología fotográfica en relación con el progreso del conocimiento faunístico.

Palabras clave: Lepidoptera, Noctuidae, *Agrotis sardzeana*, Europa, Península Ibérica, novedad faunística.

Recibido: 2 de octubre de 2011

Aceptado: 4 de octubre de 2011

Publicado on-line: 13 de octubre de 2011

Introduction

Agrotis sardzeana Brandt, 1941 (Lepidoptera: Noctuidae: Noctuinae) is a xerothermophilous moth species known to inhabit steppe and semidesert-like habitats (Pinker, 1974; Hacker & Weigert, 1990; de Freina & Behounek, 1996; Hacker & Peks, 1996; Kravchenko et al., 2006). It has been previously mentioned from the Canary Islands (Pinker, 1974, as ssp. *saharae* Pinker, 1974; Hacker & Schmitz, 1996; Báez, 1998), Cape Verde Islands (Hacker et al., 2010), Mauritania (Rungs, 1992; Hacker & Hausmann, 2010), Morocco (Rungs, 1992; de Freina & Behounek, 1996), Libya (Hacker et al., 2001a), Egypt (Wiltshire, 1948; Back, 1981), Arabian Peninsula (Wiltshire, 1952, 1964, 1977, 1980, 1990; Legrain

& Wiltshire, 1998), Sudan (De Prins & De Prins, 2011), Chad (Herbulot & Viette, 1952; De Prins & De Prins, 2011), Jordan (Hacker, 2001; Hacker & Schreier, 2001; Fabiano & Zilli, 2001), Israel (Hacker *et al.*, 2001b; Kravchenko *et al.*, 2006), Iran (from where it was originally described; see Brandt, 1941), Pakistan (Hacker & Weigert, 1990) and India (Hacker & Schmitz, 1996) (see also Schacht, 2005-2009 and Hacker *et al.*, 2010). The distribution area is, thus, typically paleotropical-subtropical of the eremic type.

In the frame of regular monitoring along the southern part of the Iberian Peninsula during the past 20 years, no specimens of *A. sardzeana* were recorded. But recently, a male was photographed and the picture was uploaded to the taxonomic-faunistic digital bank of the Iberian invertebrates (<http://www.biodiversidadvirtual.org/insectarium/>), albeit misidentified. The study of the digital image (Fig. 1) by the first author has allowed the correct identification.

Material and methods

Recording

The second author records moths regularly at a set of bulbs located close to the fence bordering the Seville airport and separate it from an urban peripheric park. Specimens are photographed readily and then released. The only witnesses of the records are, thus, the digital images. The mentioned male was found in the framework of that recording scheme.

Genital study

Two specimens from the Arabian Peninsula (leg. Albert Legrain), male and female, were dissected in order to study the genitalia by ordinary methods (Yela, 1992; Fibiger, 1997; Mikkola, 2007). No previous information was available in the scientific literature on the genitalia.



Fig. 1. - Iberian specimen of *A. sardzeana* (Seville, 16-01-2010).

Results

Records

The recorded specimen was photographed in Seville, Spain (UTM coordinates 30STG34, 10 m o.s.l.), by Manuel Ramírez Mogrera, on the 16 of January, 2010. This is not only the first mention of *A. sardzeana* from the Iberian Peninsula, but even from Europe.

Comparative external characterisation

Adults of *A. sardzeana* are easily identifiable. Externally, there is no matching species among the European fauna. Among the Iberian species, only very light specimens of *Agrotis yelai* Fibiger, 1990 (Fig. 2, E) may be confused with *A. sardzeana* (Fig. 2, J), but the 19-21 distal segments of the male

antenna of *A. sardzeana* are ciliated instead of serrate (as is the rest of the antennal flagellum), whereas in *A. yelai* there are only 8 ciliated segments at the tip of the male antenna, which shows much longer pectinations. Furthermore, orbicular and reniform spots are fused or almost fused in *A. sardzeana* but separate, at most touching, in *A. yelai*, and the basal field of the forewings is not delimited by a strip in *A. sardzeana* but clearly delimited by a strong, double, subelliptical band in *A. yelai*. Other diagnostic differences between *A. sardzeana* and the species of the *Agrotis vestigialis* (Hufnagel, 1766) group, to which *A. yelai* belongs, are as follows (see Fig. 2):

A. sardzeana Brandt, 1941: Head and thorax whitish gray; collar almost imperceptibly darker, sometimes tinted brownish yellow. Tegulae usually edged yellow-brown, mostly monotonous stained grayish. Abdomen white. Ground color of the forewings straw, heavily dusted white-gray towards the costa. Forewings relatively broad. Antemedial line almost absent, straight when present (Fabiano & Zilli, 2001); postmedial line absent. Thus, basal and subterminal fields are unbounded, fused to median field. Basal field as a pale, orange, diffuse area. Subterminal field typically pale to its inner part, with a large whitish patch near tornus between Cu2 and A1 (see Yela, 1992: 37 for nomenclature); pale strip over Cu2 from whitish patch to claviform. A shorter whitish strip distal to the reniform, along M1. Orbicular spot longitudinally elongated, uniformly whitish, fused to reniform. Claviform spot elongated, uniformly brownish, finely delimited brown. Hindwings pure white. 19-21 distal segments of the male antennae ciliated, not serrated.

(Note: individuals belonging to subspecies *saharae* Pinker, 1974 from the Canary Islands are notably paler and blurred. North African and Arabian specimens match the Iberian one; Figs. 1 and 3).

A. yelai Fibiger, 1990: Ground color of the forewings ochreous grey, seldom with whitish tinge. Forewings relatively broad. Postmedial line finely marked as a dark tiny line to absent. Basal field orange, very apparent, outlined by a strong, double, subelliptical strip. Antemarginal line as a succession of 5-6 relatively well-marked sagittal spots. Orbicular spot elliptical, filled dark brown. Reniform spot large and broad. Claviform spot elongated, very dark and broad. Hindwings pure white in males, white with brown tinge towards margin in females. 8 distal segments of the male antennae ciliated, not serrated.

Endemic to the western half of the Iberian Central Plateau and surrounding siliceous mountain ranges.

A. charoae Yela, Fibiger, Zilli & Ronkay, 2010: Ground color of the forewings ochreous, tinged gold. Forewings relatively narrow. Antemedial line as a relatively strong, double, subelliptical strip surrounding the basal field and extending backwards, forming a protruding swelling towards postmedial line between A1 and anal margin. Basal field orange, very apparent. Postmedial line pale, well marked. Antemarginal line as a succession of 5-6 well-marked, dark sagittal spots, delimited marginally by a strongly serrated pale line. Orbicular spot small, elongated, filled dark brown. Reniform spot large and broad. Claviform spot elongated, dark and relatively narrow. Hindwings pure white in males, whitish with a brown tinge in females. 10 distal segments of the male antennae ciliated, not serrated.

Endemic to the Atlantic sandy beaches of Galicia, NW Spain.

A. vestigialis (Hufnagel, 1766): Ground color of the forewings dark grayish-brown. Antemedial line as a strong, double, subelliptical strip surrounding the basal field and extending backwards, forming a short swelling towards postmedial line between A1 and anal margin. Basal field dark orange, very apparent. Median field above the claviform spot typically whitish along M3. Postmedial line well marked, dark inside and pale outside (except in individuals from isolated populations, such as the ssp. *morandini* Stanglemaier & Lexer, 1994 from Austria and apparently most of the Iberian populations to the south of Burgos, which might be assignable to an undescribed species or subspecies). Orbicular spot small, round or slightly elongated, filled dark brown. Reniform spot large and broad, not as contrasting as in

the two preceding species. Claviform spot elongated, very dark and narrow. Hindwings grayish. 17-18 distal segments of the male antennae ciliated, not serrated.

Widely distributed across most of Europe and Palaearctic Asia.

A. sabulosa Rambur, 1839: Ground color of the forewings dark gray, sometimes suffused reddish brown, dusted black towards the costa. Antemedial line as a rather inconspicuous, double, subelliptical strip surrounding the basal field and extending backwards in some individuals, forming a short swelling towards postmedial line between A1 and anal margin. Basal field dark grey with orange tinge. Postmedial lines absent or slightly marked. Median field lighter than the rest in most specimens. Orbicular spot usually small, elongated, filled gray. Reniform spot large and broad, blackish, not very contrasting. Claviform spot elongated, dark and usually very narrow. Hindwings pure white in males, whitish with a gray suffusion towards margin in females. 10 distal segments of the male antennae ciliated, not serrated. 16 distal segments of the male antennae ciliated, not serrated.

In Europe present only in the southern Spanish coasts.

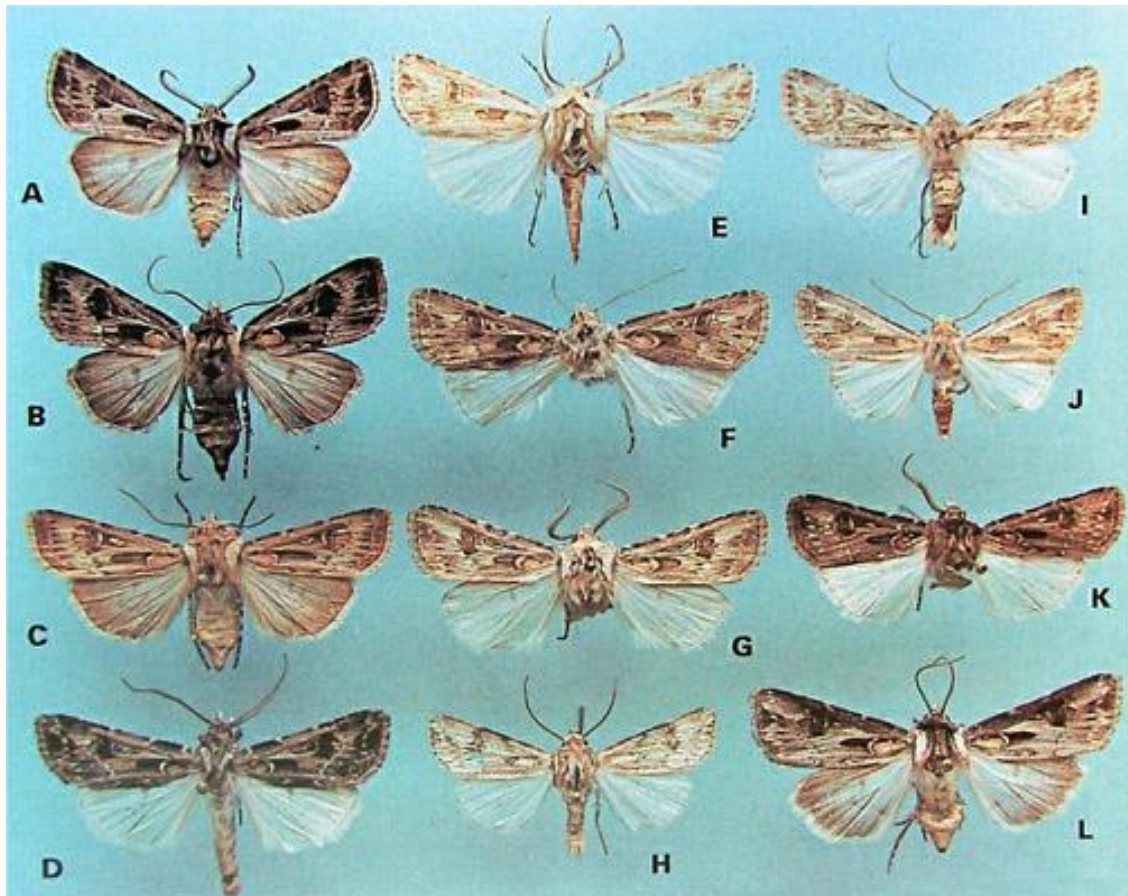


Fig. 2.- Adults of the Iberian species under discussion and other eremic *Agrotis* species (from Yela, 1992).

A, B and C: *Agrotis vestigialis* (Hungary, Switzerland and Great Britain, leg. L. & G. Ronkay, L. Rezbanyai-Reser & B. Goater).

D: *A. charoae* (Spain: Pontevedra, Cangas do Morrazo, leg. J.J. Pino Pérez).

E, F and G: *A. yelai* (Spain: Toledo, Ávila -holotype- and Madrid, leg. R. Pinker, P. Velasco & H. Flores).

H: *A. endogaea* Boisduval, [1837] (Corsica, leg. A. Legrain).

I: *A. haifae* Staudinger, 1897 (Siria, leg. A. Legrain).

J: *A. sardzeana* (United Arab Emirates, leg. A. Legrain).

K and L: *A. sabulosa* (Spain: Huelva, leg. H. Hacker & M. Huertas)



Fig. 3. - Male specimens of *A. sardzeana* from the Arabian Peninsula (leg. Albert Legrain).

Genital characterisation

Genitalia of *A. sardzeana* were undescribed yet. Male genitalia are unmistakable because of the configuration of the proximal part of the vesica; female genitalia show comparatively very long appendix bursae and corpus bursae, corresponding with very long corpus vesicae, and not so sharp tip of posterior plates. Qualitative diagnostic differences between the male and female genitalia of *A. sardzeana* and the species of the *A. vestigialis* group are as follows (see Figs. 4 and 5):

A. sardzeana: Male genitalia: basal part of the vesica with a large dorsal swelling or diverticulum (larger than in other European species of the genus) and a left lateral, subbasal, medium-sized one. Dentated plate strongly sclerotised, very large. Female genitalia: both corpus bursae and appendix bursae very long. Plates and apophyses relatively short; tip of posterior plates not so sharp.

A. yelai: Male genitalia: basal part of the everted vesica not coiling; posterior margin of the corpus vesicae straight, falling downward obliquely. Basal dorsal swelling conspicuous. Subbasal diverticulum relatively short but very wide at basis. Sclerotised, dentated plate very short and narrow. Female genitalia: both corpus bursae and appendix bursae relatively short, as well as plates and apophyses. Tip of posterior plates sharp. Ductus bursae medium long (corresponding to the medium-sized aedeagus).

A. charoae: Male genitalia: basal part of the everted vesica coiling to the left almost 180° before pointing ventrally; posterior margin of the corpus vesicae smoothly curved. Basal dorsal swelling conspicuous. Subbasal diverticulum large but only relatively wide. Sclerotised, dentated plate short and wide. Female genitalia: both corpus bursae and appendix bursae long. Plates and apophyses relatively short, as well as ductus bursae (corresponding to the relatively short aedeagus). Tip of posterior plates sharp.

A. vestigialis: Male genitalia: basal part of the everted vesica not coiling; posterior margin of the corpus vesicae straight, falling downward after building an almost square angle. Basal dorsal swelling very small or lacking. Subbasal diverticulum relatively large but wide. Sclerotised, dentated plate relatively short and narrow. Female genitalia: both corpus bursae and appendix bursae relatively long. Plates and apophyses comparatively long, as well as ductus bursae (corresponding to the relatively long aedeagus). Tip of posterior plates sharp.

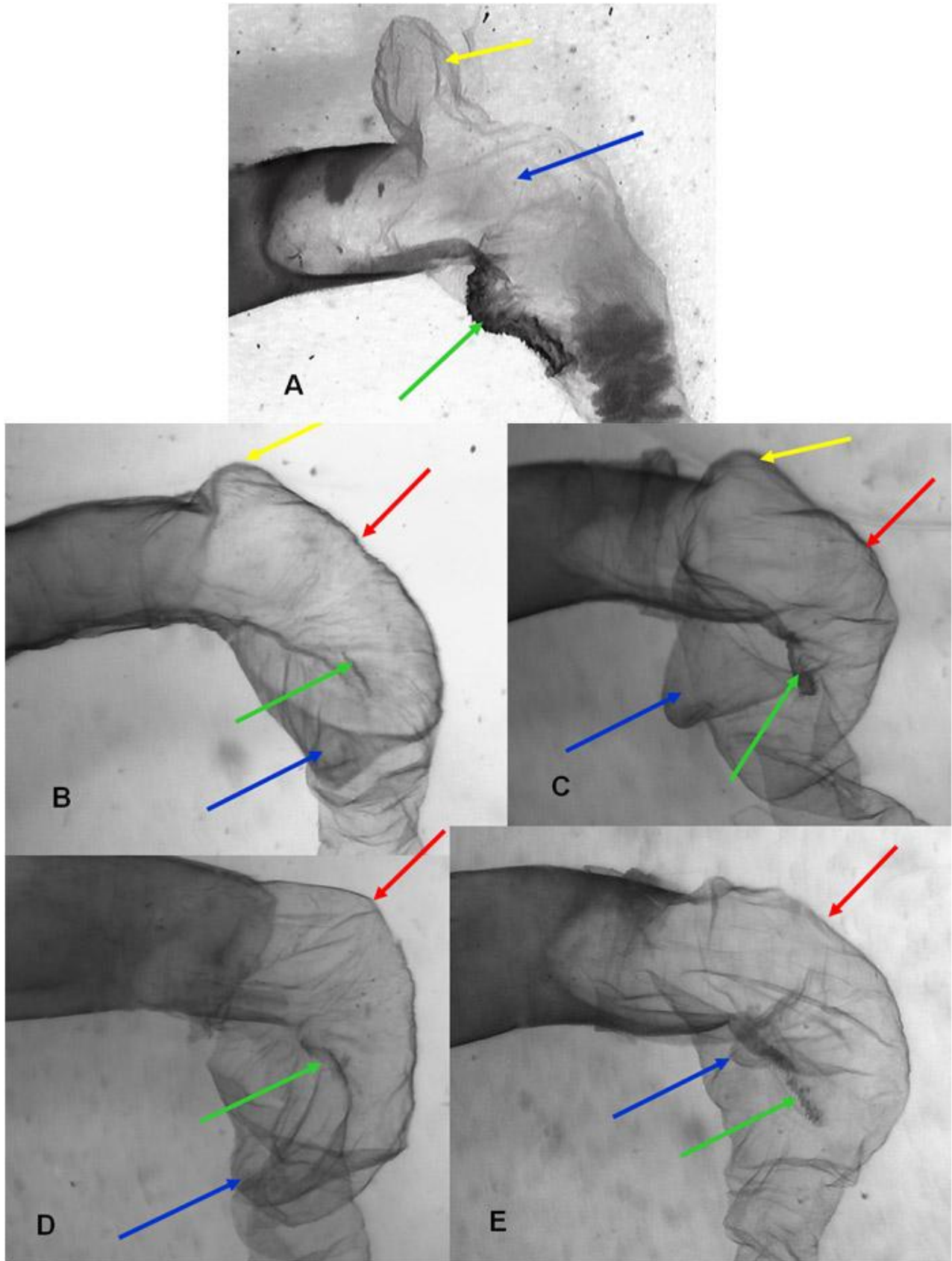


Fig. 4. - Male genitalia of *Agrotis* spp: basal part of everted vesicae. Red arrows: posterior margin of the corpus vesicae. Yellow arrows: basal, dorsal swelling. Blue arrows: subbasal diverticulum. Green arrows: sclerotised, dentated plate. A: *Agrotis sardzeana*. B: *A. yelai*. C: *A. charoae*. D: *A. vestigialis*. E: *A. sabulosa*

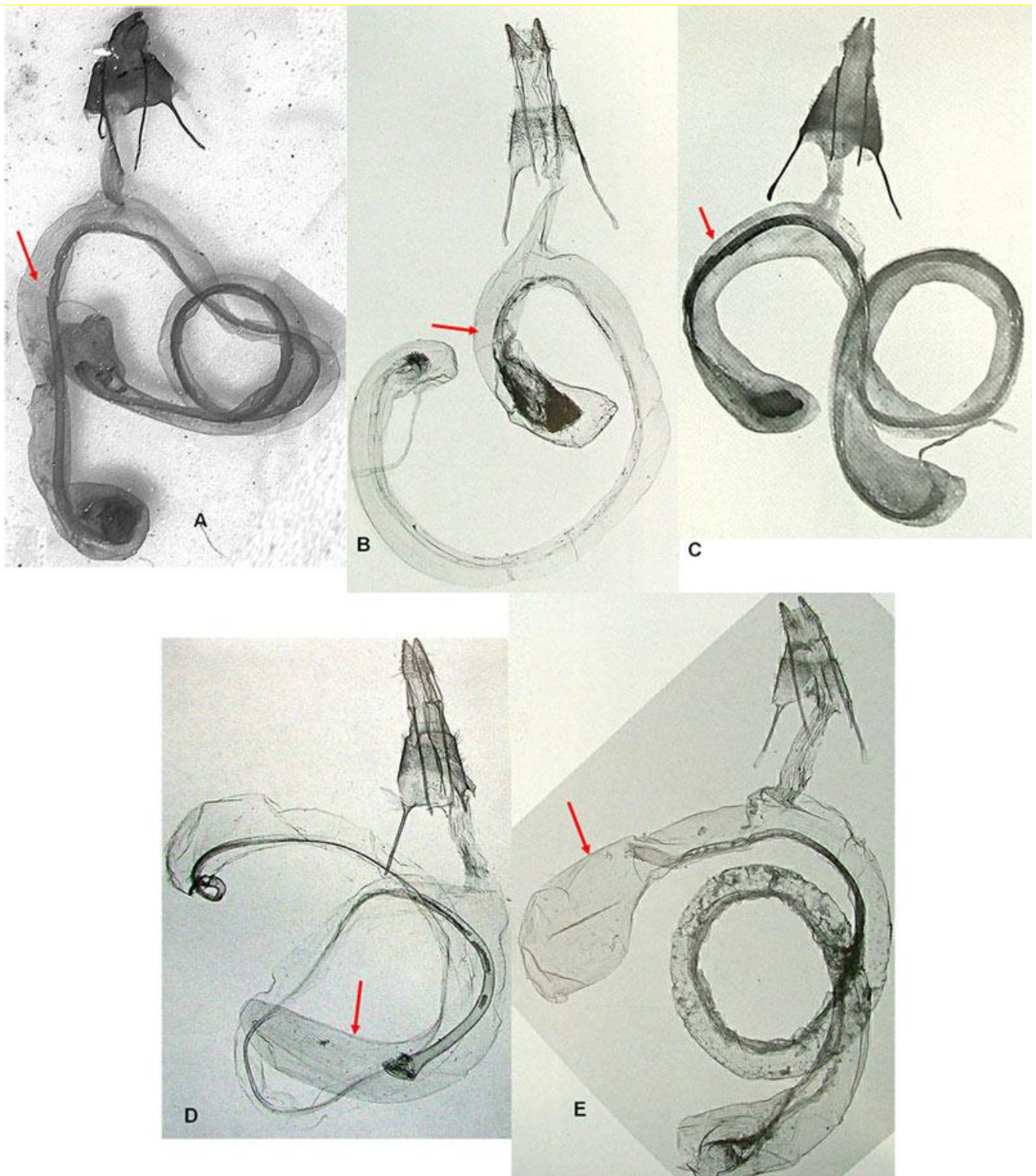


Fig. 5. - Female genitalia of *Agrotis* spp. Red arrows: appendix bursae. A: *Agrotis sardzeana*. B: *A. yelai*. C: *A. charoae*. D: *A. vestigialis*. E: *A. sabulosa* (B, D and E, according to Fibiger, 1997; C, according to Fibiger et al., 2010).

A. sabulosa: Male genitalia: basal part of the everted vesica not coiling; posterior margin of the corpus vesicae smoothly curving downward. Basal dorsal swelling very small or lacking. Subbasal diverticulum relatively small and narrow at basis. Sclerotised, dentated plate long and relatively broad. Female genitalia: both corpus bursae and appendix bursae relatively long, as well as ductus bursae (corresponding to the relatively long aedeagus). Plates and apophyses comparatively short. Tip of posterior plates sharp.

Discussion

Taxonomy

External and genital characterisation allows to distinguish easily *A. sardzeana* from other relatively similar species. Both structure of the male antenna and basal part of the vesica in males and form and size of the appendix bursae in females are species-specific features.

Ecology and spread

The presence of an eremic (with deserticolous affinities) species in southernmost Iberia is remarkable, although not exceptional. During the last 40 years, at least 10 additional xerothermophilous species previously only known from North Africa have been found in South Spain (Vargas *et al.*, in prep.). This may be due to a northern shift of their distribution areas correlated with the elevation of average temperatures and increasing drought in the Mediterranean (IPCC, 2007) in the context of the current climate change (Root *et al.*, 2003; Parmesan, 2006; Walther, 2010). Still, it is noteworthy that the Spanish mention is the northernmost of the entire distribution range (Fig. 6). It cannot be ruled out, therefore, that this species is going to be found in the near future in other locations along the northern Mediterranean shore.

The Spanish adult specimen has been found in January. According to bibliographic data (Pinker, 1974; Hacker & Weigert, 1990; de Freina & Behounek, 1996; Hacker & Peks, 1996; Kravchenko *et al.*, 2006), adults are on the wings from September to March, peaking in November, being *A. sardzeana* univoltine. Larvae feed in winter and spring, most probably on herbaceous plants.

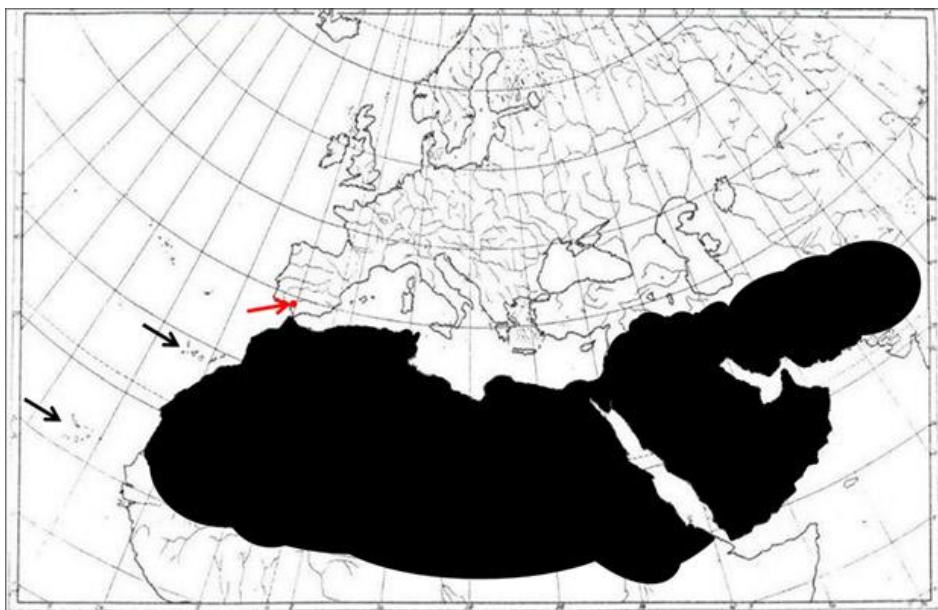


Fig. 6. - Approximate distribution area of *A. sardzeana*. Black arrows indicate the Canary and Cape Verde Islands.

The red arrow indicates the locality of the Iberian mention, the northernmost one (close to parallel 38).

Digital recording

During the last years, an important effort has been put on the compilation of Iberian faunistic data in form of georeferenced digital images uploaded to an Internet platform, the taxonomic-faunistic digital bank of the Iberian invertebrates (<http://www.biodiversidadvirtual.org/insectarium/>). One of the expected results from this activity is the contribution to the knowledge of the actual distribution of species whose range was not well known previously; another one is the discovery of yet unrecorded species for the Iberian area. For almost 8 years, 9.190 noctuid images have been uploaded, many of which have helped in fact to know in greater detail the geographical distribution of certain species. However, one single species has been reported as new to the Iberian Peninsula, specifically *A. sardzeana* (since a second one, *Earias albovenosana* (Oberthür 1917), was subsequently found to be widely distributed throughout most of the Iberian area but previously confused with *Earias vernana* (Fabricius, 1787) (Triviño *et al.*, 2010). It thus appears that the capability of that digital bank to meet the second objective is limited, probably due to geographical skewness, and in order to document possible changes in community composition in relation to climate change the implementation of more specific monitoring programs is needed.

Acknowledgment

We acknowledge the kind collaboration of José Martí, through whom the co-authors of this paper came into contact. Collection specimens of *A. sardzeana* have been kindly supplied by Albert Legrain and J. J. Bacallado. Comparative specimens of *A. charoae* were collected and sent by Juan José Pino Pérez; other comparative material was sent by Barry Goater, Hermann Hacker, Manuel Huertas Dionisio, Ladislaus Rezbanyai-Reser and László Ronkay. Curators of the MNCN, Madrid (Isabel Izquierdo, Carolina Martín Albaladejo and Mercedes París), allowed the study of material of *A. yelai* deposited in that institution. Copies of relevant papers were very kindly supplied by Gerard Tarmann during a visit to the Tiroler Landesmuseum Ferdinandeum, Innsbruck, long time ago. This paper is a contribution of DITEG research group, in the context of the BANDENCO (POII11-0277-5747) research project.

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