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The biology and distribution of glow-worms (Coleoptera: Lampyridae) in Spain

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Abstract The distribution and biology of glow-worms (Coleoptera: Lampyridae) in Spain was assessed using an online survey and a photo-biodiversity database. Between May 2009 and May 2010 45 online forms or e-mails have been received on the "¿Has visto una luciérnaga?" website ("Have you seen a glow-worm?") and over 200 photographs were uploaded to the Biodiversidad Virtual website. *Nyctophila reichii* is the species most recorded from both sources of information (95 larvae, 34 males and 25 females). Adult males and females were seen from late May until late July and larvae were found during the whole year all across Spain, even during months when adults are present. *N. reichii* was found in a wide variety of natural and semi-natural habitats and locations; it seems to be more adapted to mountainous and semi-arid regions and up to now seems almost lacking in the Northern more temperate provinces. The records of *Lamprohiza* (10 males and 5 females) show a very distinct presence in the East Mediterranean area, with the exception of a record from the North-West. It has been possible to identify a specimen of *Lamprohiza paulinoi* and one of *Lamprohiza mulsanti*. Thirteen *Lampyris* adults have been recorded; three have been identified as *Lampyris iberica*, seven as *Lampyris noctiluca* and the other three have been assigned to the genus level. Males and females were seen from the second fortnight of June till the second fortnight of August. Only one record of *Luciola* (possibly *Luciola lusitanica*) has been submitted (Huelva, near Doñana National Park). Taking all data and references into consideration the more humid and temperate zones (Atlantic coast and East and Northeast Mediterranean coast) seem to be more biodiverse in lampyrids than the more Southern Mediterranean and central parts of Spain.

Key words Spain, *Lampyris*, *Lamprohiza*, *Nyctophila,* glow-worm survey

Introduction

With the exception of recent studies investigating Portuguese Lampyridae which included the description of a new species (Geisthardt et al, 2008) to date there is a lack of knowledge about Iberian fireflies (De Cock, 2009). A general revision in the Catalogue of Palaearctic Coleoptera (Geisthardt, 2007) and other references

record the presence of at least eleven species of Lampyridae in Spain & Portugal: *Lampyris noctiluca* Linnaeus, 1758; *Lampyris raymondi* Mulsant & Rey, 1859; *Lampyris iberica* Geisthardt, 2008; *Nyctophila reichii* Jacquelin du Val, 1859 and *Nyctophila heydeni* E. Olivier, 1884 (only found on the Balearic islands); *Lamprohiza mulsanti* Kiesenwetter, 1850 and *Lamprohiza paulinoi* E. Olivier, 1884; *Phosphaenus hemipterus* Goeze, 1777; *Luciola lusitanica* Charpentier, 1825; *Phosphaenopterus metzneri* Schaufuss, 1870 (no recent records); *Pelania mauritanica* Linnaeus, 1767 (no recent records).

Studies of the Spanish lampyrid fauna are very scarce and usually limited to few anecdotal records. In spite of this, glow-worms are relatively common in Spain, especially in the countryside where villagers are used to the presence of these insects. However, many consider glow-worms to have decreased in numbers. This impression is difficult to confirm due to the limited censuses and inventories and a lack of information on how to identify different species. To improve the knowledge of the fauna of the Lampyridae in Spain, the project *¿Has visto una luciérnaga?* (Have you seen a glow-worm?) has been launched on the web in May 2009 (www.gusanosdeluz.es).

Our objective is to show the first results of presence and distribution of lampyrids in Spain as well as presenting new observations on the biology derived from the photo survey website project, *Biodiversidad Virtual* (www.biodiversidadvirtual.org) and from online survey forms at www.gusanosdeluz.es.

Methods

The idea for a project *Have you seen a glow-worm?* is based on other websites, in particular on the UK glow-worm survey (www.glowworms.org.uk). Our survey project has no funding nor affiliation, although it was initially developed whilst one of the authors was Associate Professor at the University of Cordoba. Besides general information about the ecology and species of glow-worms, an online form is provided that can be filled in by the collaborators, i.e. website visitors.
Soon after the launch of the site both authors were invited to collaborate in a picture-based biodiversity database called *Biodiversidad Virtual*. Here both authors provided lampyrid expertise in order to identify the species from images uploaded by the general public (all identified photographs and the name of the observer can be viewed at the website www.biodiversidadvirtual.org/insectarium/Familia+Lampyridae-cat183.html or http://tinyurl.com/35yhz45).

It has to be pointed out that identification of larvae is quite difficult as there are still no clear field characteristics to discriminate between the juveniles of the three species of *Lampyris* recorded in Spain. Adult identification within genera is problematic, especially for *Lamprohiza* and *Lampyris* species where photographs often show no clear distinguishing features. Consequently we often identified the specimens to genus level.

Results

Between May 2009 and May 2010 45 online forms or e-mails have been received on the website Have you seen a glow-worm? In addition over 200 photographs were uploaded to the Biodiversidad Virtual website and have been checked. Thirty online forms were accompanied by photographs or yielded enough information to identify to the species or genus level, and 187 specimens represented by uploaded photographs have been assigned to a taxonomic entity and life stage as accurately as possible (Table 1).

Nyctophila reichii

Nyctophila reichii, the Mediterranean glow-worm, characterized by its orange-yellowish tone, is the species most recorded from both sources of information. We identified 95 larvae, 34 males and 25 females (including the 6 records that show both males and females). This species shows a clear Mediterranean and Southern distribution, with no records in the Northern provinces except one from Galicia (Spanish region north of Portugal) (Figure 1).

The biology and phenology of this species is still unknown. Data of the survey allow us to show some phenological patterns for the period 2004-2010. Adult males and females were seen from late May until late July (Table 2). Despite the data it is still insufficient to draw conclusions about the relationship between latitude and day of adult emergence, the later records (second fortnight of July) correspond to the northern provinces of Spain.

Larvae were found during the whole year across all of Spain, even during months when adults are present (June and July), although in lower numbers compared to the previous and subsequent months. The latter pattern may indicate a two year life-cycle as reported for other lampyrid species, i.e. *L. noctiluca* (Tyler, 2002).

Males and females were often found in groups sometimes more than 200 individuals within a 40m^2 patch of riverside forest, or more than twelve males

	Larvae	Male	Female	Male & Female
Nyctophila reichii	95	28	19	6
Lampyris spp.	41	1	2	-
Lampyris iberica	0	0	3	-
Lampyris noctiluca	0	1	6	-
Lamprohiza spp.	-	7	5	-
Lamprohiza paulinoi	-	2	-	-
Lamprohiza mulsanti	-	1	-	-

Table 1. Lampyrid survey results.

	2004			2005			2006			2007			2008			2009			2010			TOTAL		
	M	F	L	M	F	L	M	F	L	M	F	L	M	F	L	M	F	L	M	F	L	M	F	L
January	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	-	-	7	-	-	13
February	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	3	-	-	6
March	-	-	1	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	-	-	2	-	-	7
April	-	-	1	-	-	-	-	-	1	-	-	-	-	-	2	-	-	2	-	-	3	-	-	9
May	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	1	-	6	-	-	4	1	-	13
June	1	-	-	-	-	-	-	2	1	-	1	1	2	2	1	6	4	1	3	3	2	12	12	5
July	1	-	-	-	-	-	-	2	-	3	2	-	1	-	-	6	4	1	10	5	2	21	13	3
August	-	-	-	-	-	1	-	-	-	-	-	1	-	-	1	-	-	4	-	-	1	-	-	8
September	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	-	-	-	-	-	5
October	-	-	-	-	-	-	-	-	1	-	-	2	-	-	1	-	-	5	-	-	-	-	-	9
November	-	-	-	-	-	-	-	-	1	-	-	3	-	-	2	-	-	3	-	-	-	-	-	9
December	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	6	-	-	-	-	-	8
TOTAL	2	-	4	-	-	2	-	4	4	3	3	10	3	2	15	13	8	36	13	8	24	34	25	95

Table 2. Monthly distribution of *Nyctophila reichii* records. M = males; F = females; L = larvae.

Figure 1 Geographical distribution of *Nyctophila reichii* in Spain.

beneath a faint orange garden light. The latter observation shows a possible negative impact of artificial light on the courtship behaviour and reproduction of these insects.

N. reichii was found in a wide variety of natural and semi-natural habitats and locations including herbaceous gardens, vegetable gardens, orchards (with fruit trees, almonds, olives & vineyards), along village streets, grasslands, riversides (with or without trees), elm forests, ramblas (dry river that temporarily fills and flows after sufficient rain), dense evergreen oak forests (*Quercus ilex* and *Quercus*

Habitat	Larvae	Male	Female	Habitat	Larvae	Male	Female
Garden	13	9	8	Mountain area	1	0	0
Crop land	11	1	0	Olive orchard	0	2	0
Shrubland	9	1	1	Street	0	2	0
Pine forest	11	0	0	Irrigation channel	1	0	0
Evergreen oak forest	4	2	2	Cave	1	0	0
Riverside	5	2	1	Mixed forest	0	1	0
Grassland	6	0	0	Vineyard	0	0	1
Dune beach	1	3	1	Gypsum steppe	1	0	0
Dehesa	2	1	0	Saline steppe	1	0	0
Semiarid watercourse	3	0	1	Salt marsh	1	0	0
Orchard	0	1	1	Elm forest	0	1	1
Deciduous oak forest	2	1	0	Quarry	0	0	1

Table 3. Habitat of *Nyctophila reichii*.

suber), sparse evergreen forests or "dehesas", deciduous oak forests (*Quercus pyrenaica*, *Q. faginea*), pine forests (*Pinus halepensis, P. pinaster*), shrublands (*Rosmarinus officinalis, Thymus sp.*), irrigation channel banks, watercourses, mountain areas, dune beach, salt marsh, saline steppe, gypsum steppe, caves and quarries (Table 3).

Most of the records came from anthropogenic locations: females were found displaying on the walls of buildings or in hollows in farming terraces; males below the streetlights and larvae crossing roads, or hidden beneath a stone in an orchard. However, this may be due to a sampling bias. These sites are typical locations that photographers or observers frequent or where they occasionally encounter glow-worms by mere chance (domestic gardens, orchards, riversides, parks etc) whilst more natural habitats or nature reserves are less intensively surveyed. Nonetheless *N. reichii* seems to have a wide range of habitats, from urbanised humid ecosystems to mountain areas and even quite arid environments.

Lamprohiza species

There are 15 records of *Lamprohiza* (10 males and 5 females) with a very distinct presence in the East Mediterranean area along the Valencian, Catalan and Murcian coastlines, with again the exception of a record from the North-West in Galicia, in the A Coruña/La Coruña province (Figure 2).

Although these are still preliminary results, a possible explanation for the particular interestingly geographical pattern of distribution may be the presence of different species of *Lamprohiza* in the different regions, or even more likely

Figure 2 Geographical distribution of *Lamprohiza* in Spain.

a preference of these species for coastal areas with a more temperate climate.

The difference in pygidium morphology as described by Olivier (1884) and illustrated in Geisthardt et al. (2008) lead to the identification of two specimens of *Lamprohiza paulinoi* from Valencia and Castellón (in the East Coast, by Valencia) and one of *Lamprohiza mulsanti* from Girona/Gerona (in the North East just below the French border). Both species were also reported from Northern Portugal in Vilanova de Gaia (Geisthardt et al. 2008).

Adults have been found from the second fortnight of March till the end of June. The earliest records come from Murcia, the most south-western province where *Lamprohiza* has been recorded. The latest come from A Coruña/La Coruña, Barcelona and Castellón.

No records were submitted for *Lamprohiza* larvae even though when disturbed by sounds or vibrations the larvae readily produce light from an easily recognisable lantern pattern. This may also be due to a lack of knowledge by the general public, yet this is now addressed by the Spanish "Have you seen a glow-worm" website which offers detailed information and recommendations for observation.

Lamprohiza was found in croplands, gardens and orchards (with evergreen oak forest in the surroundings), grasslands, riversides, shrublands and pine forests. One record reports a group of six females found in an herbaceous cropland.

Lampyris species

This glow-worm has been found mainly in the Northern province of Spain, except for one record in Cádiz province, in the extreme South (Figure 3).

Thirteen *Lampyris* adults have been recorded; three have been identified as *Lampyris iberica*, seven as *Lampyris noctiluca* and the other three have been assigned to the genus level *Lampyris*. Males and females were seen from the second fortnight of June till the second fortnight of August.

Lampyris glow-worms have been seen in a variety of anthropogenic and more natural habitats: along streets in villages, gardens, orchards, grasslands, crop lands, mountain areas, riversides (with or without trees), deciduous oak forests, pine forests, shrublands, dune beaches and salt marshes.

Luciola species

A single record of *Luciola*, possibly of *Luciola lusitanica*, has been submitted. The record cames from Mazagón (Palos de la Frontera, Huelva, near Doñana National Park) when an observer saw a group of 15 to 20 flying glow-worms with a white light.

Conclusions

Both *Lampyris* species and *Nyctophila reichii* share a preference for a wide range of habitats ranging from antropomorphic areas (urbanised zones, parks,

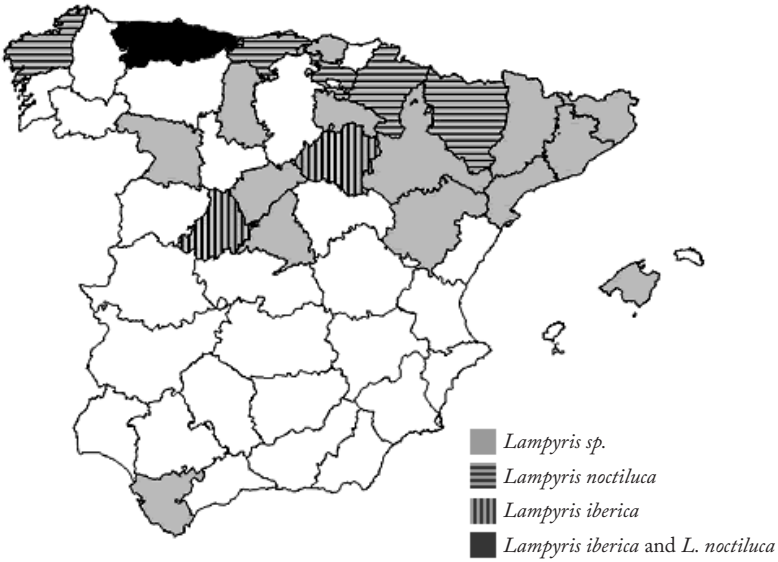

Figure 3 Geographical distribution of *Lampyris* in Spain.

gardens, orchard, croplands and graslands) to more natural zones with humid and mountainous environments. It is not yet clear if the records from more urbanised areas represent sink populations from source populations in adjacent more natural biotopes.

Interestingly larvae of *Lampyris* and *Nyctophila* are observed throughout the year and even in high numbers during winter months. Conversely in Northern Europe they evidently hide and hibernate. In the future, when more data become available, it will be possible to investigate whether this is linked with climate, latitude or altitude. We anticipate that larvae also hibernate in areas with winter temperatures below zero degrees Celsius.

Another remarkable observation is the isolated presence of *Lampyris sp.* in the extreme South. *Lampyris sp.* larvae were found there along a mountain river in Grazalema Natural Park (El Bosque). Interestingly this is known as the region with most rainfall for the whole of Spain and it might explain the presence of this genus. This may be a refugia population or may be an anthropogenic translocation as suspected in some Japanese firefly species. It may be possible there are also other humid mountain refugia in the South, though this still needs to be confirmed once more data is made available.

Some species were still overlooked in the first results of this preliminary survey: *Phosphaenus hemipterus*, *Phosphaenopterus metzneri*, *Pelania*

mauritanica, *Nyctophila heydeni* and *Luciola lusitanica* (with only a probable record). The absence of data is especially awkward for the last species with its easily recognisable bioluminescence, i.e. bright flashes. It is expected in coastal and lowland humid areas since *L. lusitanica* is also present and quite common in such habitats in Portugal (Geisthardt et al. 2008). It is more understandable that *P. hempiterus* and *P. metzneri* were overlooked, the first species because of its adult diurnal behaviour (DeCock 2000) and the latter for possibly the same reason. However, it has been rarely recorded in the past and up until now nothing is known about its biology except for its description. *P. mauritanica* has been recorded in the past from the South of the Iberian Peninsula and even from South France (Cros 1924; Lhéritier 1955). However, it is not clear whether these were false identifications or records of migrants from nearby Morocco and the other Maghreb countries where this species occurs. Several records of *N. heydeni* larvae and adult males were sent in from Mallorca during the final stages of writing this paper and details will be presented in a forthcoming paper about Spanish lampyrids.

Besides our data we add some records from the recent literature (Baselga y Novoa, 2004; Diéguez & Pérez Varcálcel, 2009): *Lampyris raymondi* has been reported in Galicia, and *P. hemipterus* also in Galicia (Lugo) and in Catalonia (Lleida).

Taking all data and references into consideration the more humid and temperate zones (Atlantic coast and East and Northeast Mediterranean coast) seem to be more biodiverse in lampyrids (*Lampyris* sp., *Lamprohiza* sp., *P. hemipterus* and *N. reichii*) than the more Southern Mediterranean and central parts of Spain (*Lampyris* sp., *N. reichii*). *N. reichii* is somewhat particular in the fact that it seems to be more adapted to mountainous and semi-arid regions and up to now seems almost lacking in the Northern more temperate provinces.

This preliminary study shows the importance of surveys with the help of the common public and the power of the internet as a tool to get easy access to new and reliable data. The number of uploaded records on the ¿Has visto una luciérnaga? website in only one year and the vast and increasing number of uploaded photographs on Biodiversidad Virtual illustrates the popularity with the public. The involvement of specialists for species identification and to provide more feedback where necessary, or to give feedback to the public about (personal) results is a crucial component of the project. For instance, we learned now that it is crucial to ask for pictures that clearly show the parts with discriminating traits (pygidium, pronotum, ventral regions, etc.) in order to make the classification easier and more accurate. In addition to a well designed and user-friendly survey website to upload data, is the provision of up-to-date online information about the species (classification tables etc.), their biology and survey tips for glow-worms to an ever widening audience. The tradition of species surveys was once more typical of North and Central European countries. Yet this study provides an example in which southern European countries, bit

by bit, are keeping pace with their northern counterparts and are able to provide valuable species distribution data that will contribute to the monitoring and conservation of future glow-worm populations in Europe.

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