Revista Ibérica de Aracnología, nº **33** (31/12/2018): 75–80.
Grupo Ibérico de Aracnología (S.E.A.). ISSN: 1576 - 9518.

DESCRIPTION OF *CHARON DANTEI* SP. NOV. AND FIRST RECORD OF *DAMON BRACHIALIS* WEYGOLDT 1999 (AMBLYPYGI: CHARONTIDAE, PHRYNICHIDAE) FROM LA RÉUNION ISLAND

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Abstract: *Charon dantei* **sp. nov.** is described from La Réunion island in the Mascarene archipelago and the presence of *Damon brachalis* Weygoldt, 1999 is also recorded for the first time from this island territory. While *D. brachialis* appears to have been introduced, it remains unclear if *C. dantei* is native to this island, or if it is an alien species. Both species appear to be very rare: of *C. dantei* only six specimens have been caught in 39 years, while in the case of *D. brachialis* only one specimen was captured, but several others were observed. This is the first report of amblypygids from the Mascarene archipelago.
Key words: Amblypygi, Charontidae, Phrynichidae, whip spiders, systematics, Mascarene archipelago.

Descripción de *Charon dantei* sp. nov. y primera cita de *Damon brachialis* Weygoldt 1999 (Amblypygi: Charontidae, Phrynichidae) de la isla Reunión
Resumen: Se describe *Charon dantei* **sp. nov.** de la isla Reunión, en el archipiélago de las Mascareñas, y se registra también, por primera vez, la presencia de *Damon brachalis* Weygoldt, 1999 en este territorio insular. Mientras *D. brachialis* parece ser una especie introducida, no está claro si *C. dantei* también lo es o por el contrario es nativo de la isla. Ambas especies parecen ser muy escasas: de *C. dantei* se han recogido sólo 6 especímenes en 39 años, mientras que de *D. brachialis* se ha recogido sólo uno pero se han observado varios más. Es la primera vez que se registran amblipígidos de las Islas Mascareñas.
Palabras clave: Amblypygi, Charontidae, Phrynichidae, amblipigios, sistemática, Islas Mascareñas.

Taxonomy/Taxonomía: *Charon dantei* **sp. n.**

Introduction

The Mascarene archipelago in the Indian Ocean has, to date, received relatively little attention despite its classification as one of the world's major biodiversity hotspots (Myers *et al.,* 2000). La Réunion is the biggest island of that chain. Appeared 2.3 million years ago from a volcanic activity (Gomy, 2000), it was never connected to any other emerged land. As the youngest island, La Réunion has a landscape shaped by ongoing volcanic activity (Gillot & Nativel, 1982; 1989) and characterized by a steep altitudinal gradient and a great variety of habitats. Two volcanoes dominate La Réunion: the extinct Piton des Neiges (3070 m) and the active Piton de la Fournaise (2631 m) (Strasberg *et al.,* 2005). The island is dissected by three huge caldera-like valleys (*cirques*) created by heavy rainfall erosion, with very deep gorges culminating in narrow outlets to the ocean. This geological barrier helps to separate the island in two different climates: the dominant wind blowing from east to west, the eastern part receives around nine meters of rainfall per year contrary to the western side which receive between 500 and 1500 mm per year (Strasberg *et al*., 2005). Together, climatic and geological variables conspire to create a complex of some 19 habitat types on La Réunion, within which species diversity and endemism broadly differ (Strasberg *et al.,* 2005; Chintauan-Marquier *et al.,* 2016; Martire & Rochat, 2008).

Environmental gradients and discontinuities across the island offer considerable opportunity for adaptive divergence and thought to have led to a great differentiation within taxa such as the bird species *Zosterops borbonicus* (Forster, 1781) (Mila *et al.,* 2010), or the mosquito species *Anopheles arabiensis* (Patton, 1905) (Morlais *et al.,* 2005) and *Aedes albopictus* (Skuse, 1894) (Paupy *et al.,* 2001). The Mascarene biota has been long separated from Madagascar, since the Seychelles and Mascarene are related more to the Asian fauna than to the Afrotropical (Hugel, 2012; Martire & Rochat, 2008).

Whip spiders were not known from the Mascarenes' fauna. Close to this archipelago, only three species were known from Madagascar (Harvey, 2003): *Charinus madagascariensis* (Fage, 1954), *Euphrynichus bacilifer* (Weygoldt, 1995) and *Phyrnichus madagascariensis* (Weygoldt, 1998) and two species were known from Seychelles Island (Simon, 1892; Harvey, 2003; Weygoldt, 2010): *Phrynichus scaber* (Gervais, 1844) and *Charinus seychellarum* (Kraepelin, 1898).

In 2013, the *Insectarium de La Reunion* contacted us regarding two specimens of *Charon* sp. collected in the eastern region of the Island (Saint-André) held in their collection, and a specimen of *Damon sp.* caught in the western region (Les Avirons) (Fig 1). They attempted to breed the *Charon* sp. in 2004, which survived three months before dying. After investigations we discovered three more specimens of *Charon* sp. held in the collection of the Natural Museum of La Reunion Island, caught in the city center of Saint-Denis in 1979, and misidentified as *Damon medius* (Herbst, 1797). All *Charon* specimens –kept dry- appeared to belong to a new species. Later (in 2017) we obtained a juvenile –unfortunately also conserved dried- which was caught in 2015 in the type locality. Therefore we visited the type locality (in 2013, and 2014), along with the primary forest of the island, and even the lava's tunnels on the eastern part of the island to find more fresh specimens but it was unsuccessful.

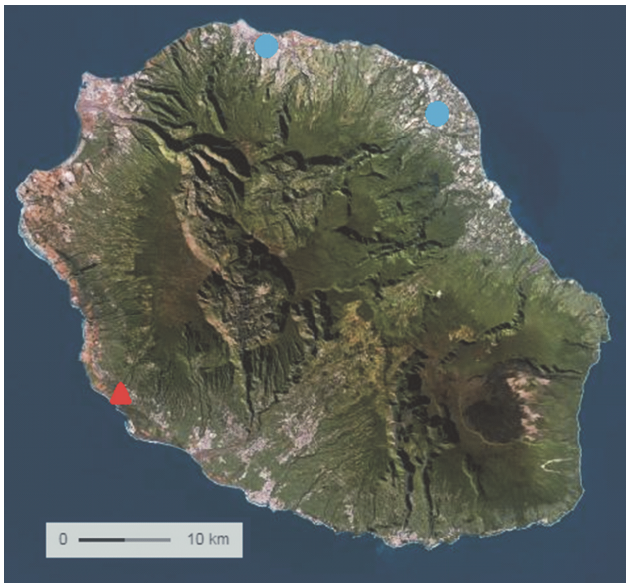


Fig. 1. Map of La Réunion island with the location of the specimens: blue circles: *Charon dantei*; red triangle: *Damon brachialis*. Map modified after Géoportail (https://www.geoportail.gouv.fr/).

The genus *Charon* is represented by six species known in the Indo-Pacific Region (Harvey, 2003; Harvey & West, 1998; Rahmadi *et al.,* 2011). Three are known from Northern Australia and Christmas Island: *C. gervaisi* Harvey & West, 1998, *C. oenpelli* Harvey & West, 1998, and *C. trebax* Harvey & West, 1998. One from Solomon islands: *Charon forsteri* (Dunn, 1949), one from Lanyu island: *C. ambreae* Reveillion & Maquart, 2018. The fifth species, *Charon grayi* (Gervais, 1842) is currently known from Indonesia (Java, Maluku, Sumbawa), Malaysia, Palau, Papua New Guinea, Philippines, Singapore and Solomon Islands (Harvey, 2003). Most likely its real distribution would be lesser, and probably restricted to the type locality (*i.e.* Manila, Luzon island, The Philippines). A taxonomical work need to be conducted to redescribe this species and fully understand its repartition in the indo-malaysian and Papuan islands. However the species described in this paper differs greatly both morphologicaly and geographicaly from the other known species among this genus making it less likely that they are in fact conspecific with any of the names previously proposed in the literature.

Material and Methods

The depicted specimens were taken in picture by Florian Réveillion with an Eos 5DII Canon DSLR and a 100 mm macro F/2.8 L IS UMS Canon lens, lighten with a 580 EXII Canon Cobra flash.The designation terms follows Réveillion & Maquart (2018) *i. e.* the patella pedipalp spines are counted distally to proximally and from proximal to distal for the femur. Ventral spines are noted in Roman numbers and dorsal spines in Arabic numbers. The first letter of the name of the segment is placed above the number of the spine. The specimens were rehydrated using distilled water, before being studied, and then re-dried as all the soft tissues were gone due to the poor conservation state of the specimens.. The surface sculpture follows the terms of Harris (1979). All labels were written in verbatim format.

Abbreviations: **MHNLR**: Muséum d'histoire naturelle, Saint-Denis, La Réunion Island, France. **MNHN**: Muséum National d'Histoire Naturelle, Paris, France. **SHNY**: Société d'Histoire Naturelle de l'Yonne, 59 rue de la république, 89150 St Valérien, France.

Results

Family Charontidae Simon, 1892

Genus *Charon* Karsh, 1879

DIAGNOSIS: The combined presence of arolium on tarsi II-IV, the presence of a row of setae proximal to the cleaning organ, the four denticles on the inner or median row of the chelicera, the presence of 2 large spines of almost equal size followed distally by a spine which length reduce during post embryonic growth on the antero dorsal margin of the pedipalp tibia and an undivided pedipalp tarsus distinguishes *Charon* from all other amblypygids (Harvey & West, 1998; Weygoldt, 2000; Rahmadi *et al.,* 2011).

KEY TO THE GENUS *CHARON*

1. Basitibia IV with three segments; distitibia IV with 20 trichobothria..... ***Charon trebax*** Harvey & West, 1998
– Basitibia IV with four segments; distitibia IV with more than 20 trichobothria..... 2
2. Pedipalp tibia with two spines in its dorsal margin; distitibia IV with 22-25 trichobothria..... 3
– Pedipalp tibia with three spines in its dorsal margin; distitibia IV with more than 25 trichobothria..... 4
3. Pedipalp patella with four antero dorsal and four antero ventral large spines; distitibia IV with 25 trichobothria.. .....***Charon forsteri*** (Dunn 1949).
– Pedipalp patella with five large antero dorsal and six large antero ventral spines ; distitibia IV with 22 trichobothria ..... ***Charon ambreae*** Réveillion & Maquart, 2018
4. Ventral margin of the pedipalp tibia with three spines; distitibia IV with 26 trichobothria; eyes reduced in size .....***Charon oenpelli*** Harvey & West, 1998
– Ventral margin of the pedipalp tibia with two spines; distitibia IV with more than 30 trichobothria; well develop eyes 5
5. Pedipalp patella with eight antero dorsal spines and eight antero ventral spines ; distitibia IV with 36 trichobothria .....***Charon grayi*** (Gervais, 1842)
– Pedipalp femur with less than 6 antero-dorsal spines; pedipalp patella with 6 antero-ventral spines ; distitibia IV with 30 trichobothria..... 6
6. 4 large spines on the antero-dorsal margin of the pedipalp femora, 5 on its antero-ventral margin; 6 large spines on the antero-dorsal margin of the pedipalp patella ....***Charon gervaisi*** Harvey & West, 1998
– Large spines on the antero-dorsal magin of the pedipalp femur, 6 on its antero-ventral margin; 5 large spines on the antero-dorsal margin of the pedipalp patella ....***Charon dantei*** **sp. nov.**

***Charon dantei* Maquart & Réveillion sp. nov.**
Figures 1-2.

DIAGNOSIS: *Charon dantei* differs from *C. trebax,* by having 4 segments on the basitibia IV, instead of 3. It differs also from *C. forsteri*, *C. trebax* and *C. oenpelli* by having 30 trichobothria on the distitibia IV, while the others have 25, 20,

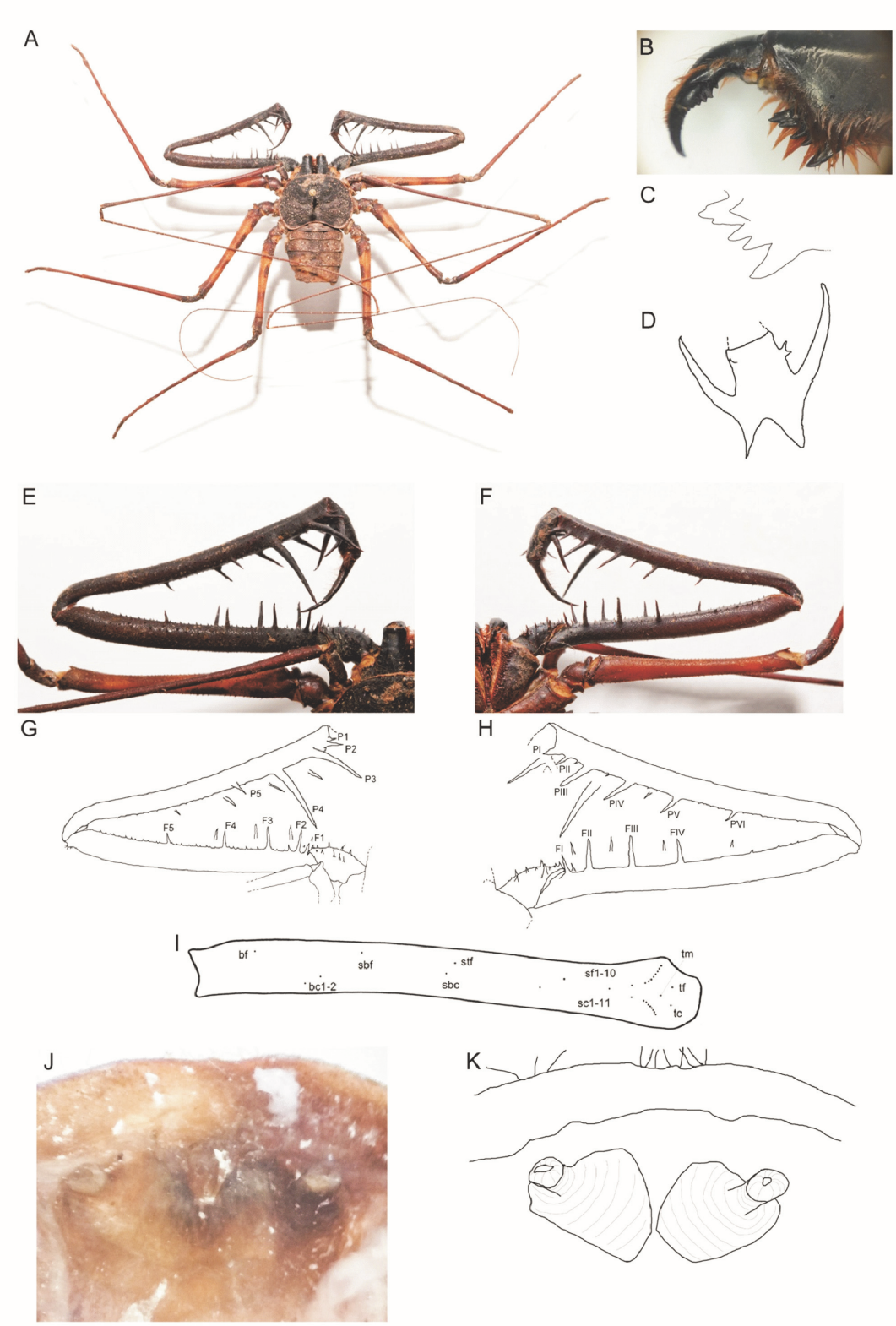


Fig. 2. *Charon dantei* sp. nov. female holotype: **A**: habitus; **B**: left chelicerae, external view; **C**: teeth of the left chelicerae, external view; **D**: right pedipalp metatarsus, internal view; **E** & **G**: left pedipalp, dorsal view; **F** & **H**: left pedipal, ventral view; **I**: distitarsus of the right leg IV; **J** & **K**: female gonopods.

26 respectively. *Charon dantei* differs from *C. grayi* and *C. gervaisi* by having 5 spines on the dorsal side of the pedipalpal femur, while *C. grayi* has 7 and *C. gervaisi* has 4 and 6 on its ventral side (5 for *C. grayi* and *C. gervaisi*), in addition, *C. dantei* possess 5 spines on the dorsal side of the pedipalp tibia (6 for *C. grayi* and *C. gervaisi*), and 6 on its ventral side (7 for *C. grayi*, 6 for *C. gervaisi*).

ETYMOLOGY: the name species is dedicated to the 13th century's Italian poet Dante Alighieri, famous for his poem *Inferno*, where he appears with Virgil crossing the Styx river on a boat driven by Charon which refers to the genus name.

DESCRIPTION: Female holotype:

Carapace: reniform; the ocular tubercle have the same coloration as the rest of the carapace, two well develop eyes in the

median ocular tubercle, median eyes well develop. Six setae on middle of the anterior margin, and 9 in each antero-lateral margin (near the lateral ocular tubercles). Deeply impressed fovea surrounded by rounded bumps. The fovea is located at posterior 1/3 of the cephalothorax length. **Sternum:** consisting of 3 sclerotized parts: tritosternum with a round base and projecting anteriorly between pedipalp coxa in an elongated process, a little over 5 times longer than wide, bearing many setae; middle piece about the same width of tritosternum, rounded, convex, anteriorly with 2 strong setae positioned centrally; third sclerite rounded and convex, about the same size as second sclerite, with 2 large setae positioned centrally. **Chelicera:** bearing four internal teeth on antero-lateral margin. Proximal one very large (about 2 times longer than wider), 2 median teeth –spines like– about half the size of the proximal one; distal teeth about 2/3 of proximal teeth, trifid: the median cusp being the largest. Presence of an external tooth on retro-lateral margin, located in front of the distal internal tooth, measuring half the median internal teeth, as long as wide (Figure 2 B-C). Claw with 6 teeth.

Pedipalp: Trochanter: 5 spines on antero-ventral margin, 3 on antero-dorsal margin and 7 on latero-ventral margin; **Femur:** bearing dorsally 5 major spines (F3=F2>F4>F1=F5), one small spine between F2 and F3 and many spinelets, F4 almost 3/4 of F2 and the distal (F5) is half of F2; ventrally with 4 primary spines, one more between FIV and the distal margin of the femur, and many spinelets (FII=FIII>FIV>FI), FIV almost 3/4 of FII, proximal spine (FI) as long as 1/2 of median spines (FII and FIII); **Patella:** bearing dorsally 5 large spines, one small between FIII and FIV and many spinelets, T1<T2=T5<T3<T4; T1=2/3 T2, T2=1/3 T3, T3=3/4 T4;bearing ventrally 6 large spines, more one small between TII and TIII, and another small between TIII and TIV and many spinelets, TVI<TI=TII<TV<TIV<TIII, TVI=2/3 TII, TII=1/2 TIII, TIV=2/3 TIII, TV=2/3 TIV; **Tibia:** bearing dorsally 1 proximal very large spine and 1 bifid distal small spine, bearing also 1 proximal very large spine and 1 distal small spine ventrally; **Tarsus:** long, hairy, without spines, basal setae line on the cleaning organ, no articulation between distitibia and terminal claw.

Legs: bearing many setae; length of I>III>II>IV, tibia I with 26 articles, tarsus I with 44 articles. Tarsi II, III, IV with 4 articles, bearing arolium at their terminal end; **Leg IV, basitibia**: divided into 4 pseudo-articles, one trichobothria on the last pseudo-article; **distitibia:** 30 trichobothria (1 bf, 2 bc, 1 sbf, 1 sbc, 1 stf, 10 sf, 11 sc, 1 tm, 1 tf, 1 tc. (Figure 2D). **Basitibia-distitibia length**: BT1>DT>BT2=BT3<BT4.

Genitalia: Gonopods rounded, with a finger-like appendice projected backward. The distal side of the appendix invaginated. Posterior margin of sternite with setae.

Color: Live: Pedipalps, cephalothorax and abdomen greyish, legs crimson bearing 4 dark stripes (Fig. 3) **Dry:** Cephalothorax, abdomen and pedipalps: dark brown. Legs: crimson, except femora II, III and IV yellowish bearing 4 dark stripes (Figure 2A).

Measurements (in mm): Holotype: Cephalothorax: length: 10.73, width: 14.97; Pedipalp: femur: 23.83, tibia: 25.27, basitarsus: 5.02, distitarsus and tarsal claw: 7.57.

TYPE MATERIAL (all kept dry):

HOLOTYPE ♀ : «France, Ile de La Réunion, 97440, Saint-André, Sous sol ou Canalisation [*basement or pipes*], capturé le [*date of capture*] 28/X/2004, Mort [*died*]: I/2005; Leperlier E. Leg.», [MNHN]; PARATYPES: 1 juvenile «France, Ile de La Réunion, 97400, Centre ville de Saint-Denis [*city center of Saint Denis*], sur un balcon [*on a balcony*].» [MNHN]. 3♀♀: «*Damon medius* [*misidentification*] 29/9/1979, Camélias, Cour du Crédit Agricole, S^{t} Denis (Reunion)» [MHNLR]. 1 juvenile «France, Ile de La Réunion, 97400, St André, 2015» [SHNY].

Family Phrynichidae Simon, 1892

A specimen of *Damon brachialis* Weygoldt, 1999 was recorded and seen multiple times in La Réunion (J. Rochat, com. pers. 2016; S. Gasnier, com. pers. 2015). Only one dry specimen of this genus was found in the collection of *L'Insectarium de La Reunion* (Fig. 4). The specimen was identified using Prendini *et al.* (2005) and Weygoldt (1999) keys and fits perfectly to the description of *Damon brachialis* Weygoldt, 1999. The species is known from Southern Africa (Zambia, Zimbabwe, Malawi and Mozambique) (Harvey 2003), despite its poor conservation state the specimen is deposed in the collections of the *Museum d'Histoire Naturelle de Paris.*

EXAMINED MATERIAL: 1♀: «France, Ile de La Réunion, [*Post code*] 97425, Les Avirons, 21/VIII/2008, Trouvé mort dans une usine de canne à sucre [*found dead in a sugar-cane transformation factory*]» [MNHN].

Discussion

The Mascarene biota is considered as one of the biodiversity hotspots (Myers *et al*., 2000). Despite its small size La Réunion's fauna remains partially unknown, and it is interesting to notice that such a large species was not described yet. Usually, most of La Réunion's endemic species are restricted to the altitude-primary forest (Warren *et al.,* 2016; Gomy *et al.,* 2016), while, in this case, both whip spiders species were found in anthropic areas. *Damon* sp. and *Charon* sp. are often found near households, and garbage disposal areas. Amblypygi introduction are very rare, and only one case was reported so far by Teruel & Fredrich (2016). The present case of *Damon brachialis* is the second reported example. While recent reports suggest that the species might be well established in La Réunion Island (J. Rochat, com. pers. 2016; S. Gasnier, com. pers. 2015), the species is known to occur in Southern Africa (Zambia, Zimbabwe, Malawi and Mozambique).

It is yet unclear whether *Charon dantei* is indigenous or not from La Réunion Island. The first record of this species was done in 1979 and since then, 3 more specimens were found recently (2004, 2015, 2016), so the species seems well established. No whip spider specimens appeared to have been observed nor collected in Mauritius nor Rodrigues islands yet. We can assume that amblypygid species might be present as well in those two islands, as the biota of the three islands is very related (Gomy, 2000; Gomy *et al.,* 2016).

Recently, with the help of the *Insectarium de La Réunion* large prospection and determinations efforts were made to fill the knowledge gap of La Réunion –and its adjacent islands- fauna. We hope to get more specimens in the future to 1) describe the male of *Charon dantei,* and 2) be able to state if the species is indigenous or not from La Réunion Island. Filling this knowledge gap will be a step further in understanding the colonisation of the volcanic island.





Fig. 3. Live holotype of *Charon dantei*. Picture with the courtesy of Sophie Gasnier (*Insectarium de La Réunion*). **Fig. 4.** Dead specimen of *Damon brachialis* in a sugar cane transformation factory in La Réunion Island (Les Avirons) in 2004. Picture with the courtesy of Sophie Gasnier (*Insectarium de La Réunion*).

Acknowledgements

We would like to warmly thank Jacques Rochat and Sophie Gasnier (Insectarium de La Réunion), without who, we would never have heard about those specimens, and for having shared with us -and allowed us to use- their pictures. Also, we would like to thank the *Muséum d'Histoire Naturelle de l'Ile de La Réunion***,** for their warm welcome, and to have kindly let us study the three specimens of *Charon dantei*. We would like also to thank the editor and reviewers whose comments helped us to improve the manuscript.

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