

First record of *Pisidium punctiferum* (Guppy, 1867) and *Eupera viridans* (Prime, 1865) (Mollusca: Sphaeriidae) from French Guiana

David MASSEMIN

Angle des rues Du Four et Des Remparts / 34380 Notre-Dame de Londres, France
yoda.massemin@hotmail.fr yoda.massemin@wanadoo.fr

Simon CLAVIER

HYDRECO, Laboratoire Environnement de Petit Saut / B.P 823 / 97388 Kourou cedex, Guyane,
France
simon.clavier@hydrecolab.com

Jean-Pierre POINTIER

USR 3278 CNRS-EPHE CRIOBE, Université de Perpignan / 66860 Perpignan cedex, France
pointier@univ-perp.fr

KEYWORDS. French Guiana, continental Bivalvia, *Pisidium punctiferum*, *Eupera viridans*, identification key.

MOTS CLÉS. Guyane, bivalves continentaux, *Pisidium punctiferum*, *Eupera viridans*, clé d'identification.

ABSTRACT. Two freshwater Bivalvia species identified as *Pisidium punctiferum* (Guppy, 1867) and *Eupera viridans* (Prime, 1865) were collected at several places from French Guiana. Those new records bring the number of freshwater-molluscs species from this French overseas territory to 27 and extend the distribution area of the mentioned species to the Guiana Shield. An identification key to continental Bivalvia from French Guiana is therefore provided.

RESUME. A l'occasion d'une étude hydrobiologique, *Pisidium punctiferum* (Guppy, 1867) et *Eupera viridans* (Prime, 1865) ont été collectés en Guyane. Ces deux bivalves, nouveaux pour l'inventaire, portent à 27 le nombre de mollusques dulcicoles connus de ce territoire ; leur aire de distribution naturelle est étendue en direction du Plateau des Guyanes. Une clé d'identification des bivalves continentaux de Guyane est proposée.

INTRODUCTION

The Guiana Shield is an old Precambrian geological formation of more than 1,600 km long, located in the north-eastern part of South America, including Guyana, Suriname, French Guiana and a part of Brazil (Amazonas, Roraima, Pará and Amapá States, west of the Amazona River). French Guiana (2°- 6° North latitude) stretches over almost 84,000 square kilometres (Figure 1); it is a hot spot of biodiversity because 80% of the territory is covered by a tropical rain forest, considered as one of the 15 last worldwide remaining clumps only partially affected by human activities (Gargominy, 2003 & Hammond, 2005). An abundant and complex hydrographical system feeds this territory where acids and poorly mineralized waters are unfavourable habitats to freshwater molluscs.

The difficulty to reach the upstream areas explains why this group was so poorly studied despite of some consequent but old works (Drouët, 1859 & Tillier, 1980), until the recent publication of a molluscs

identification guide (Massemin et al., 2009) in which 24 species of freshwater molluscs are listed. Nevertheless, thanks to hydrobiological investigations carried out in French Guiana under the auspices of the Water Framework Directive and EDF, one species was recently added to that list (Clavier et al, 2010).

The aim of the present article is to report for the first time the presence of two freshwater Bivalvia species in French Guiana (Figure 2). This discovery carries the number of freshwater molluscs species known from French Guiana to 27 (Gastropoda & Bivalvia), belonging to 7 families; it gives the opportunity to the authors to present a general illustrated identification key of the known species of continental Bivalvia inhabiting this territory (Figure 3; appendix 1).

Material and Methods

In order to assess the benthic French Guiana macroinvertebrate fauna [following the definition of Rosenberg and Resh (1993), the term "benthic" means "bottom-living" and the prefix "macro" indicates that

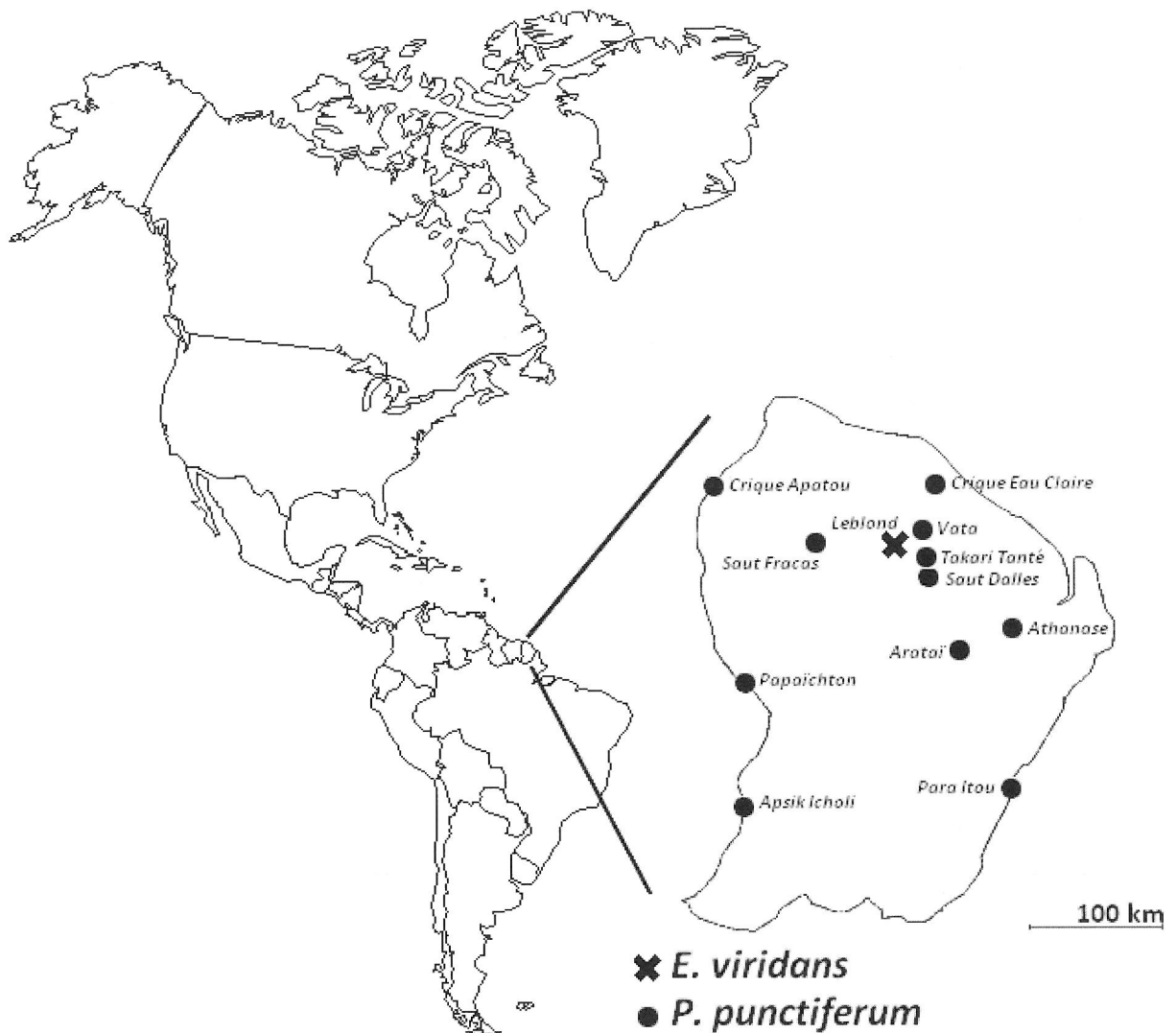


Figure 1. Geographical localization of French Guiana and mentioned localities from French Guiana.

these organisms are retained by mesh size of 200-500 μm], an important hydrobiological study was carried out by HYDRECO laboratory during the dry season 2009 (from September to December), under the auspices of the local representation of the French Ministry in charge of environmental questions (DIREN Guyane).

Samplings were conducted by one of us (SC) on the entire territory in different habitats (large rivers, mid-order streams, small streams named locally “criques” and reservoir lakes) using a D-framed hand net (200 μm mesh size). Samples were collected by sweeping the net along the banks. The first centimetres of the substratum (organic and/or inorganic) were stirred to dislodge attached or buried macroinvertebrates.

RESULTS

A total of 125 live specimens of small freshwater Bivalvia peaclams species belonging to the

Sphaeriidae Family and to two different genera, were collected in many watersheds (Figure 1, tables 1 & 2) and preserved in ethanol 70°. Registered specimens were deposited both in public (EPHE, Perpignan, France) and private collections (HYDRECO, Kourou, French Guiana). The material collected included a total of 81 *Pisidium punctiferum* (Guppy, 1867) and 44 *Eupera viridans* (Prime, 1865).

Identifications of the species were made according to specific conchologically characters (Kuiper, 1983) and original descriptions of Guppy (1867) for *P. punctiferum* and Prime (1865) for *E. viridans*.

Diagnose of the striate peaclam *P. punctiferum* was established according to the following criteria: 1/ The average size when adult is around 3 mm in length and 2.5 mm in height; 2/ The shell is oval and thin, the anterior valve is shorter and angulated in its posterior part; 3/ The test is diaphanous, finely striate concentrically and covered with numerous granular points, which are finer and more crowded on the

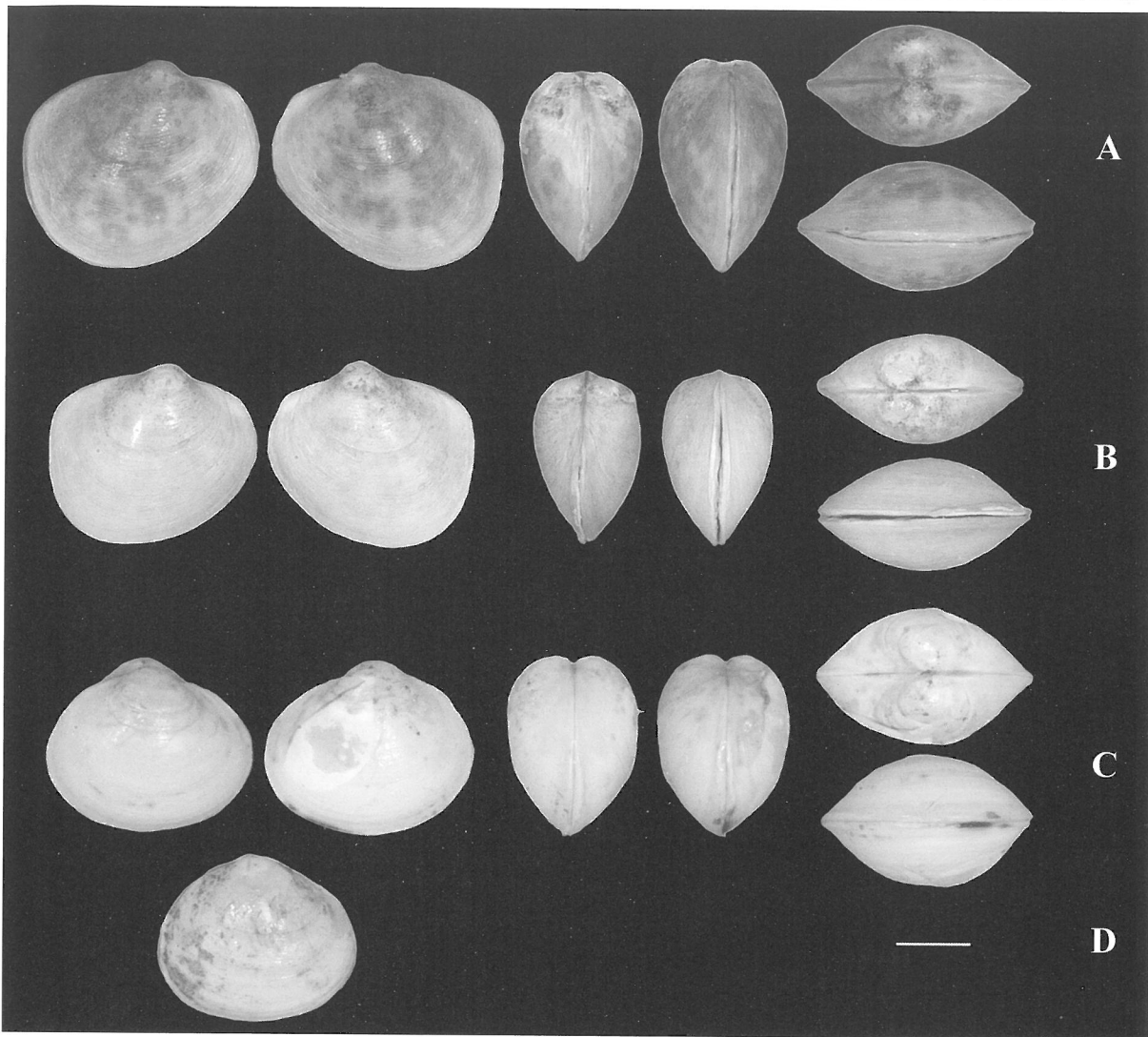


Figure 2. **A.** *Eupera viridans* (Prime, 1865), Crique Leblond, Sinnamary 4.1 mm; **B.** *Eupera viridans* Crique Leblond, Sinnamary 3.8 mm; **C.** *Pisidium punctiferum* (Guppy, 1867), Crique Arataï, Régina 2.9 mm; **C.** *Pisidium punctiferum* Saut Fracas 3.1 mm.

umbones, where the concentric striation is less evident; 4/ A short periostracum may be present and 5/ The hinge is well-developed with lateral teeth in both valves (1-1/1-1) and small cardinal teeth (2/2).

Diagnose of the mottled fingernail clam *Eupera viridans*, was established according to the following criteria: 1/ The size can be of about 8 mm when adult (Pointier, 2008); 2/ The shell is oblong, compressed and inequilateral, the anterior side is shorter and rounded, the posterior one is sub abrupt and the basal margin is slightly rounded; 3/ The test has very regular and delicate striation, a cream colour with irregular dark brown spots, 4/ There is no mention of periostracum and 5/ It presents a sub central umbo and a cardinal tooth on each valve (Pointier, 2008).

DISCUSSION

The small freshwater mussels belonging to the Sphaeriidae Family are distributed all over the world

and the main genera, *Pisidium*, is cosmopolitan (Kuiper, 1983). *Pisidium punctiferum* was described from the Caribbean Island of Trinidad in 1867, under the name *Cyclas punctifera*; the type locality is a pond at Saint Ann's River, near Port of Spain (10°39'00" N / 61°31'01" W): specimens were collected by the government botanist Prestoe and by Guppy [*The first example was found by Mr. Prestoe, the colonial botanist, when we were examining the weeds in a pond at St. Ann, near Port of Spain, for Mollusca*].

Authors took a special care to compare the collected specimens to the peaclam *Pisidium sterkianum* Pilsbry, 1897 because this species is widely distributed from the Guiana Shield [from Venezuela (specimens collected by one of us, JPP, in 1987 and identified by Kuiper) and Brazil (Agudo-Padrón, 2009; Mansur & Pereira, 2006)] to Argentina (Darrigran & Pastorino, 1995; Ituarte, 2007), including the Peruvian Amazon (Ituarte, 2004), Paraguay and Uruguay (Scarabino & Mansur, 2007). *Pisidium sterkianum* occupies the same type of

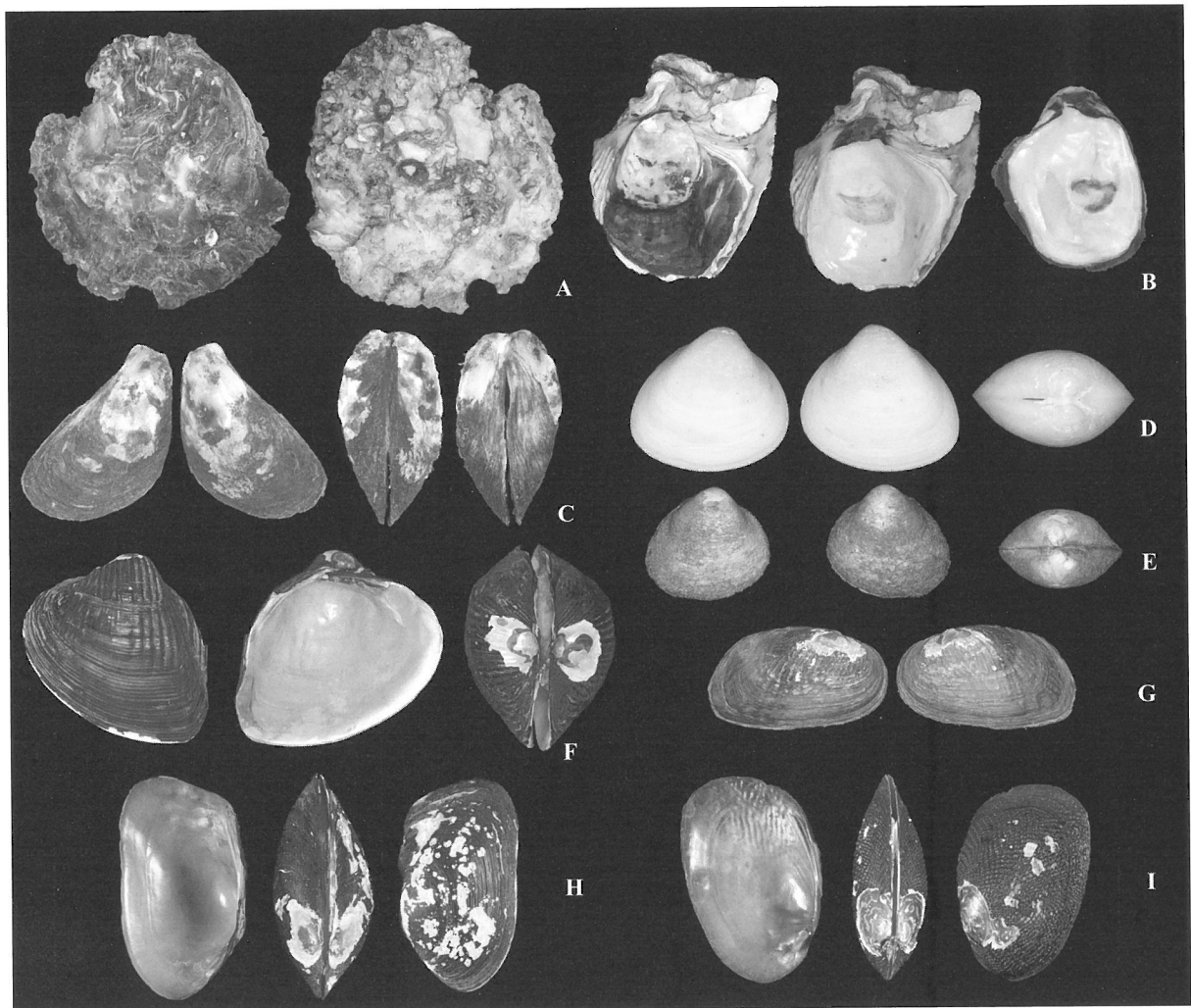


Figure 3. **A.** Ostreidae *Crassostrea rhizophorae* (Guilding, 1828), specimen collected on rocks, Montsinéry French Guiana, 93 mm; **B.** Ostreidae *Crassostrea rhizophorae* (Guilding, 1828), specimen collected on a root in a mangrove, Montsinéry French Guiana, 78 mm; **C.** Dreissenidae *Mytilopsis leucophaeata* (Conrad, 1831), Montsinéry French Guiana, 20 mm; **D.** Corbiculidae *Polymesoda* cf. *aequilatera* (Deshayes, 1855), specimen without periostracum, Montsinéry French Guyana, 24 mm; **E.** Corbiculidae *Polymesoda* cf. *aequilatera* (Deshayes, 1855), specimen with periostracum, Montsinéry French Guyana, 17 mm; **F.** Hyriidae *Castalia sulcata* (Krauss, 1849), Tampok French Guiana, 47 mm; **G.** Hyriidae *Diplodon granosus* (Bruguière, 1792), French Guiana, 19 mm; **H.** Hyriidae *Diplodon voltzi* Vernhout, 1914, MNHN, Litany French Guiana, 64 mm; **I.** Hyriidae *Diplodon granosus* (Bruguière, 1792), Holotype MNHN, Cayenne French Guiana, 38 mm.

habitats than *P. punctiferum*, i.e. small streams, lakes, etc. Consequently, *P. sterkianum* could probably be present in the study area. This species may be distinguished from *P. punctiferum* according to the following characters (Pilsbry, 1897): 1. The average size when adult is around 6 mm in length and 5 mm in height; 2. The shell is equilateral with the anterior end broadly truncated and beaks full but rather small; 3. The test, glossy, light yellowish outside and greyish-white inside, is very finely striated concentrically without granular points; 4. There is no mention in literature on the presence of periostracum and 5/ The cardinal teeth are parallel and the lateral tooth is lower and longer in the left valve.

Pisidium punctiferum is mentioned in literature (Figure 4) from the United States of America

[Kentucky, Virginia, Illinois, Texas and northeast Florida (Heard, 1979; Turgeon et al., 1998)] to southern Brazil [Rio Grande do Sul State (Agudo-Padrón, 2009; Martello et al., 2006; Simone, 2006)] and Uruguay (Henry, 1897), including the West Indies [Dominica (Starmühlner, 1988), Guadeloupe (Pointier 1974; 1976; 2008), Martinique (Guyard & Pointier, 1979; Pointier 2008), Saint-Lucia (Jordan, 1985; Mc Killop & Harrison, 1981; 1982) and Saint-Vincent (Harrison & Rankin, 1978)].

The species is mentioned in literature as living in Cuba (Starmühlner, 1988). It is probably due to misidentification, because even after recent investigations it has not been found there (Pointier et al., 2005). It is also signalled by the same author as

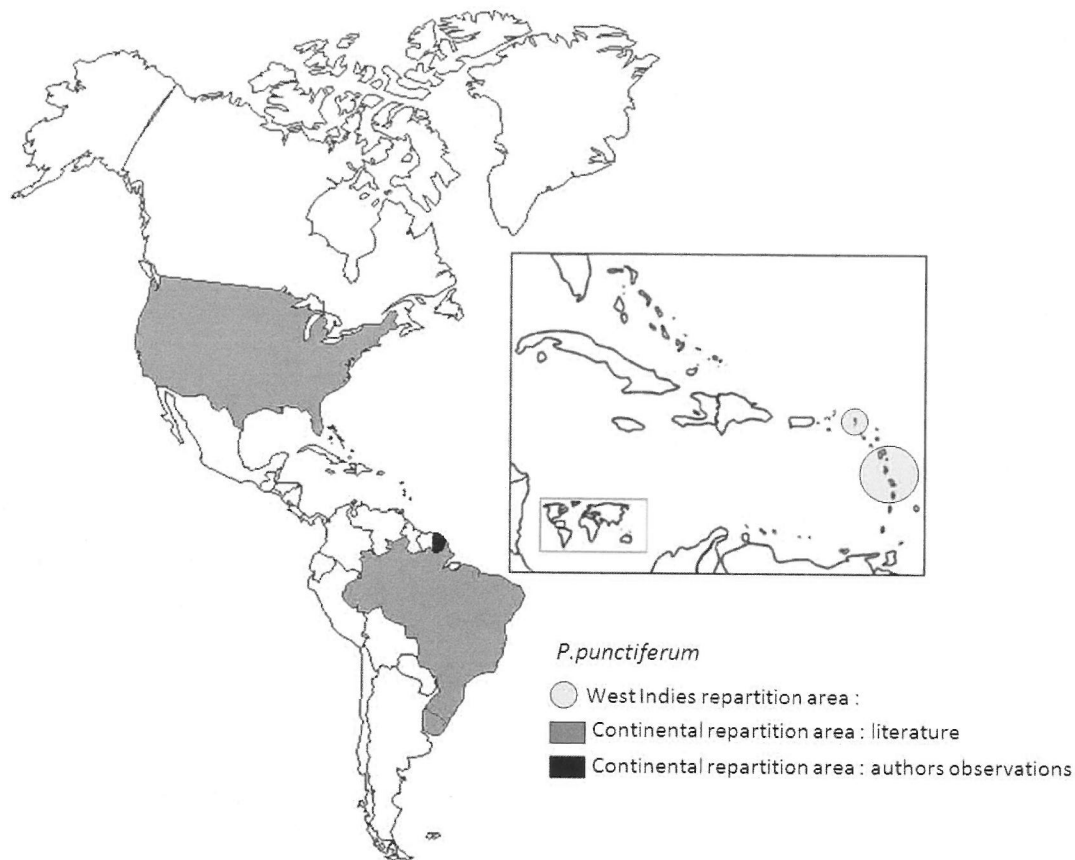


Figure 4. Distribution area of *Pisidium punctiferum*.

inhabiting Mexico, Panama, Jamaica, Venezuela and Paraguay but without any precise mention nor author. The present discovery expands the distribution of *P. punctiferum* to French Guiana and, consequently, to the Guiana Shield. Otherwise, the presence in neighbouring Suriname, where the species is not yet mentioned, is highly probable because 20 specimens were found in the Maroni River, frontier between Suriname to the west and French Guiana to the east [Apsik Icholi (05°09'06" N / 54°20'21" W), Crique Apatou (03°48'20" N / 54°08'36" W) and Papaïchton (3°05'34" N / 52°20'28" W)]. So, if the species has already been recorded in southern Brazil, its distribution area is potentially also extended to the northeast Brazil, because one piece was collected in the Oyapock River, frontier between French Guiana to the west and the Amapa State to the east.

In literature, most authors mentioned to have observed *P. punctiferum* in lentic habitat: on the Saint Vincent Island, Harrison & Rankin (1978) found the maximum population densities in swamps; In Dominica, it was observed in exposed sunlit ponds (Starmühlner, 1988); In Guadeloupe, the species is inhabiting swamps, canals and flooded meadows (Pointier, 1974, 1976). In French Guiana, *P. punctiferum* has a large distribution area all over the territory, from east to west, near the coastal line [Crique Apatou (03°48'20" N / 54°08'36" W) and Crique Eau Claire (05°08'45" N / 52° 52'09" W)] to

the head watershed [Apsik Icholi (02°59'10" N / 54°10'53" W)]. The species has a large ecological plasticity because it occupies a numerous variety of habitats as it was recorded from small streams with clear water (Crique Apatou and Crique Eau Claire) to muddy large rivers [Papaïchton (3°05'34" N / 52°20'28" W)]. The site where the most important number of specimens was collected (33) is a natural rocky riffle environment without significant entropic pressures, [Saut Dalles, Sinnamary Watershed (04°33'21" N / 52°54'03" W)]. A single individual was also found into the reservoir lake of Petit-Saut [Vata (04°51'58" N / 52°57'41" W)]. The species was mainly found in water without entropic pressure. It would be interesting to focus on the sampling effort in these habitats in the rainy season, when the freshwater level grows, creating a lot of standing water habitats.

Eupera viridans was described from the Caribbean Island of Guadeloupe in 1865, under the name of *Sphaerium viridante* by Prime (1865). The type locality is the city of Pointe-à-Pitre (16°14'00" N / 61°31'00" W). Little is known about its natural distribution (Figure 5). The species is only mentioned in literature from the West-Indian Islands of Guadeloupe (Pointier, 2008), Martinique (Delannoye, personal communication, 2010), Saint-Lucia (Pointier, 2001) and Saint-Martin (Coonans, 1967). *Eupera cubensis* (Prime, 1865) is probably a synonym of *E. viridans*. Consequently, the distribution of the species

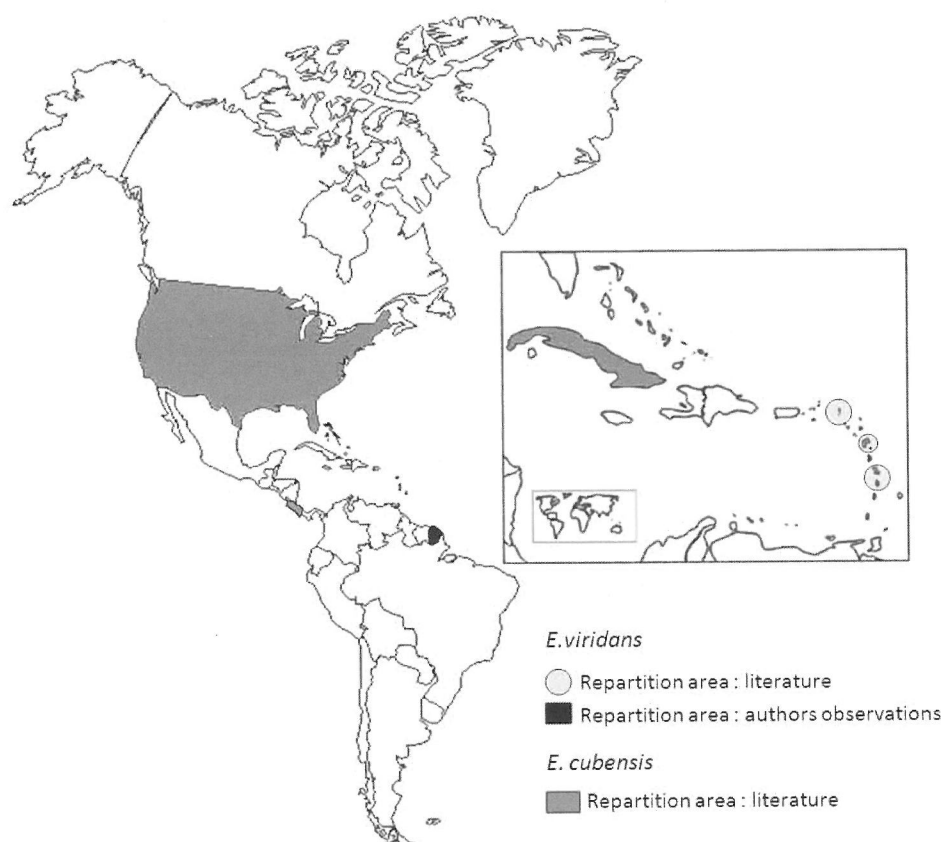


Figure 5. Distribution area of *Eupera viridans*.

could be enlarged to Cuba, Costa Rica (Volkmer-Ribeiro & Machado, 2009), Texas and Florida (Heard, 1979) and to the Upper Mississippi River Basin too (Illinois), but as an introduced species (Sneen et al., 2009). The discovery of *E. viridans* in French Guiana would be the first record of this species for the South American continent. However, this information must be taken with caution, because the systematic of this genus remains confusing and misidentifications may occur in the literature.

In the Lesser Antilles, *Eupera viridans* is common in marshes, canals and ponds, attached to the aquatic vegetation or to wood debris (Pointier, 2008). In French Guiana, the 44 observed specimens were collected in a single spot at Leblond [Sinnamary watershed (04°46'37" N / 53°07'08" W)], an altered stream under entropic pressures such as illegal gold-mining or domestic sewages (Comité de Bassin de Guyane, 2006); this Bivalvia appears like a not sensitive taxa in terms of bio indication. Punctually distributed and first mentioned on the South America continent, the species has a patrimonial value for French Guiana.

In conclusion, we have to mention that the detection

of minute clams is difficult in the coloured and charged in wood debris of the Guiana freshwaters. Lack of studies on this group together with these characteristics i.e. small size, difficult visual detection, explains the late discovery of relatively abundant taxa on this territory. Sampling method is also an explanatory factor. Without a standardized collect protocol, knowledge on freshwater molluscs remains uncompleted (Massemin et al., 2009). The use of a hand net with very small mesh size (200 µm) would be a good alternative to collect minute species. In 2010, three new species of freshwater molluscs (one Gastropoda and two Bivalvia) from French Guiana were found using this technique, increasing the number of freshwater species mentioned from this overseas department. Why couldn't the discovery of other species be expected in the future?

ACKNOWLEDGEMENTS

Simon Clavier is grateful to DIREN 973, to EDF GUYANE for finding the sampling in the Sinnamary watershed, and to the teams of HYDRECO and NT2 Aquatic Environmental Lab (AEL).

Study site	Watershed	Habitat type	GPS	Number of specimens
Crique Eau Claire	Kourou	little stream	05°08'45" N / 52° 52'09" W	1
Takari Tanté	Sinnamary	large river	04°37'18" N / 52°55'38" W	2
Vata	Sinnamary	reservoir lake	04°51'58" N / 52°57'41" W	1
Saut Fracas	Mana	large river	04°45'30" N / 53°40'49" W	4
Arataï	Approuague	large river	04°01'36" N / 52°41'35" W	17
Saut Dalles	Sinnamary	large river	04°33'21" N / 52°54'03" W	33
Athanase	Approuague	large river	04°10'50" N / 52°21'14" W	2
Apsik Icholi	Maroni	large river	02°59'10" N / 54°10'53" W	5
Crique Apatou	Maroni	little stream	05°09'06" N / 54°20'21" W	2
Papaïchton	Maroni	large river	03°48'20" N / 54° 08'36" W	13
Para Itou	Oyapock	large river	03°05'34" N / 52°20'28" W	1
Total				81

Table 1

Study site	Watershed	Habitat type	GPS	Number of specimens
Leblond	Sinnamary	mid-order stream	04°46'37" N / 53°07'08" W	44
Total				44

Table 2

LITERATURE CITED

- Agudo-Padrón, A. I. 2009. Recent Terrestrial and Freshwater Molluscs of Rio Grande do Sul State, RS, Southern Brazil Region: A Comprehensive Synthesis and Check List. *Visaya Net* (May 2009): 1-13.
- Clavier, S, Pointier, J.P. & Massemin, D. 2010. Découverte de *Gundlachia radiata* (Guilding, 1828) (Mollusca: Planorbidae: Ancyliinae) en Guyane. *Novapex*, 11(4): 115-118.
- Comité de Bassin de Guyane, 2006. État des lieux: caractérisation du district de la Guyane et registre des zones protégées, *internal publication DIREN 973 Cayenne*, 191p.
- Coonans, H.E. 1967. The non-marine Mollusca of St. Martin (Lesser Antilles). *Studies on the Fauna of Curacao and other Caribbean Islands*, 24: 118-145.
- Darrigran, G. & Pastorino, G. 1995. The Recent Introduction of a Freshwater Asiatic Bivalve, *Limnoperna fortunei* (Mytilidae) into South America. *The Veliger*, 38(2): 171-175.
- Drouët, H. 1859. Essai sur les mollusques terrestres et fluviatiles de la Guyane Française. *Extrait des Mémoires de la Société Académique de l'Aube*. XXIII : 116 p., 4pl.
- Gargominy, O. 2003. Biodiversité et conservation dans les collectivités françaises d'outre-mer. *Collection Planète Nature*. Comité français pour l'UICN, Paris, France. 246p.
- Guppy, R. J. L. 1867. Description of a new freshwater bivalve found in Trinidad. *Annals and Magazine of Natural History*, 19(111): 160-161.
- Guyard, A. & Pointier, J.-P. 1979. Faune malacologique dulçaquicole et vecteurs de la Schistosomiase intestinale en Martinique. *Annales de Parasitologie Humaine et Comparée* 54 (2): 193-205.
- Hammond, D.S. 2005. Tropical Rainforests of the Guianan Shield. *CABI Publishing, Wallingford, United Kingdom*. 560p.
- Harrison, A. D. & Rankin, J. J. 1978. Hydrobiological Studies of Eastern Lesser Antillean Islands: III. St. Vincent: Freshwater Molluscs; their distribution, population's dynamics and biology. *Archiv für Hydrobiologie*, 54:123-188.
- Heard, W.H. 1979. Identification manual of the freshwater clams of Florida. *Technical Series*, 4(2): 83pp.
- Henry, A. 1897. New Species of Mollusks from Uruguay. *Pilsbry Proceedings of the Academy of Natural Sciences of Philadelphia*, 49: p290.
- Ituarte, C. 2004. Sphaeriidae (Bivalvia) from Peruvian Amazon floodplains, with the description of *Pisidium iquito* new species. *The Nautilus*, 118 (4):167-174.
- Ituarte, C.2007. Las especies de *Pisidium* Pfeiffer de Argentina, Bolivia, Chile, Perú y Uruguay (Bivalvia-Sphaeriidae). *Revista del Museo Argentino de Ciencias Naturales*, 9(2):169-203.
- Jordan, P., 1985. Schistosomiasis. The St Lucia project. Cambridge University Press, 442p.
- Kuiper, J.G.J. 1983. The Sphaeriidae of Australia. *Basteria*, 47: 3-52.
- Mansur M.C.D. & Pereira D. 2006. Bivalves limnicos da baía do rio dos Sinos, Rio Grande do Sul, Brasil (Bivalvia, Unionoida, Veneroida e

- Mytiloidea). *Revista Brasileira de Zoologia*, 23 (4): 1123-1147.
- Martello, A.R., Kotzian, C.B. & Simões, M.G. 2006. Quantitative fidelity of recent freshwater mollusk assemblages from the Touro Passo River, Rio Grande do Sul, Brazil. *Iheringia, Série Zoologia*, 96(4):453-465.
- Massemin, D., Lamy, D., Pointier, J.-P. & Gargominy, O. 2009. Coquillages et escargots de Guyane. Seashells and snails from French Guiana. Biotope, Mèze (*Collection Parthénope*) ; Muséum National d'Histoire Naturelle, Paris. 456p.
- Mc Killop, W. B. & Harrison, A. D. 1981. Hydrobiological Studies on Eastern Lesser Antillean Islands VI: St. Lucia: Freshwater molluscs and the marsh environment. *Archiv für Hydrobiologie*, 58: 357-419.
- Pilsbry, H.A. 1897. New Species of Mollusks from Uruguay. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 49: 291-292.
- Pointier, J. P. 1974. Faune malacologique dulçaquicole de l'île de la Guadeloupe (Antilles françaises). *Bulletin du Muséum National d'Histoire Naturelle de Paris*, 3 (159): 905-933.
- Pointier, J. P. 1976. Répartition locale et biogéographie des mollusques dulçaquicole de la Guadeloupe (Antilles françaises). *Malacological Review*, 9: 85-103.
- Pointier, J.-P. 2001. Invading Freshwater Snails and Biological Control in Martinique Island, French West Indies. *Memórias do Instituto Oswaldo Cruz*, Rio de Janeiro, 96 (Supl.): 67-74.
- Pointier, J.-P. 2008. Guide to the Freshwater Molluscs of the Lesser Antilles. *ConchBooks, Hackenheim, Germany*. 128p.
- Pointier, J.-P., Yong, M. & Gutiérrez, A. 2005. Guide to the Freshwater Molluscs of Cuba. *ConchBooks, Hackenheim, Germany*, 120p.
- Prime, T. 1865. Monograph of American Corbiculadae (recent and fossil): 57.
- Rosenberg, D. & Resh, V. 1993. Freshwater Biomonitoring and Benthic Macro invertebrates. *Chapman Hall Publisher*, 512p.
- Scarabino, F. & Mansur, M.C.D. 2007. Lista sistemática de los bivalvia dulciacuícolas vivientes de Uruguay. *Comunicaciones de la Sociedad Malacológica del Uruguay*. 9(90): 89-99.
- Simone, L.R. 2006. Land and freshwater mollusks of Brazil. *EGB, Fadesp, Sao Paulo*, 390p.
- Sneen, M.E., Cummings, K.S., Minarik T. & Wasik J. 2009. The discovery of the nonindigenous, mottled fingernail clam, *Eupera cubensis* (Prime, 1865) (Bivalvia: Sphaeriidae) in the Chicago Sanitary and Ship Canal (Illinois River Drainage), Cook County, Illinois. *Journal of Great Lakes Research*, 35(4): 627-629.
- Starmühlner, F. von 1988. Ergebnisse der Österreichisch-Französischen Hydrobiologischen Mission 1979 nach Guadeloupe, Dominica und Martinique (Kleine Antillen). Teil II: Beiträge zur Kenntnis der Süß- und Brackwassermollusken von Guadeloupe, Dominica und Martinique. *Annalen des Naturhistorischen Museums in Wien Serie B*, 90: 221-340.
- Tillier, S. 1980. Gastéropodes terrestres et fluviatiles de Guyane française. *Mémoires du Muséum National d'Histoire Naturelle*. Nouvelle série. Série A, Tome 118. Paris.
- Turgeon, D.D., Quinn, J.F., Bogan, A.E., Coan, E.V., Hochberg, F.G., Lyons, W.G., Mikkelsen, P.M., Neves, R.J., Roper, C.F.E., Rosenberg, G., Roth, B., Scheltema, A., Thompson, F.G., Vecchione, M. & Williams J.D. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks. 2nd Edition. *American Fisheries Society* (Special Publication 26), Bethesda, Maryland: 526 pp.
- Volkmer-Ribeiro, C. & Machado, V. De S. 2009. Esponjas continentais (Porifera, Demospongiae) em uma comunidade bêntica filtradora na Floresta Decidual de Guanacaste, Costa Rica. Freshwater sponges (Porifera, Demospongiae) in a benthic filter feeding community at the Guanacaste Dry Forest, Costa Rica. *Iheringia, Série Zoologia*, 99 (4): 86-95.

Appendix 1

In French Guiana, Bivalvia of brackish waters, as oysters, can be observed up to more than 50km inside lands and are therefore considered by the authors to be continental species; size is expressed for adult shells.

Drawing by the authors (DM).

- | | | | |
|---|-----|--|---|
| 1 | 1.1 | Hinge dysodont
(absence of tooth)_____ | 2 |
| | 1.2 | Hinge heterodont
(cardinal and lateral teeth presents and dissimilar)_____ | 3 |
| 2 | 2.1 | Shell extended, widened and rounded
behind, end not sharp (mytiliform); internal
surface entirely pearly; in brackish water;
shell attached by a byssus to hard substratum
size of 10 to 20 mm_____ | Dreissenidae
<i>Mytilopsis leucophaeata</i> (Fig. 1) |
| | 2.2 | Shell oval to variable-shaped,
kept closely; internal surface
entirely pearly; in brackish water
size more than 9 mm_____ | Ostreidae
<i>Crassostrea rhizophorae</i> (Fig. 2) |
| 3 | 3.1 | Shell circular to suboval;
in freshwater; size less than 8mm_____ | 4 (Sphaeriidae) |
| | 3.2 | Shell rectangular to subtriangular;
in freshwater; size up to 40 mm_____ | 5 (Hyriidae) |
| | 3.3 | Shell subtriangular clam-shaped;
in brackish water; size up to 10mm_____ | 7 (Corbiculidae) |
| 4 | 4.1 | The umbo is central_____ | 8 (<i>Pisidium</i>) |
| | 4.2 | The umbo is subcentral_____ | 9 (<i>Eupera</i>) |
| 5 | 5.1 | Shell subtriangular;
cardinal teeth well developed;
test concentrically sculptured;
size up to 45 mm_____ | <i>Castalia sulcata</i> (Fig. 3) |
| | 5.2 | Shell rectangular;
cardinal teeth not well developed_____ | 6 |
| 6 | 6.1 | Tessellata sculpture;
muscle scar rounded at the posterior end;
size up to 40mm_____ | <i>Diplodon granosus</i> (Fig. 4) |
| | 6.2 | Concentric sculpture;
muscle scar angulated at the posterior end;
size up to 60mm_____ | <i>Diplodon voltzi</i> (fig.5) |
| 7 | | Pallial sinus well developed;
size more than 20 mm_____ | <i>Polymesoda aequilatera</i> (Fig. 6) |
| 8 | 8.1 | Shell oval and compressed;
test matt and diaphanous; whitish, slightly tinted
with fuscous patches;
surface finely concentrically striated and covered with
granular points;
lateral teeth similar in both valves;
minute species (3-5mm)_____ | <i>Pisidium punctiferum</i> (Fig. 7) |
| | 8.2 | Shell inequilateral and rounded; | |

test glossy light yellowish;
 surface very finely concentrically striated and uncovered
 with granular points;
 lateral teeth lower and shorter in left valve;
 size from 6 to 8 mm

Pisidium sterkianum
 (Species probably present)

9

The test is cream colour ornamented with
 dark brown spots;
 one cardinal tooth on each valve;
 size of about 8 mm

Eupera viridans (Fig. 8)

