Scientific Reports of Port-Cros National Park, 38: 129-141 (2024)

New records of marine macroalgae in Rayol-Canadel-sur-Mer, in the Adjacent Marine Area of the Port-Cros National Park (Provence, France)

Jérémy TRITZ[1], Charles-François BOUDOURESQUE[2*], Aurélie BLANFUNÉ[2], Thierry THIBAUT[2], Marc VERLAQUE[2]

[1] Domaine du Rayol - Le jardin des Méditerranées, 83820 Rayol-Canadel-sur-Mer, France.
[2] Aix-Marseille Université and Université de Toulon, CNRS, IRD, Mediterranean Institute of Oceanology (MIO), Campus of Luminy, 13288 Marseille, France.
**Corresponding author: charles-francois.boudouresque@mio.osupytheas.fr*

Abstract. The study of the herbarium of the *Domaine du Rayol* has resulted in the determination of 30 taxa: 8 green algae (Ulvophyceae), 14 red algae (Rhodophyta) and 8 brown algae (Phaeophyceae). With the exception of *Ericaria amentacea* and *E. crinita*, all of them are first reported from Rayol-Canadel-sur-Mer. *Laurenciella* cf. *marilzae* is reported for the first time in France, although already collected from Marseilles and Corsica (unpublished data). *Acrosymphyton purpuriferum*, already known from the Port-Cros Archipelago, is reported for the first time from the mainland PCNP (Port-Cros National Park) area. Two invasive species, *Caulerpa cylindracea* and *Acrothamnion preissii*, although new to the locality, but widely distributed throughout the PCNP area, have undoubtedly been present there for two decades.
Keywords: *Acrosymphyton purpuriferum*, *Acrothamnion preissii, Caulerpa cylindracea*, Domaine du Rayol, *Laurenciella* cf. *marilzae*, macroalgae, Port-Cros National Park.

Résumé. **Nouvelles signalisations de macroalgues marines au Rayol-Canadel-sur-Mer, dans l'Aire maritime adjacente du Parc national de Port-Cros (Provence, France)**. L'étude de l'herbier du Domaine du Rayol a permis de déterminer 30 taxons : 8 Ulvophyceae, 14 Florideophyceae et 8 Phaeophyceae. À l'exception d'*Ericaria amentacea* et d'*E. crinita*, tous sont nouveaux pour Rayol-Canadel-sur-Mer. *Laurenciella* cf. *marilzae* est nouvelle pour la France, bien que déjà observée à Marseille et en Corse (données inédites). *Acrosymphyton purpuriferum,* connu de l'archipel de Port-Cros, est nouveau pour la partie continentale du Parc national de Port-Cros (PNPC). Deux espèces invasives, *Caulerpa cylindracea* et *Acrothamnion preissii,* bien que nouvelles pour la localité, mais largement répandues dans le PNPC, y sont sans doute présentes depuis deux décades.
Mots-clés : *Acrosymphyton purpuriferum*, *Acrothamnion preissii, Caulerpa cylindracea*, Domaine du Rayol, *Laurenciella* cf. *marilzae,* macroalgues, Parc national de Port-Cros.

Introduction

The Port-Cros National Park (PCNP) (eastern Provence, France, Mediterranean Sea) is made up of the core areas of Port-Cros Archipelago and Porquerolles Island (land area and a marine belt 600 m wide), the Adhesion Area (a part of the land area of the

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/).

5 municipalities which have joined the PCNP)[1], and a vast Adjacent Marine Area (AMA), from La Garde to Ramatuelle, extending seawards to the edge of the continental shelf (118 600 ha). Whether or not a municipality has joined the park, the marine area located off its coastline does belong to the AMA of the PCNP (**Fig. 1**). The AMA extends over 63 km as the crow flies, from west to east.

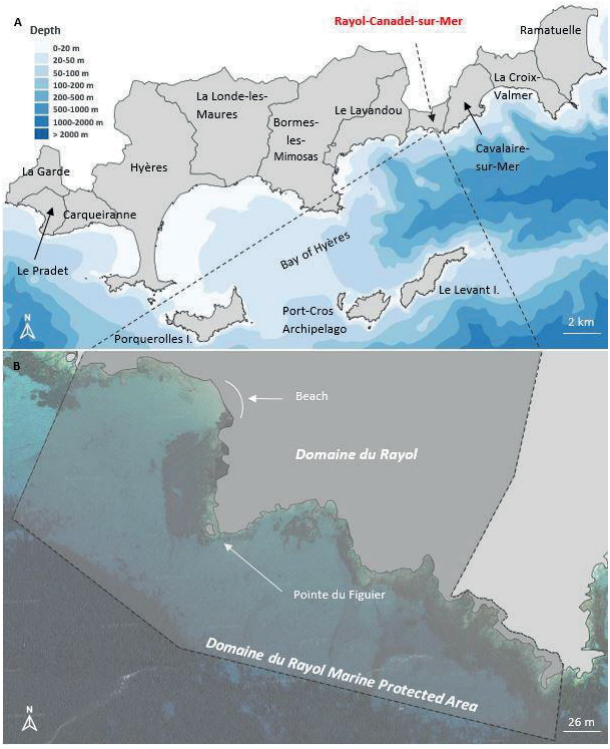

Figure 1. **A**. Map of the Optimal Adhesion Area (OAA) of the Port-Cros National Park, with the Municipality of Rayol-Canadel-sur-Mer (outside the Adhesion Area). **B**. Map of the *Domaine du Rayol* and of the *Domaine du Rayol* Marine Protected Area (PNPC, 2024).

Algae (and macroalgae – multicellular algae) are a customary polyphyletic ensemble, not a taxon. Some of them (green algae) belong to Viridiplantae (kingdom Archaeplastida), others, red algae, belong to Rhodobionta (kingdom Archaeplastida), and finally brown algae belong to the kingdom Stramenopila (Boudouresque, 2015; Boudouresque *et al.,* 2015; Boudouresque *et al.*, 2021).

[1] Adhesion has been proposed to 11 municipalities (the Optimal Adhesion Area – OAA).

Knowledge on the marine macroflora (macroalgae and seagrasses) of core areas and the AMA of the PCNP was summarized by Boudouresque *et al.* (2022). The number of reported macrophyte taxa amounts to 502: 73 green algae, 316 red algae, 104 brown algae and 9 seagrasses (Magnoliophyta) and other taxa. The number of reported taxa per site is highly heterogeneous throughout the PCNP area, ranging from 2 (La Garde) to 441 (Port-Cros Archipelago); as expected, it is correlated with the number of studies per site, 4 and 94 respectively (Boudouresque *et al.* (2022).

Rayol-Canadel-sur-Mer is one of the least studied and least known sites of the PCNP, with 4 studies and only 3 records: the seagrass *Posidonia oceanica* (Astier and Tailliez, 1984; Andromede Oceanologie, 2014) and the brown algae *Ericaria amentacea* (Thibaut *et al.,* 2014) and *E. crinita* (Blanfuné *et al.,* 2016).

Here, we studied the herbarium of marine algae of the *Domaine du Rayol*, whose specimen vouchers were often unidentified and whose determination required confirmation or correction, in order to complete the inventory of macroalgae in Rayol-Canadel-sur-Mer. The *Domaine du Rayol* has belonged to the *Conservatoire du Littoral*[2] since 1989, and manages a 14-ha Marine Protected Area (MPA) (**Fig. 1**).

Material and methods

The studied specimens were collected between 2022 and 2024 offshore of the *Domaine du Rayol* by snorkelling, from sea level down to 5 m.

The collection was not carried out according to a precise sampling plan, nor with a particular objective, but in an opportunistic manner, in order to improve the knowledge of the *Domaine du Rayol* MPA (**Fig. 1**). Large, easily distinguishable species were favoured.

The preparation of the herbarium vouchers was carried out immediately after collection, without prior preservation in alcohol or formalin, which will allow the possible subsequent use of DNA sequencing.

[2] The *Conservatoire de l'espace littoral et des rivages lacustres* is a French public organisation founded in 1975 to ensure the protection of outstanding natural areas on the coast, lake shores and stretches of water. The creation of the *Conservatoire du Littoral* (as it is commonly referred to) was inspired by the British National Trust, though the National Trust is a private charity, whereas the *Conservatoire du Littoral* is government funded.

Results and discussion

A total of 41 voucher specimens were identified, belonging to 30 taxa: 8 green algae (Ulvophyceae, Viridiplantae, kingdom Archaeplastida), 14 red algae (Florideophyceae, Rhodophyta, kingdom Archaeplastida) and 8 brown algae (Phaeophyceae, kingdom Stramenopila) (**Table 1**).

Table 1. Macroalgal species present in the *Domaine du Rayol* herbarium. For species authority, see Guiry and Guiry (2024). Collectors: Jeremy Tritz (JT), Paulin Pascal (PP) and Sarah Muttoni (SM).

Name	Habitat	Date of collection	Collectors	Voucher number
ULVOPHYCEAE	(VIRIDIPLANTAE)			
Acetabularia acetabulum	1.5 m, well-lit reef slab (Pointe du Figuier)	23/06/2022	JT, PP	25062022-10
Caulerpa cylindracea	5 m, photophilous reef (west of Pointe du Figuier)	03/07/2022	JT	03072022-2
Cladophora cf. *dalmatica*	Midlittoral zone (west of Pointe du Figuier)	24/06/2022	JT, PP	24062022-1
Codium bursa	1 m, reef (west of Pointe du Figuier)	03/07/2022	JT	03072022-14
Codium vermilaria	4 m, reef (west of Pointe du Figuier)	03/07/2022	PP	03072022-10
	1 m, reef edge (west of Pointe du Figuier)	03/07/2022	JT	03072022-6
Dasycladus vermicularis	1 m, sandy reef, photophilous (west of Pointe du Figuier)	23/06/2022	JT, PP	23062022-11
Flabellia petiolata	0.5 m, semi-sciaphilic reef (west of Pointe du Figuier)	23/06/2022	JT, PP	23062022-7
Halimeda tuna	0.5 m, photophilous reef (west of Pointe du Figuier)	23/06/2022	JT, PP	23062022-8
FLORIDEOPHYCEAE	(RHODOPHYTA)			
Acrosymphyton purpuriferum	Drifting specimen, close to the beach (west of Pointe du Figuier)	23/06/2022	SM	23062022-12
	2 m, sloping reef (west of Pointe du Figuier)	23/06/2022	JT, PP, SM	23062022-13
Acrothamnion preissii	2 m, under a shaded overhang	03/07/2022	JT	03072022-12
Chondria mediterranea (syn. *C. boryana*)	Midlittoral zone (west of Pointe du Figuier)	24/06/2022	JT, PP	24062022-3
Digenea simplex	4 m, at the foot of a rock (in front of Le Rayolet, east of Pointe du Figier)	08/07/2022	JT	08072022-6
Ellisolandia elongata	0.5 m, sciaphilous reef (east of Pointe du Figuier)	10/09/2022	JT	10092022-1

Name	Habitat	Date of collection	Collectors	Voucher number
Halopithys incurva	Near sea level, sheltered and well-lit area (east of Pointe du Figuier)	27/10/2022	JT	27102022-3
	1 m, under exposed conditions (Pointe du Figuier)	03/07/2022	JT	03072022-3
Laurenciella cf. *marilzae*	1 m, flat reef exposed to waves, photophilous (east of Pointe du Figuier)	22/06/2022	JT, PP	22062022-9
Nemalion lubricum	Midlittoral, very exposed, Pointe du Figuier	19/02/2024	JT	19022024-4
Peyssonnelia bornetii	4 m, photophilous reef (west of Pointe du Figuier)	03/07/2022	PP	03072022-11
Peyssonnelia squamaria	1 m, photophilous reef (west of Pointe du Figuier)	03/07/2022	JT	03072022-8
Phyllophora crispa	4 m, under a shaded overhang (east of Pointe du Figuier)	03/07/2022	PP	03072022-9
Rissoella verruculosa	Midlittoral, Pointe du Figuier	18/02/2024	JT	18022024-1
Spyridia filamentosa	Near sea level, sheltered and well-lit reef (east of Pointe du Figuier)	27/10/2022	PP	27102022-10
Trichleocarpa fragilis	4 m, vertical reef facing east (east of Pointe du Figuier)	08/07/2022	PP	08072022-7
PHAEOPHYCEAE	(STRAMENOPILA)			
Cladostephus hirsutus	2 m, horizontal reef (east of Pointe du Figuier)	08/07/2022	JT	08072022-5
Cystoseira compressa	2 m (Pointe du Figuier)	27/10/2022	JT	27102022-5
	1 m (west of Pointe du Figuier)	27/10/2022	JT	27102022-9
	1 m, photophilous reef slab (Pointe du Figuier)	08/07/2022	JT	08072022-4
	Pool, sea level, Pointe du Figuier	19/02/2024	JT	19022024-3
Dictyota dichotoma var. *dichotoma*	1 m, shaded overhang (Pointe du Figuier)	03/07/2022	JT	03072022-5
Dictyota dichotoma var. *intricata*	1 m, well-lit reef (east of Pointe du Figuier)	27/06/2023	JT	27062023-1
	1.5 m, well-lit reef (west of Pointe du Figuier)	08/07/2022	JT	08072022-1
Ericaria amentacea	Sea level exposed reef (Pointe du Figuier)	24/06/2022	JT, PP	24062022-2

Name	Habitat	Date of collection	Collectors	Voucher number
	Sea level exposed reef (Pointe du Figuier)	27/10/2022	JT	27102022-8
Ericaria crinita	Sea level exposed reef (Pointe du Figuier)	27/10/2022	JT	27102022-2
Halopteris filicina	2 m, reef edge (located outside the *Domaine du Rayol*)	03/07/2022	PP	03072022-13
	2 m, under an overhanging reef, (Le Rayolet, east of Pointe du Figuier)	08/07/2022	JT	08072022-8
Halopteris scoparia	2 m, under an overhanging reef (Le Rayolet, east of Pointe du Figuier)	08/07/2022	JT, PP	08072022-9
	1.5 m, photophilous reef (east of Pointe du Figuier)	27/06/2023	JT	27062023-2
	3 m, under an overhanging reef (Pointe du Figuier)	08/07/2022	JT, PP	08072022-2

The whole of these taxa have already been reported from the PCNP area (Boudouresque *et al.,* 2022), with the exception of *Laurenciella* cf. *marilzae* (see below). However only two of them have previously been reported from Rayol-Canadel-sur-Mer, namely *Ericaria amentacea* and *E. crinita* (Thibaut *et al.,* 2014; Blanfuné *et al.,* 2016).

Several of these species are regarded as species of warm affinity, the abundance of which is expected to increase with the current global warming: *Dasycladus vermicularis, Acrothamnion preissii, Digenea simplex, Spyridia filamentosa, Halopithys incurva* and *Trichleocarpa fragilis.*

Most of these taxa are common in the PCNP area, with the exception of *Acrosymphyton purpuriferum* (**Fig. 2, 3**). The latter has been reported only from the Port-Cros Archipelago by Boudouresque (1973), Belsher *et al.* (1976), Coppejans (1977) and Le Gall and Rousseau (2009). This is its first report for the mainland PCNP area.

Figure 2. *Acrosymphyton purpuriferum* (pink tuft, near the centre of the photo). Specimen 23062022-13 (**Table 1**), 2 m depth, west of Pointe du Figuier. On the right, the *Posidonia oceanica* seagrass meadow. Photo © Sarah Muttoni, courtesy of the author.

The red alga *Laurenciella* cf. *marilzae,* is new not only for the PCNP area, but also to France. The species has been described by Gil-Rodríguez *et al.* (2009), as *Laurencia marilzae*, from the Canary Islands. The species was also reported from the Azores and Brazil, and as *L. dendroides* and *L. majuscula*, from Sicily, Apulia, Aeolian Islands and Lampedusa Island (Italy), the Principality of Monaco, Croatia, Zakynthos and Karpathos islands (Greece) (Machín-Sánchez *et al.*, 2014; Rousseau *et al.,* 2017; review *in* Serio *et al.,* 2020). Our specimens from Rayol-Canadel-sur-Mer (**Table 1, Fig. 4-5**), referred to as *L.* cf. *marilzae*, correspond well to the descriptions of Gil-Rodríguez *et al.* (2009), Serio *et al.* (2020) and Metti *et al.* (2024), e.g. orange in colour, terete and soft in texture, tetrasporangial thalli erect and taller than 2 cm, deciduous branchlets absent, epidermal cells with pit-connections, epidermal cells without a palisade-like arrangement and markedly projecting in apical to

subapical portions of the axes. Unfortunately, the *corps en cerise*, the presence, abundance and localization of which are diagnostic, are poorly preserved in our specimens, although they seem to be definitely present. In addition to the study specimens, *L. marilzae* was recorded in the Gulf of Aiacciu (Ajaccio, Corsica) and at Sormiou (Marseilles, western Provence) at 0.5 m depth in May-June 2016 by one of the authors (Line Le Gall and Marc Verlaque, unpublished data).

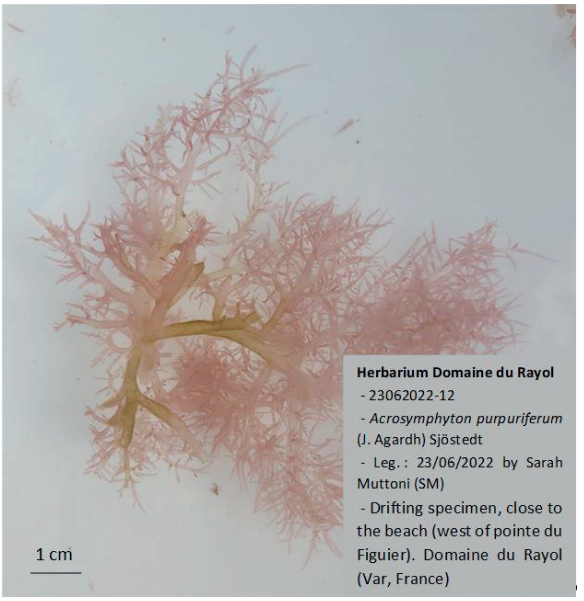

Figure 3. *Acrosymphyton purpuriferum*. Specimen 23062022-12. Herbarium of the *Domaine du Rayol*.

Two species are non-indigenous and invasive: *Caulerpa cylindracea* and *Acrothamnion preissii*. The first one, *C. cylindracea*, native to southern Australia (Verlaque *et al.,* 2003), was first reported from the Mediterranean in Tunisia in 1985 (Zenetos *et al.,* 2017). The vector of introduction is unknown. It is now very common throughout the Mediterranean (Verlaque *et al.,* 2004; Piazzi *et al.,* 2005; Verlaque *et al.,* 2015; van der Loos *et al.,* 2023), and in particular in the PCNP area since the 2000s (Boudouresque *et al.,* 2022). We can assume that the species has been present in Rayol-Canadel-sur-Mer since the 2000s, as elsewhere in the PNPC area. The second species, *A. preissii*, is native to the Pacific Ocean. In the Mediterranean, it was first reported from Leghorn (Livorno, Tuscany, Italy) and it is assumed that the vector of introduction was the fouling on ship hulls (Cinelli and Sartoni, 1969). It has become very invasive in Tuscany, covering up to 60% of the substrate between the sea surface and 40 m depth (Cinelli *et al.,* 1984). The species contains

very toxic brominated compounds, located in specialized, shiny gland cells called '*bromuques*', and is strongly avoided by herbivores such as the sea urchin *Paracentrotus lividus*, which gives it an advantage in its competition with native species (Tomas *et al.,* 2011). From Tuscany, *A. preissii* has invaded much of the western Mediterranean. In the PCNP area, it was first recorded in Ramatuelle (Thélin, 1984); subsequently, it had been reported from Giens Peninsula, Cavalaire-sur-Mer, Port-Cros Archipelago and Le Levant Island (Klein *et al.,* 2005; Ourgaud, 2010; Klein and Verlaque, 2011). Unlike Tuscany, a strong negative ecological impact of *A. preissii* has not been reported in the PCNP area.

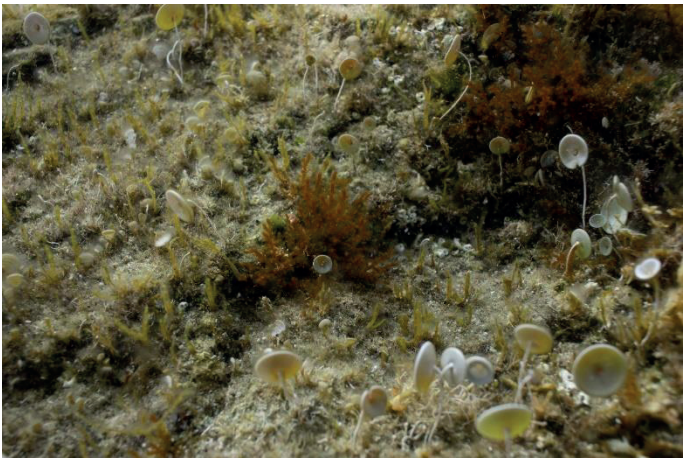

Figure 4. *Laurenciella* cf. *marilzae*, in the centre and top right. Scattered and especially bottom right: *Acetabularia acetabulum*. Photo © Sarah Mutoni.

The brown alga *Ericaria crinita* seems to have always been abundant in the PCNP area, both in the past (Jahandiez, 1914; Molinier *et al.,* 1959) and today (Blanfuné *et al.,* 2016). However, in some regions, it has experienced a severe decline. It is regionally extinct in French Catalonia (Occitania), near-extinct in Languedoc (Occitania) and Western Provence, and functionally extinct in French Riviera (Thibaut *et al.,* 2005, 2015; Blanfuné *et al.,* 2016). It is therefore important to verify that the status of *E. crinita* in the PCNP area (Eastern Provence) remains healthy, which seems to be confirmed by its recent observation in Rayol-Canadel-sur-Mer (**Table 1**).

Figure 5. Specimens of *Laurenciella* cf. *marilzae* from Rayol-Canadel-sur-Mer (**Tabl. 1**).

Conclusion

Presenting 30 taxa of macroalgae, including 28 taxa previously unreported from a site of the AMA of the PCNP, Rayol-Canadel-sur-Mer, may seem futile. Most of these taxa are common in the region, and their presence there was highly probable, although *Laurenciella* cf. *marilzae* is reported for the first time in France.

Yet, at a time when global change, including global warming, biological invasions and other human impact, is causing significant and rapid changes in flora, fauna and ecosystems, each taxon record represents a valuable benchmark that helps us measure and understand these changes. In addition, the specimens are preserved in a herbarium, that of the *Domaine du Rayol*. Herbaria constitute tools of inestimable value: the data is long-term and even very long-term; it is possible to return to the specimen, to correct or update its determination; it is possible to sequence the DNA of the specimen. Overall, far from being a naïve, post-modern approach, herbaria constitute one of the most modern and effective tools in the service of science (e.g. Funk, 2007; Liao, 2013; Bataan *et al.,* 2021).

Acknowledgements. This study was made possible thanks to the tools of the *Plateforme macrophytes* of the MIO (Mediterranean Institute of Oceanography) and Aix-Marseille University. The authors are grateful to Sarah Muttoni and Paulin Pascal for field assistance, and to Michael Paul, a native English speaker, for proofreading the text.

References

ANDROMEDE OCEANOLOGIE, 2014. *La Méditerranée dévoile ses dessous – Cartographie continue des habitats Marins*. Partenariat Agence de l'Eau RMC – Andromède, Agence de l'Eau Publisher, Marseille.

ASTIER J.M., TAILLIEZ P., 1984. Pour un plan d'occupation des fonds marins: Inventaire des herbiers de posidonies du littoral du Var. *Ann. Soc. Sci. Nat. Archéol. Toulon Var*, 36: 35-46.

BATAAN D.A.U., GERALDINO P.J.L., SILAPAN J.R., LIAO L.M., 2021. Marine benthic algal composition after 45 years in an urbanized bay in Cebu, Philippines. *Philippine J. Sci.*, 151 (S1): 157-166.

BELSHER T., AUGIER H., BOUDOURESQUE C.F., COPPEJANS E., 1976. Inventaire des algues marines benthiques de la rade et des îles d'Hyères (Méditerranée France). *Trav. Sci. Parc. Natl. Port-Cros*, 2: 39–89.

BLANFUNÉ A., BOUDOURESQUE C.F., VERLAQUE M., THIBAUT T., 2016. The fate of *Cystoseira crinita*, a forest-forming Fucale (Phaeophyceae, Stramenopiles), in France (Northwestern Mediterranean Sea). *Estuar. Coast. Shelf Sci*., 181: 196–208.

BOUDOURESQUE C.F., 1973. Recherches de bionomie analytique, structurale et expérimentale sur les peuplements benthiques sciaphiles de Méditerranée occidentale (fraction algale). Les peuplements sciaphiles de mode relativement calme sur substrats durs. *Bull. Mus. Hist. Nat. Marseille*, 33 : 147–225.

BOUDOURESQUE C.F., 2015. Taxonomy and phylogeny of unicellular eukaryotes. *In: Environmental microbiology: Fundamentals and applications. Microbial ecology*. BERTRAND J.C., CAUMETTE P., LEBARON P., MATHERON R., NORMAND P., SIME-NGANDO T. (eds.), Springer publ.: 191-257.

BOUDOURESQUE C.F., CAUMETTE P., BERTRAND J.C., NORMAND P., SIME-NGANDO T., 2015. Systematic and evolution of microorganisms: general concepts. *In: Environmental microbiology: Fundamentals and applications. Microbial ecology*. BERTRAND J.C., CAUMETTE P., LEBARON P., MATHERON R., NORMAND P., SIME-NGANDO T. (eds.), Springer publ.: 107-144.

BOUDOURESQUE C.F., PERRET-BOUDOURESQUE C.F., RUITTON S., 2021. Les algues marines en Provence: phylogénie, importance, vulnérabilité et protection. *Ann. Soc. Sci. Nat. Archéol. Toulon Var*, 73 (2): 70-95.

BOUDOURESQUE C.F., PERRET-BOUDOURESQUE M., BLANFUNÉ A., 2022. Diversity of marine and brackish macrophytes in the Port-Cros National Park (Provence, France, Mediterranean Sea): taxa and research effort over space and time. *Diversity*, 14 (329): 1-41.

CINELLI F., SARTONI G., 1969. *Acrothamnion* J. Ag. (Rhodophyta, Ceramiaceae): genere algale nuovo per il mare Mediterraneo. *Pubbl. Staz. Zool. Napoli*, 37: 567-574.

CINELLI F., SALGHETTI U., SERENA F., 1984. Nota sull'areale di *Acrothamnion preissii* (Sonder) Wollaston nell'Alto Tirreno. *Quad. Mus. Stor. Nat. Livorno*, 5: 57-60.

COPPEJANS E., 1977. *Bijdrage tot de studie van de wierpopulaties (Chlorophyceae, Phaeophyceae, Rhodophyceae) van het fotofiel infralitoraal in het noordwestelijk Mediteraan bekken*. Deel I: Tekst: 1–243. Deel II: Iconografie, i–xix + 296 plates. Deel III: Tabellen, 1–3 + 339 tables. Doctoral thesis Reijksuniversiteit Gent, Belgium.

FUNK V., 2007. 100 *Uses For a Herbarium*. http://www.virtualherbarium.org/vh/100usesaspt.html (accessed on 9 June 2023).

GIL-RODRÍGUEZ M.C., SENTIÉS A., DÍAZ-LARREA J., CASSANO V., FUJII M.T., 2009. *Laurencia marilzae* sp. nov. (Ceramiales, Rhodophyta) from the Canary Islands, Spain, based on morphological and molecular evidence. *J. Phycol.,* 45 (1): 264-271.

GUIRY M.D., GUIRY G.M. 2024. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. https://www.algaebase. Accessed on February 20th, 2024.

JAHANDIEZ E., 1914. *Les îles d'Hyères*. Imprimerie particulière de l'auteur, Hyères: 1- 382.

KLEIN J., VERLAQUE M., 2011. Macroalgae newly recorded, rare or introduced to the French Mediterranean coast. *Cryptogamie, Algologie*, 32: 111–130.

KLEIN J., RUITTON S., VERLAQUE M., BOUDOURESQUE C.F., 2005. Species introductions, diversity and disturbances in marine macrophyte assemblages of the northwestern Mediterranean Sea. *Mar. Ecol. Prog. Ser*., 290: 79–88.

LE GALL L., ROUSSEAU F., 2009. *Biodiversité de la flore algale du Parc national de Port-Cros et de l'île de Porquerolle*s. Rapport de fin de Contrat PNPC and MNHN. Muséum National d'Histoire Naturelle publ., Paris: 1–31.

LIAO L.M., 2013. Redefining the role of natural history collections and museums in an era of global climate change. *Philippine J. Syst. Biol.*, 7: 53-62.

MACHÍN-SÁNCHEZ M., LE GALL L., NETO A.I., ROUSSEAU F., CASSANO V., SENTÍES A., FUJII M.T., DÍAZ-LARREA, PRUD'HOMME VAN REINE W.F., BONILLO C., GIL-RODRÍGUEZ, M.C., 2014. A combined barcode and morphological approach to the systematics and biogeography of *Laurencia pyramidalis* and *Laurenciella marilzae* (Rhodophyta*). Eur. J. Phycol.*, 49 (1): 115-127.

METTI Y., FURNARI G., SERIO D., 2024. Molecular analyses reveal the presence of *Corynecladia* J. Agardh (Rhodophyta, Rhodomelaceae) in the Mediterranean Sea with two new species, *C. millarii* sp. nov. and *C. mediterranea* sp. nov. *Cryptogamie, Algologie*, 45 (2): 11-30.

MOLINIER R., MOLINIER R., TALLON G., 1959. L'excursion en Provence de l'Association internationale de phytosociologie (27 mai-4 juin 1958). Imprimerie générale de Provence: Marseille: 1–109.

OURGAUD M., 2010. *Évaluation de L'impact de* Caulerpa racemosa *sur le coralligène dans le Parc national de Port-Cros*. Master Biologie et Écologie Marine (Océanographie), Aix-Marseille University, Marseille: 1–20.

PIAZZI L., MEINESZ A., VERLAQUE M., AKÇALI B., ANTOLIĊ B., ARGYROU M., BALATA D., BALLESTEROS E., CALVO S., CINELLI F., CIRIK S., COSSU A., D'ARCHINO R., DJELLOULI A.S., JAVEL F., LANFRANCO E., MIFSUD C., PALA D., PANAYOTIDIS P., PEIRANO A., PERGENT G., PETROCELLI A., RUITTON S., ŽULJEVIĊ A., CECCHERELLI G., 2005. Invasion of *Caulerpa racemosa* var. *cylindracea* (Caulerpales, Chlorophyta) in the Mediterranean Sea: an assessment of the spread. *Cryptogamie, Algologie,* 26 (2): 189-202.

PNPC, 2024. *Catalogues de données géographiques des parcs nationaux de France, Parc-national de Port-Cros*. https://catalogue.parcnational.fr/catalogue/pnpc/fre/catalog.search#/search?facet.q=type%2Fdataset. Accessed on 26 February, 2024.

ROUSSEAU F., GEY D., KURIHARA A., MAGGS C.A., MARTIN-LESCANNE J., PAYRI C., DE REVIERS B., SHERWOOD A.R., LE GALL L., 2017. Molecular phylogenies support taxonomic revision of three species of *Laurencia* (Rhodomelaceae, Rhodophyta), with the description of a new genus. *Eur. J. Taxon*., 269: 1-19.

SERIO D., FUNAI G., METTI Y., 2020. Molecular analysis confirms *Laurenciella marilzae* (Rhodophyta, Rhodomelaceae) in the Mediterranean Sea, a species often misidentified as *Laurencia dendroidea. Botanica Marina*, 63 (6): 527-535.

THELIN I., 1984. Nouvelle signalisation d'*Acrothamnion preissii* (Sonder) Wollaston sur les côtes françaises de la Méditerranée. Trav. Sci. Parc. Natl. Port-Cros, 10: 171-172.

THIBAUT T., PINEDO S., TORRAS X., BALLESTEROS E., 2005. Long-term decline of the populations of Fucales (*Cystoseira, Sargassum*) in the Albères coast (northwestern Mediterranean). *Mar. Pollut. Bull.*, 50: 1472-1489.

THIBAUT T., BLANFUNÉ A., MARKOVIC L., VERLAQUE M., BOUDOURESQUE C.F., PERRET-BOUDOURESQUE M., MAĆIC V., BOTTIN L., 2014. Unexpected abundance and long-term relative stability of the brown alga *Cystoseira amentacea*, hitherto regarded as a threatened species, in the north-western Mediterranean Sea. *Mar. Pollut. Bull.*, 89: 305–323.

THIBAUT T., BLANFUNÉ A., BOUDOURESQUE C.F., VERLAQUE M., 2015. Decline and local extinction of Fucales in the French Riviera: the harbinger of future extinctions? *Mediterr. Mar. Sci.*, 16 (1): 206-224.

TOMAS F., BOX A., TERRADOS J., 2011. Effects of invasive seaweeds on feeding preference and performance of a keystone Mediterranean herbivore. *Biological Invasions*, 13: 1559-1570.

VAN DER LOOS L.M., BAFORT Q., BOSCH S., BALLESTEROS E., BÁRBARA I., BERECIBAR E., ... & DE CLERCK O., 2023. Non-indigenous seaweeds in the Northeast Atlantic Ocean, the Mediterranean Sea and Macaronesia: a critical synthesis of diversity, spatial and temporal patterns. *European Journal of Phycology*, 1-30.

VERLAQUE M., DURAND C., HUISMAN J.M., BOUDOURESQUE C.F., LE PARCO Y., 2003. On the identity and origin of the Mediterranean invasive *Caulerpa racemosa* (Caulerpales, Chlorophyta). *Eur. J. Phycol.*, 38: 325-339.

VERLAQUE M., AFONSO-CARRILLO J., GIL-RODRIGUEZ M.C., DURAND C., BOUDOURESQUE C.F., LE PARCO Y., 2004. Blitzkrieg in a marine invasion: *Caulerpa racemosa* var. *cylindracea* (Bryopsidales, Chlorophyta) reaches the Canary Islands (NE Atlantic). *Biological Invasions,* 6: 269-281.

VERLAQUE M., RUITTON S., MINEUR F., BOUDOURESQUE C.F., 2015. CIESM Atlas of exotic species. 4. Macrophytes. BRIAND F. (ed.), CIESM Publisher, Monaco: 1-362.

ZENETOS A., ÇINAR M.E., CROCETTA F., GOLANI D., ROSSO A., SERVELLO G., SHENKAR N., TURON X., VERLAQUE M., 2017. Uncertainties and validation of alien species catalogues: The Mediterranean as an example. *Estuar. Coast. Shelf Sci.*, 191: 171-187.