Bulletin de la Société entomologique de France, **118** (3), 2013 : 371-377.

Sexual dimorphism in the second-instar nymphs of *Aonidomytilus albus* (Cockerell, 1813) (Hemiptera, Diaspididae)

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Abstract. – The second-instar male and female nymphs of the armoured scale insect *Aonidomytilus albus* (Cockerell) show appreciable difference in shape and morphology. These morphological differences are described and illustrated.

Résumé. – **Dimorphisme sexuel au deuxième stade larvaire chez *Aonidomytilus albus* (Cockerell, 1813) (Hemiptera, Diaspididae)**. Les larves mâle et femelle du deuxième stade de la Cochenille diaspine *Aonidomytilus albus* (Cockerell) présentent des différences dans la forme du corps et la morphologie. Leurs caractéristiques sont décrites et illustrées.

Keywords. – Cassava armoured scale insect, second-instar male and female nymphs, *Manihot esculenta*, Madagascar.

The armoured scale insects or diaspidids (Hemiptera, Coccoidea, Diaspididae) are the most specialized plant parasites in Hemiptera and cause serious phytosanitary problems in the world (Beardsley & Gonzalez, 1975). Their correct identification can only be made from a detailed study of the adult females on microscope slides (Miller & Davidson, 2005; Miller & Kosztarab, 1979). They can be serious pests, especially when they are invasive species (Ben-Dov, 2012) like on cassava crops (*Manihot esculenta* Crantz) (Euphorbiaceae) in South America, Asia and Africa. In many countries of humid and sub-humid tropics, in Africa as in Madagascar, cassava is one of the major sources of food and constitutes also a nutritionally strategic famine reserve crop in areas of unreliable rainfall (Cock, 1982).

Aonidomytilus albus (Cockerell, 1893) is a pantropical polyphagous species. It is a serious pest of cassava (Bellotti, 1979; Bellotti & Schoonhoven, 1978; Miller & Davidson, 2005). This species has been known in Madagascar since 1912 under the name of its synonym *Mytilaspis* (*Coccomytilus*) *dispar* Vayssière, 1913, described from Madagascar but synonymized by Ferris (1941). Mamet (1950, 1953, 1959), in his studies of the Coccoidea of Madagascar, already mentioned the species under the name of *Aonidomytilus albus* (Cockerell) from a collection from Mahitsy, V.1950 (*R. Paulian coll.*) and Manakambahiny-Est, VI.1951 (*A. Robinson coll.*).

Over the last ten years, this species has caused serious damage to cassava crops in Madagascar. Heavy infestations were recorded between 1998 and 2002 when the dry season was longer during this period. In those years, this insect was of economic importance in Madagascar (Razafindrakoto *et al.*, 1999; Raeliarisoa Razafindrakoto & Matile-Ferrero, 2008). Chemical control is often difficult, and is frequently followed by recurrent infestations (Miller & Davidson, 2005; Razafindrakoto *et al.*, 1999; Riehl, 1990). A study on its morphology was carried out, starting in 1998 in Madagascar where accurate identification of armoured scale insect pests was a critical first step toward developing effective pest management systems.

In other respects, armoured scale insects are characterized by extremely reduced morphological characters in the adult female (loss of legs and reduced antennal segments). The current classification of the Diaspididae is largely based on the external features of the adult female (BALACHOWSKY, 1954; BEN-DOV, 1990; MILLER & DAVIDSON, 2005). According to HOWELL & TIPPINS (1990), there was very little descriptive information available on immature forms but since, there are many examples (*e. g.* TAKAGI, 2000, 2002; AONO, 2009; HENDERSON, 2011).

BORATYNSKI (1953) was the first to demonstrate sexual dimorphism in the second-instar nymphs in the two subfamilies Aspidiotinae and Diaspidinae: *Diaspidiotus bavaricus* (Lindinger, 1912), *Quadraspidiotus ostreaeformis* (Curtis, 1843) presently *Diaspidiotus ostreaeformis* (Curtis, 1843), *Q. zonatus* (Frauenfeld, 1868) presently *D. zonatus* (Frauenfeld, 1868), *Aulacaspis rosae* (Bouché, 1833), *Carulaspis sp.*, *Chionaspis salicis* (Linnaeus, 1758) and *Lepidosaphes ulmi* (Linnaeus, 1758). BENNETT & BROWN (1958) reported colour differences in both eggs and crawlers males and females of *Pseudaulacaspis pentagona* (Targioni Tozzetti, 1886). STOETZEL & DAVIDSON (1974a, b) illustrated sexual dimorphism in the immature stages of 9 species of Aspidiotinae: *Abgrallaspis ithacae* (Ferris, 1938), *A. townsendi* (Cockerell, 1905) presently *Diaspidiotus ancylus* (Putnam, 1878), *Aspidiotus cryptomeriae* Kuwana, 1902, *A. nerii* Bouché, 1833, *Diaspidiotus liquidambaris* (Kotinsky, 1903), *Diaspidiotus mccombi* McKenzie, 1963, *D. osborni* (Newell & Cockerell, 1898), *Hemiberlesia diffinis* (Newstead, 1893), and *H. lataniae* (Signoret, 1869).

Preliminary studies of the immature stages of *Aonidomytilus albus*, belonging to the Diaspidinae Lepidosaphedini, were shown on a poster (RAELIARISOA RAZAFINDRAKOTO & MATILE-FERRERO, 2008). Here we give the detailed morphological description and illustrations of the second-instar male and female nymphs of this species.

MATERIAL AND METHODS

The second-instar male and female nymphs were obtained and mounted on slide from collections made by the first author in Madagascar, from material on *Manihot esculenta*, Ambohimanga-Alaotra, 30.XI.2003 and Antananarivo, Ambatobe, 7.IV.2012. Part of the material

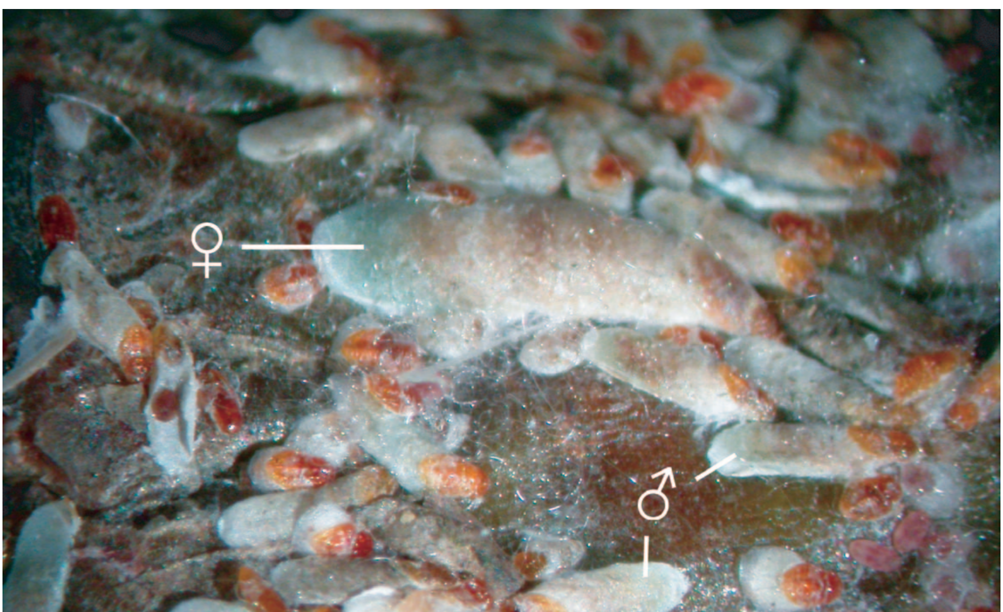

Fig. 1. – *Aonidomytilus albus* (Cockerell), insects in life. Adult female scale cover (L = 2.5-3.0 mm) and male scale cover (L = 1.2-1.5 mm) (*photo J. Legrand, MNHN Paris*).

is deposited in the Muséum national d'Histoire naturelle, Paris, and in Fofifa/Centraderu, station Alaotra, Ambohitsilaozana, Madagascar.

Description of the second-instar male and female nymphs

Unmounted material. – Fig. 1. The scale cover of *Aonidomytilus albus* is different in shape and colour in each sex. The second-instar male nymph produces an elongate narrow scale whitish, with the exuviae of the first-instar nymph light brown at one end. The second-instar female nymph is covered by a pyriform waxy scale, whitish, with the exuviae of the first-instar female nymph light brown at one end.

Mounted second-instar male nymph. – Fig. 2A-G. Body elongate-oval, more or less parallel-sided, 0.45-0.55 mm long, 0.23-0.30 mm wide, membranous.

Pygidium. Segment VI and following abdominal segments fused. With 2 pairs of lobes. Median lobes (L1) parallel-sided, large, rounded apically, notched on both sides, separated by a space equal to width of a single lobe. Second lobes bilobed, with inner lobule narrower than a median lobe, outer lobule about half as wide as inner lobule. Four large marginal 2-barred macroducts present, one on each prepygidial and pygidial segments V-VIII. Gland spines conspicuous, longer than lobes, present in a pair between median lobes. A single gland spine present on each of segments VI to VIII of pygidium. Submarginal setae as long as gland spines, one on each pygidial segments dorsally and ventrally (fig. 2B).

Venter. Antennae one-segmented, each bearing 3 sensory setae, 1 basiconic seta and 1 pointed seta (fig. 2D). Eye spot present. Labium short, unsegmented. Legs absent. Anterior spiracles each with 1 five-locular disc pore, exceptionally 2 disc pores (fig. 2E). Microducts numerous in submarginal clusters on abdomen (abdominal segments II-VI each with 3-5 microducts), less numerous on abdominal segments I and II; submedian microducts present in small numbers on all abdominal segments and on mesothorax. They are absent on metathorax. Some microducts are scattered on frontal area.

Small macroducts present in few numbers (1-3) on margin of mesothorax, metathorax and on abdominal segments I-II (fig. 2G). Few gland tubercles are scattered among microducts on thorax and abdominal segments I-II (fig. 2F).

Dorsum. Small macroducts numerous, arranged on abdomen in three longitudinal series: marginal, submarginal and submedian; only a few macroducts present on marginal area (1 duct on each side of abdominal segments I-IV) (fig. 2C). Submarginal small macroducts present in clusters of 3-5 on each abdominal segment; submedian small macroducts present on abdominal segments IV-VII, absent from segments I-III. Anteriorly around submargins, there are groups of small macroducts as far forward as mesothorax. Small macroducts absent on head.

Mounted second-instar female nymph. – Fig. 3A-G. Body pyriform, 0.85-0.92 mm long, 0.45-0.54 mm wide, membranous.

Pygidium. Margin similar to margin of second-instar male (fig. 3B). Two pairs of lobes present, second pair bilobed. Median lobes notched on both sides separated by a space equal to width of a single lobe. Four pairs of marginal macroducts present, one pair on each of prepygidial and pygidial segments V-VIII. Gland spines and submarginal setae similar in size and in distribution as in second-instar male nymph.

Venter. Antennae one segmented with 3 sensory setae, one basiconic seta and one pointed seta (fig. 3D). Labium unsegmented, short and conical. Eyes present, eye-spot like. Legs absent. Anterior spiracles with five-locular disc pores, each with 1, exceptionally 2 disc pores (fig. 3E). Few microducts present: 1-3 microducts on each side of abdominal segments I to VII. Small gland tubercles scattered among microducts on thorax and abdominal segments I-IV (fig. 3F). Very few microducts present in submedian and median areas of body, often absent.

Small macroducts present on mesothorax, metathorax and abdominal segments I-III, in very few numbers on margins and submargins (fig. 3G).

Dorsum. Small macroducts present on abdomen and arranged in two series, marginal and submarginal; 1 or 2 ducts on marginal and submarginal areas on each abdominal segment (fig. 3C). Absent from the submedian areas of head, thorax and abdomen, except on segment VII where one submedian macroduct is present.

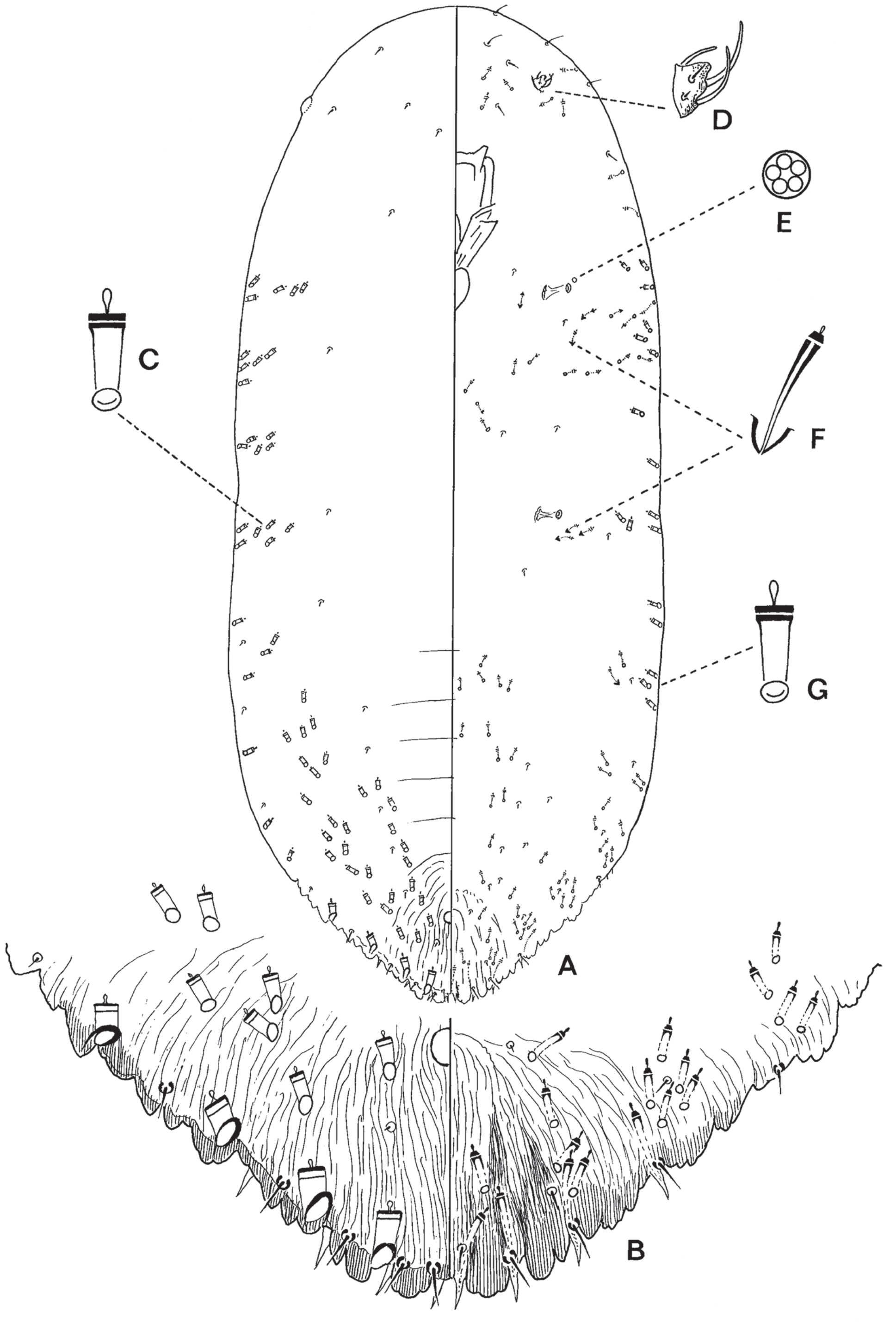

Fig. 2. – *Aonidomytilus albus* (Cockerell), second-instar male nymph. – A, General view of the body (left, dorsal view; right, ventral view). – B, Pygidium enlarged. – C, Dorsal macroduct. – D, Antenna. – E, Spiracular disc-pore. – F, Ventral gland tubercle. – G, Ventral macroduct.

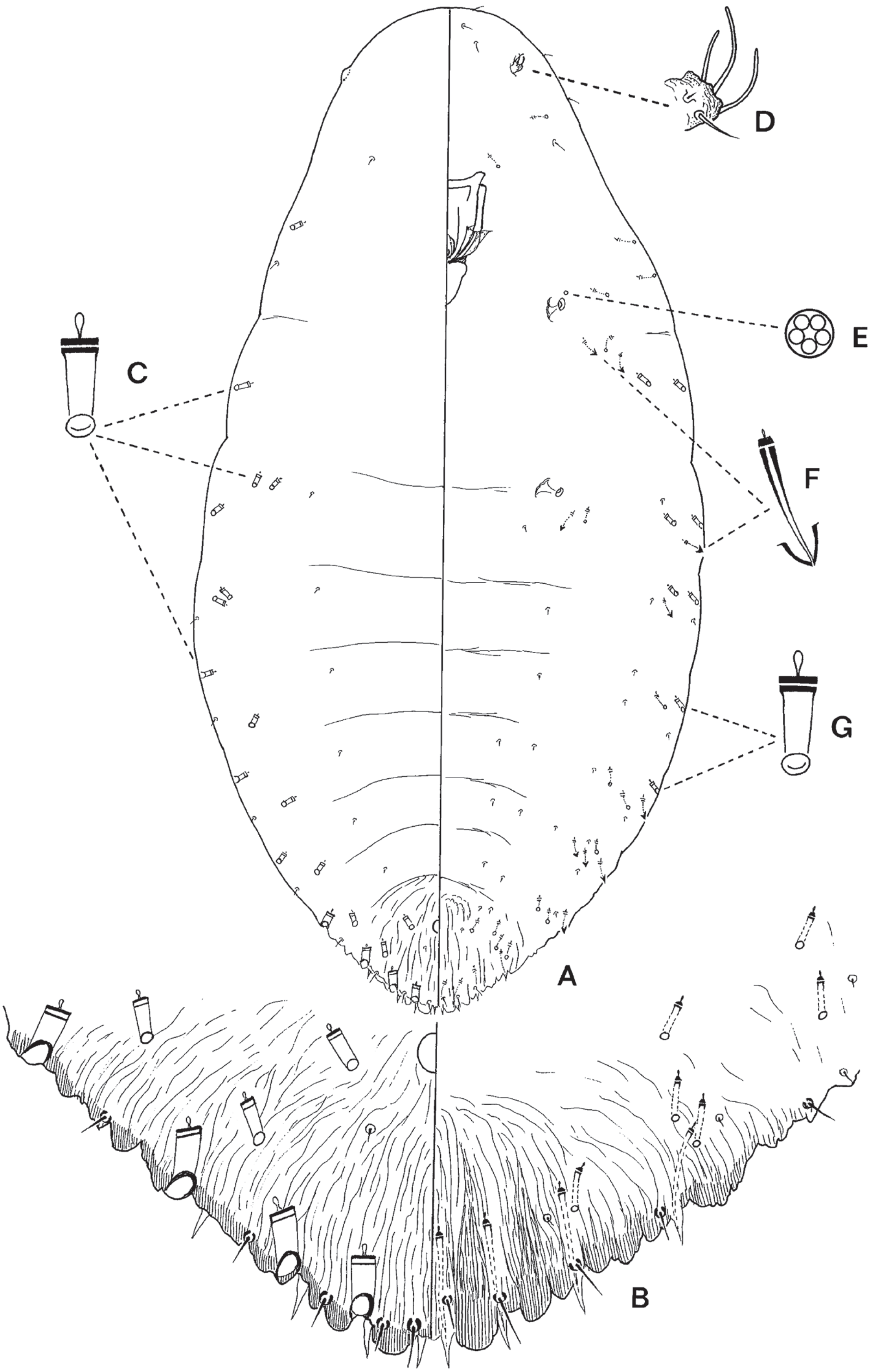

Fig. 3. – *Aonidomytilus albus* (Cockerell), second-instar female nymph. – A, General view of the body (left, dorsal view; right, ventral view). – B, Pygidium enlarged. – C, Dorsal macroduct. – D, Antenna. – E, Spiracular disc-pore. – F, Ventral gland tubercle. – G, Ventral macroduct.

COMMENTS

The second-instar nymphs of *Aonidomytilus albus*, as in all Diaspididae, are sexually dimorphic to some degree (HOWELL & TIPPINS, 1990). The shape of the second-instar male nymph is parallel-sided and the second-instar female nymph is pyriform to fusiform as is the adult female of each species. The tubular duct system is developed in both sexes. Four types of ducts are present in both sexes but sexual dimorphism is shown here by the number of those ducts: numerous in the male and fewer in the female. Antennal setae are similar in both sexes. Pygidium well developed in both sexes, composed of segment VI and following abdominal segments fused. Pygidial margin similar in both sexes. Marginal setae and gland spines of pygidium similar in both sexes. Each anterior spiracle of *A. albus* has 1-2 disc pores, as BORATYNSKI (1953) observed in three species of the Lepidosaphidini group. Our observation shows also that the spiracular disc pores each possesses five-loculi in *Aonidomytilus albus*.

ACKNOWLEDGEMENTS. – The first author wishes to thank the Muséum national d'Histoire naturelle, Paris, for financial support. We thank Thierry Bourgoin for support, Jean Legrand who kindly made the photograph and the artists Hélène Le Ruyet, Gilbert Hodebert and Laurent Fauvre, from the same institution mentioned above. Doug J. Williams, Natural History Museum, London, is thanked for constructive comments.

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Stéphane Boucher, Hervé Brustel & Cyrille Van Meer. – ***Platycerus spinifer* Schaufuss, élément autochtone de France continentale (Col., Lucanidae)**

Platycerus spinifer Schaufuss, 1863 (*nec* 1862 *sensu auct*.) a été décrit sur une petite série des deux sexes “d’Espagne Centrale” [*nec* “Asturies” (Baraud, 1993)]. Durant la majeure partie du xx[e] siècle l’espèce fut considérée tantôt comme synonyme, tantôt comme variété de *P. caraboides* (Linné, 1758), y compris par les spécialistes réputés. Pourtant, elle en est très clairement distincte. Cette confusion eut en partie pour origine la méconnaissance générale de l’espèce, très peu d’échantillons ayant circulé avant les années 1960-1970. Elle fut réévaluée seulement à cette époque [*cf.* la brève synthèse de Baraud (1993)]. Depuis lors, une littérature assez abondante et fournie, hispanique pour la plupart, a contribué à ce que *P. spinifer* soit beaucoup mieux connu. Sa répartition est étendue à la majeure partie de la péninsule Ibérique, Espagne (du piémont des Pyrénées à la Sierra Nevada) et Portugal (Centre et Nord), principalement sur les reliefs, parfois élevés (> 2500 m) (voir notamment Español, 1973 ; Grosso-Silva, 1999 ; GTLI, 2008-2013 ; López-Colón, 2000 ; Martínez de Murguía *et al.*, 2003 ; Nieto & Alexander, 2010). La larve habite et consomme de préférence des souches et troncs morts ou dépérissants de Fabaceae arbustives du genre *Genista*, également des Fagaceae des genres *Fagus* et *Quercus*. Larves et adultes sont grégaires, parfois en nombre. L’adulte est actif au printemps, volontiers héliophile, mais discret. La bionomie de l’espèce semble assez comparable à celles des autres *Platycerus* d’Europe.

Platycerus spinifer est le plus souvent considéré comme un endémique de la péninsule Ibérique ; Baraud (1993) l’avait toutefois localisé en France des Pyrénées-Atlantiques, massif de la grande forêt d’Iraty (> 300 m, < 2300 m), *via* M. Lavit. Le (ou les) spécimen de Baraud n’est pas aujourd’hui dans sa collection au Muséum national d’Histoire naturelle à Paris. Cette unique référence, non confirmée depuis, considérée douteuse par certains, ne peut en effet être tenue pour formellement établie. Il en est de même de toutes autres citations de France, reprenant celle-ci ou dépourvues d’un minimum de précisions avérées ou vérifiables. D’autre part, une récente indication fut diffusée en ligne sur le forum Web *Le Monde des Insectes* (2008) : un petit mâle de Larrau, Pyrénées-Atlantiques (sans autre précision, > 300 m, < 2300 m), soit proche d’Iraty. Ce spécimen n’est sans doute pas un *P. spinifer*. Pour s’en convaincre, on peut faire la comparaison avec un autre petit mâle, du véritable