

## On a bloom of the macroalga *Dictyota implexa* (brown algae) in Corsica (France, north–western Mediterranean Sea)

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**Résumé :** Sur un bloom de la macroalgue *Dictyota implexa* (algues brunes) en Corse (France, nord–ouest de la Méditerranée). L'algue brune *Dictyota implexa*, signalée dans la plupart des mers et océans du monde, est peut-être une espèce cryptogénique, c'est-à-dire non–indigène dans une partie de son aire actuelle, et dont l'aire d'origine n'est pas identifiée. De la fin du printemps à l'été 2025, sa prolifération a été observée dans deux sites de Corse (Plaine orientale et golfe de Sant'Amanza). L'ombrage qu'elle provoque semble avoir un effet négatif sur les faisceaux de feuilles de la magnoliophyte marine *Posidonia oceanica*.

**Mots-clés.** Algues brunes, bloom, Corse, *Dictyota implexa*, *Posidonia oceanica*.

**Abstract :** The brown alga *Dictyota implexa*, reported worldwide from most seas and oceans, is perhaps a cryptogenic species, that is to say a non–indigenous species in part of its current range, and whose native area has not yet been identified. From late spring to summer 2025, its blooms were observed at two sites in Corsica (the Plaine orientale and the Gulf of Sant'Amanza). The shading it causes would appear to have a negative impact on the leaf shoots of the seagrass *Posidonia oceanica*.

**Key words :** Bloom, brown algae, Corsica, *Dictyota implexa*, *Posidonia oceanica*.

**Resumo :** Pri iu prolifero de la makroalga *Dictyota implexa* (brunalgoj) en Korsikio (Francio, nord–uesta Mediteraneo). La brunalgo *Dictyota implexa*, menciita en la plej multaj maroj kaj oceanoj en la mondo, eble estas kriptogena specio, tio estas ne–indigena en parto de ĝia nuna disvastiĝ–areo, kaj kies devena areo ne estas konata. De la fino de la printempo ĝis la somero 2025, ĝia proliferado estis observata en du lokoj de Korsikio (Orienta Ebenajo kaj golfo de Sant'Amanza). La ombro, kiun ĝi estigas ŝajne negative efikas al la folifaskoj de la mara magnolifito *Posidonia oceanica*.

**Ŝlosilvortoj.** brunalgoj, prolifero, Korsikio, *Dictyota implexa*, *Posidonia oceanica*.

### Introduction

The macroalgae constitute a highly polyphyletic complex of multicellular photosynthetic organisms: they belong to *Viridiplantae* (green algae), *Rhodophyta* (red algae) (kingdom *Archaeplastida*) and to *Phaeophyceae* (brown algae) (kingdom *Stramenopiles*) (BOUDOURESQUE, 2015; BOUDOURESQUE *et al.*, 2021a). Macroalgae are widespread in the photic (supralittoral, midlittoral and

infralittoral zones) and mesophotic (circalittoral zone) domains of the marine realm (e.g., PÉRÈS and PICARD, 1964; PÉRÈS, 1982; BALLESTEROS *et al.*, 1984; BALLESTEROS, 1990, 2006; PIAZZI *et al.*, 2012; LE FUR *et al.*, 2018; BLANFUNÉ *et al.*, 2022; SFRISO *et al.*, 2025). Some of them are perennial and present year–round, such as *Fucales* of the genera *Cystoseira*, *Ericaria*, *Gongolaria* and *Sargassum* (GIACCONE, 1971; BLANFUNÉ *et al.*, 2022), while others thrive seasonally (FELDMANN, 1938). In

some species, seasonal development may take the form of a bloom, the size of which is irregular from one year to the next; this is the case, for example, for the proliferation of *Ulva* spp. (SHILI *et al.*, 2002; MARCHINI *et al.*, 2004) and *Cladophora vagabunda* (Linnaeus) C. Hoek (LARDICCI *et al.*, 2001) in some brackish lagoons.

Here we report a late spring–summer bloom of the brown alga *Dictyota implexa* (Desfontaines) J. V. Lamouroux (*Phaeophyceae*) in an embayment of southern Corsica (Sant’Amanza) and near the marina of Taverna (Corsica; northwestern Mediterranean Sea).

### MATERIAL AND METHODS

The observations were carried out in the framework of the RenforC programme. The objective of this programme is to compare, at a single site, four methods for restoring the seagrass *Posidonia oceanica* (Linnaeus) Delile meadow (PERGENT *et al.*, 2021; MATTEI, 2022; ANDRÉ *et al.*, 2024; PERGENT *et al.*, 2024) which respect the ethical criteria proposed by BOUDOURESQUE *et al.* (2021b) (see also MONNIER *et al.*, 2024; PERGENT–MARTINI *et al.*, 2024). The restoration experiments, involving transplantation of 12 000 *P. oceanica*

cuttings by scuba diving, began in 2021 at Sant’Amanza, at 15 m depth (PERGENT *et al.*, 2021).

The observations were also carried out in the framework of the Corsican *Posidonia* monitoring network (Réseau de Surveillance Posidonie en Corse – RSP). The aim of this programme, implemented between 2004 and 2007, is to monitor the health of the *P. oceanica* meadow, particularly at its lower limit, all around the coast of Corsica (PERGENT and BERTRANDY, 2013; PERGENT *et al.*, 2014). The Corsican RSP is based on the principles of the *Posidonia* monitoring network of the French Région Sud (Provence and French Riviera) (BOUDOURESQUE *et al.*, 1990, 2000; CHARBONNEL and BOUDOURESQUE, 2003; MEINESZ, 2010; PERGENT and BERTRANDY, 2013), with improved methods.

The study sites are located in the Gulf of Sant’Amanza (southern Corsica), at 14–15 m depth (RenforC programme) and 33 m depth (RSP programme, lower limit of *P. oceanica*) and near the marina of Taverna (between Bastia and Aléria, northern Corsica), at 15 m depth (Fig. 1).

In a *P. oceanica* meadow, the mat consists of the set of rhizomes and roots, which are very little putrescible, and the sediment that fills the interstices. We speak of dead mat when the rhizomes no longer bear leaf shoots (MOLINIER and PICARD, 1952; BOUDOURESQUE *et al.*, 2016). The bottom at the study sites consists of dead *P. oceanica* mat, with or without relict leaf shoots. Transplantation of *P. ocea-*

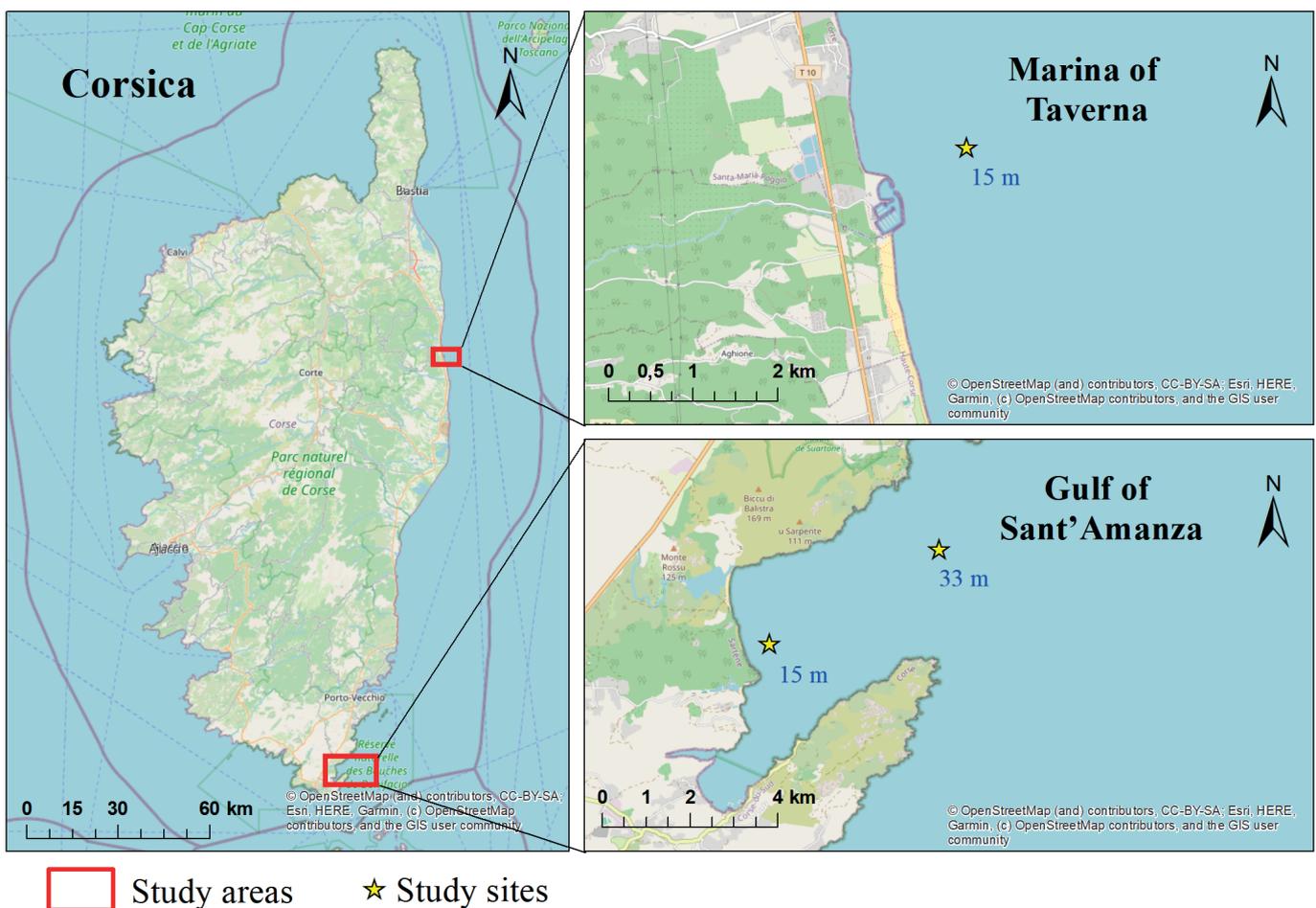


Fig. 1. Map of Corsica, with localisation of the study areas and the three study sites (stars).

*nica* cuttings was performed on dead matte without living leaf shoots (PERGENT *et al.*, 2021).

The determination of *Dictyota implexa* was carried out using the extensive bibliographical data and herbaria of the *Plateforme Macrophytes* (Aix-Marseille University, OSU Pythéas, Luminy Campus). The collected specimens correspond well to the descriptions of e.g. HAMEL (1931–1939), TRONHOLM *et al.* (2010), CORMACI *et al.* (2012) and RODRÍGUEZ-PRIETO *et al.* (2013). The reproductive organs were not present. The specimens studied are preserved in the HCOM herbarium (Aix-Marseille University) under the numbers HCOM AB-0012 and HCOM AB-0013 (Sant’Amanza, Corsica, 15 m depth, 13 June 2025), and HCOM AB-0014, HCOM AB-0015, HCOM AB-0016 and HCOM AB-0017 (Taverna, Corsica, 14 m depth, 7 July 2025).



## Results

In June and July 2025, the Sant’Amanza study sites, both at 14–15 m and 33 m depth (the *Posidonia oceanica* lower limit) were carpeted with an almost continuous layer of *Dictyota implexa* (Fig. 2), the thickness of which could exceed 10 cm, covering the apices of *P. oceanica* leaf shoots (Fig. 3–8). A similar bloom was observed near the marina of Taverna.

Fig. 2. Specimens of *Dictyota implexa* collected near the marina of Taverna (Corsica) on July 7<sup>th</sup>, 2025, 14 m depth. Centimetric scale. Fig. 3. The carpet of *Dictyota implexa* (whitish) at Sant’Amanza, 15 m depth, growing on a dead matte of *Posidonia oceanica* with some relict patches of live *P. oceanica* (green narrow leaves). 13 June 2025. Photo © Gérard PERGENT.

Fig. 4. The carpet of *Dictyota implexa* at Sant’Amanza, 15 m depth, growing on a dead matte of *Posidonia oceanica* with some relict patches of live *P. oceanica*. Note the thickness of the carpet, which can cover the apex of the leaf shoots. 13 June 2025. Photo © Gérard PERGENT.

Fig. 5. *Dictyota implexa* (whitish) almost completely enveloping two leaf shoots of *Posidonia oceanica*. On the right, the light green leaves belong to the green alga *Caulerpa prolifera* (Forsskål) J. V. Lamouroux. Sant’Amanza, 15 m depth, 2 July 2025. Photo © Serena ANDRÉ.

Fig. 6. *Dictyota implexa* enveloping leaf shoots of *Posidonia oceanica*. Sant’Amanza, 15 m depth, 2 July 2025. Photo © Serena ANDRÉ.



The sites where *P. oceanica* cuttings have been transplanted were also affected by the *D. implexa* bloom. This is the case for sites where the biodegradable anchor device, corresponding to the method of CALVO *et al.* (2014) and SCANNAVINO *et al.* (2014), was deployed (Fig. 9).

## Discussion and conclusions

*Dictyota implexa*, often reported as *D. dichotoma* (Hudson) L.V. Lamouroux var. *implexa* (Desfontaines) S.F. Gray, *D. divaricata* J.V. Lamouroux, or *D. linearis* (C. Agardh) Greville, has been described from the Mediterranean Sea. It is also reported from the Atlantic Ocean, the Red Sea and the Indo–Pacific Ocean (e.g. FELDMANN, 1937; TAYLOR, 1960; SILVA *et al.*, 1996; TRONHOLM *et al.*, 2010; EINAV *et al.*, 2021; GUIRY, 2024). Such a worldwide distribution is generally indicative of a cryptogenic species (*sensu* CARLTON, 1996), i.e., a species that was dispersed by humans during the early days of global navigation, and whose region of origin (the Mediterranean, the Atlantic, or the Indo–Pacific?) remains unknown (CARLTON, 1996).

Although spring–summer blooms of *Dictyota implexa* have not been specifically reported in the literature, several of the co–authors of this article recall having already observed them, as well as spring–autumn blooms of other *Dictyota* species (*D. dichotoma*, *D. fasciola*), for example in eastern Provence and Corsica (France).

*Posidonia oceanica* is highly sensitive to light reduction (e.g., GUIDETTI and FABIANO, 2000; ELKALAY

*et al.*, 2003; BOUDOURESQUE *et al.*, 2009; FAKIRIS *et al.*, 2023). Irradiance controls the depth of the lower limit of the meadow (MOLINIER and PICARD, 1952; PERGENT *et al.*, 1995; RUIZ and ROMERO, 2001; GACIA *et al.*, 2012); the depth of the latter may change over time depending on direct or indirect anthropogenic impacts which alter the water transparency (BOUDOURESQUE *et al.*, 2000; PERGENT *et al.*, 2014). Experimentally, a decrease in irradiance for 30 days is sufficient to reduce growth, biomass and starch storage of *P. oceanica* for a long time (RUIZ and ROMERO, 2001). Under fish farms in Croatia, shading is the main factor explaining changes occurring in the *P. oceanica* meadow (PUHR and PIKELJ, 2012).

We can assume that the *D. implexa* bloom, and the shade it generated for at least five weeks, has had a negative impact on *P. oceanica*, both on natural patches and transplanted cuttings, causing a reduction of shoot density and leaf length. We observed a decrease of ~15% in shoot density in invaded areas, both natural and transplanted patches. Other competitive mechanisms can be involved, such as suffocation, competition for nutrients and allelopathy.

Chemical compounds produced by *D. implexa* have antimicrobial, antioxidant, and cytotoxic activity; they include phenolic compounds, tannic acid, diterpenes, and flavonoids (De Rosa *et al.*, 1986; DEMIREL *et al.*, 2009; TRANG THUY and MEN, 2025). As some of these compounds are herbivore deterrents, *D. implexa* is therefore likely avoided by herbivores, which could explain its proliferation; if this were the case, grazing pressure from



Fig. 7. The carpet of *Dictyota implexa* at Sant'Amanza, 33 m depth, near the lower limit of the *Posidonia oceanica* meadow. 2 July 2025. Photo © Serena ANDRÉ.



Fig. 8. *Dictyota implexa* enveloping leaf shoots of *Posidonia oceanica*, near the lower limit of the meadow. Sant'Amanza, 15 m depth, 2 July 2025. Photo © Serena ANDRÉ.

herbivores, potentially the fish *Sarpa salpa* (Linnaeus, 1758) (VERGÉS *et al.*, 2009), would be diverted to an alternative resource, *P. oceanica*. However, the characteristic bite marks of *S. salpa* were uncommon on *P. oceanica* leaves at the study sites. The heatwave, of June 2025, affecting both terrestrial and marine environments, may also have contributed to the proliferation of *D. implexa*.

The observation we report was fortuitous. At the time, we did not recognize its potential significance and therefore did not survey the entire coast of Corsica to determine whether this bloom was solely confined to the three sites mentioned, or whether it had a wider geographical distribution. Similarly, its depth range remains unknown.

Many observations that seem unimportant at the time are never published, and disappear with the fading memory or death of the observers. By publishing our observations, we have tried to preserve the memory of them, in case, in the future, these observations become significant.

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Fig. 9. A biodegradable anchor device for transplanting *Posidonia oceanica* cuttings, partially covered by *Dictyota implexa*. Sant'Amanza, 15 m depth, 2 July 2025. Photo © Serena ANDRÉ.

#### REFERENCES

- ANDRÉ S., MOLENAAR H., MONNIER B., PERGENT-MARTINI C., and PERGENT G., 2024.— *Suivi des transplantations des herbiers à Posidonia oceanica dans le golfe de Sant'Amanza (Bonifacio). Synthèse du suivi 2024 (t+3)*. Édit. GIS Posidonie Centre de Corse publ., Corte, France: 1–37.
- BALLESTEROS E., 1990.— Structure and dynamics of the *Cystoseira caespitosa* Sauvageau (*Fucales*, *Phaeophyceae*) community in the North-Western Mediterranean. *Scientia Marina*, 54(2): 155–168.
- BALLESTEROS E., 2006.— Mediterranean coralligenous assemblages: A synthesis of present knowledge. *Oceanogr. mar. Biol.: Annu. Rev.*, 44: 123–195.
- BALLESTEROS E., ROMERO J., GILI J.M. and ROS J.D., 1984.— L'estatge infralitoral de les illes Medes: les algues fotofiles. In: *Els sistemes naturals de les Illes Medes*, ROS J., OLIVELLA I. and GILI J.M. (eds.), Edit. Institut d'Estudis Catalans, Barcelona, Spain: 661–675.
- BLANFUNÉ A., VERLAQUE M., BOUDOURESQUE C.-F., ROZIS E. and THIBAUT T., 2022.— *Les forêts marines de France et de Méditerranée. Guide de détermination des espèces-ingénieurs. Sargassaceae, Fucales, Phaeophyceae*. Edit. Presses Universitaires de Provence, Aix-en Provence, France: 1–207.
- 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. and SIME-NGANDO T. (eds.), Édit. Springer, Switzerland: 191–257.
- BOUDOURESQUE C.-F., BERTRANDY M. C., BOULADIER É., FORET P., MEINESZ A., PERGENT G. and VITIELLO P., 1990.— Le Réseau de surveillance des herbiers de posidonies mis en place en région Provence-Alpes-Côte d'Azur. *Rapp. P.V. Réun. Commis. internationale. Explor. sci. Médit.*, 32 (1): 11.
- BOUDOURESQUE C.-F., CHARBONNEL E., MEINESZ A., PERGENT G., PERGENT-MARTINI C., CADIOU G., BERTRANDY M. C., FORET P., RAGAZZI M. and RICO-RAIMONDINO V., 2000.— A monitoring network based on the seagrass *Posidonia oceanica* in the north-western Mediterranean Sea. *Biol. mar. Mediterr.*, 7(2): 328–331.
- BOUDOURESQUE C.-F., BERNARD G., PERGENT G., SHILI A. and VERLAQUE M., 2009.— Regression of Mediterranean seagrasses caused by natural processes and anthropogenic disturbances and stress: a critical review. *Botanica Marina*, 52(5): 395–418.
- BOUDOURESQUE C.-F., PERGENT G., PERGENT-MARTINI C., RUITTON S., THIBAUT T. and VERLAQUE M., 2016.— The necromass of the *Posidonia oceanica* seagrass meadow: Fate, role, ecosystem services and vulnerability. *Hydrobiologia*, 781: 25–42.
- BOUDOURESQUE C.-F., PERRET-BOUDOURESQUE M. and RUITTON S., 2021a.— Les algues marines en Provence: phylogénie, importance, vulnérabilité et protection. *Ann. Soc. Sci. nat. Archéol. Toulon Var*, 73(2): 70–95.
- BOUDOURESQUE C.-F., BLANFUNÉ A., PERGENT G. and THIBAUT, T., 2021b.— Restoration of seagrass meadows in the Mediterranean Sea: A critical review of effectiveness and ethical issues. *Water*, 13(1034): 1–35.
- CALVO S., SCANNAVINO A., LUZZU F., DI MAIDA G., PIRROTTA M., ORESTANO C., PAREDES F., MONTAGNINO F.M. and TOMASELLO A., 2014.— Tecnica di reimpianto mediante supporto biodegradabile. In: *Conservazione e gestione della naturalità negli ecosistemi marino-costieri. Il trapianto delle praterie di Posidonia oceanica*; BACCI T., LA PORTA B., MAGGI C., NONNIS O., PAGANELLI D.,

- RENDE S.F. and POLIFRONE M. (eds.), *Manuali e Linee Guida n. 106/2014*. Edit. ISPRA, Roma, Italy: 47–51.
- CARLTON J.T., 1996.— Biological invasions and cryptogenic species. *Ecology*, 77(6): 1653–1655.
- CHARBONNEL É. and BOUDOURESQUE C.-F., 2003.— Les 20 ans d'expérience du Réseau de surveillance Posidonies. *Le Courrier de la Nature*, France, 206: 18–23.
- CORMACI M., FURNARI G., CATRA M., ALONGI G. and GIACCONE G., 2012.— Flora marina bentonica del Mediterraneo. *Phaeophyceae*. *Boll. Accad. Gioenia Sci. nat.*, 45 (375): 1–508.
- DEMIREL Z., YILMAZ-KOZ F.F., KARABAY-YAVASOGLU U.N., OZDEMIR G. and SUKATAR A., 2009.— Antimicrobial and anti-oxidant activity of brown algae from the Aegean Sea. *J. Serbian chem. Soc.*, 74(6): 619–628.
- DE ROSA S., DE STEFANO S. and ZAVODNIK N., 1986.— Hydrozulenoid diterpenes from the brown alga *Dictyota dichotoma* var. *implexa*. *Phytochemistry*, 25(9): 2179–2181.
- EINAV R., GUIRY M.D. and ISRAEL A., 2021.— A revised list of seaweeds from the Red Sea (1756–2020). *Isr. J. Plant Sci.*, 68 (3): 175–247.
- ELKALAY K., FRANGOULIS C., SKLIRIS N., GOFFART A., GOBERT S., LEPOINT G. and HECQ J.H., 2003.— A model of seasonal dynamics of biomass and production of the seagrass *Posidonia oceanica* in the Bay of Calvi (Northwestern Mediterranean). *Ecol. Model.*, 167: 1–18.
- FAKIRIS E., GIANNAKOPOULOS V., LEFTHERIOTIS G., DIMAS A. and PAPAETHODOROU G., 2023.— Predictive mapping of Mediterranean seagrasses—exploring the influence of seafloor light and wave energy on their fine-scale spatial variability. *Remote Sensing*, 15(2943): 1–18.
- FELDMANN J., 1937.— Les algues marines de la côte des Albères. I–III. Cyanophycées, Chlorophycées, Phéophycées. *Rev. Algol.*, 9(3–4): 141–335.
- FELDMANN J., 1938.— Recherches sur la végétation marine de la Méditerranée : la côte des Albères. *Rev. Algol.*, 10 (1–4): 1–340.
- GIACCONE G., 1971.— Le Cistoseire delle coste italiane. I. Contributo. *Ann. Univ. Ferrara*, N.S., Sezione IV, Botanica, 4(3): 45–70.
- GUIDETTI P. and FABIANO M., 2000.— The use of lepidochronology to assess the impact of terrigenous discharges on the primary leaf production of the Mediterranean seagrass *Posidonia oceanica*. *Mar. Pollut. Bull.*, 40(5): 449–453.
- GUIRY M.D., 2024.— *Dictyota implexa*. In: *AlgaeBase*. GUIRY M.D. and GUIRY G.M. World-wide electronic publication, National University of Ireland, Galway, Ireland. <https://www.algaebase.org>; searched on 20 August 2025.
- HAMEL G., 1931–1939.— *Phéophycées de France*. Édit. imprimerie Wolf, Rouen, France: 1–XLVI + 1–432 + 10 plates.
- LARDICCI C., COMO S., CORTI S. and ROSSI F., 2001.— Recovery of the macrozoobenthic community after severe dystrophic crises in a Mediterranean coastal lagoon (Orbetello, Italy). *Mar. Pollut. Bull.*, 42(3): 202–214.
- LE FUR I., DE WIT R., PLUS M., OHEIX J., SIMIER M. and OUISSE V., 2018.— Submerged benthic macrophytes in Mediterranean lagoons: Distribution patterns in relation to water chemistry and depth. *Hydrobiologia*, 808(1): 175–200.
- MARCHINI A., GAUZER K. and OCCHIPINTI-AMBROGI A., 2004.— Spatial and temporal variability of hard-bottom macrofauna in a disturbed coastal lagoon (Sacca de Goro, Po River Delta, North-western Adriatic Sea). *Mar. Pollut. Bull.*, 48: 1084–1095.
- MATTEI J., 2022.— Les jardiniers de la mer replantent la prairie corse. *Le Point*, 2596: 68–69.
- MEINESZ A., 2010.— Surveillance des limites inférieures de la végétation sous-marine littorale. In: *Mer vivante*. 16<sup>e</sup> édition. Edit. Lyons Club Nice Doyen publ., Nice, France: 15–18.
- MOLINIER R. and PICARD J., 1952.— Recherches sur les herbiers de phanérogames marines du littoral méditerranéen français. *Ann. Inst. Océanogr.*, 27(3): 157–234.
- MONNIER B., PERGENT G. and BOUDOURESQUE C.F., 2024.— Le miracle des posidonies et des zostères. In: *La mer dans tous ses états*. BOUDOURESQUE C.-F. and PERRET-BOUDOURESQUE M. (eds.), Édit. Émile Communication, Aubagne, France: 67–77.
- PÉRÈS J.-M., 1982.— Structure and dynamics of assemblages in the benthic. *Marine Ecology*, vol. 5., part 1. KINNE O. (eds), Edit. John WILEY and sons Ltd, Chichester, UK: 119–185.
- PÉRÈS J.-M. and PICARD J., 1964.— Nouveau manuel de bionomie benthique de la mer Méditerranée. *Rec. Trav. Stat. mar. Endoume*, 31 (47): 3–137.
- PERGENT G. and BERTRANDY M.C., 2013.— Le Réseau de Surveillance Posidonie, toujours copié, jamais égalé. In: *GIS Posidonie: plus de 30 ans au service de la protection et de la gestion du milieu marin*. LE DIRÉACH L. and BOUDOURESQUE C.-F. (eds.), GIS Posidonie publ., Marseille, France: 25–29.
- PERGENT G., PERGENT-MARTINI C., and BOUDOURESQUE C.-F., 1995.— Utilisation de l'herbier à *Posidonia oceanica* comme indicateur biologique de la qualité du milieu littoral en Méditerranée: État des connaissances. *Mésogée*, 54: 3–27.
- PERGENT G., BEIN A., BLANFUNÉ A., DEDEKEN M., OBERTI P., ORSINI A., PERGENT-MARTINI C., RUITTON S. and SHORT F., 2014.— Monitoring and expansion of *Posidonia* monitoring networks along Corsican coastline. In: *Proceedings of the 5th Mediterranean symposium on marine vegetation*, Portorož, Slovenia, 27–28 October 2014. LANGAR H., BOUAFIF C. and OUERGI A. (eds.), RAC/SPA publ., Tunis, Tunisia: 131–136.
- PERGENT G., BRIAC M. and PERGENT-MARTINI C., 2021.— Séquestration du carbone bleu: une solution pour réduire les impacts du changement climatique? *Travaux*, 973: 54–57.
- PERGENT G., PERGENT-MARTINI C., MONNIER B., ACUNTO S., ANDRÉ S., BARRALON E., BOUDOURESQUE C.F., CALVO S., CASTEJON-SILVO I., CULIOLI J.M., GOIRAND-MAUBERRET C., LEHMANN L., MOLENAAR H., OBERTI P., PEY A., PIAZZI L., SANTONI M.C., TERRADOS J. and TOMASELLO A., 2024.— Comparison and optimization of *Posidonia oceanica* meadows strengthening protocols. Abstract 2024. World Seagrass Conference and 15th International Seagrass Biology Workshop 'Seagrasses in the Anthropocene', Napoli, Italy, June 2024.
- PERGENT-MARTINI C., ANDRÉ S., CASTEJON I., DETER J., FRAU F., GERAKARIS V., MANCINI G., MOLENAAR H., MONTEFALCONE M., OPRANDI A., PERGENT G., POURSANIDIS D., ROYO L., TERRADOS J., TOMASELLO A., VENTURA D. and VILLERS F., 2024.— Guidelines for *Posidonia oceanica* restoration. Report Cooperation agreement Mediterranean Posidonia Network (MPN), French Biodiversity Agency (OFB) and University of Corsica Pasquale Paoli (UCPP), Corte, France, N°OFB-22–1310: 29 p. + Appendices.

- PIAZZI L., GENNARO P. and BALATA D., 2012.— Threats to macroalgal coralligenous assemblages in the Mediterranean Sea. *Mar. Pollut. Bull.*, **64**: 2623–2629.
- PUHR K. and PIKELJ K., 2012.— The effect of *in situ* shading on a *Posidonia oceanica* meadow situated within a fish farm induced moderately nutrient enriched environment. *Mar. Pollut. Bull.*, **64**: 1537–1548.
- RODRÍGUEZ-PRIETO C., BALLESTEROS E., BOISSET F. and AFONSO-CARRILLO J., 2013.— *Guía de las macroalgas y fanerógamas marinas del Mediterráneo occidental*. Edit. Omega, Barcelona, Spain: 1–656.
- RUIZ J.M. and ROMERO J., 2001.— Effects of *in situ* experimental shading on the Mediterranean seagrass *Posidonia oceanica*. *Mar. Ecol. Prog. Ser.*, **215**: 107–120.
- RUIZ J.M. and ROMERO J., 2003.— Effects of disturbances caused by coastal constructions on spatial structure, growth dynamics and photosynthesis of the seagrass *Posidonia oceanica*. *Mar. Pollut. Bull.*, **46**: 1523–1533.
- SCANNAVINO A., PIRROTTA M., TOMASELLO A., DI MAIDA G., LUZZU F., BELLAVIA C., BELLISSIMO G., COSTANTINI C., ORESTANO C., SCALFANI G. and CALVO S., 2014.— Biodegradable anchor modular system for transplanting *Posidonia oceanica* cuttings. In: *Proceedings of the 5th Mediterranean symposium on marine vegetation*, Portorož, Slovenia, 27–28 October 2014. LANGAR H., BOUAFIF C. and OUERGI A. (eds.), RAC/SPA publ., Tunis, Tunisia: 236–237.
- SFRISO A., TOMIO Y. and SFRISO A. A., 2025.— Climatic changes shift macroalgal assemblages from cold- to warm-adapted species: The Venice Lagoon as a study case. *Environments*, **12**(149): 1–20.
- SHILI A., TRABELSI E. B. and BEN MAIZ N., 2002.— Seasonal dynamics of macroalgae in the South Lake of Tunis. *J. Coast. Conserv.*, **8**: 127–134.
- SILVA P., BASSON P.W. and MOE R.L., 1996.— *Catalogue of the benthic marine algae of the Indian Ocean*. Edit. Univ. California Press, Berkeley, USA: i–xiv + 1–1259.
- TAYLOR W.R., 1960.— *Marine algae of the eastern tropical and subtropical coasts of the Americas*. Edit. The University of Michigan Press, Ann Arbor, USA: 1–870.
- TRANG THUY N.N. and MEN T.T., 2025.— Phytochemical and bioactive analysis of extracted brown macroalgae (*Dictyota implexa*) collected in Vietnam. *Biochem. Res. Intl.*, 2025 (1, 9461117): 1–14.
- TRONHOLM A., STEEN F., TYBERGHEIN L., LELIAERT F., VERBRUGGEN H., RIBERA SIGUAN M.A. and DE CLERCK O., 2010.— Species delimitation, taxonomy and biogeography of *Dictyota* in Europe (*Dictyotales, Phaeophyceae*). *J. Phycol.*, **46**: 1301–1321.
- VERGÉS A., ALCOVERRO T. and BALLESTEROS E., 2009.— Role of fish herbivory in structuring the vertical distribution of canopy algae *Cystoseira* spp. in the Mediterranean Sea. *Mar. Ecol. Prog. Ser.*, **375**: 1–11.

