

# *The Antennal Sensilla of Oxelytrum erythrurum (Blanchard) and Oxelytrum apicale (Brullé) (Coleoptera: Silphidae)*

**Adriana Oliva**

**Neotropical Entomology**

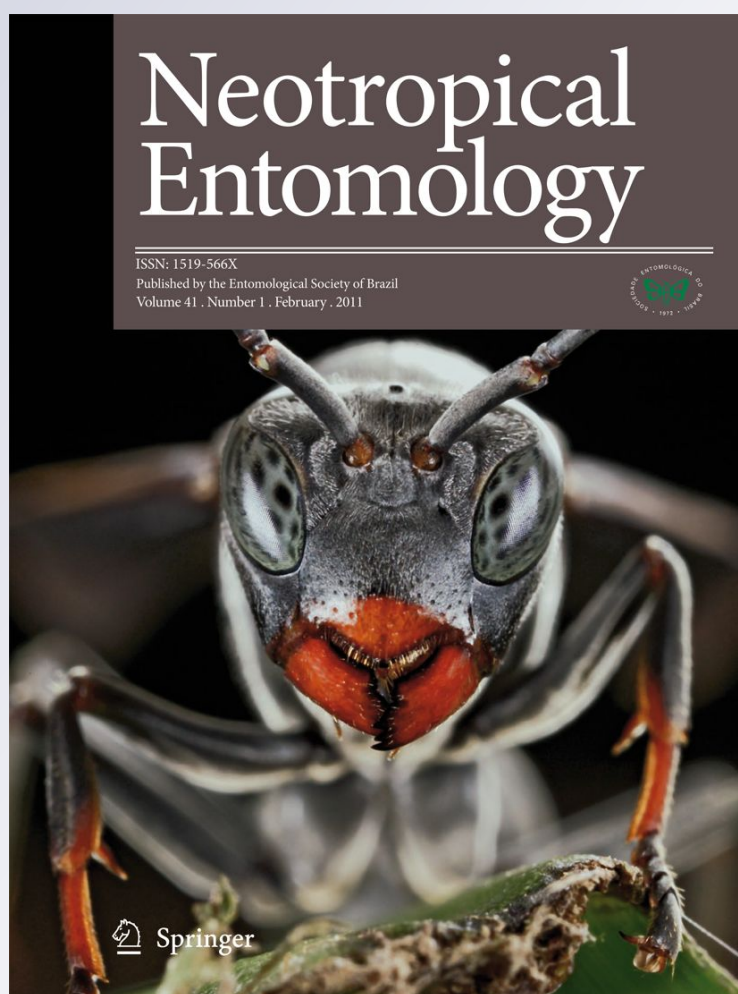
ISSN 1519-566X

Volume 41

Number 5

Neotrop Entomol (2012) 41:395-403

DOI 10.1007/s13744-012-0060-x



 Springer

**Your article is protected by copyright and all rights are held exclusively by Sociedade Entomológica do Brasil. This e-offprint is for personal use only and shall not be self-archived in electronic repositories. If you wish to self-archive your work, please use the accepted author's version for posting to your own website or your institution's repository. You may further deposit the accepted author's version on a funder's repository at a funder's request, provided it is not made publicly available until 12 months after publication.**

# The Antennal Sensilla of *Oxelytrum erythrurum* (Blanchard) and *Oxelytrum apicale* (Brullé) (Coleoptera: Silphidae)

A OLIVA

Lab de Entomología forense, CONICET Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires, Argentina

**Keywords**

Corpse succession, neotropical fauna, olfaction, sarcosaprophages

**Correspondence**

Adriana Oliva, Lab de Entomología forense, Museo Argentino de Ciencias Naturales, Avenida Ángel Gallardo 470, C1405DJR, Buenos Aires, Argentina; aoliva@macn.gov.ar; arg\_insect@yahoo.com.ar

Edited by Roberto Romani – University of Perugia

Received 13 February 2012 and accepted 4 June 2012

Published online 28 June 2012

© Sociedade Entomológica do Brasil 2012

**Abstract**

The typology and placement of antennal sensilla of the carrion beetles *Oxelytrum erythrurum* (Blanchard) and *Oxelytrum apicale* (Brullé) (Coleoptera: Silphidae) were studied using scanning electron microscopy. Two types of sensilla chaetica, two types of sensilla trichodea, four types of sensilla basiconica, one type of sensilla coeloconica, and an unidentified type of sensillum were found in both species. Sensilla chaetica type 1 are found on the antennomeres proximal to antennal club (A1–A8); chaetica type 2 are found on the club (A9–A11). Sensilla trichodea are found on A9–A11; one type (T1) is found on the proximal portion of the club, the other type (T2) on the apical portion. Basiconica type 1 are found on the dorsal surface of A9–A11; they are much denser on the apical portion of the antennal club than on the proximal. In *O. erythrurum*, a nocturnal species of the Chaco-Pampean plain, T2 two are found on A10 and A11. In *Oxelytrum apicale*, a mountain species, probably diurnal, only A11 bears T2, but they are denser than in the other species. It is suggested that *O. apicale* depends more on contact chemoreception than *O. erythrurum*. The ventral surface of the antennal clubs shows no remarkable difference between species.

**Introduction**

Silphidae is a small, worldwide family of moderate-sized to large beetles with scavenging or predatory habits, sometimes both combined. They are commonly called carrion beetles because of their association with dead vertebrate carcasses (Peck & Anderson 1985). The family is placed in the Superfamily Staphylinoidea, Series Staphyliniformia, and it is divided in two subfamilies (Newton & Thayer 1992, Dekeirsschieter *et al* 2011). The subfamily Nicrophorinae Kirby comprises species which exploit small carcasses (birds, lizards, small rodents) and have biparental care of larvae. The subfamily Silphinae Latreille does not exhibit such care; scavenging species are often attracted to large carcasses (Peck & Anderson 1985). Because they may appear on human bodies, these species are interesting to the forensic entomologist. Payne & King (1970) found two

species of Silphidae-Silphinae on dead pig carcasses. Adults fed only on dipteran larvae: They appeared when maggot activity was evident, and they were observed with larvae in their mandibles. The larvae appeared under the dried remains after the dipteran larvae had left them. Dekeirsschieter *et al* (2011) record seven species of Silphidae (three Nicrophorinae and four Silphinae) from forest or agricultural biotopes, none from urban sites.

In Argentina, the Silphidae are represented by one genus of each subfamily (Oliva & Di Iorio 2008), with two species of *Nicrophorus* Fabricius and six species of *Oxelytrum* Gistel (Fabricius 1801, Gistel 1848). The species of *Oxelytrum* are rather large (8–15 mm in length), flat, long-legged beetles, black or dark brown in color, in most species with characteristic reddish marks on the pronotal margins. Males usually have thicker protarsi than females. The most common of Argentinean species is *Oxelytrum*

*erythrurum* (Blanchard), which has been collected from many localities of the Chaco-Pampean plain (Oliva & Di Iorio 2008) and recorded from human corpses in rural or semi-rural environments (Oliva 2001, sub *Hyponecroides*) and from pig carcasses in field experiments (Centeno et al 2002, sub *Hyponecroides*). In Buenos Aires (34° 36'47.3394"S; 58°22'38.0274"W) and surrounding areas, adults of *O. erythrurum* have been gathered by officials at the scene from human corpses 8–12 days after death; adults with young larvae are found 12–18 days after death and large larvae without adults 18–30 days after death (Oliva 2004). In Brazil, Uruhary-Rodrigues et al (2010) found *Oxelytrum cayennense* (Stürm) on man-sized pig carcasses near Manaus; adults preyed on larvae of Diptera, but larvae of *O. cayennense* were observed feeding on pig tissues from the fifth day onwards. Mise et al (2008) found *O. erythrurum* and *Oxelytrum discicolle* (Brullé) on pig carcasses in Curitiba, Paraná. In Colombia, *O. discicolle* was found on human corpses in Cali by Barreto et al (2002), and on pig carcasses at a rural area near Bogotá, by Segura et al (2009, 2011).

Peck & Anderson (1985) suggested that the original *Oxelytrum* stock diverged into two lineages. The first of these originated the species which live on the Andean slopes or in the Chilean coastal lowlands. The second comprises species living in lowlands to middle mountain elevation. In the same paper, we find that Andean species have less prominent eyes than the other species. In Argentina, there are two species with this characters: *Oxelytrum apicale* (Brullé), which has been found in the SW of Argentina in areas 2,500–4,500 m asl and *Oxelytrum biguttatum* (Philippi), which has been collected from the same area between 2,300 and 3,000 m asl and from Patagonia. Oliva & Di Iorio (2008) suggested that the two Andean species found in Argentina may be diurnal and that they may be active during the warmest part of the day, as a strategy to survive in the harsh mountain environment. One fact that points to this is that *O. apicale* has been collected only from November to April (Peck & Anderson 1985), which in Argentina is the warm period of the year. Instead, *O. erythrurum* has been collected in or near Buenos Aires in both summer and winter (Oliva & Di Iorio 2008).

For this study, I propose the hypothesis that interspecific differences in the visual organs would be accompanied by differences in the olfactory organs, namely the antennae. The antenna of Silphidae is composed of 11 antennomeres, which have been here named A1–A11; A9–A11, broadened and flattened, form an apical club. Antennomere 8 is strongly cupuliform in Nicrophorinae but less pronounced in some Silphinae; this structure is convergent with Histeroidea, Hydrophiloidea, and several Scarabaeoidea (Hansen 1999). Olfaction is performed by chemoreceptors, which are located on the flagellum (A3–A11) of the

antenna (Chapman 1998); since Silphidae have clubbed antennae, we should expect the chemoreceptors to be located on the club (A9–A11). This is the case in Nicrophorini (Ernst 1972, Kalinová et al 2009). In other families of Coleoptera which also have clubbed antennae, the chemoreceptors are restricted to the club, no matter how many antennomeres it comprises; for instance, in ladybirds (Coleoptera: Coccinellidae), the club comprises A10 and A11, and chemoreceptors are restricted to these (Jourdan et al 1995, Hamilton et al 1999).

There are no studies on the antennal morphology of *Oxelytrum*; the antennal microstructure of *Nicrophorus* (Silphidae: Nicrophorinae) has been studied by Ernst (1969, 1972). Kalinová et al (2009) studied carcass attractiveness to two European species of *Nicrophorus*. Earlier, scanning electron microscopic studies on antennal fine morphology have been performed in several insect families, on Coleoptera alone: Hu et al (2009) on seed weevils (Coleoptera: Bruchidae); Ploomi et al (2003) and Talarico et al (2011) on ground beetles (Coleoptera: Carabidae); Crook et al (2003) and Lopes et al (2005) on wood borers (Coleoptera: Cerambycidae); Sen & Mitchell (2001) on the Colorado potato beetle (Coleoptera: Chrysomelidae); Hamilton et al (1999) and Jourdan et al (1995) on ladybird beetles (Coleoptera: Coccinellidae); and Merivee 1992 and Merivee et al (1998, 1999) on click beetles (Coleoptera: Elateridae). Among many papers treating other orders of insects, one might mention Setzu et al 2011 on blow flies (Diptera: Calliphoridae); Sukontason et al (2004) on Calliphoridae, Sarcophagidae, and Muscidae (Diptera); Bowen (1995) on mosquitoes (Diptera: Culicidae); Park et al (2002) on fruit-flies (Diptera: Drosophilidae); Sukontason et al (2007) on Muscidae (Diptera); Abouzied (2008) on Sarcophagidae (Diptera); Nelson et al (2003) on dustywings (Neuroptera: Coniopterygidae); Ochieng et al (1998) on the desert locust (Orthoptera: Acrididae). In classifying sensilla, the terminology of Merivee et al (1999) was used in this study.

## Material and Methods

Two male and one female specimens of *O. erythrurum* were taken from a sample in 75% ethanol from Argentina: Entre Ríos province: Parque Nacional El Palmar (31° 58'59.9874"S; 58°17'59.9994"W), collected by C. Grismado, 7.iii.2011, on remains of *Euphractus sexcinctus* (Mammalia: Xenarthra: Dasypodidae). They were rinsed in water and the head and pronotum of each specimen was dissected out. The pieces were then soaked in ethanol 95% for 48 h, and afterwards dehydrated in an ethanol–xylol series. For comparison, two dry-pinned specimens of *O. apicale* from Argentina: Salta Province: Piedra del Molino (25°10'0.1194"S; 65°52'0.1194"W),



Arroyo Cachi, 3,310 m asl, collected by Martínez, xii.1987, from the general collection of the Museo Argentino de Ciencias Naturales, were relaxed in boiling water and the antennae were dissected out, soaked for several days in ethanol 95%, and then gradually dehydrated in an ethanol–xylol series. The pieces were coated with 60% palladium and 40% gold in a VG Scientific sputter coater. They were then examined in a Phillips XL30 SEM microscope of Dutch origin, at 10–15 KW. Interpretation of the structures photographed follows mainly Merivee *et al* (1999). A total of 24 microphotographs of *O. erythrurum* and 30 of *O. apicale* were taken. To count the sensilla on the antennal club, the image of each antennomere was divided into ten lengthwise segments, and the sensilla on four adjacent segments were counted on a 200×150 mm print. Larger and less numerous sensilla were counted directly.

## Results

Two types of sensilla chaetica, one with two subtypes (Figs 3, 4 and 8), two types of sensilla trichodea (Figs 8, 12, 13, 19 and 20), four types of sensilla basiconica (Figs 8, 10, 11, 12, 13 and 19), one type of grooved peg (Fig 14), and a type of sensillum which could not be placed (Fig 15) were identified on the antenna of *O. erythrurum* and *O. apicale*.

### Antennal morphology in *O. erythrurum* (*Habitus*: Fig 1)

**Gross morphology of the antenna.** The antenna is formed by 11 segments, the last three forming an elongate ovate, rather lax club (Fig 2). The shape and measurements of antennomeres in Table 1. Antennomeres have been numbered A1–A11 for convenience. Antennomere 8 is dilated in its anterior portion, weakly cupuliform (Fig 3). The cuticle of the antennomeres is reticulate (Fig 3).

**Morphological types and distribution of antennal sensilla.** Sensilla chaetica type 1 are decumbent, longitudinally grooved, set in articulatory sockets open on the side towards the antennal apex (Fig 3). They are found on antennomeres 1–8. Sensilla Chaetica 1 are of two sizes (Table 2). The smaller have been called sensilla chaetica 1a, the larger ones sensilla chaetica 1b (Fig 3, Ch1a, Ch1b). Chaetica 1a are found on the dorsal and ventral surface of each segment; chaetica 1b are found only on the apex of the segment (Fig 2). At the base of these bristles, a semicircle of three to eight small pores (each about two micrometers in diameter) has been observed on the open side of the articulatory socket (Fig 7). These pores appear to be clusters of small pores, suggesting glands associated with the sensillum chaeticum. The appearance of the

pores is much like those described by Nelson *et al* (2003) in the dustywing *Semidalis flinti* Meinander (Neuroptera: Coniopterygidae). Dustywings are covered in wax particles. This is not the case in carrion beetles, but the antennae of the latter are covered in a substance which is very hard to remove in dried specimens and which would be consistent with an organic secretion.

Sensilla chaetica type 2 have a basal collar of microspines (Figs 8, 10, 11 and 12; Ch2). Their walls are thick (Fig 11); they bear longitudinal grooves, and they narrow to a blunt tip. They are found on A9–A11, disposed in irregular lines along the dorsal and ventral surfaces (Figs 4, 5, 6 and 9). On the dorsal surface of A 11, however, there is a large area where sensilla chaetica are short and very sparse (Fig 6). Although the appearance of the microspines is a little different on A 9 and A 10, all the sensilla chaetica on the antennal club have been considered the same type for description, until more detailed studies are available.

Sensilla trichodea type 1 are strongly curved, abruptly narrowed at the curve and then tapering gradually to a blunt apex (Fig 8; T1). They are longitudinally grooved, set in a tight socket with a low thin collar. They are found on A9 and in small numbers at the base of A10 and A11 (Tables 2 and 3). Sensilla trichodea type 2 are longer than type 1 (Table 2), gradually acuminate and gently curved towards the antennal shaft (Figs 10, 11 and 12; T2). They are found on A10 and A11.

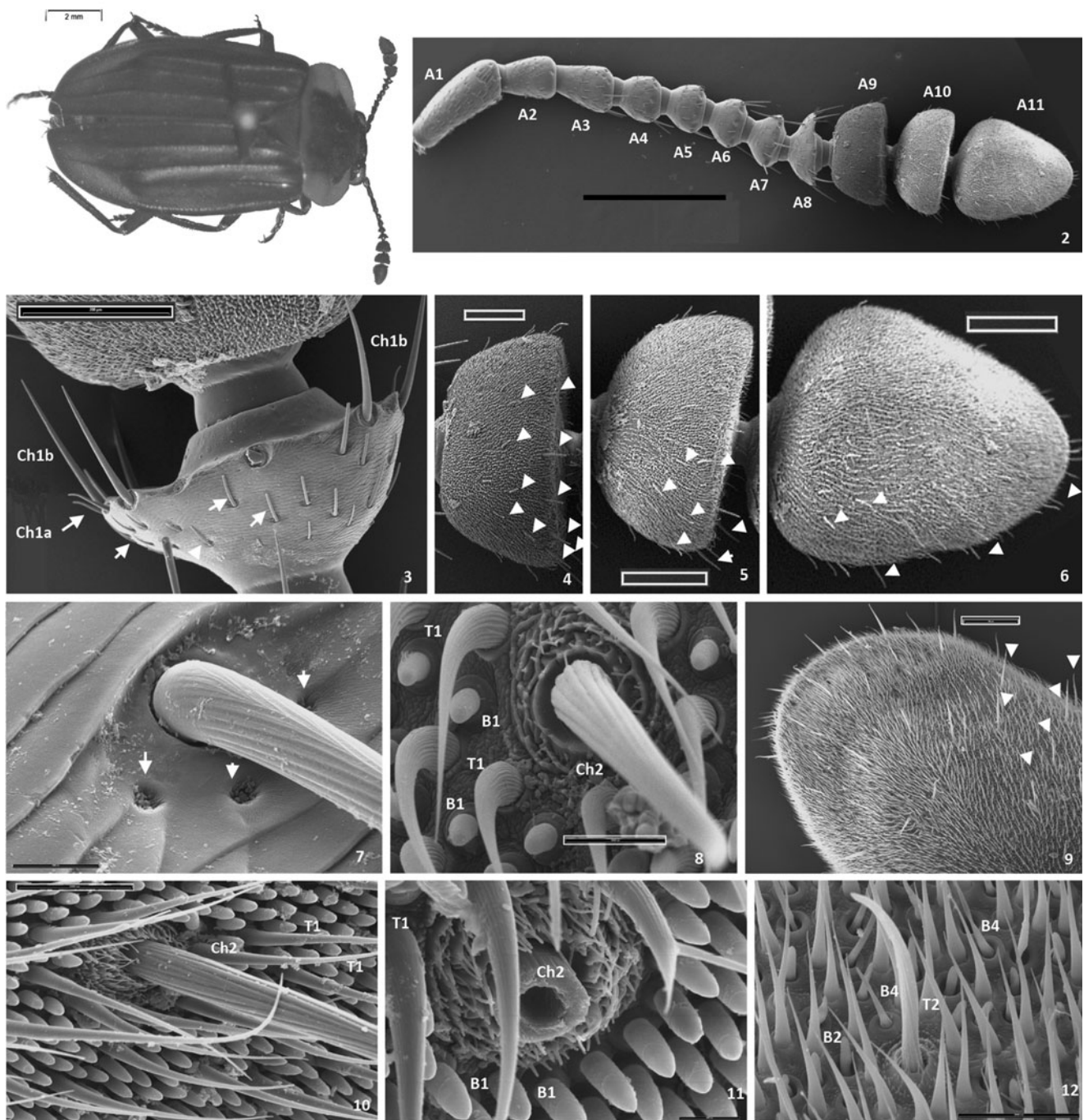
Sensilla basiconica type 1 are shaped as very long cones, almost cylindrical, ungrooved, with blunt subconical tip (Figs 8, 10 and 11; B1; Table 2). The socket is tight, and it has a thick, high collar. Basiconica type 1 are present on the dorsal surface of A9–A11, and they have the same appearance all over, but they are sparser on A9 (Fig 8), while on A10 and A11 they are very dense (Figs 10 and 11; Table 3). They are best observed on the central part of the dorsal surface of A11; on the lateral margins the dense sensilla trichodea they obscure the basiconica. This disposition of the sensilla causes a different texture on A9 than on A10 and A11 (Fig 2).

**Ventral surface:** No differences have been observed on antennomeres 1–8 between the dorsal and the ventral aspects. On the antennal club, the sensilla trichodea are less dense on the ventral surface, and there are three types of sensilla basiconica and also two other kinds of sensilla, all of which have not been found on the dorsal surface.

Sensilla basiconica type 2 are shorter than type 1 (Figs 12 and 13; B2; Table 2), with a looser socket and a narrower basal collar. They have been observed on the ventral surface alone (Table 3).

Sensilla basiconica type 3 are like the precedent in the characters of their socket, but the peg is very short and hardly protrudes from the later (Fig 13; B3; Tables 2 and 3).

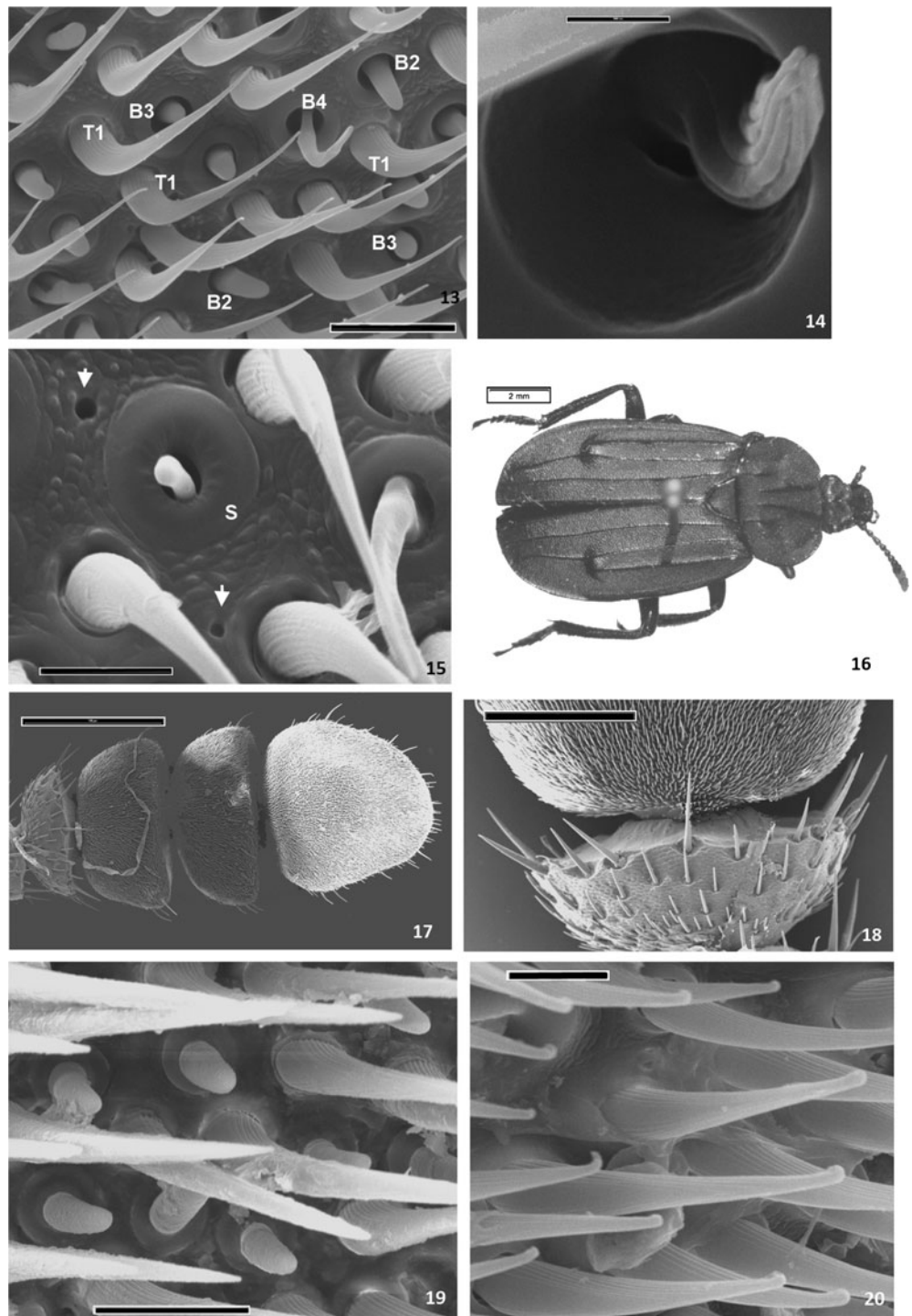
Sensilla basiconica type 4 are very slender, strongly curved (Fig 12; B4) to nearly straight (Fig 13; B4). They look rather like



Figs 1–12 *Oxelytrum erythrurum*. **1** Habitus in dorsal aspect (scale bar=2 mm); **2** clavate or clubbed antenna in dorsal aspect. Frontal margin of antenna faces upper side of figure (scale bar=1 mm); **3** male, antennomere 8 in dorsal aspect, showing dilated frontal margin (facing left in picture) (scale bar=200  $\mu$ m); **4** antennomere 9, dorsal. Arrows indicate sensilla chaetica type 2, longer and thicker on lateral margins marked as Ch 2) (scale bar=250  $\mu$ m); **5** antennomere 10, dorsal, same as above (scale bar=250  $\mu$ m); **6** antennomere 11, dorsal, same as above (scale bar=250  $\mu$ m); **7** antennomere 8, base of sensillum chaeticum type 1b, with open socket. Arrows indicate pores (scale bar=5  $\mu$ m); **8** antennomere 9, dorsal: Sensillum chaeticum type 2 (Ch 2), grooved, with basal collar of microspines; sensilla trichodea type 1 (T 1), strongly curved, with longitudinal grooves and acuminate apices; sensilla basiconica type 1 (B 1), with tight sockets and thick, raised collars (scale bar=10  $\mu$ m); **9** antennomere 11, ventral, showing sensilla chaetica type 2 nearly as long on the middle of the ventral surface as on the lateral margins (scale bar=100  $\mu$ m); **10** male, antennomere 11, dorsal: sensilla trichodea type 2 (T2), straight; sensilla basiconica type 1 (B) scale bar=2  $\mu$ m); **11** male, antennomere 10, dorsal: Sensillum chaeticum type 2, broken, showing thick wall and basal microspines (scale bar=5  $\mu$ m); **12** female, antennomere 11, ventral: Sensillum chaeticum type 2 (arrowhead); sensilla trichodea type 2 (T2); basiconica type 2 (B2) and type 4 (B4) weakly curved (scale bar=20  $\mu$ m).



Figs 13–20 *Oxelytrum erythrurum* and *Oxelytrum apicale*. **13** *Oxelytrum erythrurum* female, antennomere 9 in ventral aspect, showing curved sensilla trichodea type 2 (*T1*), sensilla basiconica type 2 (*B2*) with loose socket and collar thinner than in *B1*, sensilla basiconica type 3 (*B3*) similar to precedent but protruding very little from collar (*B3*) and sensilla basiconica type 4 (*B4*), long, thin, strongly curved (in the present case), with loose socket and thin collar (scale bar=10  $\mu\text{m}$ ); **14** *Oxelytrum erythrurum* female, antennomere 9, ventral: Sensillum coeloconicum (scale bar=0.5  $\mu\text{m}$ ); **15** *Oxelytrum erythrurum* female, antennomere 9, ventral: Pores (arrows) and unidentified sensillum (*S*) (scale bar=5  $\mu\text{m}$ ); **16** *Oxelytrum apicale*, habitus in dorsal aspect (scale bar=2 mm); **17** *Oxelytrum apicale*, antennal club, dorsal (scale bar=500  $\mu\text{m}$ ); **18** *Oxelytrum apicale*, antennomere 8, dorsal: not expanded (scale bar=200  $\mu\text{m}$ ); **19** *Oxelytrum apicale*, antennomere 10, dorsal: Sensilla trichodea type 1 and sensilla basiconica (scale bar=10  $\mu\text{m}$ ); **20** *Oxelytrum apicale*, antennomere 11, dorsal: Sensilla trichodea type 2 with blunt tips (scale bar=20  $\mu\text{m}$ ).



sensilla trichoidea, but their narrow, rounded apex and the thick basal collars place them in the basiconica group. They are rarer than the other types. Sensilla coeloconica are rare; they are found on the lateral margins of the ventral surface of A<sub>9</sub>. They are short (Table 2), made up of seven to eight finger-like structures. The division may be seen down to the base; these are definitely not sensilla with apical finger-like projections. The socket is large, loose, collarless, although the

actual insertion of the peg lies at the bottom of the socket (Fig 14). The absence of a collar has been a decisive factor in classifying this sensillum as coeloconicum.

Sensillum type x is about 3  $\mu\text{m}$  long, with a slender peg weakly dilated at the apex (Fig 15; S). There is a wide, weakly raised collar.

A few single pores have been found scattered on the ventral surface of antennomeres 9–11 (Fig 15; arrows). Unlike

Table 1 Measurements ( $\pm 2 \mu\text{m}$ ) and shape of antennomeres of *Oxelytrum erythrurum* and *Oxelytrum apicale*.

Antennomere	Length ( $\mu\text{m}$ )	Basal width ( $\mu\text{m}$ )	Maximal width ( $\mu\text{m}$ )	Shape
<i>O. erythrurum</i>				
1	714	143	285	Elongate
2	326	171	257	Elongate
3	385	242	257	Elongate
4	257	171	285	Bead-shaped
5	228	143	285	Bead-shaped
6	214	143	214	Bead-shaped
7	200	228	314	Bead-shaped
8	200	157	400	Dilated into disk
9	285	257	342	Flat, trapeze-shaped
10	85	542	2085	Flat, trapeze-shaped
11	665	400	457	Flat, tapering
<i>O. apicalis</i>				
1	584	146	248	Elongate
2	189	77	204	Elongate
3	467	131	248	Elongate
4	204	77	238	Bead-shaped
5	175	77	235	Bead-shaped
6	204	77	263	Bead-shaped
7	146	77	321	Bead-shaped
8	175	146	409	Hemispherical
9	263	204	528	Flat, trapeze-shaped
10	277	204	528	Flat, trapeze-shaped
11	496	175	530	Flat, tapering

the pores at the base of sensilla chaetica 1, these pores do not appear to be associated with a sensillum. Measurements of sensilla are found in Table 2.

*Antennal morphology of O. apicale (Habitus: Fig 16)*

*Gross morphology of the antenna.* Similar to the antenna of *O. erythrurum*, but antennomere 8 is not dilated, and almost hemispherical (Figs 17 and 18); and A11 shorter and

more rounded apically than in *O. erythrurum* (Fig 17). Measurements are in Table 2.

*Morphological types and distribution of sensilla.* In this species, A9 and A10 have a similar appearance (Fig 17), while A11 has a different texture because of denser sensilla trichodea (Figs 19 and 20). The types are basically the same as in *O. erythrurum*. There are sensilla trichodea type 1 on A9 and A10 (Fig 19), sensilla trichodea type 2 on A11 (Fig 20).

Table 2 Types and measurements of sensilla of *Oxelytrum erythrurum* (Measurements  $\pm 1 \mu\text{m}$ ; for sensilla chaetica  $\pm 5 \mu\text{m}$ ).

Type	Length ( $\mu\text{m}$ )	Base ( $\mu\text{m}$ )	Socket ( $\mu\text{m}$ )	Collar ( $\mu\text{m}$ )	Antennomere
Chaetica 1 a	20-50	2-3	4	-	A1-8
Chaetica 1 b	100-300	5		-	A1-8 apex
Chaetica 2	30-50	5	6	-	A9-10
Trichodea 1	20	3-4	5	1	A9 (base A10, A11)
Trichodea 2	30-50	3-5	5-6	1	A10, A11
Basiconica 1	5-8	2	6	1.5	A9-11
Basiconica 2	3-4	1	5	1	A9-11 ventral
Basiconica 3	1.5	1	5	2	A9-11 ventral
Basiconica 4	8	1	5	1.5	A9-11 ventral
Coeloconica	3-5	3	5	-	A9-11 ventral
Sensillum x	3	0.5	5	2-3	A9-11 ventral



As in the precedent species, there are numerous sensilla basiconica under the layer of elbowed sensilla trichodea. Distribution is shown in Table 3.

## Discussion

The sensilla chaetica (S.ch.) are mechanoreceptors (Merivee 1992, Ochieng *et al* 1998, Merivee *et al* 1998, 1999, 2002, 2005). S.ch. 11, which are proximal to the club (antennomeres 1–8), appear to correspond to sensilla chaetica of *Melanotus villosus* (Geoffroy) (Coleoptera: Elateridae), described as "long sickle-shaped strong bristles with longitudinal grooves acuminate towards the tip, which are located in an open articulatory socket" (Merivee *et al* 1999). S.ch. 2, found on the antennal club (antennomeres 9–11) differ from type 1 mainly by the basal collar of cuticular microspines.

Sensilla trichodea (S.t.) of two types are found on A9–A11 in both species. S.t. 1 are found on the proximal portion, associated with sparser sensilla basiconica. S.t. 2 are found on the apical portion; they might correspond to sensilla trichodea type I in Merivee *et al* (1999), although they are shorter.

Sensilla basiconica type 1 are found on the dorsal surface of the antenna.

Structures similar to basiconica (S.b.) 3 are found on the antennae of the ground beetle *Bembidion properans* Stephens (Coleoptera: Carabidae) (Merivee *et al* 2002) and also in the wood-borer *Dectes texanus* LeConte (Coleoptera: Cerambycidae) (Crook *et al* 2003), in which they are characterized as contact chemoreceptors. "Mechanosensitive cells record when taste organs touch the substrate" (Keil 1997).

This suggests that s.b. 1 in dorsal position are used in detecting feeding/mating substrate from afar, while the sensilla in ventral position (s.b. 2, 3, and 4, coeloconica and sensilla type x) are involved in close contact.

Structures similar to s.b. 4 are described from the antennae of the domestic fly *Musca domestica* L. (Diptera: Muscidae) (Sukontason *et al* 2004). Park *et al* (2002) mention "intermediate sensilla" which combine characters of sensilla basiconica and trichodea sensilla in the fruit fly *Drosophila* sp. (Diptera: Drosophilidae). The unusual strong curve of the s.b. 4 in Fig 12 may be an artifact, but it is not unusual for basiconica of one type to have either straight or curved pegs (Merivee *et al* 1999).

Sensilla coeloconica are rare, but because of their small size, they might have been overlooked in some cases because the long sensilla trichodea obscured them. Sensilla similar to this have been described in the flesh fly *Liosarcophaga babyari* Lehrer (Diptera: Sarcophagidae) (Abouzied 2008) and in the fly *Hydrotaea chalcogaster* (Wied.) (Diptera: Muscidae) (Sukontason *et al* 2007).

Sensillum type x was found on the ventral surface of antennomere 9. The only similar structures found in precedent papers are setae on the dorsum of gibbous water beetles (Coleoptera: Hydrophilidae: Berosini); however, these are placed within sunken punctures and have no collar (Oliva 1992, 2010). These structures have been found on the dorsum of the head, the pronotum, and the elytra of different species. One interesting point is that gibbous water beetles of the genus *Derallus* have elytral punctures bearing a sensillum similar to sensillum type x, accompanied by one, two, or three pores according to the species.

Table 3 Number and distribution of sensilla of *Oxelytrum erythrurum* and *Oxelytrum apicale*.

Type	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	Aspect
<i>O. erythrurum</i>												
Chaetica 1a	56	32	22	18	12	14	10	22				Dorsal
Chaetica 1b	2	4	4	4	4	4	4	4				Dorsal
Chaetica 2									14±2	24±2	30±2	Dorsal
Trichodea 1									1,200±50	100±50	100±50	Dorsal
Trichodea 1									1,350±50	-	-	Ventral
Trichodea 2									-	1,400±50	1,600±50	Dorsal
Trichodea 2									-	1,700±50	1,800±50	Ventral
Basiconica 1									450±20	850±20	3,600±50	Dorsal
Basiconica 2									2,500±50	2,500±50	3,000±50	Ventral
Basiconica 3									700±50	700±50	800±50	Ventral
Basiconica 4									200±20	200±20	400±20	Ventral
<i>O. apicale</i>												
Chaetica 2									20	20	22	Dorsal
Trichodea 1									2,000	2,400		Dorsal
Trichodea 2											3,600	Dorsal
Basiconica 1									620	900	3,600	Dorsal

On the other hand, sensillum type x in the antenna of *O. erythrurum* has a pore very close to it, and another a little distance off. This suggests that the peculiar elytral punctuations in *Derallus* may be the product of the concentration of sensilla type x and accompanying pores. The function of the sensilla of Hydrophilidae has not been elucidated.

The main difference between *O. erythrurum* and *O. apicale* is in the distribution of the sensilla on the antennal club (Table 3). In *O. apicale*, T2 are limited to A11, but the total number of sensilla trichodea is greater than in the other species.

Merivee *et al* (1999), comparing the allied Elaterid species *M. villosus* (Merivee *et al* 1999), *Agriotes obscurus* (Merivee 1992), and *Limonius aeruginosus* (Merivee *et al* 1998), pointed out that the sole important differences in the number and placement of sensilla concern "olfactory trichoid and blunt-tipped basiconic sensilla, which evidently are related to the differences in olfactory search tactics of the three species". This can be applied to the species of *Oxelytrum*. Olfaction may be used to detect food or mates, but carrion-beetles form mating and feeding aggregations on animal carcasses, so that finding a feeding substrate would often imply finding a mate. This modality is common to other corpse frequenting beetles, such as hide-beetles (Coleoptera: Dermestidae) (Von Hoermann *et al* 2011). Carrion beetles, then, can be expected to have sensilla specialized for detecting products of decay of animal substances. Von Hoermann *et al* (2011) studied this aspect in hide-beetles, which are attracted especially by benzyl butyrate. They point out, however, that males of the sexton beetle *Nicrophorus* (Coleoptera: Silphidae) attract females with a pheromone, which often, but not always is released in the presence of carrion. Based in this, one may expect carrion beetles to have sensilla specialized for one or more volatile compounds from carrion, for prey (larvae of Diptera), for pheromones, for humidity, and possibly for some other stimuli such as salt (Merivee *et al* 2002) or pH (Merivee *et al* 2005). However, while carrion must be located from afar (basiconica), prey has to be recognized at close quarters (trichodea). S.b. 1 are found on the dorsal surface of the antennal club; they are sparser on the proximal portion and denser on the apical portion of the club. Basiconica types 2, 3, and 4 have been found only on the ventral surface of the club. This suggests two modalities of smelling, such as might be, detecting a carcass from afar and exploring it for mates and for prey (larvae of Diptera). The olfactory sensilla of the click-beetle *M. villosus* (Elateridae) are placed mainly on the ventral surface of the antennae (Merivee *et al* 1999). Sukontason *et al* (2004), working on forensically important flies (Diptera) which must locate animal remains often from long distances, remarked that basiconica sensilla are the most numerous type of antennal sensillum in all the fly species examined. This agrees

with the present findings; both species studied have a great concentration of s.b. 1 on A11. On the other hand, *O. erythrurum* has s.t. 2 on a larger area, while *O. apicale* has a greater number of them on A11. If these sensilla are contact chemoreceptors (Merivee *et al* 1999), then it may be assumed that *O. apicale* uses more contact chemoreception. Instead, *O. erythrurum* in the wide Chaco-Pampean plain, with a milder, more humid climate, would rely on its sense of smell to detect carcasses from afar but would often find maggots near the surface. Adults of this species arrive to quite fresh carcasses; they have been found on dead pigs after only 2 days (Centeno *et al* 2002). No data are available about the feeding habits of *O. apicale*, but in a mountain climate, with dry air and often with strong winds, carcasses dry quickly and maggots tend to hide in cracks in the carcass.

**Acknowledgments** The SEM photographs were taken by Lic. Fabián Tricárico, technician of the Museo argentino de Ciencias naturales (Buenos Aires, Argentina). I thank the referees who read a precedent version of this paper and pointed out a considerable number of subjects which could be amplified. This study was performed as part of my duties as career researcher for the Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICET) of Argentina.

## References

- Abouzed EM (2008) Antennal and maxillary palp sensillae of male and female *Liosarcophaga babyari* Lehrer (Diptera: Sarcophagidae). Bull Ent Soc Egypt 85:29–48
- Barreto M, Burbano ME, Barreto P (2002) Flies (Calliphoridae, Muscidae) and beetles (Silphidae) from human cadavers in Cali, Colombia. Mem Inst Oswaldo Cruz, Rio de Janeiro, 97(1): 137–138
- Bowen MF (1995) Sensilla basiconica (grooved pegs) on the antennae of female mosquitoes: electrophysiology and morphology. Entomol Exp Appl 77:233–238
- Centeno N, Maldonado M, Oliva A (2002) Seasonal patterns of Arthropods occurring on sheltered and unsheltered pig carcasses in Buenos Aires province (Argentina). Forensic Sci Int 126 (2002):63–70
- Chapman RF (1998) The insects. Structure and function, 4th edn. Cambridge University Press, Cambridge, 752 + xiii pp
- Crook DJ, Higgins RA, Ramaswami SB (2003) Antennal morphology of the soybean stem-borer *Dectes texanus texanus* LeConte (Coleoptera: Cerambycidae). J Kansas Entom Soc 76(3):397–405
- Dekeirsschieter J, Verheggen FJ, Haubruge E, Brostaux Y (2011) Carrion beetles visiting pig carcasses during early spring in urban, forest and agricultural biotopes of Western Europe. J Insect Sci 11:73
- Ernst K-D (1969) Die Feinstruktur von Riechsensillen auf der Antenne des Aaskäfers *Necrophorus* (Coleoptera). Z Zellforsch Mikrsk Anat 94:72–102
- Ernst K-D (1972) Die ontogenie der basiconischen Riechsensillen auf der Antenne von *Necrophorus* (Coleoptera). Z Zellforsch Mikrsk Anat 129:217–236
- Fabricius JC (1801) Systema Eleutheratorum. Academici Novi, Kiliae. Vol. 1
- Gistel J (1848) Naturgeschichte des Thierreichs für höhere Schulen. Stuttgart. XVI + 1-216 + (4) p., plates 1-32
- Hamilton RM, Dogan EB, Schaljee GB, Booth GM (1999) Olfactory response of the lady beetle *Hippodamia convergens* (Coleoptera: Coccinellidae) to prey related odors, including a scanning

- electron microscopy study of the antennal sensilla. *Environ Entomol* 28:812–822
- Hansen M (1999) *World Catalogue of Insects*, volume 2: Hydrophiloidea (s. str.) (Coleoptera). Apollo Books, Stenstrup, 416 p
- Hu F, Zhang G-N, Wang J-J (2009) Scanning electron microscopy studies of antennal sensilla of buchid beetles, *Callosobruchus chinensis* (L.) and *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). *Micron* 40:320–326
- Jourdan H, Barbier R, Bernard J, Ferran A (1995) Antennal sensilla and sexual dimorphism of the adult ladybird beetle *Semiadalia undecimnotata* Schn. (Coleoptera: Coccinellidae). *Int J Insect Morphol Embryol* 24(3):307–322
- Kalinová B, Podskalská H, Růžická J, Hoskovec M (2009) Irresistible bouquet of death—how are burying beetles (Coleoptera: Silphidae: *Nicrophorus*) attracted by carcasses. *Naturwissenschaften* 96:889–899
- Keil TA (1997) Functional morphology of insect mechanoreceptors. *Microsc Res Tech* 39:506–531
- Lopes O, Marques PC, Araujo J (2005) The role of antennae in mate recognition in *Phoracantha semipunctata* (Coleoptera: Cerambycidae). *J Insect Behav* 18(2):243–257
- Merivee E (1992) Antennal sensilla of the female and male elaterid beetle *Agriotes obscurus* L. (Coleoptera; Elateridae). *Proc Estonian Acad Sci Biol* 30:078104
- Merivee E, Rahi M, Bresciani J, Ravn HP, Luik A (1998) Antennal sensilla of the click beetle *Limonius aeruginosus* Olivier (Coleoptera: Elateridae). *J Insect Morphol Embryol* 27(4):311–318
- Merivee E, Rahi M, Luik A (1999) Antennal sensilla of the click beetle *Melanotus villosus* (Geoffroy) (Coleoptera: Elateridae). *Int J Insect Morphol Embryol Phys* 28:41–51
- Merivee E, Ploomi A, Rahi M, Bresciani J, Ravn HP, Luik A, Sammelselg V (2002) Antennal sensilla of the ground beetle *Bembidion properans* Steph. (Coleoptera: Carabidae). *Micron* 33:429–440
- Merivee E, Ploomi A, Milius M, Luik A, Heidema M (2005) Electrophysiological identification of antennal pH receptors in the ground beetle *Pterostichus oblongopunctatus*. *Physiol Entomol* 30:122–133
- Mise KM, Martins CBC, Köb EL, Almeida LM (2008) Longer decomposition process and the influence on Coleoptera fauna associated with carcasses. *Braz J Biol* 68(4):907–908
- Nelson DR, Freeman TP, Buckner JS, Hoelmer KA, Jackson CG, Hagler JR (2003) Characterization of the cuticular surface wax pores and the waxy particles of the dustywing, *Semidalis flinti* (Neuroptera: Coniopterygidae). *Comp Biochem Physiol B* 136:343–356
- Newton AF, Thayer MK (1992) Current classification and family-group names in Staphyliniformia (Coleoptera). *Fieldiana Ent* (n s) 67:1–92
- Ochieng SA, Hallberg E, Hansson BS (1998) Fine structure and distribution of antennal sensilla of the desert locust, *Schistocerca gregaria* (Orthoptera: Acrididae). *Cell Tissue Res* 291:525–536
- Oliva A (1992) Cuticular microstructure in some genera of Hydrophilidae (Coleoptera) and their phylogenetic significance. *Bull Inst R Sci Nat Belg* 62:33–56
- Oliva A (2001) Insects of forensic significance in Argentina. *Forensic Sci. Int., Forensic Entomology Special Issue* (Ed. M. Benecke) 120 (2001): 145–154
- Oliva A (2004) Description of the larva of *Oxelytrum erythrurum* (Blanchard, 1849) (Coleoptera: Silphidae). *Bull Soc R Belg Entomol* 140:141–144
- Oliva A (2010) Redescription of *Derallus strigipennis* Orchymont, 1940 (Coleoptera: Hydrophilidae), new records and a key to species of *Derallus* Sharp 1882. *Revta Mus Argentino Cienc Nat* (n s) 12(1):91–97
- Oliva A, Di Iorio OR (2008) La familia Silphidae Latreille, 1807 (Coleoptera) en la Argentina. In: Claps LE, Debandi G, Roig-Juñent S (eds) *Biodiversidad de Artrópodos argentinos* (2): 461–470
- Park S-K, Shanbhag SR, Dublin AE, de Bruyne M, Wang Q, Yu P, Shimoni N, D’Mello S, Carlson JR, Harris GL, Steinbrecht RA, Pikielny CW (2002) Inactivation of olfactory sensilla of a single morphological type differentially affects the response of *Drosophila* to odors. *J Neurobiol* 51:248–260
- Payne JA, King EW (1970) Coleoptera associated with pig carrion. *Entomol Mon Mag* 105(1969):224–232
- Peck SB, Anderson RS (1985) Taxonomy, phylogeny and biogeography of the carrion beetles of Latin America (Coleoptera: Silphidae). *Quaest Entomol* 21:247–317
- Ploomi A, Merivee E, Rahi M, Bresciani J, Ravn HP, Luik A, Sammelselg V (2003) Antennal sensilla in ground beetles (Coleoptera, Carabidae). *Agron Res* 1(2):221–228
- Segura NA, Usaquén W, Sánchez MC, Chuaire L, Bello F (2009) Succession pattern of cadaverous entomofauna in a semi-rural area of Bogotá. *Colomb Forensic Sci Int* 187(1):66–72
- Segura NA, Bonilla MA, Usaquén W, Bello F (2011) Entomofauna resource distribution associated with pig cadavers in Bogotá DC. *Med Vet Entomol* 25:46–52
- Sen A, Mitchell BK (2001) Olfaction in the Colorado potato beetle: ultrastructure of antennal sensilla in *Leptinotarsa* sp. *J Biosci* 26 (2):233–246
- Setzu MD, Poddhige S, Angioy AM (2011) Sensilla on the antennal funiculus of the blow fly, *Protophormia terraenovae* (Diptera, Calliphoridae). *Micron* 42:471–477
- Sukontason K, Sukontason KL, Piangjai S, Boonchu N, Chaiwong T, Ngern-klun R, Sripakdee D, Vogtsberger RC, Olson JK (2004) Antennal sensilla of some forensically important flies in families Calliphoridae, Sarcophagidae and Muscidae. *Micron* 35:671–679
- Sukontason K, Methanitikorn R, Chaiwong T, Kurahashi H, Vogtsberger RC, Sukontason KL (2007) Sensilla of the antenna and palp of *Hydrotaea chalcogaster* (Diptera: Muscidae). *Micron* 38:218–223
- Talarico F, Brandmayr P, Giglio A, Massolo A, Zetto Brandmayr T (2011) Morphometry of eyes, antennae and wings in three species of *Siagona* (Coleoptera, Carabidae). *ZooKeys* 100:203–214
- Uruhary-Rodrigues A, Rafael JA, Pujol Luz JR, Loureiro Henriques A, de Carvalho Queiroz MM, Rocha Barbosa R, Neves Baroni M (2010) Association of *Oxelytrum cayennense* (Silphidae, Coleoptera) with pig carcasses (*Sus scropha*, Suidae) in Terra Firme areas in Manaus, Amazonas, Brazil. *EntomoBrasilis* 3(2):45–48
- Von Hoermann C, Ruther J, Reibe S, Madea B, Ayasse M (2011) The importance of carcass volatiles as attractants for the hide beetle *Dermestes maculatus* (De Geer). *Forensic Sci Int* 212:173–179