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Scageliopsis patens (Ceramiales, Rhodophyta), a new introduced species along the European coast

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Abstract – *Scageliopsis patens*, previously known from southern Australia and reported for the North Atlantic at the Azores Islands, is recorded for the first time along the European coast. This new alien species was collected in the subtidal and lower intertidal zones at seven Atlantic locations of the Iberian Peninsula, within the warm Atlantic Iberian area (Cantabrian Sea and south of Portugal). A comparison is made with the two other species of the genus *Scageliopsis* as well as morphologically similar *Antithamnionella* species in order to differentiate it from similar ceramiacean species.

European coast / geographical distribution / introduced species / morphology / Portugal / *Scageliopsis patens* / Spain / Rhodophyta

Résumé – *Scageliopsis patens*, précédemment connu du sud de l'Australie et récolté dans les Iles des Açores (Atlantique nord), est rapporté pour la première fois le long des côtes européennes. Cette nouvelle espèce invasive a été récoltée dans les zones subtidale et intertidale basse dans sept sites atlantiques de la Péninsule Ibérique, dans des aires atlantiques ibériques chaudes (mer Cantabrique et sud du Portugal). *Scagelopsis patens* est comparé aux deux autres espèces du genre *Scageliopsis* et aux espèces *d'Antithamniella* morphologiquement semblables afin de le différencier au sein des espèces céramiacées proches.

Côte européenne / distribution géographique / espèces introduites / morphologie / Portugal / *Scageliopsis patens* / Espagne / Rhodophyta

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INTRODUCTION

The introduction of exotic species is changing ecosystems throughout the world. More than 1,000 non-indigenous aquatic species have been recorded from coastal Europe, i.e. navigational inland waterways for ocean-going vessels and adjacent water bodies (Gollasch, 2006). The identification and tracking of new introduced species are essential for environmental management purposes.

The genus *Scageliopsis* was described by Wollaston in 1981 and it is represented by 3 species that are considered Indo-Pacific: *Scageliopsis patens* E.M. Wollaston from southern Australia (Wollaston, 1981), *Scageliopsis strongylokystis* Athanasiadis from western Australia (Athanasiadis, 1996) and *Scageliopsis tsitsikammae* Stegenga, R.J. Anderson *et* J.J. Bolton from South Africa (Stegenga *et al.*, 2000). Subsequently, Athanasiadis & Tittley (1994) recorded *Scageliopsis patens* in the Azores Islands, for the first time in the Northern Hemisphere. In this study we report specimens attributable to *S. patens*, collected in the north of Spain and in the south of Portugal.

The emergence of this species along the Atlantic Iberian Peninsula represents a new introduced species for the European coast. This new record does not seem to be a sporadic occurrence in the Iberian Peninsula and it has a similar pattern of introduction to other rhodophycean alien species that have recently been registered in the area, such as *Lomentaria hakodatensis* (Bárbara & Cremades, 1996), *Antithamnion amphigeneum* A. Millar (Secilla *et al.*, 1997), *Heterosiphonia japonica* Yendo (as *Dasysiphonia* sp., Bárbara *et al.*, 2003), *Grateloupia turuturu* Yamada (Bárbara & Cremades, 2004) and *Dasya sessilis* Yamada (Peña & Bárbara, 2006).

The aim of this work is to describe *Scageliopsis patens* for the Iberian Peninsula and give an update of the distribution of this new alien species along the European coast.

MATERIAL AND METHODS

The first specimens were collected by scuba diving in the summer of 2004 in the vicinity of the harbour of Bilbao (Basque coast, northern Spain). Further collections along the Cantabrian Sea, as well as on the Portuguese coast were made, from 2005 to 2006 (Fig. 1). Material was preserved in 4% formalin seawater or KEW solution [40% ethanol (70%), 40% seawater, 10% glycerine and 10% formaldehyde (4%)]. Microscope slides were mounted in 20-80% Karo® Syrup-distilled water. Line drawings were made using a camera lucida and photographs were taken with a Nikon DN100 digital camera mounted on a Nikon E440 (Tokyo, Japan) microscope. Preserved specimens are deposited at the herbaria of the University of the Basque Country (BIO), University of Algarve (UALG-personal PhD herbarium) and University of Santiago de Compostela (SANT).

Specimens examined: **Spain**. Guipuzcoa: Igeldo (43°19'08''N, 2°02'16''W), 8.x.2006, growing on *Pterocladiella capillacea* (S.G. Gmelin) Santelices *et* Hommersand, *Laurencia obtusa* (Hudson) J.V. Lamouroux, *Ceramium ciliatum* (J. Ellis) Ducluzeau and *Centroceras clavulatum* Montagne in the low intertidal zone, BIO-Algae 4282-4283. Vizcaya: Gorliz, Isla Pobre (43°25'15''N, 2°57'54''W), 9.viii.2005, at 4 m depth on *Dasya hutchinsiae* Harvey, BIO-Algae 4098; Barrika, Matxilando (43°24'54''N, 2°58'16''W), 21.vii.2004, at 5-7 m depth on *Pterosiphonia complanata* (Clemente) Falkenberg,

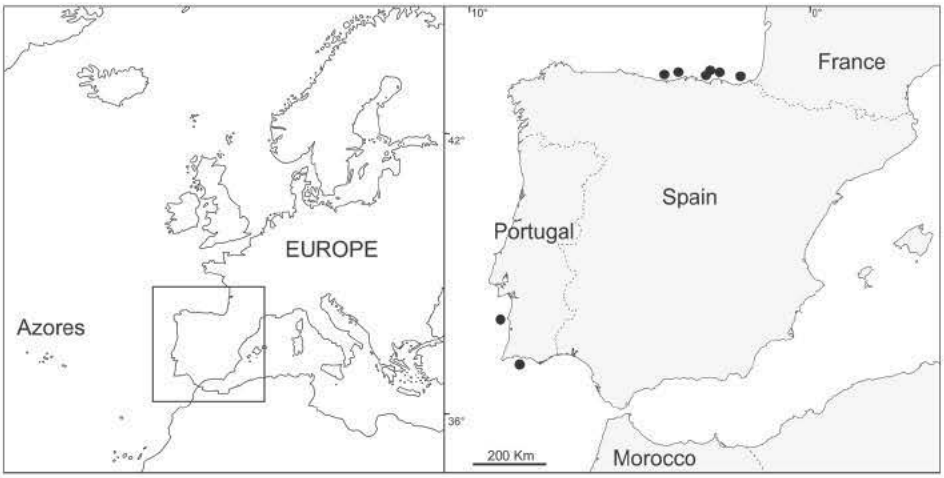


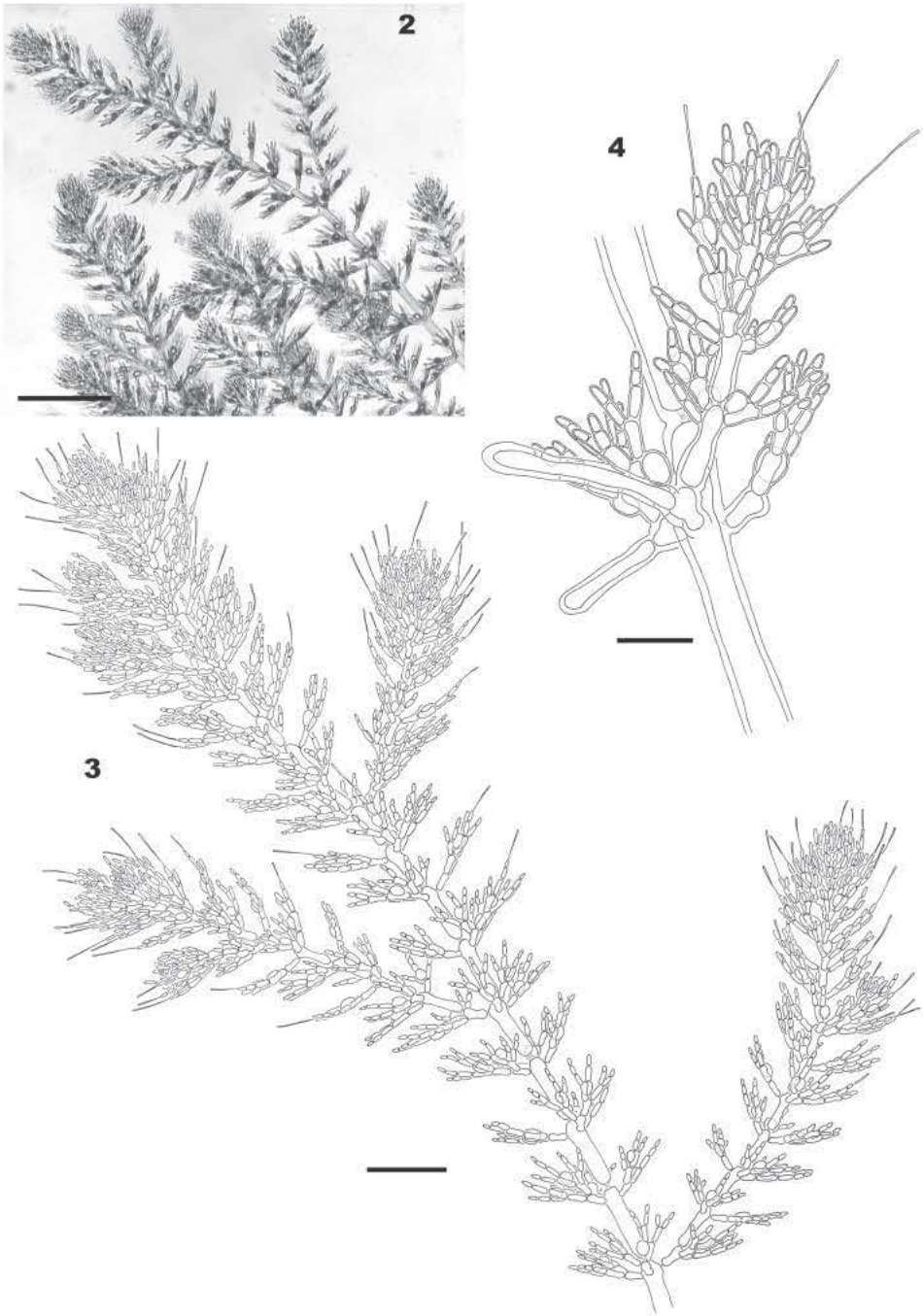
Fig. 1. Distribution of *Scageliopsis patens* along the Iberian Peninsula.

Pterosiphonia ardreana Maggs *et* Hommersand, *Champia parvula* (C. Agardh) Harvey and *Acrosorium ciliolatum* (Harvey) Kylin, BIO-Algae 3873; Muskiz, La Arena (43°21'12''N, 3°06'45''W), 7.ix.2006, growing on *Herposiphonia* sp. on sandy rocks in the low intertidal zone, SANT-Algae 18905; Bermeo, San Juan de Gaztelugatxe (43°26'47''N, 2°46'46''W), 8.ix.2006, growing on *Stypocaulon scoparium* (L.) Kützing on sandy rocks in the low intertidal zone, SANT-Algae 18906. Cantabria: Liencres, Playa de Somocueva (43°24'54''N, 2°58'16''W), 7.x.2006, growing on *Jania longifurca* Zanardini and sponges on sandy rocks in the low intertidal zone, SANT-Algae 18908-18909. Asturias: Ribadedeva, Playa de La Franca (43°23'45''N, 4°34'07''W), 6.x.2006, growing on sandy rocks in the low intertidal zone, SANT-Algae 18907. **Portugal**. Alentejo: Sines (37°56'34''N, 8°51'27''W), growing on jetty piles, 3.iv.2007, UALG-Algae 9545. Algarve: Armação de Pêra (37°02'31''N, 8°20'22''W), 16.iv.2006, at 20-22 m depth on *Dictyota dichotoma* (Hudson) J.V. Lamouroux, *Corallina elongata* J. Ellis *et* Solander, *Halopteris filicina* (Grateloup) Kützing and on top of erect foliaceous bryozoans, UALG-Algae 976; 15.iii.2007, at 11-15 m depth on *Zonaria tournefortii* (J.V. Lamouroux) Montagne, SANT-Algae 19297.

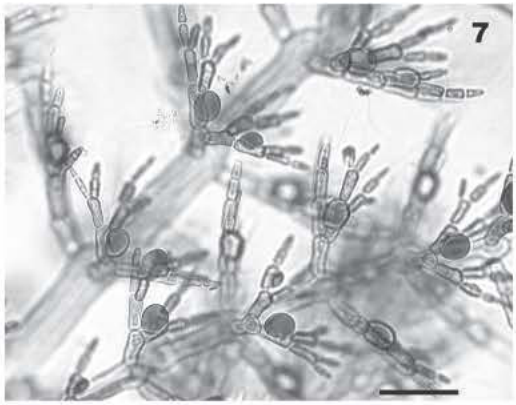
RESULTS

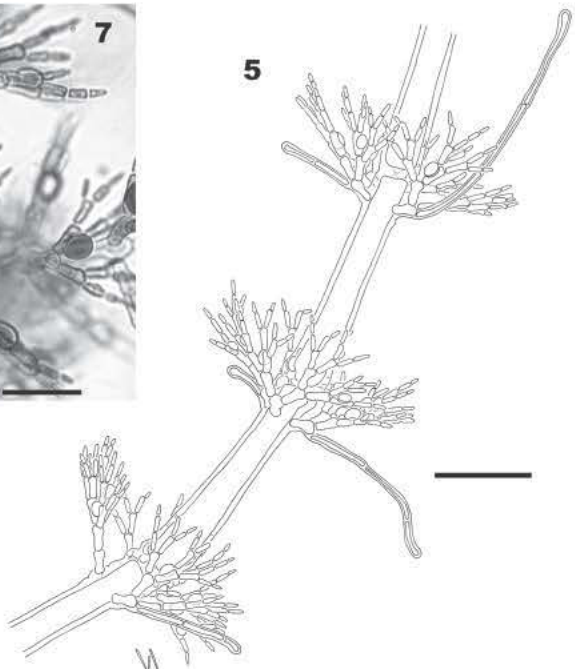
Description

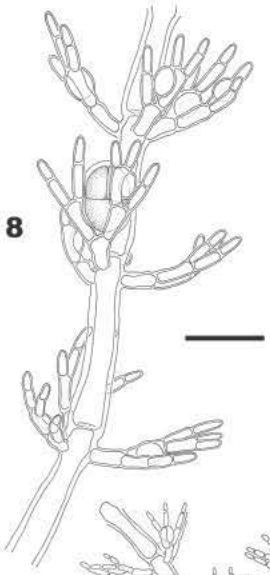
Thallus up to 4 mm high, pink to red in colour, delicate and flaccid, prostate and erect axes ecorticate forming dense plumes, attached by rhizoids (Fig. 2). Main axes enlarging from apical cells 5-7 µm wide to a maximum diameter of 20-45 µm, with cylindrical cells of 2-6 (-12) diameters long. Growth of indeterminate axes by transverse division of apical cells, producing a straight to slightly sinusoidal apex. Each axial cell producing 3 similar whorl-branchlets, perpendicular to the axis or slightly curved towards the apex (Fig. 3), 80-140 µm long, 6-12 µm in diameter, and composed of 4-7 cells of 2-3 diameters long. Whorl-branchlets subdichotomously branched from the basal cell, which is usually larger

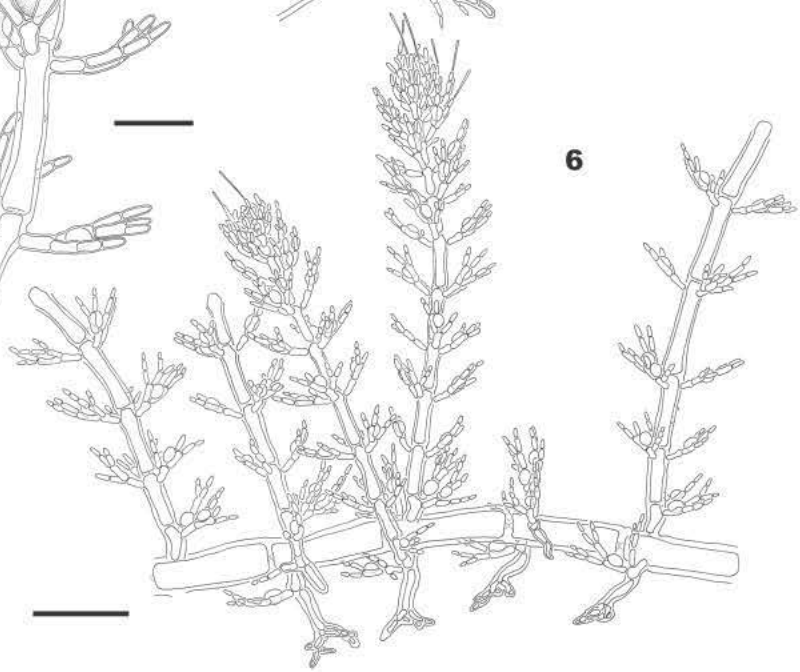


Figs 2-4. *Scageliopsis patens* E.M. Wollaston. **2.** Habit of erect thallus. Scale bar = 200 µm. **3.** Aspect of main axis. Notice the long hairs. Scale bar = 100 µm. **4.** Development of adventitious axis from basal branch cell. Scale bar = 40 µm.









Figs 5-8. *Scageliopsis patens* E.M. Wollaston. **5.** Detail of well-developed whorl-branchlets with up to four subdichotomous ramifications, and the rhizoidal development from the basal cells. Scale bar = 100 µm. **6.** Postrate axes attachment by multicellular rhizoids. Scale bar = 100 µm. **7.** Detail of whorl-branch organization and gland cells position. Scale bar = 40 µm. **8.** Tetrasporangia formed on the basal cell. Scale bar = 40 µm.

in size than contiguous cells. Terminal cells with rounded tips and often bearing a long hair (Fig. 3). New lateral axis arises from the basal cell of the whorl-branchlet, at intervals of 4-11 axial cells (Figs 3-4). Multicellular rhizoids formed by basal cells of the whorl-branchlets, 1-2 per cell, terminating in a multicellular discoid attachment pad (Figs 5-6). Gland cells frequent, borne adaxially on terminal or lower cells of the whorl-branchlets, ovoid, 16-20 × 12-15 µm, usually touching only the mother cell (Fig. 7).

Tetrasporangia sessile, on the basal and adjacent cell of the whorl-branchlets (Fig. 8), one per cell, ovoid to oblong, 35-39 × 24-28 µm, with cruciate-decussate division.

Sexual reproductive structures not observed.

Habitat

In the north of Spain, specimens were collected from the lower intertidal zone to the subtidal zone at 7 m depth. In the lower intertidal zone *Scageliopsis* was found epilithic on sandy rocks or on algal turfs, growing epiphytic on many algae: *Stypocaulon scoparium* (L.) Kützing, *Herposiphonia* sp., *Jania longifurca* Zanardini, *Pterocladiella capillacea* (S.G. Gmelin) Santelices *et* Hommersand, *Laurencia obtusa* (Hudson) J.V. Lamouroux, *Ceramium ciliatum* (J. Ellis) Ducluzeau and *Centroceras clavulatum* Montagne, at moderately exposed sites. At sublittoral levels, it occurred growing epiphytic on *Pterosiphonia complanata* (Clemente) Falkenberg, *P. ardreana* Maggs *et* Hommersand, *Champia parvula* (C. Agardh) Harvey, *Acrosorium ciliolatum* (Harvey) Kylin, *Dasya hutchinsiae* Harvey, *Dictyota dichotoma* (Hudson) J.V. Lamouroux, *Corallina elongata* J. Ellis *et* Solander, *Halopteris filicina* (Grateloup) Kützing, *Zonaria tournefortii* (J.V. Lamouroux) Montagne and epizoic on erect foliaceous bryozoans, at exposed to protected sites. Material from Portugal was only collected in the sublittoral zone (11-22 m depth).

DISCUSSION

Scageliopsis patens was originally described from Australia by Wollaston (1981), later it was recorded for the North Atlantic in the Azores Islands (Athanasiadis & Tittley, 1994; Neto, 1994; Tittley & Neto, 1994), and now, the diagnostic characters described for this species agree with the material found in the north of Spain and the south coast of Portugal, which represents the first record of *Scageliopsis patens* for the Iberian Peninsula and Europe.

The genus *Scageliopsis* E.M. Wollaston is characterised by whorls of (2-) 3 (-4) whorl-branchlets, which become subdichotomously branched starting from the basal cell, by ovoid gland cells touching only the bearing cell, by the elongation of fertile axes after carposporophyte initiation, and a partial fusion of the supporting cell and the fertile axial cell during development of the carposporophyte (Wollaston, 1981; Athanasiadis, 1996; Womersley, 1998). Three species of the genus *Scageliopsis* have been described (Athanasiadis, 1996; Stegenga *et al.*, 2000): *Scageliopsis patens*, *S. strongylokystis* and *S. tsitsikammae*. Of these 3 species (Table 1), *S. strongylokystis* from western Australia has much longer cells and whorl-branchlets (up to 450 µm long), and conspicuous spherical

Table 1. Comparison of morphological features and distribution of *Scageliopsis* species and similar *Antithamnionella* species. Information taken from: Athanasiadis (1996)[1], Athanasiadis & Tittley (1994)[2], Stegenga *et al.* (2000)[3], Wollaston (1981)[4], Womersley (1998)[5].

	Number of whorl-branches	*Whorl-branch ramification*	*Whorl-branch divisions starting from*	*Whorl-branches length (µm)/ number of cells*	*Periaxial cell* vs *suprabasal cell*	*Gland cell morphology*	*Gland cell ontogeny*	*Distribution*
Scageliopsis patens E.M. Wollaston [2,4,5]	3	subdichotomous	periaxial cell	90-200 /4-7	similar or larger	lens-shaped to ovoid	from terminal cells	Southern Australia, Azores Islands, Atlantic Iberian Peninsula
Scageliopsis strongylokystis Athanasiadis [1]	2-3	subdichotomous, trichotomous	periaxial cell	up to 450 / up to 10	similar or smaller	spherical	from terminal cells	Western Australia
Scageliopsis tsitsikammae Stegenga, R.J. Anderson *et* J.J. Bolton [3]	2(-3)	subdichotomous	periaxial cell, 2nd cell	up to 100 / up to 8	similar	lens-shaped to ovoid	from terminal cells	South Africa
Antithamnionella boergesenii (Cormaci *et* G. Furnari) Athanasiadis [1]	4-5	simple, alternate distichous	2nd cell	up to 250 / up to 15	smaller	lens-shaped to elliptical	from terminal cells	Western Mediterranean, Canary Islands, Caribbean Sea, Basque Country
Antithamnionella elegans (Berthold) Price *et* John [1]	3	simple, alternate distichous	2nd, 3rd cell	up to 300 / up to 12	smaller	lens-shaped to elliptical	from intercalary cells	Western Mediterranean, Japan, Spain
Antithamnionella breviramosa (E.Y. Dawson) E.M. Wollaston [1]	(2-)3	subdichotomous, unilateral	2nd, 3rd cell	up to 240 / up to 13	smaller	lens-shaped to elliptical	from terminal cells	Bermuda, Florida, North Carolina, Eastern Australia, Solomon Islands, Hawaii

gland cells, features which differentiate it from the other species. Likewise, *S. tsitsikammae* from South Africa has mainly 2 shorter (up to 100 µm long) and less branched whorl-branchlets that clearly distinguish it from *S. patens* that usually has 3 whorl-branchlets up to 200 µm long and is more branched.

Scageliopsis patens closely resembles *Antithamnionella boergesenii* (Cormaci *et* G. Furnari) Athanasiadis, a frequent species on the Basque coast (Gorostiaga *et al*., 2004). However, *A. boergesenii* has 4-5 whorl-branchlets per axial cell (Cormaci & Furnari, 1988; Athanasiadis, 1996) that distinguish it from *S. patens* (Table 1). Other species that show great similarity with *S. patens* are *Antithamnionella elegans* (Berthold) J.H. Price *et* D.M. John and *A. breviramosa* (E.Y. Dawson) E.M. Woll., since they have 3 whorl-branchlets per axial cell and each of them ramifies pseudichotomously (Athanasiadis, 1996). Nevertheless, in *S. patens* the ramification of the whorl-branchlets begins in the periaxial cell and not in the second or third cell of the branch, as in the genus *Antithamnionella* Lyle. In addition, the periaxial cells are longer than the contiguous cells of the branch (smaller or isodiametric in most species of *Antithamnionella*) (Athanasiadis, 1996).

The introduction of *Scageliopsis* along the coasts of the Iberian Peninsula may have occurred by maritime transport from the Azores, either by ships hull fouling or by ballast water release. This transport vector would explain the wide and scattered distribution of this species, which was in fact firstly described for several harbours in Australia. In the Azores, it is considered to be introduced in the Faial and Saõ Miguel islands (Cardigos *et al*., 2006). It is surprising that *S. patens* appeared suddenly in several places in Spain and Portugal. However, its small size makes it difficult to find, and the scarcity of detailed studies in ceramiaceous algae and sandy habitats in those areas implies that some species remain undetected or misidentified. Therefore, we conclude that *S. patens* has probably been present in the Iberian Peninsula for some time.

On the other hand, the appearance of *Scageliopsis* in the intertidal zone and under sandy conditions extends the habitat of this species, which was previously documented only for the subtidal zone.

Scageliopsis patens was found in the warm Atlantic Iberian area (Cantabrian Sea and the south of Portugal) only during the summer and the autumn months and only two samples were found in March and April (Armação de Pêra). It has not been found in Galicia and the north of Portugal. Presumably due to the maximum sea temperatures in the northwest of the Iberian Peninsula in summer being only 18ºC whereas in the warm Atlantic Iberian area it can reach 22-24ºC for example in the Azores Archipelago. However, although the temperature in the Mediterranean Sea is about 22-24ºC in summer, *S. patens* has not yet been reported in this area (Verlaque, 2001; Boudouresque & Verlaque, 2002; Klein *et al*., 2005; Streftaris *et al*., 2005).

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