

## Description of the cave organ in three species of the genus *Belminus* (Hemiptera: Reduviidae: Triatominae) by optical and scanning electron microscopy

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*The cave organ is a sensory receptor in the antenna pedicel of some Reduviidae. This paper describes this organ for the first time in three species of the genus Belminus, Belminus corredori, Belminus ferroae and Belminus herreri, by optical and scanning electron microscopy. The structures presented a general pattern similar to one reported for other species of Triatominae.*

Key words: sensory organs - pedicellar structure - antenna

The cave organ was originally described in the pedicel of the antenna of *Triatoma infestans* by Barth (1952) but under the name of *cova das cerdas* because of the presence of numerous digitiform prolongations covering the internal surface (Catalá et al. 1998). This organ was defined by Barth (1952) as a cuticular invagination formed by a closed ellipsoidal cavity in the pedicel, with a thin connecting channel open at the invagination. Among the Triatominae, descriptions of this structure have been reported for 18 species of the genera *Triatoma* Laporte, 1832, *Rhodnius* Stål, 1859, *Panstrongylus* Berg, 1879, and *Eratyrus* Stål, 1859 (Barth 1952, Catalá 1994, Catalá et al. 1998, Weirauch 2003), but no description has been published for the genus *Dipetalogaster* Usinger, 1939 (Weirauch 2003). In other subfamilies of Reduviidae, such as Peiratinae, Reduviinae and Stenopodainae, the description of the cave organ has been reported by Weirauch (2003) and this structure is becoming a structure of value in the study of phylogenetic systematics of Reduviidae. This organ has not been recorded in the genus *Belminus* Stål, 1859, and here we describe this pedicellar structure in three species: *Belminus herreri* Lent and Wygodzinsky, 1979, *Belminus corredori* Galvão and Angulo 2006 and *Belminus ferroae* Sandoval, Pabón, Jurberg and Galvão 2007.

We used specimens of the three species of *Belminus* from laboratory colonies kept at a temperature of 24°C ± 3°C and a relative humidity of 60% ± 10%. The insects were fed on Dictyoptera of the genus *Blaberus* Serville, 1831. The parental specimens of these colonies were captured in the following localities in Colombia: *B. corredori* in San Gil, department of Santander, in 2003, *B. herreri* in San Martín, department of Cesar, in 2001, and

*B. ferroae* in Toledo, department of Northern Santander, in 2004 (Sandoval et al. 2004, 2010, Galvão & Angulo 2006). The antennae were removed at the scape for study by optical microscopy (OM), clarified with 10% w/v KOH for 1-2 h at 50°C, washed with plenty of water, dehydrated in ethanol and immersed in phenol for half an hour. Five antennae were examined in each nymphal stage and in adults of both sexes for the three species under study. Drawings of the cave organ were made in under *camera lucida* at 40X. Even though *T. infestans* Klug, 1834 was not analysed in this paper, we included a drawing of its cave organ for the purpose of comparing it with the *Belminus* species cave organs studied here. For scanning electron microscopy (SEM), antennae of adults of both sexes were removed and directly mounted in a lateral position on a double-sided tape onto a metal support and then metallised with gold for 2 min in a SPI-Module™ operated at 10 mA. The micrographs were taken with a Hitachi S-2500 electron microscope operated at 20 kV.

The species of Triatominae for which the cave organ has been studied are shown in Table I. This sensory structure was observed only in adults of both sexes in the three species of the genus *Belminus*; there was no apparent sexual dimorphism. The cave organ is located in the external lateral region, near the distal trichobothria, as reported for other Reduviidae (Barth 1952, Catalá 1994, Catalá et al. 1998, Weirauch 2003). Under OM, the cave organ shows three clearly differentiated areas: the opening, the tunnel and the main cavity (Fig. 1). In these three species, the opening is clearly sclerotised and is larger in size in *B. ferroae* (Fig. 2A, B). A heavily sclerotised tunnel is also observed, sometimes bent, which narrows down towards the end that connects to the main chamber; this chamber is clearly sub-spherical (Fig. 1). These characteristics contrast with those of species of *Rhodnius*, *Triatoma* and *Panstrongylus* which have a main chamber that is clearly enlarged (Catalá et al. 1998). By SEM, differences in the opening were also observed: *B. corredori* and *B. herreri* were smooth,

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in contrast to *B. ferroae*, which has a more ornamented tegument around the opening (Fig. 2). An opening with smooth borders is common in species of the genus *Triatoma*, and the opening is more ornamented in *Rhodnius* species (Catalá 1994). The opening structures were 7.4–14.8  $\mu\text{m}$  in width for the species of *Belminus* (Table II), similar but less variable than the widths reported for the genera *Rhodnius* (6–20  $\mu\text{m}$ ) and *Triatoma* (3–20  $\mu\text{m}$ ) (Catalá 1994). The function of the cave organ

remains controversial; Barth (1952) proposes that it is an infrared receptor. Other electrophysiological studies in *T. infestans* support this hypothesis (Lazzari & Wicklein 1994). However, Catalá et al. (1998) states that the ultrastructure of the cave organ studied in five species of Triatominae is also consistent with an olfactory function and its position on the outer face of the pedicel, as well as its particular spatial pattern, suggests a possible role in monitoring molecules during flight. Catalá et al.

TABLE I  
List of species of Triatominae that have had the cave organ studied by method and references

Genus	Species	Approach	References
<i>Triatoma</i>	<i>T. infestans</i> (Klug 1834)	OM, SEM, TEM, EAG	Barth (1952), Catalá (1994), Lazzari and Wicklein (1994)
	<i>T. guasayana</i> Wygodzinsky & Abalos 1949	SEM	Catalá (1994)
	<i>T. patagonica</i> Del Ponte 1929	SEM	Catalá (1994)
	<i>T. rubrovaria</i> (Blanchard 1843)	OM	Catalá et al. (1998)
	<i>T. dimidiata</i> (Latreille 1811)	OM	Catalá et al. (1998), Weirauch (2003)
	<i>T. protracta</i> Uhler 1894	OM	Catalá et al. (1998)
	<i>T. sordida</i> (Stål 1859)	OM, SEM, TEM	Barth (1952), Catalá et al. (1998)
<i>Panstrongylus</i>	<i>P. megistus</i> (Burmeister 1835)	OM	Barth (1952), Catalá et al. (1998)
	<i>P. geniculatus</i> (Latreille 1811)	OM	Weirauch (2003)
<i>Rhodnius</i>	<i>R. pictipes</i> Stål 1872	SEM	Catalá (1994), Catalá and Schofield (1994)
	<i>R. neglectus</i> Lent 1954	SEM	Catalá (1994), Catalá and Schofield (1994)
	<i>R. nasutus</i> Stål 1859	SEM	Catalá (1994), Catalá and Schofield (1994)
	<i>R. prolixus</i> Stål 1859	OM, SEM	Barth (1952), Catalá (1994), Catalá and Schofield (1994), Weirauch (2003)
	<i>R. ecuadoriensis</i> Lent & Leon 1958	SEM	Catalá (1994), Catalá and Schofield (1994)
	<i>R. paraensis</i> Sherlock, Guitton & Miles 1977	SEM	Catalá (1994), Catalá and Schofield (1994)
	<i>R. pallescens</i> Barber 1932	SEM	Catalá (1994), Catalá and Schofield (1994)
	<i>R. neivai</i> Lent 1953	SEM	Catalá (1994), Catalá and Schofield (1994)
<i>Eratyrus</i>	<i>E. mucronatus</i> Stål 1859	OM	Weirauch (2003)
<i>Dipetalogaster</i>	<i>D. maxima</i> <sup>a</sup> (Uhler 1894)	OM	Weirauch (2003)
<i>Belminus</i>	<i>B. herreri</i> Lent & Wygodzinsky 1979	OM, SEM	This paper
	<i>B. corredori</i> Galvão & Angulo 2006	OM, SEM	This paper
	<i>B. ferroae</i> Sandoval, Pabón, Jurberg & Galvão 2007	OM, SEM	This paper

a: without cave organ; EAG: electroantennogram; OM: optical microscopy; SEM: scanning electron microscopy; TEM: transmission electron microscopy.

(1998) do not disregard the infrared function proposed by Barth (1952), instead assigning a double function to the cave organ. The discovery of this organ in apterous Reduviidae suggests that this structure works well for species with no or low dispersal capacity by flight (Weirauch 2003). *B. corredori* is the only species of the genus

for which both sexes are brachypterous, but this species has a cave organ of similar development as the other two species of *Belminus*, which are macropterous.

For the first time, the description of the cave organ is reported for the genus *Belminus* with a main pattern similar to that described for other species of Reduviidae. Even though not all known species of the *Belminus* genus were analysed in this paper, we propose that the ornamentation around the opening and the dimensions and the design of the tunnel and of the chamber could be specific characteristics of the genus *Belminus*.

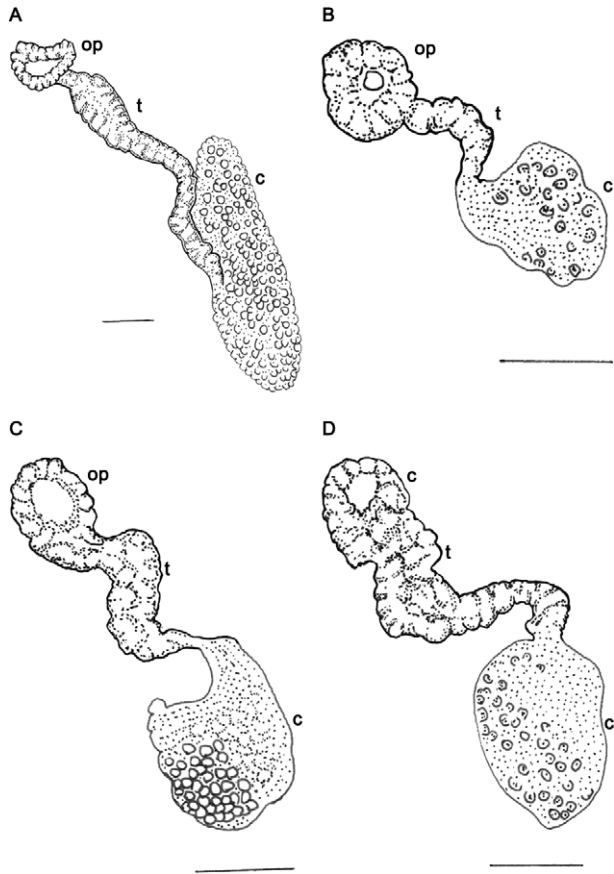


Fig. 1A: cave organ showing the opening (op), tunnel (t) and main cavity (c) in *Triatoma infestans*; B: in *Belminus corredori*; C: in *Belminus ferroae*; D: in *Belminus herreri*. Bar = 20  $\mu$ m.

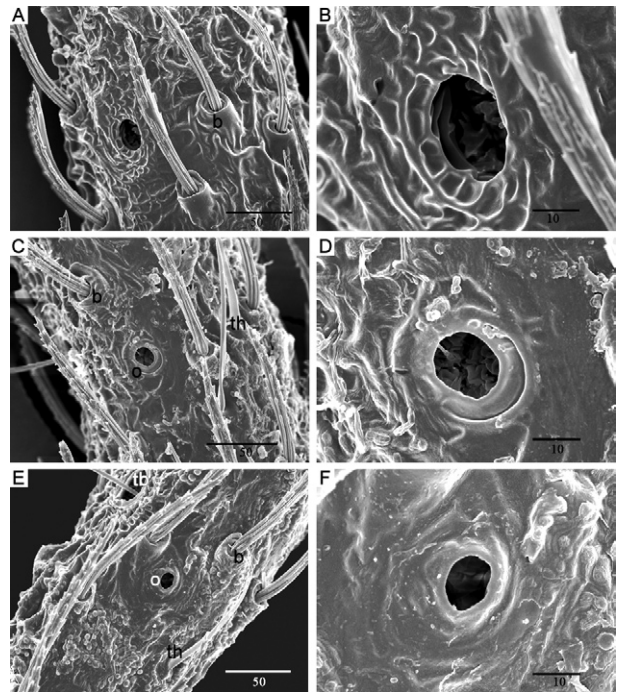


Fig. 2: external side of the second antennal segment (pedicel) showing the external opening of cave organ (o) 1,500-5,000X. A, B: *Belminus ferroae*; C, D: *Belminus herreri*; E, F: *Belminus corredori*; b: bristle; tb: distal trichobothria; th: thin-wall trichoid. Bar in microns.

TABLE II  
Measurements in microns of the main structures of the cave organ in the three species of *Belminus*

Structure	<i>Belminus corredori</i>	<i>Belminus herreri</i>	<i>Belminus ferroae</i>
Opening (diameter major)	10.87 (1.73, 15.89)	9.8 (2.89, 29.10)	11.32 (1.21, 10.73)
Tunnel	29.39 (5.64, 19.18)	37.87 (9.69, 25.58)	29.64 (5.63, 19)
Cavity	24.21 (4.00, 16.52)	32.11 (7.95, 24.77)	33.35 (5.12, 15.36)
Total longitude	62.99 (6.91, 10.97)	78.22 (18.52, 23.68)	76.98 (4.25, 5.52)

average, standard deviation and coefficient of variation in parenthesis.

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