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

C. Prado e Castro1,2*, 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
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 also been 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).


*Sarcophaga (Discachaeta) amita* Rondell, 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).


**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 (Richter, 1990).

Studied specimens: 01.07.2004, 1 male.

**Sarcophaga (Liopygia) argyrostroma** (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 —Docistostaurus marocanus (Thunberg, 1815), Schistoecerca gregaria (Forskål, 1775), S. paraensis (Burmeister, 1861)–, nymphs and imagos of locusts —Locusta migratoria (Linnaeus, 1758)–, larvae (Melolontha hippocastani Fabricius, 1801) and imagos of beetles (Lachnosterna sp.), as predators of lepidopteran pupae —Lyma ant 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).

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 (Martinez-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 (Uromastyx hardwickii 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).


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 & Rosads, 2009). Our record confirms and expands its distribution in the country. This species, already mentioned from several places in Spain, had not been previously collected related to corpses 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 mesophitic forests, fields, pastures, parks, gardens, cattle farms and settlements. It is a hemisynanthropic species (Verves & Khrokalo, 2009).


*Sarcophaga (Liosarcophaga) teretirostris* Pandelle, 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 candidans (Pfeiffer, 1841) (Lopes, 1940).


*Sarcophaga (Myorhina) nigriventris* Meigen, 1826

This species, widely distributed in Europe, reaching Denmark in the North, North Africa, Near East, Transcaucasia, 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 imagos Apis mellifera Linnaeus, 1758 (Séguy, 1965) and breed in dead mice, small birds, dead and living terrestrial snails – Brehus desponsus methylina (Menke, 1828), Cepaea nemoralis, Cernuella sp., Eobania sp., Helicella virgata (Da Costa, 1778), Helicopsis retowskii (Clessin, 1883), Helix aspersa, Helix cantianaformis Bourguignat, 1884, Helix pomatia Linnaeus, 1758, Monacha sp., Oxychilus alliarius (J.S. Miller, 1822), Theba cantiana Montagu, 1803, Xeropicta krynickii (Krynicki, 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...
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 Palaearctic 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 Palaearctic limit. Larvae develop in corpses of vertebrate and invertebrate animals, decaying meat and faeces. It is known as facultative parasite of succineid 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).


*Sarcophaga (Parasarcophaga) albiceps* Meigen, 1826

Species widely distributed in the Palaearctic 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.— Número de machos adultos de Sarcophagidae capturados en lugares sombrios y soleados durante el experimento.

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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), *Selenephera lunigera* (Esper, 1784)– and tentheadrid larva – *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

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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.

<table>
<thead>
<tr>
<th>Species</th>
<th>COIMBRA</th>
<th>ALTO ARAGÓN</th>
<th>MURCIA</th>
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<tbody>
<tr>
<td>Ravinia pernix</td>
<td>X</td>
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<tr>
<td>Sarcophaga (Bercaea) africana</td>
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<td>S. (Parasarcophaga) albiceps</td>
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<td>S. (Discachaeta) amita</td>
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<td>S. (Krameromyia) anaces</td>
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<td>S. (Liopygia) argyrostroma</td>
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<td>S. (Heteronychia) balanina</td>
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<td>S. (Thyroscenma) belgiana</td>
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<td>S. (Liopygia) cressipalpis</td>
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<td>Sarcophila sp.</td>
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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, Transcaucus, Near and Middle East, West Siberia, Kazakhstan and Central Asia. Larvae are parasites or predators of Lumbricidae, but occasionally necrophagous (Povolny & Verves, 1997). Flies are attracted to flowering plants (Verves, 1975), cattle dung and faeces (Martínez-Sanchez et al., 2000). Flies prefer different herbaceous mesophitic 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. argyrostroma* (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.

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References


