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Celtodoryx girardae gen. nov. sp. nov., a new sponge species (Poecilosclerida: Demospongiae) invading the Gulf of Morbihan (North East Atlantic, France)

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Abstract: *Celtodoryx girardae* is described as new species and new genus. The new genus has clear relationships with several genera of the Coelosphaeridae. The choanosomal skeleton is a plumoreticulation of anisostrongyles or anisotylotes, with ectosomal tylotes, all megascleres bearing terminal spines. The microscleres belong to three types, arcuate isochelae of two sizes and oxychaetes. This sponge was sighted for the first time in the Ria of Etel (1996) and then in the Gulf of Morbihan (1999) (Brittany). Since then, the sponge, which seems to have fast spread dynamics, has become very abundant with tens of large specimens. On the basis of several criteria, this sponge is thought to be an introduced species: (i) it is new to the area; (ii) its distribution is rather localized; (iii) its dispersion from the first localised station follows a perceptible pattern; (iv) it has a strong tendency to proliferate; (v) there is a potential introduction source (oyster farms). The sponge is a successful competitor overgrowing other sessile invertebrates such as sea fans and other sponges.

Résumé : Celtodoryx girardae *gen. nov. sp. nov., une nouvelle espèce d'éponge (Poecilosclerida: Demospongiae) invasive du Golfe du Morbihan (nord-est Atlantique, France). Celtodoryx girardae* est décrite comme nouvelle espèce et nouveau genre clairement apparentée à plusieurs genres de Coelospheridae. Le squelette du choanosome est une réticulation plumeuse d'anisostrongyles ou d'anisotylotes, avec des tylotes ectosomiques, tous les mégasclères portent des épines à leurs extrémités. Les microsclères sont de trois types, des isochèles arqués de deux tailles différentes et des oxychètes. L'éponge a été aperçue pour la première fois dans la Ria d'Etel (1996) et ensuite dans le Golfe du Morbihan (1999) (Bretagne). Elle semble avoir une dynamique de dispersion rapide, et depuis elle est devenue très abondante avec des dizaines de gros individus. Sur la base de plusieurs critères, cette éponge pourrait être une espèce introduite : (i) elle est nouvelle dans l'aire considérée ; (ii) sa distribution est encore très localisée ; (iii) depuis sa première signalisation, sa dispersion dans l'espace est logique ; (iv) elle a tendance à proliférer ; (v) il existe une source potentielle d'introduction dans l'aire où elle a été découverte (ostréiculture). L'éponge est un redoutable compétiteur pour l'espace qui s'étend sur d'autres invertébrés sessiles tels que des gorgones ou d'autres éponges.

Keywords: *Porifera*; Invasive species; Systematics; Proliferation; New species; New genus

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Introduction

A new opportunistic sponge species has been regularly observed since 1999 in the Gulf of Morbihan (NE Atlantic coast of France), an environment influenced by a complex of anthropogenic constraints and by a number of invasive species (Afli & Chenier, 2002). The sponge, which belongs to a new genus, recently appeared in an area where numerous surveys have been made for over 30 years. Annual surveys since 2000 allowed investigation of its ecological preferences and dispersion patterns. Taking into account some of its characteristics, the new sponge is suspected of being an introduced species. Among the Porifera, documented cases of introduced species such as *Haliclona loosanoffi* Hartman, 1958 in the oyster beds of The Netherlands (Van Soest, 1976) are rare (Gamel, 1987). This makes the discovery of a possible invasive species on the NE Atlantic coast of France all the more remarkable, especially since the sponge was found in abundance, with large specimens competing with indigenous sessile organisms.

Several mechanisms of introduction are feasible. Human activities involving aquaculture (especially oyster culture), ballast water or oceanaria are known to be the source of introduced species (see references in Carlton & Geller, 1993). In marine environment, the most infamous introduced species of the last century has been *Caulerpa taxifolia* (M. Vahl) C. Agardh, 1817 in the Western Mediterranean and *Mnemiopsis leidyi* Agassiz, 1865 in the Black Sea (e.g. Vinogradov et al., 1989; Carlton, 1996). In the NE Atlantic and British Channel the introduction of the gulfweed *Sargassum muticum* (Yendo) Fensholt, 1955 (e.g. Critchley et al., 1983; Walker & Kendrick, 1998) and the marine gastropod *Crepidula fornicata* (Linnaeus, 1758) (e.g. Blanchard, 1995; Montaudoin et al., 1999) are among the most noticeable invasive species that have appeared during the last decades with well-known impact on native biodiversity, ecosystem functioning, animal and plant health and human activities. In this paper, we assess the potential impact of a hitherto unknown sponge as an active filter-feeding invader.

Material and methods

Description

Specimens were collected by SCUBA diving in the Gulf of Morbihan where the species is presently very common. After collection, they were kept in seawater for a few hours and then preserved in alcohol or formalin. For the study of spicules, the tissue was digested in boiling nitric acid. The dissociated spicules were separated by filtration on a 0.2 µm Cyclopore membrane, sputter–coated with gold-palladium for observation under a Hitachi S570 scanning electron microscope (SEM) or mounted on glass slides for light microscopy. Spicule size was measured using light microscopy or on SEM photographs. A minimum of 30 spicules of each category was measured. Skeletal architecture and histology were studied by light microscopy on polished sections. These were obtained by cutting a piece of sponge embedded in Araldite with a low speed saw using a diamond-wafering blade. The sections were then wet-ground with abrasive paper or polishing discs.

Ecological survey

After its first definite sighting in autumn 1999, the distribution of the species has been assessed by about 500 dives in different localities of the area and a questionnaire was distributed to amateur diving clubs in order to identify new locations. A survey of four different permanent transects, laid perpendicular to the shore, 80 m long and 25 m apart, was implemented in 2001 to assess the species' ecological preferences (depth, habitat, epibiosis, etc.) and its size structure. The four transects were located between 3 and 19 m depth, and the surveys were performed each summer (July or August) between 2001 and 2005. The size of the sponges was assessed in terms of surface covered, by measuring the maximum length and width of all specimens surveyed. Measurements of sponges along the four permanent transects were pooled into 5 size-classes (< 500 cm^2, 500-1000 cm^2, 1000-1500 cm^2, 1500-2000 cm^2, > 2000 cm^2). The size distribution according to depth was studied by considering four different depth ranges: < 5 m, 5-10 m, 10-15 m and > 15 m. The associated flora and fauna was determined at least at the genus level and when possible at species level.

Results

Demospongiae Sollas, 1885
Order Poecilosclerida Topsent, 1928
Suborder Myxillina Hajdu, Van Soest & Hooper, 1994
Family Coelosphaeridae Dendy, 1922
Celtodoryx gen. nov.

Type species: *Celtodoryx girardae* sp. nov.

Diagnosis

Coelosphaeridae with a plumoreticulate choanosomal skeleton of ascending tracts made up of anisostrongyles or anisotylotes with terminal spines, interconnected by oblique anastomoses and numerous scattered spicules, ending at surface in brushes of tylotes with terminal spines. Three distinct microscleres, two types of arcuate isochelae and oxychaetes.

Celtodoryx girardae sp. nov.

Type material

Holotype: Muséum National d'Histoire Naturelle, Paris, n° MNHN D JV 92, alcohol 95°, from "Les Gorets", Gulf of Morbihan, depth 7 m, July 2001, coll. B. Perrin.

Paratype: Muséum National d'Histoire Naturelle, Paris, n° MNHN D JV 93

Etymology

Named *Celtodoryx* because of the Celtic heritage of the geographical origin, the suffix "-doryx" being widely used for naming the genera of the Coelospheridae family, and *girardae* from Annie Girard who has observed the first specimen.

Locality and habitat

To date, the sponge is only known from the Gulf of Morbihan: interior and exterior of the Gulf and Ria of Etel (Fig. 1). The type material was collected at the site "Les Gorets" (Site 1) on rocky substratum at 7 m depth.

The Gulf of Morbihan and Ria of Etel are semi-closed environments characterized by high turbidity and strong hydrodynamism. The western basin of the gulf of Morbihan is connected to the Atlantic by a 1-km long channel. The turbidity varies between 2.5 and 40 NTU (6.1 to 100 $mg.L^{-1}$) and the current velocity can reach 5 $m.s^{-1}$, the sea-water being often swirling in the western basin of the gulf. The seawater temperature varies between 5 and 20°C, and the salinity is quite constant (32 to 32.5). There is no thermocline, and the tidal range within the Gulf is about 4.5 m. The sponge species of our study is presently distributed on rocks but also on soft-bottoms, rare on vertical cliffs and abundant on bottom between 2 and 38 m that are gently sloping downwards. The maximum density of the sponge and the largest specimens were observed between 8 and 10 m.

Morphology

The sponge is thickly encrusting to massive (Fig. 2A, B), covering areas of up to 1 m^2, with a mean thickness of 8-10 cm, reaching a maximum of 50 cm. Specimens of ca. 1 m^3 have been observed. Their color in life is pale yellow to yellow. The surface is punctuated, rather regularly microlobate, with lobes being round *in situ* (2 - 2.5 cm x 1 - 1.5 cm) and more irregular after collection. The consistency is soft. Oscules are located at the top of small chimneys. No special pore areas nor fistules can be observed. Very abundant mucus is produced upon collection.

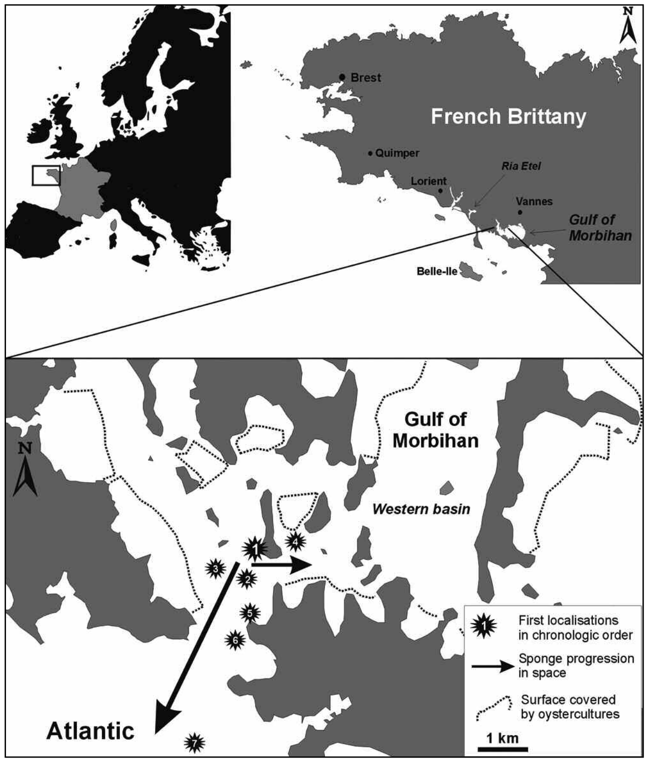

Figure 1. *Celtodoryx girardae*. Localisation and progression in space and time of the sponge within the Gulf of Morbihan: first observations between 1999 and 2002 in sites 1, 2, 3 and 4 (respectively "Les Gorets", "Gregan East", "Gregan West" and "La Cale"; observations within the channel between the Gulf and the Atlantic in 2002 (sites 5 "Le Faucheur" and 6 "Phare de Port-Navallo") and outside the Gulf in 2003 (site 7 "Faille Crouesty").

Figure 1. *Celtodoryx girardae*. Localisation et progression dans l'espace et le temps de l'éponge dans le Golfe du Morbihan: premières observations entre 1999 et 2002 aux sites 1, 2, 3 et 4 (respectivement "Les Gorets", "Gregan Est", "Gregan Ouest" et "La Cale" ; observations dans le détroit entre le Golfe et l'Atlantique en 2002 (sites 5 "Le Faucheur" et 6 "Phare de Port-Navallo") et à l'extérieur du Golfe en 2003 (site 7 "Faille Crouesty").

Skeleton

The choanosomal skeleton is densely plumoreticulate. Sinuous ascending tracts are mostly 60 to 80 µm in diameter (but up to 200 µm) made up of choanosomal spicules feebly coherent with scarce spongin (Fig. 3A). Tracts are interconnected irregularly by thinner oblique bundles and dispersed spicules. The ends of the tracts, which fan up and become tangential at the surface, make up the ectosomal skeleton.

Spicules: Choanosomal anisostrongyles or stylotes, straight or slightly curved with a few strong spines at each extremity, single or divided into several smaller ones (Fig. 3B, C). 260-330 x 8-12 µm (mean 290 µm ± 17.5 x 9.5 µm ± 1.0). Ectosomal tylotes or subtylotes (Fig. 3C), always

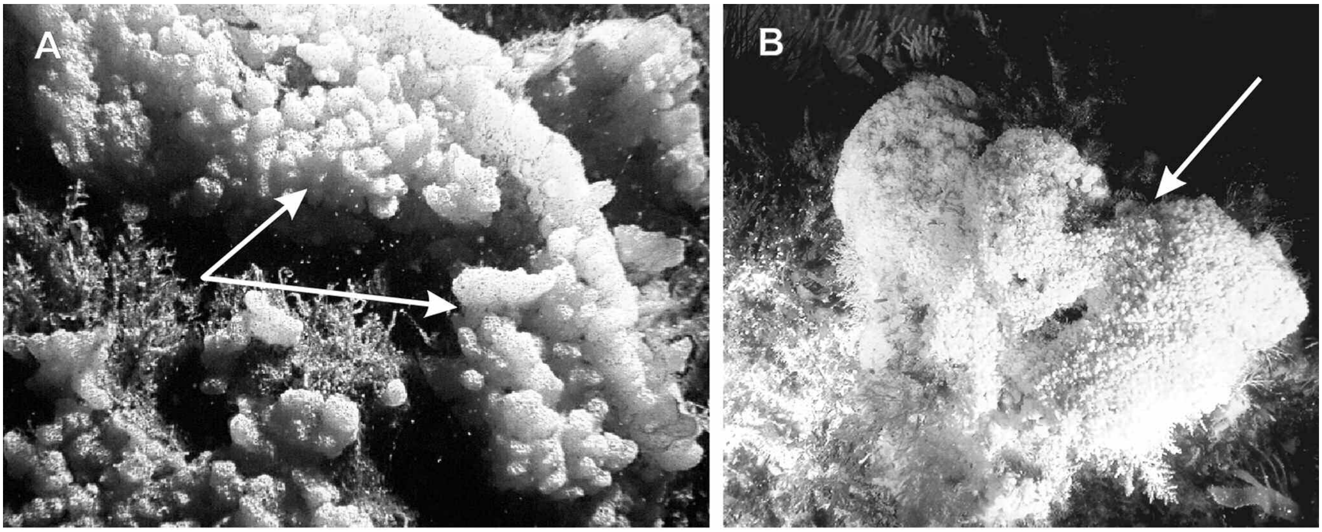

Figure 2. *Celtodoryx girardae*. Underwater pictures. **A.** Encrusting growth form, with visible round lobes at the surface and oscules located at the top of small chimneys. **B.** Massive growth form (L = 55 cm, h = 35 cm, th = 8 cm).

Figure 2. *Celtodoryx girardae*. Photographies sous-marines. **A.** Forme encroûtante avec des lobes arrondis visibles à la surface et des oscules localisés au sommet de petites tubulures. **B.** Forme massive (L = 55 cm, h = 35 cm, ép = 8 cm).

straight, with the head completely covered by spines. Spines more numerous but smaller than those of the choanosomal spicules. 180-240 x 2-8 µm (mean 202 µm ± 13 x 5.7 µm ± 1.2) Arcuate isochelae of two size classes, widespread throughout the sponge body. Isochelae type 1 (Fig. 3B, D) 45-60 µm long (mean length 53.6 ± 3.7) with shaft 4-6.8 µm wide, central tooth 18-22 µm long, and a space between the two central teeth of 12-15 µm. Isochelae type 2 (Fig. 3E) 24-30 µm long (mean length 27.8 ± 2.5) with shaft 1.7-3.4 µm wide, central tooth 10.2-12 µm long and a space between the two central teeth of 3.4-5 µm. Microspined oxychaetes (Fig. 3B, F) abundant throughout the sponge body, with sharp spines obliquely disposed, 55-90 x 0.7-1 µm (mean length 71.3 ± 7.5).

Ecology

Distribution over time and space. The sponge was first observed by Annie Girard in the Ria of Etel in 1996, but the species remained undetermined. In September 1999 it was recorded in the Gulf of Morbihan (sites 1 to 4; Fig. 1) as an undescribed abundant species, and in November 1999 in the Ria of Etel (sites called Vieux Passage, Magouër and Rameau). In 2000 and 2001, the earliest observations were confirmed. Within the latter two years, growth forms changed from thinly encrusting to massive and easily recognisable specimens. In the Gulf of Morbihan, the sponge lived then within a 4 km^2 area and was definitely absent outside the Gulf. Observations made in 2002 confirmed the positions of the sponge within the Gulf and the Ria of Etel, and 7 specimens were recorded near the entrance of the Gulf at often-visited diving sites (sites 5 and 6). The largest specimen, about 1 m^3, was then observed at the site 3 "Gregan West". A mass mortality occurred during the winter 2003, growth forms were then mainly encrusting, but the sponge distribution was nevertheless confirmed, the deepest record being at 38 m depth outside the Gulf (site 7). The sponge recovered well after the 2003 winter mortality, but to date no other records became available as far outside the Gulf or from the adjacent islands (Houât, Hoëdic, Groix and Belle-Ile).

Presently, the sponge is mainly distributed in shallow waters, between 4 and 8 m depth (Fig. 4). The number of specimens attained along the four transects did not markedly differ over time (from a total of 45 specimens in 2001 to 51 in 2005). Before 2004, the largest specimens were observed between 5 and 10 m, whereas the smallest ones were always deeper than 15 m. In 2005, the size distribution in depth was significantly different from the previous years. Indeed, the largest specimens were recorded deeper than 15 m and the smallest were in shallow waters (Fig. 4).

The demographic structure was quite stable between 2001 and 2002 with respectively 69 and 61% of specimens covering an area greater than 1000 cm^2 (Fig. 5). The total surface area of sponges along transects represented then 87200 cm^2 in 2001 and 75800 cm^2 in 2002, the largest specimens measuring appreciatively 6000 cm^2.

During the winter 2003, a mass mortality affected several sponge species and had a drastic effect on the size structure of the *C. girardae* population. In summer 2003,

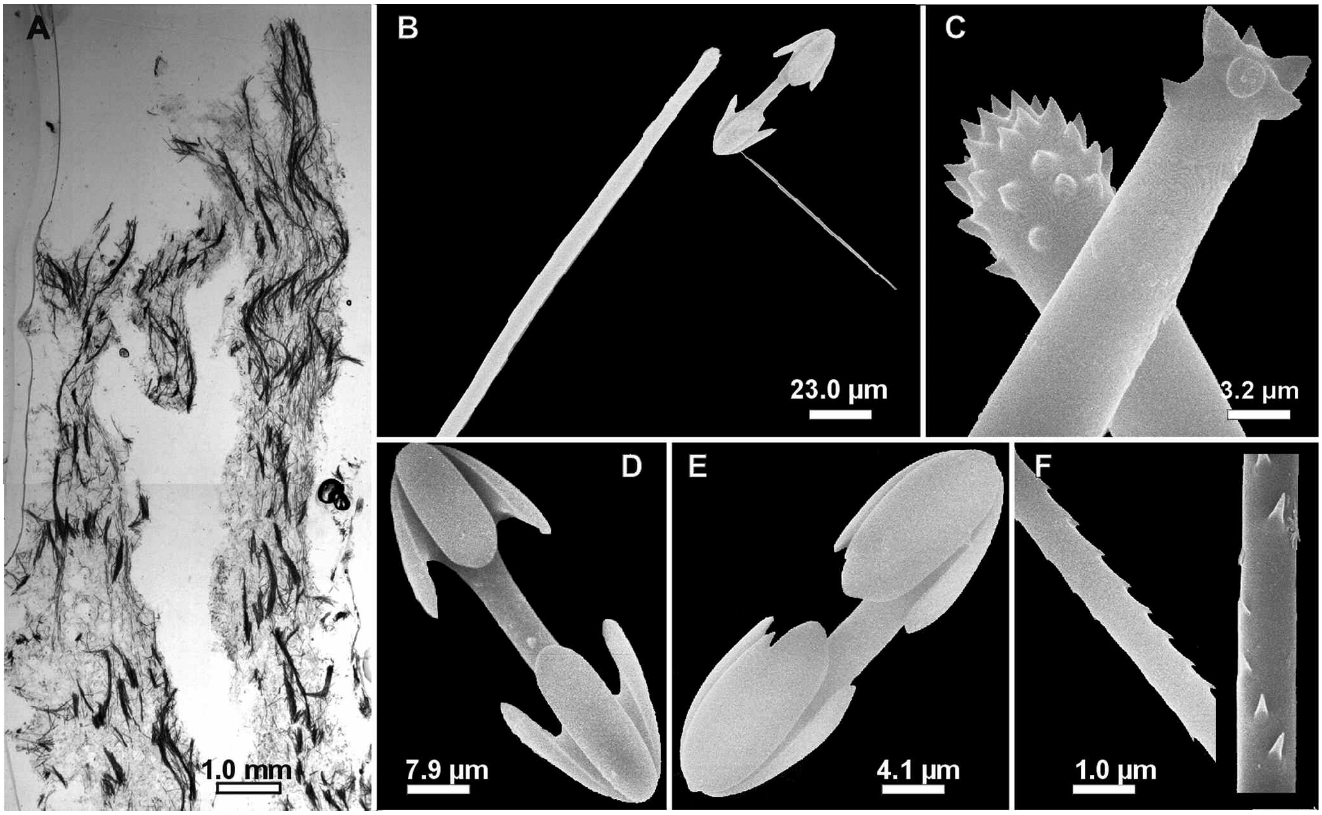

Figure 3. *Celtodoryx girardae*. **A.** The plumoreticulate skeleton with sinuous ascending tracts made up of megascleres and few dispersed microscleres. **B.** The three main spicules, tylotes, arcurate isochelae and oxychaetes. **C.** Head of a choanosomal anisostrongyle or stylote with a few strong spines and head of an ectosomal tylote completely covered by more numerous but smaller spines. **D.** Isochelae "type 1" 45-60 µm long. **E.** Isochelae "type 2" 24-30 µm long. **F.** Detail of microspined oxychaetes, with sharp spines obliquely disposed.

Figure 3. *Celtodoryx girardae*. **A.** Squelette plumeux et reticulé de régions ascendantes sinueuses constituées de mégasclères et de quelques microsclères dispersés. **B.** Les trois types principaux de spicules, tylote, isochèles arqués et oxychètes. **C.** Tête d'anisostrongyle choanosomial or de tylote garni de quelques fortes épines et tête d'un tylote ectosomial entièrement recouvert dépines plus nombreuses mais plus petites. **D.** Isochèle de type 1, 45-60 µm de longueur. **E.** Isochèle de type 2 de 24-30 µm de longueur. **F.** Détail d'oxychètres à microépines avec des épines obliquement disposées.

85% of the sponges were smaller than 500 cm^2 (35% smaller than 100 cm^2). In 2003, the total surface area of *C. girardae* along transects decreased to a sixth of the previous value (approx. 12000 cm^2). Most sponges exhibited an encrusting growth form, and the largest observed specimen measured 2400 cm^2. Then in 2004 and 2005, the sponge showed very good recovery. In 2004, the demographic structure was equivalent to the years before the mortality event, and the sponges were covering an area 5 times higher than in 2003. In 2005, the demographic structure of the surveyed population changed markedly (Fig. 5). In summer 2005, the specimens larger than 1500 cm^2 represented 61% of the population, covering an area of about 13 m^2, displaying a two-fold increase since 2004.

Associated organisms. *Celtodoryx girardae* was predominantly found on muddy rocky blocks previously covered by rhodobionts. The new sponge competes for space with many other sessile invertebrates. Particularly between 8 and 10 m depth, *C. girardae* competes with another demosponge, *Esperiopsis fucorum* (Esper, 1791-1794), the two sponges often being intermingled. Deeper, between 15 and 20 m depth, the sponge is also in strong interaction with the gorgonian *Eunicella verrucosa* (Pallas, 1766) and tends to engulf the base of the colonies. The new sponge is very often covered by epibionts like rhodobionts, hydrozoans, anthozoans and bryozoans (Table I). Several mobile species temporally lie on the sponges, Ophiurids being particularly abundant at the Ria Etel. Finally, the hairy crab *Pilumnus hirtellus* (Linnaeus, 1761) is often burrows between the tissue and the substratum at the base of *C. girardae*.

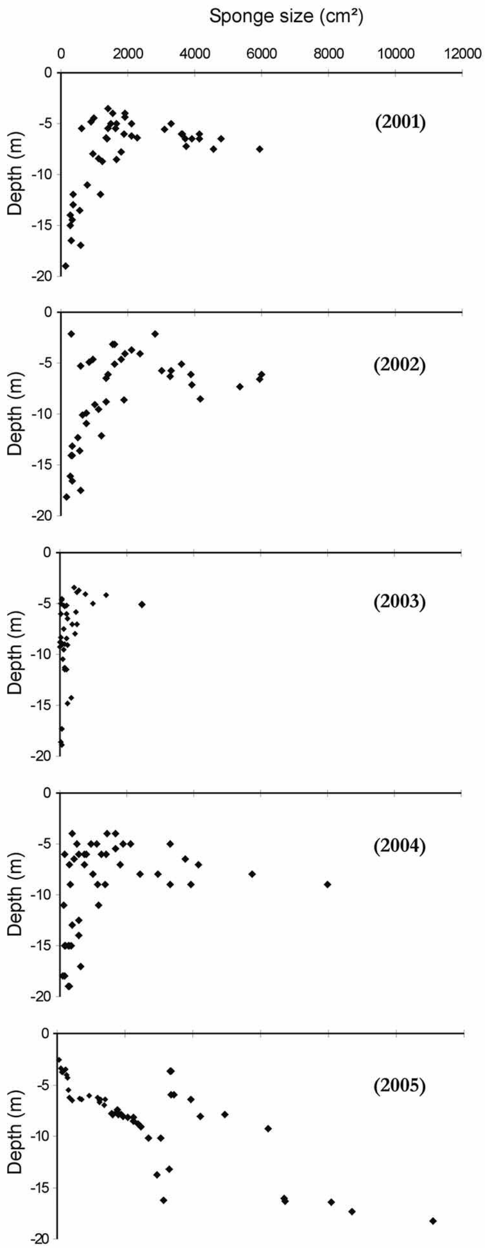

Figure 4. *Celtodoryx girardae*. Changes over time of sponge sizes distribution according to depth. The effect of depth on the sponge sizes has been tested with the non parametric test of Kruskal Wallis: 2001 $H (3, N = 45) = 24.33$ and $p < 0.001$; 2002 $H (3, N = 41) = 22.06$ and $p < 0.001$; 2003, $H (3, N = 40) = 6.05$ and $p = 0.11$; 2004 $H (3, N = 47) = 19.21$ and $p < 0.001$; 2005 $H (3, N = 51) = 22.01$ and $p < 0.001$.

Figure 4. *Celtodoryx girardae*. Variations temporelles de la distribution des tailles d'éponge en fonction de la profondeur. L'effet de la profondeur sur la taille des éponges a été testé avec le test non paramétrique de Kruskal Wallis : 2001 $H (3, N = 45) = 24{,}33$ et $p < 0{,}001$; 2002 $H (3, N = 41) = 22{,}06$ et $p < 0{,}001$; 2003, $H (3, N = 40) = 6{,}05$ et $p = 0{,}11$; 2004 $H (3, N = 47) = 19{,}21$ et $p < 0{,}001$; 2005 $H (3, N = 51) = 22{,}01$ et $p < 0{,}001$.

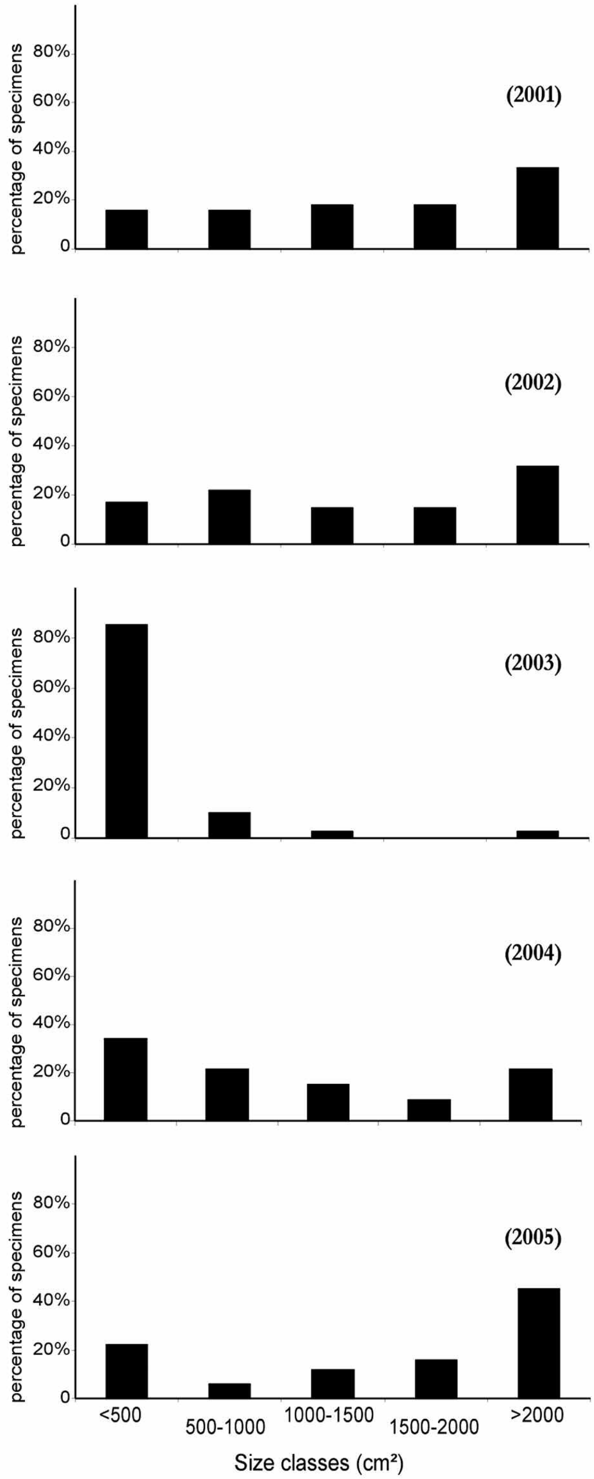

Figure 5. *Celtodoryx girardae*. Changes over time in size structure of the population surveyed from 2001 to 2005, N was respectively 45, 41, 40, 47 and 51.

Figure 5. *Celtodoryx girardae*. Variations temporelles de la structure de taille de la population suivie de 2001 à 2005, N égal respectivement à 45, 41, 40, 47 et 51.

Table 1. *Celtodoryx girardae*. Epibiontic species regularly observed.
Tableau 1. *Celtodoryx girardae*. Espèces épibiontes régulièrement observées.

FLORA	*Brongniartella byssoides* (Goodenough & Woodward) F.Schmitz , 1893	*Sargassum muticum* (Yendo) Fensholt, 1955
	Calliblepharis ciliata (Hudson) Kützing, 1843	*Solieria chordalis* (C.Agardh) J.Agardth, 1842
	Ceramnium rubrum (Hudson) Agardth, 1811	*Osmundea pinnatifida* (Hudson) Stackhouse, 1809
	Chondrus crispus Stackhouse 1797	*Plocamium cartilagineum* (Linnaeus) P.S.Dixon, 1967
	Delesseria sanguinea (Hudson) V.Lamouroux, 1813	*Bonnemaisonia asparagoides* (Woodward) C.Agardth, 1822
	Gracilaria sp	*Pterothamnion plumula* (J.Ellis), Nägeli, 1855
	Heterosiphonia plumosa (J.Ellis) Batters, 1902	*Hypoglossum hypoglossoides* (Stackh.) Collins & Hervey, 1919
	Callophylis laciniata (Hudson) Kützing, 1843	*Scytosiphon lomentaria* (Lyngbye) Link, 1833
	Polysiphonia lanosa (Linnaeus) Tandy 1931	*Apoglossum ruscifolium* (Turner) J.Agardth, 1898
	Rhodymenia pseudopalmata (V.Lamouroux) Silva, 1952	*Lomentaria clavellosa* (Turner) Gaillon, 1828
SESSILE FAUNA		
Anthozoans	*Actinothoe sphyrodeta* (Gosse, 1858),	*Epizoanthus couchii* (Johnston in Couch, 1844)
	Aiptasia mutabilis (Gravenhorst, 1831)	
Hydrozoans	*Aglaophenia pluma* (Linnaeus, 1767)	*Nemertesia antennina* (Linnaeus, 1758)
	Aglaophenia tubulifera (Hincks, 1861)	*Nemertesia ramosa* (Lamarck, 1816)
	Amphisbetia operculata (Linnaeus, 1758)	*Sertularella polyzonias* (Linnaeus, 1758)
	Halecium halecinum (Linnaeus, 1758)	*Sertularella gayi* (Lamouroux, 1821)
	Kirchenpaueria pinnata (Linnaeus, 1758)	*Sertularia argentea* (Linnaeus, 1758)
	Obelia dichotoma (Linnaeus, 1758)	*Hydralmania falcata* (Linnaeus, 1758)
	Plumularia setacea (Linnaeus, 1758)	
Bryozoans	*Bugula turbinata* (Alder, 1857)	*Electra pilosa* (Linnaeus, 1767)
	Bugula plumosa (Pallas, 1766)	*Membranipora membranacea* (Linnaeus, 1767)
	Cellepora pumicosa Waters, 1877 non auctt	*Schizomavella linearis* (Hassal, 1841)
	Crisia ramosa (Harmer, 1891)	
Ascidians	*Aplidium elegans* (Giard, 1872),	*Diplosoma spongiforme* (Giard, 1872)
	Aplidium punctum (Giard, 1873)	*Aplidium argus* (Milne-Edwards, 1841)
	Ascidia mentula Müller, 1776	*Polyclinum aurantium* (Milne-Edwards, 1841)
	Ciona intestinalis (Linnaeus, 1758)	*Polysyncraton* sp.
	Didemnum sp.	*Pycnoclavella aurilucens* Garstang, 1891
MOBILE FAUNA		
Polychæte worms	*Sabellaria spinulosa* Leuckart, 1849	*Spirorbis borealis* Daudin, 1800
	Salmacina dysteri (Huxley, 1855)	
Mollusc bivalves	*Aequipecten opercularis* (Linnaeus, 1758)	*Hiatella arctica* (Linnaeus, 1767)
Crustaceans	*Acasta spongites* (Poli, 1795)	*Pilumnus hirtellus* (Linnaeus, 1761)
	Balanus perforatus Bruguière, 1789	
Echinoderms	*Antedon bifida* (Pennant, 1777)	*Marthasterias glacialis* (Linnaeus, 1758)
	Asterias rubens Linnaeus, 1758	*Ophiothrix fragilis* (Abildgaard, in O.F. Müller, 1789)
	Asterina gibbosa (Pennant, 1777)	

Discussion and conclusion

Remarks on the systematics

Celtodoryx girardae is characterized by differentiated ectosomal and choanosomal megascleres, diactinal ectosomal megascleres and tridentate arcuate chelae microscleres. It clearly belongs to the order Poecilosclerida and the suborder Myxillina. According to the recent redefinition of the family by Van Soest (2002), the new sponge is presently classified in the Coelosphaeridae. Sequences of the sponge 18S and 28S rRNA (GeneBank accession numbers are respectively DQ241772 and DQ241773) were compared with existing ones from several representatives of Poecilosclerida and others extracted from the GenBank, but unfortunately without any member of the Coelosphaeridae (neither sequences nor samples available). Constructed phylogenetic trees confirm the phylogenetic positions of this species among the Poecilosclerida (Borchiellini, pers. comm.).

The classification of the new genus in the family Coelosphaeridae appears to be less than fully satisfactory. In the redefinition of Van Soest (2002), the Coelosphaeridae have a reticulate skeleton, whereas *Celtodoryx* gen. nov. has a clearly plumoreticulate skeleton. However, Van Soest includes in the family the genus *Acanthodoryx* Lévi, 1961, which has a plumose to plumoreticulate choanosomal skeleton and which is nevertheless considered, not only as a member of Coelosphaeridae, but also as a subgenus of *Lissodendoryx* Topsent, 1892. *Lissodendoryx* is also defined as having a "*choanosomal skeleton…forming an isodictyal reticulate architecture of single spicules with a clearly reticulate skeleton*" (translation from the original text; Topsent, 1892). Thus the family as construed at present is most probably polyphyletic. This highlights the need for molecular analysis of other genera in order to resolve the phylogeny among the Poecilosclerida and particularly the Coelosphaeridae. In this family, the new genus differs from *Acanthodoryx* by having a plumoreticulate skeleton rather than a plumose skeleton with little anastomosis, the nature of the choanosomal megascleres, anisostrongyles or stylotes with spined ends instead of acanthostyles, and the presence of oxychaetes. *Celtodoryx girardae* shares the presence of oxychaetes with *Chaetodoryx* Topsent, 1927 (= *Coelectys* Topsent, 1936), but differs by having a plumoreticulate skeleton instead of a reticulate one with smaller echinating acanthostyles. The monospecific *Acanthodoryx* is known only from shallow water in the Philippines, whereas *Chaetodoryx*, with two species, occurs in the Cape Verde Islands and the NW Mediterranean.

Suspicion of a newly introduced species

The origin of this species is unresolved. Taking into account the huge number of studies done in the last 30 years on the benthic communities for the classification of the Gulf as a French ZNIEFF*, it is unlikely that *C. girardae* could be a previously discrete species which suddenly proliferated due to changes in the ecological conditions. On the other hand, our observations support the hypothesis of a new introduction in the Gulf of Morbihan, already heavily colonized by a number of alien species (for a review see Afli & Chenier, 2002). Indeed, *C. girardae* shares some characteristics with typical introduced species (Williamson & Fitter, 1996; Boudouresque & Verlaque, 2002). The species is new to the area. Its present distribution is strictly localized, whereas adjacent similar biotopes are devoid of the new species. Its dispersion followed a discernable pattern from the first population observed in 1999. Moreover, within the sites colonized in the Gulf of Morbihan and the Ria Etel, the sponge had an evident tendency to proliferate, successfully competing with many other sessile organisms. Finally, but most importantly, the Gulf of Morbihan is exposed to several potential sources of biological introductions. Aquaculture, especially developed in the lagoons along the French coast, is among the main vectors for invasions. Oyster transfer is considered as an important vector of a number of macroalgae introductions (Verlaque, 2001), but this is also probably true for many sessile animals (Occhipinti-Ambrogi & Savini, 2003). Thus, the sponge might have been introduced with spats of oysters, the gulfweed *S. muticum* or other alien species.

Celtodoryx girardae has also some of the characteristics of a successful invasive species enumerated by Morton (1996). Stress on the marine environment favours the spreading of alien species. Invasions are generally facilitated either in environments that are strongly impoverished or subjected to strong pollution and anthropogenic forcing (e.g. Black Sea basin) (Occhipinti-Ambrogi & Savini, 2003). In the Gulf of Morbihan, the success of *C. girardae* may be thus favoured by the severe degradation of some parts of the colonized area due to sewage, general eutrophication or dredging activities (Afli & Chenier, 2002). Being eurytopic, the sponge has the ability to colonize a wide range of substrata, from the interior of the gulf with wide environmental fluctuations, to the open-ocean, and from very shallow to 38 m deep. *Celtodoryx girardae* has obviously a fast dynamic. Unfortunately, as reproduction remains unobserved, its fecundity or its age of maturity has not been assessed. The sponge had a good ability to repopulate previously colonized habitats, following a population crash caused by unusually low temperatures in winter 2003.

The sponge shares with well known invasive bivalves (e.g. *Dreissena polymorpha*, *Corbicula fluminea*) a suspension feeding strategy. Like other suspension-feeders, *C. girardae* may impact its environment in two ways (Darrigran, 2002). It is likely to be responsible for the intensive release of inorganic compounds (PO_4, NO_3, NO_2, NH_4) and may therefore be a major source of bioavailable nutrients. Sponges are also efficient biofilters, with a sophisticated aquiferous system, able to filter a water volume equivalent to their own volume within a few seconds. With no other selection of the nutritive particles than the size of the inhalant pores, these actively pumping organisms can be considered as "biological particle traps" (Pérez et al., 2005) able to retain almost 100% of the bacteria size organic materials (*e.g.* Reiswig, 1971; Reiswig, 1975; Larsen & Riisgard, 1994). Because of their feeding habits, sponges can also collect and concentrate or degrade a wide range of pollutants (Arnoux et al., 1992; Hansen et al., 1995; Pérez et al., 2002; Pérez et al., 2003; Pérez et al., 2005). Thus, as has been recently discussed by Orlova et al. (2004) for *D. polymorpha*, we may assume that *C. girardae* may be a biofilter that contributes to the depuration of colonized areas or a new source of pollution in the Gulf of Morbihan. Further surveys are needed to assess the possible effects of this new invasion on native biota and on the equilibrium of the benthic communities in the Gulf of Morbihan.

Taking into account that *C. girardae* is new in the area where previous biological introductions have been recorded and respective vectors have been described, we conclude

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that this invasive sponge is likely to be introduced. The main information lacking, however, is the geographic origin of this species. Although French law forbids it, oyster splat is still frequently imported from Japan and Korea to Europe (Verlaque, 2001), of which sponge faunas are still poorly known. Several members of the Coelosphaeridae have been reported from taxonomic studies on the coast of Japan and Korea (*e.g.* Rho et al., 1969; Rho & Sim, 1972; Hoshino, 1981). However it does not seem that a sponge with affinities to *Celtodoryx* has been described from these areas, and more generally from other parts of the world. For the time being, presumably alien sponges are reported only from the coast of the North Sea (Van Soest, 1976) and the Levantine area in the Mediterranean (Por, 1978). However, due to the level of difficulty in sponge taxonomy and the lack of properly designed inventories, especially in the eastern part of the Mediterranean and in the Red Sea as well, a critical revaluation is needed for this group (Zibrowius, 1992). Well-supported cases of sponge introduction are thus rather rare, making the discovery of an alien sponge on the coast of France all the more remarkable.

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