

Sarcophagidae (Diptera) attracted to piglet carcasses including new records for Portuguese fauna

C. Prado e Castro^{1,2*}, M. D. García³, M. I. Arnaldos³ & D. González-Mora⁴

Sarcophagidae is a Dipteran family of worldwide distribution, comprising more than 2500 species, of which 309 occur in Europe (Pape, 2004). They are a very common element of the fauna related to decomposing organic matter since many of their species develop in excrement, carrion... belonging to the necrophagous component of the sarcosaprophagous community (Smith, 1986; Povolný & Verves, 1997; among others). They can be found associated with carcasses throughout both the early and late stages of decomposition (Byrd & Castner, 2010). Although Povolný & Verves (1997) cite only few species involved in forensic cases, there are many works in which this family is mentioned as associated to human corpses (Goff, 1991; Anderson, 1995; Benecke, 1998; Introna *et al.*, 1998; Zehner *et al.*, 2004). Many of them are also involved in myiasis in man and animals (Zumpt, 1965; Goff *et al.*, 2010). All the above support the need and interest of knowledge about the family, since its members are potentially amongst the most useful insects for investigation of suspicious human death (Wells *et al.*, 2001; Grassberger & Reiter, 2002; Buenaventura *et al.*, 2009).

The identification of Sarcophagidae species, mainly of the Sarcophaginae subfamily, is complicated, being only possible by using the structure of male genitalia. Thus, the females can be identified when related to males. This is one of the reasons for why, although these species are quite well known, many partial aspects are still unknown, such as the

faunistic composition of certain places or countries. This is the case of Portugal, the Dipteran fauna of which is still not well known, despite the efforts made by several authors, the most recent due to Carles-Tolrá & Rosado (2009).

In this work we present the first data on sarcosaprophagous Sarcophagidae in Portugal, increasing the knowledge about this fauna in the country. The data are of interest not only from a faunistic but also from a forensic point of view because of the particular interest and relevance of this family for this purpose.

The study was performed in the Botanical Garden of the University of Coimbra, a green area in the centre of the city (UTM coordinate 29TNE45 – Coimbra, Beira Litoral; altitude: 55 m), in a forested zone inaccessible to visitors. The shrubby and arboreous vegetation was mainly composed of *Ailanthus altissima* (Simaroubaceae), *Laurus nobilis* (Lauraceae), *Celtis australis* (Cannabaceae), *Olea europaea* (Oleaceae), and *Eucalyptus spp.* (Myrtaceae). Two sites were chosen, 100 m apart each from other, the first one in a clearing with direct sunlight almost all day, the other in a shaded area.

The experiment was carried out using two traps – a version of Schoenly trap designed to collect sarcosaprophagous arthropods (Prado e Castro *et al.*, 2009), one placed in the sunny area and the other in the shady one, each with a 5 kg piglet carcass as bait. Sample collections from each trap consisted in removing the bottles with arthropods (immersed in

¹ Centro de Biologia Ambiental, Departamento de Biologia Animal, Faculdade de Ciências da Universidade de Lisboa, Ed. C2, Campo Grande, 1749-016 Lisboa, Portugal.

² Centro de Ciências Forenses, Instituto Nacional de Medicina Legal, Coimbra, Portugal.

³ Área de Zoología, Facultad de Biología, Universidad de Murcia, 30100 Murcia, España.

⁴ Departamento de Zoología y Antropología Física, Facultad de Biología, Universidad Complutense de Madrid. 28040 Madrid, España

* Corresponding author. Email: cbcastro@fc.ul.pt

a preservative solution) and substituting them with others filled with clean solution. This was made always at the same hour, daily for the first 30 days, and afterwards on alternate days until the end of the experiment. A 40% ethylene glycol solution with formalin and detergent was used in the trap as killing and temporary preservative agent for the arthropods, after which they were moved to 80% ethanol.

This study was conducted along four months, from 26 May to 24 September 2004. Spring was selected as the convenient sampling period since it has been proved to be the most diverse time of the year, at least in other regions of the Iberian Peninsula (Arnaldos *et al.*, 2004).

A total of 978 adult specimens were collected, 760 of which were females, which remain unidentified. The study of males has allowed the identification of 18 species. Ten of them were not known previously from Portugal or, even, from the Iberian Peninsula. Names for species follow Pape *et al.* (2002) and new records are marked with an asterisk.

Ravinia pernix (Harris, 1780)

This species, widely distributed through the Palaearctic region, is known as coprophagous, being at present related to both human and animal faeces, although their larvae have been found on dead snails (Séguy, 1941) and other dead animals (Papp, 1971; Richet, 1990; Tantawi *et al.*, 1996; Povolný & Verves, 1997), being facultative predators of other schizophagous maggots (Pickens, 1981). It has been recently collected in Portugal with emergence traps (Carles-Tolrá & Rosado, 2009). In the Iberian Peninsula, *R. pernix* has been also collected related to carcasses in Murcia (Romera *et al.*, 2003) and in Huesca (Castillo Miralbes, 2002), having been reported from a human corpse in Spain (*cf.* Velásquez *et al.*, 2010).

Studied specimens: 11.07.2004, 1 male; 01.08.2004, 1 male.

Sarcophaga (Bercaea) africa (Wiedemann, 1824)

This species is known to be widely distributed in the Iberian Peninsula (*cf.* Romera *et al.*, 2003). It is a common eusynanthropic species of great medical and veterinary importance. Larvae are found in decaying animal matter, generally in human faeces, including refuse pits, lavatories, dustbins; rarely in bovine and pork dung and occasionally in animal

carcasses. They cause occasional intestinal myiasis of humans. Adult flies dominate in farmyards, being practically absent in the wild. They are attracted to the same substrates as larvae and also to decomposed fruits, mixed vegetation and flowering plants (Verves & Khrokalo, 2009). *Sarcophaga africa* has been taken into account for estimation of postmortem intervals (Introna *et al.*, 1998). In our study it has been collected all along the sampling period, being the most abundant Sarcophagidae species during the experiment. In the Iberian Peninsula it has been also collected related to corpses in Murcia (Romera *et al.*, 2003).

Studied specimens: 31.05.2004, 1 male, 01.06.2004, 1 male, 02.06.2004, 1 male, 03.06.2004, 1 male, 05.06.2004, 4 males, 09.06.2004, 2 males, 10.06.2004, 1 male, 11.06.2004, 2 males, 12.06.2004, 2 males, 14.06.2004, 2 males, 16.06.2004, 2 males, 18.06.2004, 1 male, 20.06.2004, 2 males, 27.06.2004, 1 male, 29.06.2004, 2 males, 01.07.2004, 2 males, 03.07.2004, 5 males, 09.07.2004, 1 male, 13.07.2004, 2 males, 15.07.2004, 1 male, 17.07.2004, 1 male, 19.07.2004, 1 male, 25.07.2004, 1 male, 01.08.2004, 2 males, 05.08.2004, 3 males, 09.08.2004, 5 males, 13.08.2004, 1 male, 18.08.2004, 2 males, 23.0.2004, 1 male, 28.08.2004, 1 male, 02.09.2004, 4 males, 09.09.2004, 2 males, 16.09.2004, 1 male, 24.09.2004, 4 males.

**Sarcophaga (Discachaeta) amita* Rondani, 1860

Up to now, this species was known from Central and Western Europe, not having been collected in Portugal. So, this represents the first record from the country. *Sarcophaga amita*, although cited in Spain, has not been previously collected related to corpses in any place of the Iberian Peninsula. Larvae are obligate parasites of terrestrial Gastropoda, similarly to other species of *Discachaeta* (Verves, 1993).

Studied specimens: 08.06.2004, 1 male, 24.09.2004, 1 male.

**Sarcophaga (Helicophagella) hirticrus* Pandellé, 1896

A western Palaearctic species, in the Iberian Peninsula it was referred from the east half. This is the first reference for Portugal, extending its distribution area in the Peninsula. In Spain it has been also collected related to corpses in Murcia (Romera *et al.*, 2003) and in Huesca (Castillo Miralbes, 2002). Larvae are known bred from snails *Helix aspersa* O.F. Müller, 1774 (Barfoot, 1969) and dead snails *Cepaea nemoralis* (Linnaeus, 1758) (Beaver, 1972).

Studied specimens: 31.05.2004, 1 male, 10.06.2004, 1 male, 05.07.2004, 1 male, 28.08.2004, 2 males.

***Sarcophaga (Helicophagella) melanura* Meigen, 1826**

A Holarctic and Oriental species, also known from the Afrotropical region (Mauritania), it has been collected in low numbers in our experiment, and only in the shady site. In Spain, where it is a widely represented species, it has been also collected related to corpses in Huesca (Castillo Miralbes, 2002). Larvae are usually bred in faeces, dung, sometimes in corpses of invertebrate and small vertebrate animals, and are reared on those substances. They are facultative parasites of snails *Arion hortensis* A. Férussac, 1819 and *Helix aspersa*, adult acridid orthopteran *Chorthippus brunneus* (Thunberg, 1815), larvae of beetle *Oryctes nasicornis* (Linnaeus, 1758) and caused facultative wound myiasis of hedgehogs, rats and rabbits as well as cutaneous and intestinal myiasis of humans (Verves & Khrokalo, 2009). Adult flies are mostly attracted to fruit and meat and can be collected from bushes near human excrement, animal dung and dead bodies of different animals (Nandi, 2002).

Studied specimens: 03.06.2004, 1 male, 22.06.2004, 1 male.

***Sarcophaga (Heteronychia) pandellei* (Rohdendorf, 1937)**

This species is restricted to South-Western Europe and North Africa (Algeria, Tunisia), being known in Portugal, from Espinho (Peris *et al.*, 1998) and Évora (Carles-Tolrá & Rosado, 2009). *Sarcophaga pandellei*, known from several Spanish locations, had not been previously collected related to corpses in any place of the Iberian Peninsula. Larvae are obligate parasites of terrestrial Gastropoda, similarly to other species of *Heteronychia* (Verves, 1993).

Studied specimens: 03.06.2004, 1 male, 05.06.2004, 1 male, 09.06.2004, 1 male, 11.06.2004, 1 male, 14.06.2004, 3 males, 16.06.2004, 1 male, 01.07.2004, 1 male, 28.08.2004, 1 male.

****Sarcophaga (Heteronychia) vagans* Meigen, 1826**

A Palaearctic species not previously referred from Portugal. Up to now this species, already cited in Spain, has not been collected related to corpses in any place of the Iberian Peninsula. Larvae are obligate parasites of terrestrial snails (Verves & Khrokalo, 2009). This species accompanies thin forests and bushy habitats and is mostly common at lower elevations (Povolný & Verves, 1997).

Studied specimens: 28.08.2004, 1 male, 09.09.2004, 1 male, 24.09.2004, 1 male.

****Sarcophaga (Krameromyia) anaces* Walker, 1849**

This species is widely distributed in South and Middle-Europe, North Africa and Near East (Turkey), although it had not been collected in Portugal. So, this is the first record from this country. Broadly distributed in Spain, it has been collected related to corpses in Huesca (Castillo Miralbes, 2002). This species is known breeding from snail *Helix (Cochliella) acuta* O.F. Müller, 1774 (Böttcher, 1912) and *Cepaea nemoralis* (Richet, 1990).

Studied specimens: 01.07.2004, 1 male.

***Sarcophaga (Liopygia) argyrostoma* (Robineau-Desvoidy, 1830)**

This species, a highly indicative one (Benecke, 1998) and almost cosmopolitan in distribution, was the third most abundantly collected during the experiment. In Spain it is common and it has been collected related to corpses in Murcia (Romera *et al.*, 2003) and in Huesca (Castillo Miralbes, 2002). It has also been reported from a human corpse in Spain (Martínez-Sánchez *et al.*, 2006). Larvae breed in corpses of vertebrate and invertebrate animals, rarely in faeces. They are also known as parasites of terrestrial snails, oothecae –*Doclostaurus maroccanus* (Thunberg, 1815), *Schistocerca gregaria* (Forskål, 1775), *S. parnensis* (Burmeister, 1861)–, nymphs and imagoes of locusts –*Locusta migratoria* (Linnaeus, 1758)–, larvae (*Melolontha hippocastani* Fabricius, 1801) and imagoes of beetles (*Lachnosterna* sp.), as predators of lepidopteran pupae –*Lymantria monacha* (Linnaeus, 1758)– and eggs of sea turtles *Caretta caretta* (Linnaeus, 1758) and *Chelonia mydas* (Linnaeus, 1758) and causing facultative tissue myiasis of sheep and men and occasional intestinal human myiasis. Adult flies dominate in farmstead and yards, being practically absent in the wild; they are attracted to the same substrates and also to decomposed fruits, mixed vegetations and flowering plants (Verves & Khrokalo, 2009).

Studied specimens: 30.05.2004, 2 males, 01.06.2004, 2 males, 11.06.2004, 1 male, 14.06.2004, 1 male, 16.06.2004, 3 males, 18.06.2004, 2 males, 25.06.2004, 1 male, 27.06.2004, 2 males, 03.07.2004, 1 male, 09.07.2004, 1 male, 13.07.2004, 2 males, 15.07.2004, 1 male, 17.07.2004, 2 males, 22.07.2004, 2 males, 22.07.2004, 2 males, 28.07.2004, 2 males, 01.08.2004, 1 male, 05.08.2004, 2 males.

***Sarcophaga (Liopygia) crassipalpis* Macquart, 1839**

This is a well known eusynantropic species, present in tropical and subtropical zones of all biogeographical regions (Povolný & Verves, 1997) and widely distributed in Spain. It was the second species more abundantly collected during the experiment, showing a clear preference for the sunny site. In Spain it has been also collected related to corpses in Murcia (Romera *et al.*, 2003) and in Huesca (Castillo Miralbes, 2002). It has also been reported from a human corpse in Spain (Martínez-Sánchez *et al.*, 2006). Larvae breed in corpses of vertebrate and invertebrate animals and are also known as producers of facultative cutaneous myiasis of humans, sheep and reptilian hosts (*Uromastix hardwicki* Gray, 1827) and as predators of oothecae of locusts –*Schistocerca gregaria*, *S. cancellata* (Serville, 1839)–. Flies feed on faeces, corpses, homopteran excreta, flowers and food (Verves & Khrokalo, 2009).

Studied specimens: 31.05.2004, 1 male, 01.06.2004, 4 males, 11.06.2004, 1 male, 12.06.2004, 1 male, 14.06.2004, 1 male, 16.06.2004, 2 males, 20.06.2004, 1 male, 22.06.2004, 4 males, 27.06.2004, 6 males, 29.06.2004, 2 males, 01.07.2004, 4 males, 03.07.2004, 3 males, 11.07.2004, 1 male, 13.07.2004, 1 male, 15.07.2004, 1 male, 17.07.2004, 1 male, 19.07.2004, 1 male, 22.07.2004, 1 male, 25.07.2004, 1 male, 01.08.2004, 3 males, 05.08.2004, 2 males, 23.08.2004, 1 male, 02.09.2004, 1 male, 16.09.2004, 2 males, 24.09.2004, 2 males.

***Sarcophaga (Liosarcophaga) portschinskyi* (Rohdendorf, 1937)**

Species widely distributed throughout the Palaearctic region, it has been recently collected for the first time in Portugal, in Évora (Carles-Tolrá & Rosado, 2009). Our record confirms and expands its distribution in the country. This species, already mentioned from several places in Spain, has not been previously collected related to corpses from anywhere on the Iberian Peninsula. Nevertheless, larvae are known to breed in corpses of vertebrate and invertebrate animals, are also known as facultative parasites of terrestrial snails and as predators of lepidopteran pupae *Lymantria dispar* (Linnaeus, 1758). Flies feed on faeces, corpses, homopteran excreta, flowers and food and prefer meadows, steppes, bushes, borders of mesophytic forests, fields, pastures, parks, gardens, cattle farms and settlements. It is a hemisynanthropic species (Verves & Khrokalo, 2009).

Studied specimens: 28.05.2004, 1 male, 30.05.2004, 1 male, 05.06.2004, 1 male, 09.06.2004, 1 male, 16.06.2004, 1 male, 25.06.2004, 1 male, 27.06.2004, 3 males, 29.06.2004, 1

male, 01.07.2004, 1 male, 13.07.2004, 1 male, 15.07.2004, 1 male, 22.07.2004, 3 males, 25.07.2004, 1 male, 28.07.2004, 2 males, 01.08.2004, 2 males, 05.08.2004, 1 male, 16.09.2004, 2 males.

****Sarcophaga (Liosarcophaga) teretirostris* Pandellé, 1896**

A west European species not previously recorded from Portugal. This is, thus, its first reference from the country. This species, known in Spain, has not been previously collected related to corpses anywhere on the Iberian Peninsula despite larvae being known to develop in decaying flesh and meat and animal carcasses (Povolný & Verves, 1997); they are facultative parasites of terrestrial snails: *Helix lactea* O.F. Müller, 1774 (Beaver, 1972) and *Helicella candicans* (Pfeiffer, 1841) (Lopes, 1940).

Studied specimens: 30.05.2004, 1 male, 02.06.2004, 1 male, 25.07.2004, 1 male, 13.08.2004, 2 males, 18.08.2004, 1 male, 02.09.2004, 2 males, 09.09.2004, 1 male, 16.09.2004, 1 male, 24.09.2004, 4 males.

****Sarcophaga (Myorhina) nigriventris* Meigen, 1826**

This species, widely distributed in Europe, reaching Denmark in the North, North Africa, Near East, Transcaucasus, Russian Far East (Primorye), was unknown as living in Portugal. So, this is its first record from the country. *Sarcophaga nigriventris*, known from Spain, had not been previously collected related to corpses from anywhere on the Iberian Peninsula.

Larvae mature within the maternal uterus and are nourished by secretions from the accessory glands. Female larviposits 2nd instar larvae directly on to suitable host. Larvae are parasites of imago *Apis mellifera* Linnaeus, 1758 (Séguy, 1965) and breed in dead mice, small birds, dead and living terrestrial snails –*Brephulopsis cylindrica* (Menke, 1828), *Cepaea nemoralis*, *Cernuella* sp., *Eobania* sp., *Helicella ericetorum* (Linnaeus, 1758), *Helicella virgata* (Da Costa, 1778), *Helicopsis retowskii* (Clessin, 1883), *Helix aspersa*, *Helix cantianiformis* Bourguignat, 1884, *Helix pomatia* Linnaeus, 1758, *Monacha* sp., *Oxychilus alliarius* (J.S. Miller, 1822), *Theba cantiana* Montagu, 1803, *Xeropicta krynickii* (Krynicky, 1833)–, oothecae and adult locusts (*Schistocerca gregaria*), larvae and adult beetles (*Blaps mucronata* Latreille, 1804, *Carabus coriaceus* Linnaeus, 1758, *Necrophorus humator* (Gleditsch, 1767)– and adult honey bees *Apis mellifera*. In beehives and nests of bumblebees –*Bombus terrestris* (Linnaeus, 1758)–, larvae of this fly are predators of preimaginal phases of

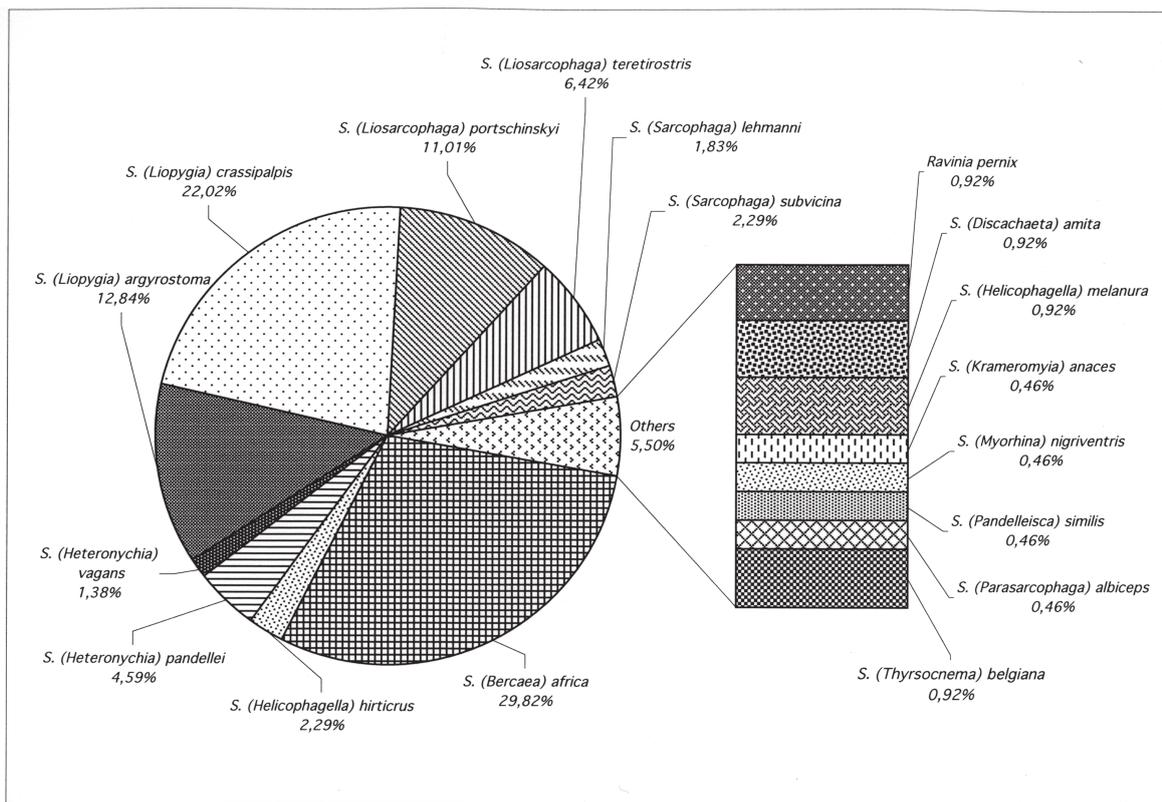


Fig. 1.— Relative abundante of Sarcophagidae species collected during the sampling period.

Fig. 1.— Abundancia relativa de especies de Sarcophagidae capturadas durante el período de muestreo.

hosts. This species is very adaptive: it occurs especially in dry sunlit habitats of both natural and secondary character, population densities distinctly decreasing to the north of the distributional area and at high elevations. Flies feed at flowers, aphid excreta and decomposed animal matters (Povolný & Verves, 1997; Verves & Khrokalo, 2009).

Studied specimens: 28.08.2004, 1 male.

****Sarcophaga (Pandelleisca) similis* Meade, 1876**

This species is known from the Oriental region (Southern China) and, in the Palearctic region, from France to South Korea and from Finland to Iran (Pape, 1996). This record is the first of its presence in the Iberian Peninsula and represents an enlargement of its known distribution until the western Palearctic limit. Larvae develop in corpses of vertebrate and invertebrate animals, decaying meat and faeces. It is known as facultative parasite of suc-

cineid snails, predator of lepidopteran pupae —*Dendrolimus pini* (Linnaeus, 1758), *Lymantria monacha*, *Mamestra oleracea* (Linnaeus, 1758)— and causing occasionally intestinal and facultative myiasis of wounds, eyes and ears of humans. Adult flies feed at cadavers, faeces, food, destroyed fruits and flowers. This hemisynanthropic mesophilic species prefers meadows, bushes, forest borders, sea shores, fields, pastures, parks, gardens, cattle farms and settlements (Verves & Khrokalo, 2009).

Studied specimens: 24.09.2004, 1 male.

****Sarcophaga (Parasarcophaga) albiceps* Meigen, 1826**

Species widely distributed in the Palearctic and Oriental regions (Pape, 1987), this is its first record from Portugal. *Sarcophaga albiceps*, known from Spain, was never collected related to corpses before, in the Iberian Peninsula, although larvae are known to develop in corpses of vertebrate and invertebrate

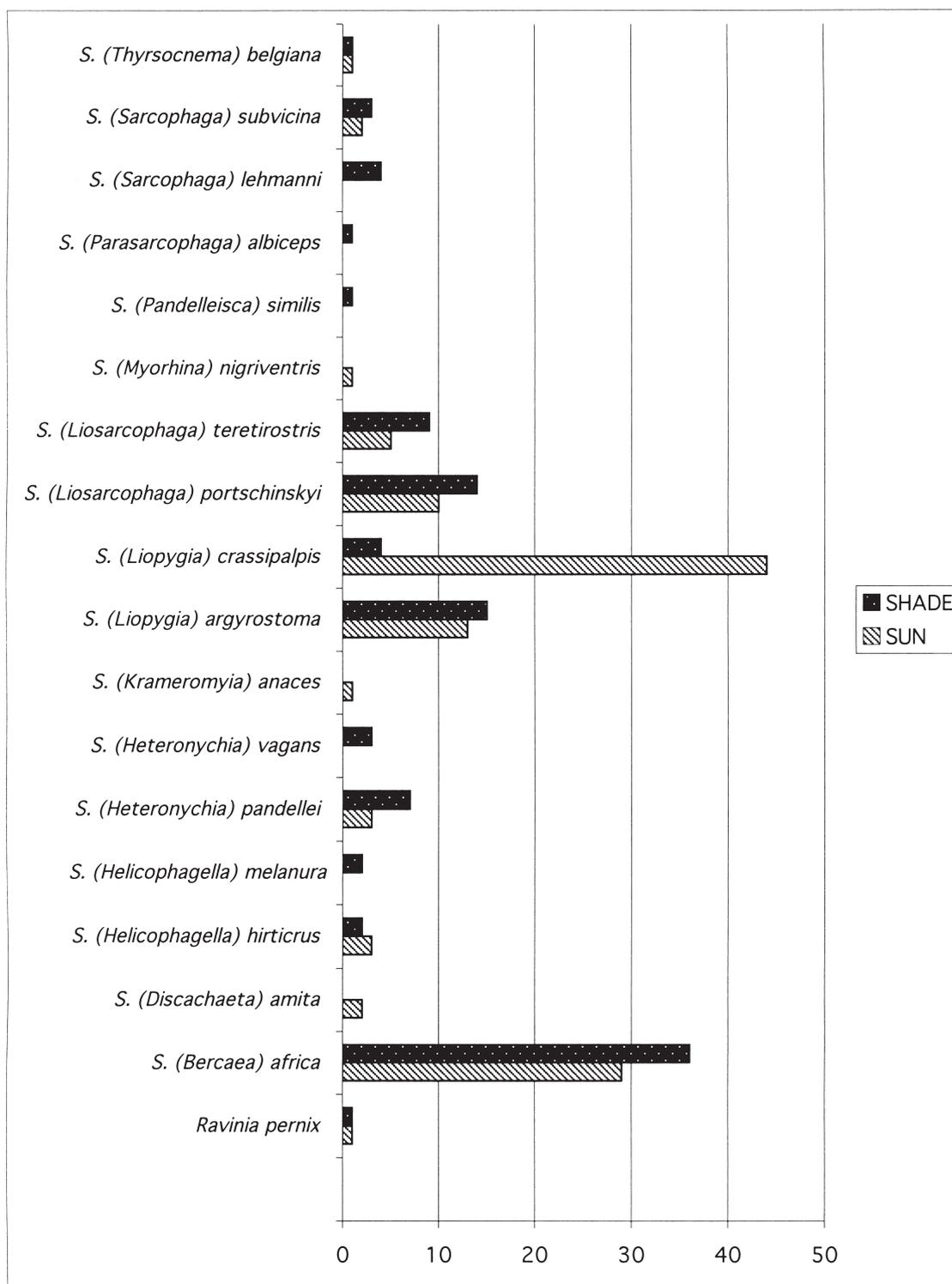


Fig. 2.— Number of adult Sarcophagidae (males) captured at the exposed and shaded sites during the experiment.

Fig. 2.— Número de machos adultos de Sarcophagidae capturados en lugares sombríos y soleados durante el experimento.

Table 1.— Sarcophagidae species present in animal carcasses, in the Iberian Peninsula. Shaded area corresponds to species present in all localities.

Table 1.— Especies de Sarcophagidae presentes en cadáveres de animales en la Península Ibérica. El área sombreada indica especies que aparecieron en todas las localidades.

Species	COIMBRA	ALTO ARAGÓN	MURCIA
<i>Ravinia pernix</i>	X	X	X
<i>Sarcophaga (Bercaea) africa</i>	X		X
<i>S. (Parasarcophaga) albiceps</i>	X		
<i>S. (Discachaeta) amita</i>	X		
<i>S. (Krameromyia) anaces</i>	X	X	
<i>S. (Liopygia) argyrostoma</i>	X	X	X
<i>S. (Heteronychia) balanina</i>			X
<i>S. (Thyrsocnema) belgiana</i>	X		
<i>S. (Liopygia) crassipalpis</i>	X	X	X
<i>S. (Liopygia) cultellata</i>		X	X
<i>S. (Heteronychia) filia</i>			X
<i>S. (Helicophagella) hirticrus</i>	X	X	X
<i>S. (Liosarcophaga) jacobsoni</i>		X	X
<i>S. (Heteronychia) javita</i>			X
<i>S. (Sarcophaga) lehmanni</i>	X	X	
<i>S. (Liosarcophaga) marshalli</i>			X
<i>S. (Helicophagella) melanura</i>	X	X	
<i>S. (Myorhina) nigriventris</i>	X		
<i>S. (Heteronychia) pandellei</i>	X		
<i>S. (Liosarcophaga) portschinskyi</i>	X		
<i>S. (Heteronychia) siciliana</i>		X	
<i>S. (Pandelleisca) similis</i>	X		
<i>S. (Sarcophaga) subvicina</i>	X		
<i>S. (Liosarcophaga) teretirostris</i>	X		
<i>S. (Liosarcophaga) tibialis</i>		X	X
<i>S. (Heteronychia) vagans</i>	X		
<i>S. (Sarcophaga) variegata</i>		X	
<i>Sarcophila</i> sp. aff. <i>japonica</i>		X	
<i>Sarcophila</i> sp.			X

animals as well as in decaying meat and faeces; adult flies feed at cadavers, faeces, food, destroyed fruits, flowers. This hemisynanthropic mesophilic species prefers meadows, bushes, forest borders, sea shores, fields, pastures, parks, gardens, cattle farms, settlements (Verves & Khrokalo, 2009). Larvae are also known as facultative predators of lepidopteran pupae –*Aporia crataegi* (Linnaeus, 1758), *Dasychira albodentata* Bremer, 1864, *Dendrolimus albolineatus* Matsumura, 1921, *D. pini*, *D. segregatus* (Butler, 1877), *D. sibiricus* (Butler, 1877), *Lymantria dispar*, *L. monacha*, *Nomagria* sp., *Orgyia antiqua* (Linnaeus, 1758), *Selenephra lunigera* (Esper, 1784)– and tenthredinid larva

–*Acantholyda posticalis* (Matsumura 1912)–. They are parasites of larvae and adult beetles (*Melolontha* sp., *Oryctes nasicornis*, *Polyphylla fullo* (Linnaeus, 1758), *Saperda populnea* (Linnaeus, 1758)– and cause facultative cutaneous myiasis of buffalo, bovines and humans.

Studied specimens: 31.05.2004, 1 male.

Sarcophaga (Sarcophaga) lehmanni Mueller, 1922

This is the second reference of this species for Portugal since it has been recently collected at Évora (Carles-Tolrá & Rosado, 2009). In our experiment, *S. lehmanni* was only collected in the shady

trap. Known in Spain, in the Iberian Peninsula it has been also collected related to corpses in Huesca (Castillo Miralbes, 2002). This species is distributed in Europe (absent from the British Is.) North Africa, Transcaucasus, Near and Middle East, West Siberia, Kazakhstan and Central Asia. Larvae are parasites or predators of Lumbricidae, but occasionally necrophagous (Povolný & Verves, 1997). Flies are attracted to flowering plants (Verves, 1975), cattle dung and faeces (Martínez-Sánchez *et al.*, 2000). Flies prefer different herbaceous mesophytic coenoses, being absent in forests (Verves, 1973).

Studied specimens: 10.06.2004, 1 male, 16.06.2004, 1 male, 01.08.2004, 1 male, 28.08.2004, 1 male.

****Sarcophaga (Sarcophaga) subvicina*** Rohdendorf, 1937

Species widely distributed in Europe, already cited in Spain, is recorded from Portugal for the first time. This species has not been previously collected related to corpses anywhere on the Iberian Peninsula.

Studied specimens: 01.06.2004, 1 male, 01.07.2004, 1 male, 13.07.2004, 1 male, 22.07.2004, 1 male, 25.07.2004, 1 male.

****Sarcophaga (Thyrsonecma) belgiana*** (Lehrer, 1976)

This species is restricted to Western Europe (Andorra, France, Spain), having already been mentioned from several Spanish cities. Up to now it was unknown in Portugal; so, this is the first record from this country. The species has not been previously collected related to corpses in any place of the Iberian Peninsula.

Studied specimens: 25.07.2004, 1 male, 23.08.2004, 1 male.

Data reported here are the first on the family Sarcophagidae related to cadavers in Portugal. The fauna of Sarcophagidae in Coimbra (central Portugal) during spring and summer was dominated by four species: *Sarcophaga africa* (29.28%), *S. crassipalpis* (22.02%), *S. argyrostoma* (12.84%) and *S. portschinskyi* (11.01%) (Fig. 1). They appear in both sunny and shady places with more or less similar abundance except *S. crassipalpis*, which was clearly more abundant in the sunny bait (Fig. 2). This aspect can be of applied forensic interest since it could suggest the environmental characteristics of a given forensic scene.

The fauna reported is composed of 18 species, a quite important diversity when compared with that from other Iberian areas such as Alto Aragón, with 13 species (Castillo Miralbes, 2002) and Murcia, also with 13 species (Romera *et al.*, 2003) (Table 1), especially taking into account that the last two represent the fauna collected in the four seasons of the year, while that from Coimbra was collected only during spring and summer. Recently, Carles-Tolrá & Rosado (2009), in a study carried out for a whole year and half, using emergence traps in Évora, referred, among others, 17 species of Sarcophagidae of which, by their breeding habits, seven species could be related to corpses.

The new record of ten species of Sarcophagidae in Portugal (one of them new for the Iberian Peninsula) can be due to the scarcity of accurate information for the area. In fact, Pape *et al.* (2002) cited 146 species of Sarcophagidae inhabiting the Iberian Peninsula and the islands belonging to Spain and Portugal, of which only 11 (7.53%) were referred from the Portuguese mainland, and Carles-Tolrá & Rosado (2009) have referred an additional 14 previously unknown species so increasing to 25 (17.12%) the total number of species known from this country. With the 10 species referred as new in this work, the species known as inhabiting the country are 35 (23.97%), thus gradually improving the knowledge about the family in this geographical area.

Because of the role that Sarcophagidae play in the decomposition process of animal matter, they have potential interest for forensic purposes; so, further efforts should be made to achieve a proper knowledge about this family (species present, distribution, phenology...) in the country and to apply actual entomological data to forensic practice.

Acknowledgements

We would like to thank Jardim Botânico da Universidade de Coimbra for allowing the realization of fieldwork and Dr. Yu. G. Verves for his contributions and suggestions to improve this work.

References

- Anderson, G. S., 1995. The use of insects in death investigations: an analysis of cases in British Columbia over a five year period. *Canadian Society of Forensic Science Journal*, 28: 277-292.

- Arnaldos, M. I., Romera, E., Presa, J. J., Luna, A. & García, M. D., 2004. Studies on seasonal arthropod succession on carrion in the southeastern Iberian Peninsula. *International Journal of Legal Medicine*, 118: 197-205.
- Barfoot, S. D., 1969. *Sarcophaga nigriventris* Meigen and *S. hirticrus* Pandellé (Dipt., Calliphoridae) both bred from *Helix aspersa* Müller (Mollusca, Helicidae). *Entomologist's Monthly Magazine*, 105: 144.
- Beaver, R. A., 1972. Ecological studies on Diptera breeding in dead snails. I. Biology of the species found in *Cepaea nemoralis* (L.). *Entomologist*, 105: 41-52.
- Benecke, M., 1998. Six forensic entomology cases: description and commentary. *Journal of Forensic Sciences*, 43: 797-805.
- Böttcher, G., 1912. Die männlichen Begattungswerkzeuge bei dem Genus *Sarcophaga* Meig. und ihre Bedeutung für die Abgrenzung der Arten. *Deutsche entomologische Zeitschrift* (Berlin), 1912(6): 705-736.
- Buenaventura, E., Camacho, G., García, A. & Wolff, M., 2009. Sarcophagidae (Diptera) de importancia forense en Colombia: claves taxonómicas, notas sobre su biología y distribución. *Revista Colombiana de Entomología*, 35: 189-196.
- Byrd, J. H. & Castner, J. L., 2010. Insects of Forensic Importance. In: J. H. Byrd, & J. L. Castner (eds.). *Forensic Entomology. The Utility of Arthropods in Legal Investigations*. CRC Press. Boca Raton: 39-126.
- Carles-Tolrá, M. & Rosado, J., 2009. Algunos Dípteros de Portugal capturados mediante trampas de emergencia (Insecta, Diptera). *Boletín de la Sociedad Entomológica Aragonesa*, 44: 343-348.
- Castillo Miralbes, M., 2002. Estudio de la entomofauna asociada a cadáveres en el Alto Aragón (España). *Monografías de la Sociedad Entomológica Aragonesa*, 6: 1-94.
- Goff, M. L., 1991. Comparison of insect species associated with decomposing remains recovered inside dwellings and outdoors on the island of Oahu, Hawaii. *Journal of Forensic Sciences*, 36: 748-753.
- Goff, M. L., Campobasso, C. P. & Gherardy, M., 2010. Forensic Implications of Myiasis. In: J. Amendt, C. P. Campobasso, M. L. Goff, & M. Grassberger (eds.). *Current Concepts in Forensic Entomology*. Springer. Dordrecht-Heidelberg-London-New York: 313-325.
- Grassberger, M. & Reiter, C., 2002. Effect of temperature on development of *Liopygia* (= *Sarcophaga*) *argyrostoma* (Robineau-Desvoidy) (Diptera: Sarcophagidae) and its forensic implications. *Journal of Forensic Sciences*, 47: 1332-1336.
- Introna, F., Campobasso, C. P. & Di Fazio, A., 1998. Three case studies in forensic entomology from southern Italy. *Journal of Forensic Sciences*, 43: 210-214.
- Lopes, H. S. de, 1940. Contribuição conhecimento do gênero *Udamopyga* Hall e de outro sarcophagídeos que vivem em moluscos no Brasil (Diptera). *Revista de entomologia* (Rio de Janeiro), 11(3): 924-954.
- Martínez-Sánchez, A., Magaña, C., Pérez-Bañón, C., Rojo, S. & González-Mora, D., 2006. Taxonomy and larval study of flesh flies (Diptera: Sarcophagidae) associated with human corpses in Spain. *Proceedings of the Fourth Meeting of European Association for Forensic Entomology*, Bari: 63 [abstract].
- Martínez-Sánchez, A., Rojo, S. & Marcos-García, M. A., 2000. Annual and spatial activity of dung flies and carrion in a Mediterranean holm-oak pasture ecosystem. *Medical and Veterinary Entomology*, 14(1): 56-63.
- Nandi, B. C., 2002. *The Fauna of India and the Adjacent Countries. Diptera. Vol. 10. Sarcophagidae*. Zoological Survey of India. Calcutta. xxiv + 608 pp.
- Pape, T., 1987. *The Sarcophagidae (Diptera) of Fennoscandia and Denmark*. Fauna Entomologica Scandinavica, 19. Scandinavian Science Press Ltd. Copenhagen. 203 pp.
- Pape, T., 1996. *Catalogue of the Sarcophagidae of the World (Insecta, Diptera)*. Memoirs on Entomology International 8. Associated Publishers. Gainesville, Florida. 558 pp.
- Pape, T., 2004. *Fauna Europaea: Sarcophagidae*. Fauna Europaea version 1.1, <http://www.faunaeur.org> [last update 3 June 2010|version 2.2].
- Pape, T., González-Mora, D., Peris, S. V. & Báez, M., 2002. Sarcophagidae. In: M. Carles-Tolrá (ed.). *Catálogo de los Dípteros de España, Portugal y Andorra (Insecta)*. Monografías SEA, Vol 8. Zaragoza: 218-221.
- Papp, L., 1971. Ecological and production biological data on the significance of flies breeding in cattle droppings. *Acta Zoologica Hungarica*, 17: 91-105.
- Peris, S. V., González-Mora, D. & Mingo, E., 1998. Los Heteronychiina de la Península Ibérica: Subgénero *Heteronychia s.str.*, y descripción de una especie nueva de Tánger. (Diptera, Sarcophagidae) *Boletín de la Real Sociedad Española de Historia Natural (Sección Biología)*, 94(1-2): 165-178.
- Pickens, L. G., 1981. The life history and predatory efficiency of *Ravinia lherminieri* (Diptera: Sarcophagidae) on the face fly (Diptera: Muscidae). *Canadian Entomologist*, 113(6): 523-526.
- Povolný, D. & Verves, Y., 1997. *The Flesh-Flies of Central Europe*. Spixiana, supplement 24. Munchen. 260 pp.
- Prado e Castro, C., Chichorro, D., Serrano, A. & García, M. D., 2009. A modified version of Schoenly trap for collecting sarcosaprophagous arthropods. Detailed plans and construction. *Anales de Biología*, 31: 1-6.
- Richet, R., 1990. Élevage de larves de diptères sarcophagides. *Imago*, 39: 9-13.

- Romera, E., Arnaldos, M. I., García, M. D. & González-Mora, D., 2003. Los Sarcophagidae (Insecta, Diptera) de un ecosistema cadavérico en el sureste de la Península Ibérica. *Anales de Biología*, 25: 49-63.
- Séguy, E., 1941. *Études sur les mouches parasites*. Tome II. *Calliphorines (suite), Sarcophagines et Rhinophorines de l'Europe occidentale et méridionale*. Encyclopédie Entomologique 21. Paris. 436 pp.
- Smith, K. G. V., 1986. *A Manual of Forensic Entomology*. The Trustees of the British Museum (Natural History). London. 205 pp.
- Tantawi, T. I., Elkady, E. M., Greenberg, B. & ElGhaffar, H. A., 1996. Arthropod succession on exposed rabbit carrion in Alexandria, Egypt. *Journal of Medical Entomology*, 33: 566-580.
- Velásquez, Y., Magaña, C., Martínez-Sánchez, A. & Rojo, S., 2010. Diptera of forensic importance in the Iberian Peninsula: larval identification key. *Medical and Veterinary Entomology*, doi: 10.1111/j.1365-2915.2010.00879.x.
- Verves, Yu. G., 1973. [Contribution to the knowledge of fauna of flies of family Sarcophagidae of Kanev Reservation.] *Vestnik zoologii (Kyiv)*, 7(1): 24-29 (in Russian with English summary).
- Verves, Yu. G., 1975. [The feeding of imago of sarcophagids (Diptera, Sarcophagidae) at flowers in the borders of the Mid-Dnieper region.] *Visnik L'vivs'kogo universitetu. Seriâ biologična*, 17: 113-115 (in Ukrainian with English summary).
- Verves, Yu. G., 1993. 64h. Sarcophaginae. In: E. Lindner (ed.). *Die Fliegen der paläarktischen Region*, 11 (331): 441-504.
- Verves, Yu. G. & Khrokalo, L.A., 2009. 14. Superfamily Oestroidea. Family Sarcophagidae, In: J. Gerlach (ed.). *The Diptera of the Seychelles islands*. Pensoft. Sofia: 270-303.
- Wells, J. D., Pape, T. & Sperling, F. A. H., 2001. DNA-based identification and molecular systematics of forensically important Sarcophagidae (Diptera). *Journal of Forensic Sciences*, 46: 1098-1102.
- Zehner, R., Amendt, J., Schuett, S., Sauer, J., Krettek, R. & Povolný, D., 2004. Genetic identification of forensically important flesh flies (Diptera: Sarcophagidae). *International Journal of Legal Medicine*, 118: 245-247.
- Zumpt, F., 1965. *Myiasis in man and animals in the Old World*. Butterworths. London. 267 pp.

Recibido / Received, 22-VII-2010

Aceptado / Accepted, 20-X-2010

Publicado en línea / Published online, 16-XI-2010

Publicado impreso / Published in print, 29-XII-2010