THE MARANO AND GRADO LAGOON

Annalisa Falace [1], Adriano Sfriso [2], Daniele Curiel [3], Giorgio Mattassi [4], Floriana Aleffi [4]

[1] *Dipartimento di Scienze della Vita, Università di Trieste*
[2] *Dipartimento di Scienze Ambientali, Università di Venezia*
[3] *SELC-Coop. Soc., Venezia*
[4] *ARPA Friuli-Venezia Giulia, Palmanova (UD)*

Riassunto

La Laguna di Marano e Grado é parte del sistema deltizio lagunare del Nord Adriatico. È localizzata tra il fiume Isonzo ad Est ed il Tagliamento ad Ovest ed ha una superficie di circa 160 km^2. I principali studi condotti sui due bacini riguardano aspetti idro-geo-sedimentologici, comunità macrozoobentoniche ed acquicoltura, mentre pochi sono i dati disponibili relativamente alle macroalghe ed alle fanerogame. I dati quali-quantitativi sulle macroalghe che vengono qui riportati si riferiscono principalmente a studi condotti negli anni 1992-93 sui substrati mobili dei due bacini. Sia i dati floristici che quelli quantitativi hanno evidenziato la dominanza di popolamenti a bassa diversità di Ulvales e *Gracilariopsis longissima*. Sono state riportate quattro specie di fanerogame, *Cymodocea nodosa, Nanozostera noltii, Zostera marina* e *Ruppia maritima.* Più di recente, nel luglio 2007, le macrofite bentoniche sono state raccolte in 19 stazioni al fine sia di aggiornare l'informazione esistente sulla flora e sulla vegetazione dei due bacini sia di stabilire il loro Stato Ecologico (SE) secondo quanto previsto dalla WFD (2000/60/EC). Il confronto con i dati precedenti evidenzia la riduzione sia del ricoprimento che della biomassa delle macrofite, in particolare dei popolamenti ad Ulvales, ed un incremento della ricchezza specifica. Ciononostante, poiché non sono disponibili dati storici sulle macrofite bentoniche della laguna di Marano e Grado, sono necessari ulteriori indagini su scale spaziali differenti per valutare meglio la dinamica e le caratteristiche biologiche di questi bacini.

Abstract

The Marano and Grado Lagoon is part of the lagoon-delta system of the North Adriatic Sea. It is situated between the Isonzo river to the East and the Tagliamento river to the West and has a surface of ca. 160 km^2. The main studies on the lagoon deal with hydro-geo-sedimentological aspects, macrozoobenthic communities and aquaculture issues, whereas few data are available on macroalgal flora and seagrass stands. The macroalgal quali-quantitative data reported in the present paper mainly refer to studies carried out during the 1992-93 on soft-bottoms of the two basins. Both floristic and quantitative data highlighted the dominance of low-diversity settlements of Ulvales and *Gracilariopsis longissima.* Four species of phanerogams were censed, *Cymodocea nodosa, Nanozostera noltii, Zostera marina* and *Ruppia maritima.* More recently, in July 2007, benthic macrophytes were sampled in 19 sites in order to update the available information on the flora and vegetation of this basin and to assess the Ecological Status (ES) according to the WFD (2000/60/EC). The comparison with previous data highlights the reduction of macrophyte coverage and biomass, especially Ulvales stands, and an increase in taxa richness. Nevertheless, since long-term information for benthic macrophytes for the Marano and Grado Lagoon are not available, further investigations on different spatial scales are necessary to better evaluate the macrophyte dynamics and the biological characteristics of those basins.

Key-words: Adriatic Sea, Angiosperms, Friuli-Venezia Giulia, Marano and Grado lagoon, Mediterranean Sea, Seaweeds, Transitional waters

1 Introduction

In the Adriatic Sea, during the last three decades, a significant floristic impoverishment of the most sensitive taxa had occurred, as a result of anthropogenic disturbances (sewage, dredging, aquaculture, industrial and agricultural discharges) (Sfriso et al. 1993, Cormaci and Furnari 1999, Falace 2000, Munda 2000, Falace and Bressan 2003, Falace et al. 2005). In particular, recent investigations carried out in the Northern Adriatic Sea on algal colonisation, on both natural and artificial substrata, have highlighted a reduction of the abundance of Fucales that made the vegetation very uniform and dominated by turf-forming algae (Falace and Bressan 1994, 1999 a, b, 2003, Falace 2000, Ceschia et al. 2007).

The most comprehensive work concerning the algal flora of the Gulf of Trieste was carried out by Pignatti and Giaccone (1967). Subsequent studies on the algal flora in this area are fragmentary, restricted to limited areas and in general they refer to its poorer summer flora (Ghirardelli and Pignatti 1968, Giaccone and Pignatti 1972, Ghirardelli et al. 1973, 1974, 1975, Franzosini et al. 1983–1984, Franzosini and Bressan 1988, Bressan and Godini 1990, Bressan et al. 1991, 2000, Bussani and Vucovic 1992, Falace et al. 2005). Recently, comprehensive studies aiming at evaluating the occurrence of long-term floristic changes have been carried out by Falace (2000), Falace and Bressan (2003), Ceschia et al. (2007).

The first papers on the Marano and Grado lagoon concerned sediments (Feruglio 1936), physico-chemical water variables (Faganelli 1956) and the distribution of macrozoobenthos communities (Busulini 1955, Vatova 1961, Vatova 1965). Over the years, the number of publications has increased; these mainly deal with sedimentological, geochemical and hydrological characteristics (Brambati 1972, Orel et al. 1980, Brambati et al. 1983, Brambati et al. 1990, Fanzutti et al. 1994, Belli et al. 1996), macrozoobenthic communities (Brambati and Stolfa Zucchi 1971, Zucchi Stolfa 1976, 1979, Orel et al. 2001, Sconfietti and Marchini 2001, Sconfietti et al. 2003) and aquaculture issues (Orel 1979, Lanari et al. 1990, Orel et al. 1996). Studies on microalgal communities are rare (Tolomio 1976, Cabrini et al. 1993). Few data are available on macroalgal flora and seaweed stands (Simonetti 1968, 1973, Corvi 1977-78, Curiel et al. 1998).

Other studies have been undertaken on intertidal sediment microphytobenthos at Marano (Sdrigotti and Welker 2002) and on hard substrata off-shore the Marano and Grado lagoon (Curiel et al. 2000-2001). In the framework of the Adriatic Transborder INTERREG IIIA Programme “ANSER” a study on the distribution and state of conservation of angiosperm meadows in the Marano and Grado lagoon has been recently performed. This research is especially focused on their detailed mapping of angiosperm meadows throughout the lagoon, and on the definition of impacts exerted by birds and human activities in a series of focal areas, but data are not yet available.

Between the early works on submerged macrophyte assemblages and the ‘90s no data were published. However, anecdotal information indicates that important changes from the ’80s to the ’90s occurred, especially due to blooms of Chlorophyceae. During the same period nutrient enrichment, causing abnormal and extensive growth of nuisance macroalgae, was also recorded in the Venice Lagoon (Sfriso 1987, Curiel et al. 2004).

This paper aims at updating the flora and vegetation information on the Marano and Grado Lagoon and to meet the WFD (2000/60/EC) objectives by assessing the Ecological Status of those basins.

2 Description of the site

The Marano and Grado Lagoon is part of the lagoon-delta system of the North Adriatic Sea, stretching between the mouths of the Po and Isonzo rivers (Brambati et al. 1988). The lagoon is placed between the Isonzo river to the East and the Tagliamento river to the West, has a total surface of 160 km^2, and extend parallel to the coastline along 32 km; the mean distance between the internal edges and the barrier islands is about 5 km (Brambati 1970).

The origin of the Marano and Grado Lagoon dates back to the 4th and 6th centuries but its morphology has changed in time principally because of the Tagliamento and Isonzo river delta evolution (Brambati 1996). In the lagoon six principal basins (Marano: 50.6 km^2, S. Andrea: 21.5 km^2, Buso: 35.6 km^2, Morgo: 3.0 km^2, Grado: 33.1 km^2 and Primero: 13.7 km^2), are present, each with its own inlet through which the tidal currents flow in and out (Fig. 1).

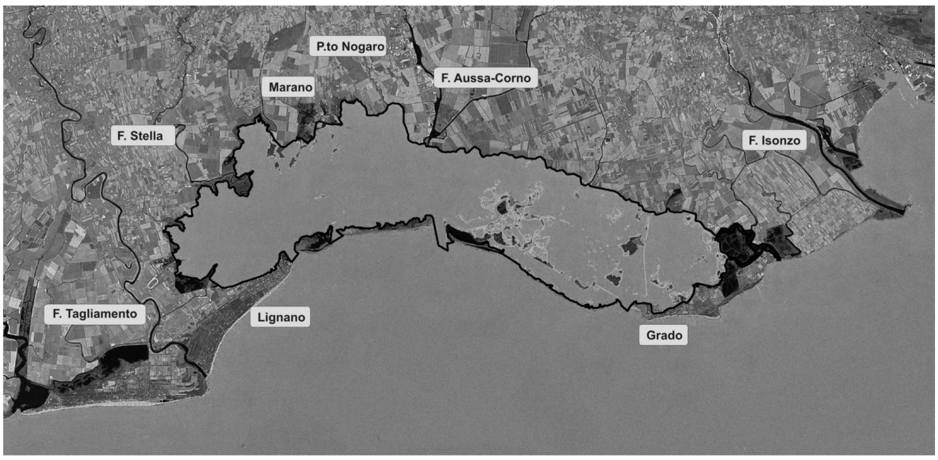

Fig. 1 - Map of the Marano and Grado lagoon.

The highest exchange at the sea-inlets, estimated in the ‘50s, is about 8750 $m^3 s^{-1}$ during a syzygial tide (Dorigo 1965). Tides, which are the main driving force of lagoon hydrodynamics, are semidiurnal with an average tidal range of 65 cm (Gatto and Marocco 1993).

The designation of the paralic system in those basins is not only determined by geographical and historical factors, but is based on geo-morphological and hydraulic differences. The Marano basin shows a wide shallow water body with few areas above the sea level and channels linking the numerous plain spring rivers flowing into its internal edge. Water transport during tidal cycles is essentially diffusive (Marocco 1995). On the contrary, the Grado basin is characterized by morphological reliefs (islands) and marshes, it is shallower than Marano, and has a more complex hydrographic network (Gatto and Marocco 1992, 1993). The water transport during the tidal cycles is essentially advective (eastwards) but it becomes partially diffusive towards the Marano basin.

Some watercourses flow along the internal edges of the lagoon, coming from the resurgence area of the Friuli-Venezia Giulia plain. Moving from West to East these are the following rivers: Stella, Turgnano, Cormor, Zellina, Corno, Aussa and Natissa; the last one is the only tributary river of the Grado basin (Mattassi et al. 1991). The mean freshwater outflow is ca. 78.0 m^3s^{-1} at Marano and ca. 20.5 m^3s^{-1} at Grado (Marocco 1995). Moreover, the freshwater supply of 22 water-scooping machines is significant, that put in the basin ca. 200 million cubic meters of waters yearly (ARPA Friuli-Venezia Giulia 2006).

The lagoon sediments at the sea-inlets are composed of calcareous sand. They become finer along the channels towards the inner part of the lagoon (Brambati 1969). Fine sediments are on average greater at Grado than at Marano. Both organic carbon and nitrogen contents increase with the decrease of the size of sediment particles, ranging from 0.7% and 0.05%, respectively, at the sea-inlets, to 1.3% and 0.15%, at the internal edges (Brambati 1980).

As the physical-chemical features, the Grado basin shows mean salinity values higher (ca. 28.5 psu) than the Marano basin (ca. 22.2 psu). Water temperature shows a gradient from the river mouths to the sea-inlets with mean values of ca. 15.8°C at Marano and ca. 14.8°C at Grado. On average, the pH values of the water column change depending on space and time but they are higher at Grado (>8.0) than at Marano (between 7.0 and 7.65, rarely >8.0), because of the river outflows (Brambati 1969).

The mean oxygen concentration in the water column is 97-100% (Mattassi et al. 2006). Occasionally, during macrophyte or phytoplankton blooms, the water column may become oversaturated, whereas neither hypoxic or anoxic events have been observed. Total nitrogen and total phosphorus concentrations in water are the highest close to the river mouths and show a decreasing gradient towards the sea-inlets. The mean total nitrogen is 1545 μg L^{-1} at Marano and 526 μg L^{-1} at Grado. Total phosphorus mean values range between 35 μg L^{-1} at Marano and 9 μg L^{-1} at Grado (Mattassi et al. 2006).

The Marano and Grado lagoon include two sites declared wetlands of international importance by the Ramsar Convention: “Valle Cavanata” and “Foci del Fiume Stella”. Moreover the whole lagoon basin is a Site of Community Importance within the Natura 2000 Network (SCI – IT3320037) (Mattassi et al. 2006).

The present lagoon morphology is due to the last reclamation activities dating back to the first twenty-year period of the 20^{th} century (Mattassi et al. 2006). Afterwards, many morphological works have been carried out (breakwaters, commercial and tourist ports with about 6000 moorings). Those have caused significant changes in the lagoon water circulation (Mattassi et al. 2006).

Moreover, at the river mouths, close to tourist ports and to industrial areas, high metal concentrations in surface sediments are present (Marocco 1995, Brambati 1996, Adami et al. 1997), in particular mercury (Hg). This metal shows a East-West gradient with the highest concentrations in the Grado basin (14 mg kg^{-1} dry weight), whereas at Marano Hg reaches a concentration of ca. 1-2 mg kg^{-1} dry weight. Its presence is related to the Isonzo river outflow (rich in cinnabar coming from the Hg mine of Idria, Slovenia), which transports mercury in the Grado basin. An additional Hg input comes from the Aussa-Corno industrial area (Mattassi et al. 1991, Piani and Covelli 2000, Mattassi et al. 2004, Piani et al. 2005). Due to the Hg contamination, much of the lagoon and its hinterland have been included in the “Polluted Areas of National Interest”.

Notwithstanding metal contamination, through the ages fishery has been a considerable support for the local population and today it is a significant economic business. The clam *Tapes philippinarum* Adams *et* Reeve was introduced in the lagoon in the ‘80s and clam-farming is an important activity nowadays. Indeed, metal bio-availability is low and clam contamination is within the law limits (Hg: <0.5 mg g^{-1} fwt, Cd: <1.0 mg g^{-1} fwt, Pb: <1.5 mg g^{-1} fwt) (Sfriso et al. 2008). At present, clam-farming areas extend over ca. 3.2 km^2 at Marano and ca. 14.4 km^2 at Grado, even if this activity showed a noticeable decline in the last decades (Spoto and Visentin 2000).

3 Macroalgae

The macrophyte quali-quantitative data reported in the present paper mainly refer to Curiel et al. (1998) study which was carried out during 1992-93 period on the soft-bottoms of Marano and Grado Lagoon (Fig. 1). Samples were taken in 17 sites at Grado (16 in the eastern sector of the lagoon and 1 in the western part) in April, June and July 1992 and in 27 sites at Marano (from Porto Buso-Canale Pian to Aprilia Marittima). In 1993, a reduced number of sampling sites was considered. On the whole, 42 taxa were identified i.e.: 16 Chlorophyta, 18 Rhodophyta, 8 Ochrophyta: among them 7 Phaeophyceae and 1 Xantophycea (Tab. 1). Both the floristic and quantitative data highlighted the dominance of Ulvales and *Gracilariopsis longissima* settlements and showed a poor species richness. Moreover, the most abundant species showed a characteristic distribution both at Marano and Grado. Indeed, tidal flats were dominated by “*Ulva rigida*” whereas *G. longissima* colonized deeper waters. The middle littoral close to the mainland was characterized by the presence of *Gracilaria bursa-pastoris. Vaucheria* sp. prevailed on muddy bottoms in the internal channels.

3.1 The Grado basin

In 1992, the eastern part of the Grado basin in its inner and northern area was characterized by widespread populations of *U. rigida*. This species showed a mean biomass of ca. 2 kg fwt m^{-2} with a peak of 5-6 kg fwt m^{-2} in spring-summer with a coverage of 70-80%. The western part resulted colonized by several seaweeds at South, while *U. rigida* showed wide coverage and high biomasses (3-4 kg fwt m^{-2}) in deeper waters at North.

The comparison with previous data (Corvi 1977-78) highlighted the decrease of seaweed stands and the Ulvales dominance (in particular *U. rigida*) in the whole basin. In 1993, macrophyte biomass appeared strongly reduced due to many factors that led to macroalgal regression as it was observed in the Venice Lagoon (Sfriso and Marcomini 1996).

3.2 The Marano basin

In 1992, the most abundant and widespread species were *U. rigida* on tidal flats (mean biomass 4-5 kg fwt m^{-2}, with a peak of 6 kg fwt m^{-2}) and *G. longissima* mainly in the sheltered sites (Sacca della Croce and Sacca Medran Grande) or in areas affected by river (Stella, Zellina) and canal (Cormor) outfalls, with a biomass peak of 17 kg fwt m^{-2}. Other species with significant biomasses were *Chaetomorpha linum* (5-6 kg fwt m^{-2}) and *Chondria capillaris* (0.1-0.2 kg fwt m^{-2}).

In summer, *U. rigida, C. linum* and *G. longissima* collapsed in the presence of high temperatures and low water renewal. The decomposing thalli were colonized by Cyanophyta (*Spirulina* sp).

Also at Marano the sampling campaigns carried out in 1993 revealed a general reduction/absence of vegetation. Macroalgae were present with a measurable biomass (peak value: 1 kg fwt m^{-2}) only in few areas.

4 Angiosperms

4.1 The Grado basin

According to their ecology the 4 species censed at Grado displayed a characteristic distribution. *Cymodocea nodosa* was generally recorded on coarse sediment in sites close to the sea-inlets. *Nanozostera noltii* was present in the middle littoral, both in seawater and near the mainland, along channel shores or on sandbanks. *Zostera marina* prevailed both in brackish and in sea-waters, while *Ruppia maritima* was found on shallow bottoms close to freshwater inputs.

The South-West areas of the basin resulted dominated by *N. noltii*. The extension of the seagrass beds ranged between some square meters to several hectares, with a density of 3600-7000 shoots m^{-2}. On the southern area of this basin, *N. noltii* was replaced by *Z. marina* in deeper waters below the tidal level or along shores of navigable channels. In the northern part of the Grado basin, *C. nodosa* did not form uniform meadows but it was recorded in restricted areas with a density of 1500 shoots m^{-2}. Pelitic bottoms inside the lagoon and the edges of small channels were mainly colonized by *Vaucheria* sp.

Seaweed beds resulted dominant in the southern area of the Grado basin where *N. noltii* and *Z. marina* were widespread. Those seagrasses showed similar quantitative values in both the sampling periods; on the contrary, *C. nodosa* was rare.

4.2 The Marano basin

In 1992 *N. noltii* was abundant both close to the sea-inlets and on channel banks on shallow bottoms of the inner areas. *Z. marina* formed wide meadows in the Lignano area, while inside the lagoon it showed a reduced distribution. *C. nodosa* constituted thick meadows only on sandy bottoms between Porto Buso and Porto S. Andrea and *R. maritima* was found just at the mouths of the Zellina river. In 1993 a remarkable reduction of seaweed meadows was noticed especially in the shallow bottoms of the Marano basin near the mainland.

Conclusions

The few available data do not permit to assess temporal changes of the flora and vegetation occurred in the Marano and Grado Lagoon over a long period. Also, considering the remarkable floristic changes which were observed in several Mediterranean areas during the last decades, the available data do not enable us to draw significant conclusions on the current status of the submerged vegetation. Nevertheless, the submerged vegetation of the Marano and Grado Lagoon appeared to be characterized by a reduced species diversity in comparison with other areas of the Northern Adriatic Sea. Monospecific Ulvales and *G. longissima* stands were the dominant taxa, probably because of the lacking of hard substrata. The biomass decline noticed by Curiel et al. (1998) in 1993 contemporarily with the changes which were recorded in the Venice Lagoon during the same period (Sfriso 1996, Sfriso and Marcomini 1996, Curiel et al. 2004), seemed to be mainly correlated to anomalous climatic conditions. Those affected the macroalgal growth synergically acting with the decreasing of the lagoon eutrophication.

The recent sampling campaigns carried out in May-July 2007 highlighted a further reduction of macrophyte coverage and biomass, especially Ulvales stands, and an increase of taxa richness (Falace et al. 2007, 2008, 2009, Sfriso et al. 2008). At present, macroalgae and seagrasses mainly colonise the central area of the Marano and Grado Lagoon, whereas the southern and northern areas are poor both in biomass and species composition. In particular, the worsening of the environmental conditions in the area northwards of the Grado bridge has been highlighted. Moreover, the absence of intensive aquaculture activities and commercial big harbours, which are accountable for the new introductions recorded in other lagoons, limits the presence of non-indigenous species.

Macroalgal and seagrass data collected in May-July 2007 on 19 sampling sites located in both the lagoon basins have been analyzed by using two phytobenthic indices: the Ecological Evaluation Index (EEI) (Orfanidis et al. 2001, 2003) and the Rapid-Macrophytes Quality Index (R-MaQI) (Sfriso et al. 2007, 2009), recently set up to evaluate the ecological status of transitional environments in the Mediterranean eco-region (Falace et al. 2009, Sfriso et al. 2009). Both the indices show a “Good-High” quality, characterized by wide seagrass meadows, in the central areas of the Marano and Grado Lagoon and close to the sea-inlets. “Bad” and “Poor” conditions were found in the western part of the Marano basin, connected with the main fresh water outfalls, and in the eastern part of the Grado basin where no macrophytes were recorded, except a Xantophycea.

Further sampling campaigns in different seasons are in progress to better appreciate the dynamics and biological characteristics of the Marano and Grado Lagoon. A continuous and exhaustive pluriannual monitoring program aiming at sampling macroalgal and seagrass populations is necessary for an accurate ES assessment. That program should also take into particular account the most recent stressors due to human activities such as bottom dredging and aquaculture.

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Tab. 1 - List of macrophytobenthos species recorded in the Marano and Grado lagoon. i=invasive, ni=non-invasive

Taxa	Non-indigenous		References
	i	ni	
RHODOPHYCEAE			
Acrochaetium sp.			35
Acrothamnion preissii (Sonder) E.M. Wollaston		+	35
Anotrichium barbatum (C. Agardh) Nägeli			35
Antithamnion cruciatum (C. Agardh) Nägeli			22, 35
Bangia fuscopurpurea (Dillwyn) Lyngbye			35
Boergeseniella fruticulosa (Wulfen) Kylin			35
Callithamnion corymbosum (J.E. Smith) Lyngbye			22, 35
Ceramium cimbricum H.E. Petersen f. *flaccidum* (H.E. Petersen) G. Furnari *et* Serio			35
Ceramium circinatum (Kützing) J. Agardh			35
Ceramium codii (H. Richards) Feldmann-Mazoyer			22, 35
Ceramium diaphanum (Lightfoot) Roth			22
Ceramium siliquosum (Kützing) Maggs *et* Hommersand			35
Chondria capillaris (Hudson) M.J. Wynne			22, 35
Dasya baillouviana (S.G. Gmelin) Montagne			22, 35
Erythropeltis discigera (Berthold) F. Schmitz			35
Erythrotrichia carnea (Dillwyn) J. Agardh			35
Gastroclonium reflexum (Chauvin) Kützing			35
Gayliella flaccida (Harvey *ex* Kützing) T.O. Cho *et* L.J. McIvor			35
Gelidium pusillum (Stackhouse) Le Jolis			35
*Gracilaria armata (*C. Agardh) Greville			22
Gracilaria bursa-pastoris (S.G. Gmelin) P.C. Silva			35
Gracilaria gracilis (Stackhouse) M. Steentoft, L.M. Irvine et W.F. Farnham			35
Gracilariopsis longissima (S.G. Gmelin) M. Steentoft, L.M. Irvine et W.F. Farnham			35
Hydrolithon boreale (Foslie) Y. M. Chamberlain			35
*Hydrolithon farinosum (*J.V. Lamouroux) D. Penrose *et* Y.M. Chamberlain			35
Hydrolithon sp.			22
Hypnea musciformis (Wulfen) J. V. Lamouroux			35
Laurencia obtusa (Hudson) J.V. Lamouroux			22, 35
Lithophyllum pustulatum (J.V. Lamouroux) Foslie			22, 35
Neosiphonia elongella (Harvey) M.S. Kim *et* I.K. Lee			22
Nitophyllum punctatum (Stackhouse) Greville			35

Taxa	Non-indigenous		References
	i	ni	
Palisada patentiramea (Montagne) Cassano, Sentíes, Gil-Rodriguez *et* M.T. Fujii			35
Peyssonnelia sp.			22
Pneophyllum fragile Kützing			35
Polysiphonia elongata (Hudson) Sprengel			35
Polysiphonia furcellata (C. Agardh) Harvey			35
Polysiphonia sanguinea (C. Agardh) Zanardini			22, 35
Polysiphonia sertularioides (Grateloup) J. Agardh			35
Polysiphonia cf. subtilissima Montagne			35
Polysiphonia subulata (Ducluzeau) P. *et* H. Crouan			22, 35
Porphyra leucosticta Thuret			22, 35
Pterothamnion plumula (J. Ellis) Nägeli			35
Rhodophyllis divaricata (Stackhouse) Papenfuss			35
Seiropsora sp.			22
Spyridia filamentosa (Wulfen) Harvey			22, 35
TOTAL RHODOPHYTA=45			
OCHROPHYTA			
Phaeophyceae			
Asperococcus fistulosus (Hudson) Hooker			22
Cystoseira barbata (Stackhouse) C. Agardh			22, 35
Cystoseira compressa (Esper) Gerloff *et* Nizamuddin			22
Ectocarpus siliculosus (Dillwyn) Lyngbye			22
Ectocarpus siliculosus (Dillwyn) Lyngbye var. *hiemalis* (P. *et* H. Crouan *ex* Kjellman) Gallardo			35
Fucus virsoides J. Agardh			22, 35
Nemacystus flexuosus (C. Agardh) Kylin			22
Scytosiphon lomentaria (Lyngbye) Link			22
Sphacelaria cirrosa (Roth) C. Agardh			35
Total Phaeophyceae=9			
Xantophyceae			
Vaucheria submarina (Lyngbye) Berkeley			35
Vaucheria sp.			22
Total Xantophyceae=2			
TOTAL OCHROPHYTA=11			
CHLOROPHYTA			
Blidingia minima (Nägeli *ex* Kützing) Kylin			35
Blidingia ramifera (Bliding) Garbary *et* Barkhouse			35
Bryopsis hypnoides J.V. Lamouroux			22

Taxa	Non-indigenous		References
	i	ni	
Chaetomorpha aerea (Dillwyn) Kützing			22, 35
Chaetomorpha ligustica (Kützing) Kützing			35
Chaetomorpha linum (O.F. Müller) Kützing			22, 35
Cladophora albida (Nees) Kützing			22, 35
Cladophora dalmatica Kützing			22
Cladophora prolifera (Roth) Kützing			35
Cladophora rupestris (Linnaeus) Kützing			22
Cladophora sericea (Hudson) Kützing			22, 35
Cladophora vadorum (Areschoug) Kützing			35
Cladophora vagabunda (Linnaeus) C. Hoek			35
Entocladia viridis Reinke			22, 35
Gayralia oxysperma (Kützing) K. L. Vinogradova *ex* Scagel *et al*			35
Phaeophila dendroides (P. *et* H. Crouan) Batters			35
Pringsheimiella scutata (Reinke) Höhnel *ex* Marchewianka			35
Ulothrix flacca (Dillwyn) Thuret			35
Ulothrix implexa (Kützing) Kützing			22, 35
Ulothrix subflaccida Wille			22
Ulva clathrata (Roth) C. Agardh			22, 35
Ulva compressa Linnaeus			35
Ulva flexuosa Wulfen			22, 35
Ulva intestinalis Linnaeus			22, 35
Ulva laetevirens Areschoug			35
Ulva linza Linnaeus			22
"*Ulva rigida*" C. Agardh			22, 35
Ulva rotundata Bliding			35
Ulvella lens P. *et* H. Crouan			22, 35
TOTAL CHLOROPHYTA=29			
TOTAL SPECIES=85			
ANGIOSPERMAE			
Cymodocea nodosa (Ucria) Ascherson			22
Nanozostera noltii (Hornemann) Tomlinson *et* Posluzny			22
Ruppia maritima Linnaeus			22
Zostera marina Linnaeus			22
TOTAL ANGIOSPERMAE=4			

THE LAGOON OF VENICE

Adriano Sfriso [1], Daniele Curiel [2], Andrea Rismondo [2]

[1] Dipartimento di Scienze Ambientali, Università di Venezia
[2] SELC- Società per l'Ecologia delle Lagune e delle Coste, Venezia

Riassunto

Viene presentata la check-list delle macrofite (macroalghe e angiosperme sommerse) attualmente presenti nella laguna di Venezia, evidenziando le specie nuove per quest'ambiente e per il Mediterraneo. Questi dati sono associati ad una lista delle specie scomparse o non più ritrovate e a liste dei taxa inquirenda, dei taxa excludenda e dei taxa nuda. Inoltre vengono presentati dati sulla copertura, distribuzione e produzione di biomassa delle macroalghe e delle angiosperme per tutta la laguna. Nella laguna di Venezia, attualmente sono presenti 305 taxa di cui 300 sono macroalghe. La lista comprende 163 Rhodophyta (54.3%), 59 Ochrophyta [57 Phaeophyceae (19.0%), 2 Xanthophyceae (0.7%)], 78 Chlorophyta (26.0%) e 5 Spermatophyta. Centoquattro taxa (ca. 34.7%) sono nuove introduzioni per la laguna Veneta e fra queste 15 (ca. 14.4%) sono specie nuove anche per il Mediterraneo. Le specie scomparse o non più ritrovate sono 87 (8 Chlorophyta, 54 Rhodophyta e 25 Ochrophyta). Mappe di distribuzione e produzione di biomassa sui fondi incoerenti della laguna sono disponibili a partire dal 1980 e riguardano soprattutto le Ulvaceae e le Gracilariaceae. Nel 1980 lo standing crop (SC) e la produzione primaria netta (NPP) e lorda (GPP) per l'intera laguna sono state stimate in 841, 2912 e 18499 ktonnellate in peso fresco, rispettivamente. Nel 2003 i valori di SC, NPP e GPP sono scesi a 89, 472 e 2358 ktonnellate. A partire dal 1990 sono state prodotte anche mappe della distribuzione delle angiosperme sommerse considerando le tre specie più abbondanti presenti nella laguna Veneta: *Cymodocea nodosa*, *Zostera marina* and *Nanozostera noltii*. Le altre due specie: *Ruppia cirrhosa* e *Ruppia maritima* presentano infatti biomasse puntiformi e del tutto trascurabili. La distribuzione delle angiosperme è stata mappata nuovamente nel 2002, mettendo in evidenza i cambiamenti dei valori di copertura e la forte riduzione di *N. noltii*. Nel 2003, una nuova mappatura ha permesso di determinare anche lo standing crop e la produzione netta di ogni specie considerata separatamente.

Abstract

The check-list of the macrophytes (macroalgae and submerged angiosperms) which presently populate the lagoon of Venice, the new introduced species, the species that have disappeared, the taxa inquirenda, the taxa excludenda and the taxa nuda are here presented. In addition, data on the changes of macroalgal and angiosperm both biomass coverage and primary production in the whole lagoon are reported. In the Venice Lagoon, 305 taxa are currently present of which 300 are macroalgae: 163 Rhodophyta (54.3%), 59 Ochrophyta

[57 Phaeophyceae (19.0%) and 2 Xanthophyceae (0.7%)] 78 Chlorophyta (26.0%); Spermatophyta are 5. One hundred and four taxa (ca. 34.7%) are new records for the lagoon and out of them 15 (ca. 14.4%) have been recorded in the Mediterranean Sea for the first time. Eighty seven taxa (54 Rhodophyceae, 25 Phaeophyceae and 8 Chlorophyceae,) have disappeared from the lagoon or have not been found in the recent years. Maps of the macroalgal biomass recorded on soft substrata of the lagoon (mainly Ulvaceae and Gracilariaceae) have been available since 1980 when the summer standing crop (SC), and the annual net (NPP) and gross (GPP) production were estimated to be ca. 841, 2,912, 18,498 ktonnes fwt, respectively. In 2003, SC, NPP and GPP decreased to ca. 89, 472, 2,358 ktonnes fwt. Since 1990, angiosperm maps have been also drawn by considering the coverage of the three main species which populate the lagoon: *Cymodocea nodosa*, *Zostera marina* and *Nanozostera noltii*. The other two species, *Ruppia cirrhosa* e *Ruppia maritima*, are present in small patches and have a negligible biomass. The lagoon was mapped again in 2002 underlining the change of bottom colonization, especially the marked reduction of *N. noltii*. In 2003, a new angiosperm map showed also the SC and NPP of each species separately.

Key-words: Adriatic Sea, Angiosperms, Mediterranean Sea, Seaweeds, Transitional waters, Venetia, Venice Lagoon

1 Introduction

The Venice Lagoon is one of the most studied coastal basins in the world and the first researches on marine macrophytes date back to the 18th and 19th centuries (Olivi 1794, Agardh 1824-42, Naccari 1828, Zanardini 1841-1871, Meneghini 1842-46, Bertoloni 1862, Ardissone 1867, De Toni-De Toni-Levi 1885-1924) with a production of big monographies which take into consideration only the taxonomic and chorologic aspects of the species recorded. Successively, in the 20th century other authors studied the lagoon or reported on species collected in that basin (Forti 1931, Sighel 1938, Schiffner and Vatova 1938, Vatova 1940, Pignatti 1962, Pignatti et al. 1962, 66, La Rocca 1976, Giaccone 1978) adding information on the description of the species and the environmental features for the first time.

The most recent studies date back to 1983 (Sfriso and Curiel 2007), when a lot of researches which consider both the taxonomic and ecological aspects started. Particular attention was paid to the blooms and production of some species such as *Ulva* spp. and *Gracilaria* spp. and their relationship with some environmental parameters.

Many recent papers have dealt with the introduction or recording of new and alien species. Many of them have colonised the whole lagoon or some limited areas competing severely with the indigenous species which often are strongly on the decrease. Since 1983, ca. 242 papers, which quoted one taxon at least, have been written; that number does not consider the abstracts of congress, meetings and workshops and grey literature. A lot of papers take also into consideration the distribution and growth of the five spermatophyta (*Cymodocea nodosa*, *Zostera marina*, *Nanozostera noltii, Ruppia cirrhosa, Ruppia maritima*) which colonise the lagoon and have been studied mostly since 1990 (Caniglia et al. 1990a, b) when the first map of *C. nodosa*, *Z. marina* and *N. noltii* were drawn. Successively, maps underwent continuous updating and many studies on growth, production and relationship with the environment of the above said angiosperms have to be quoted. Indeed, submerged angiosperms, represented mainly by *C. nodosa* and *Z. marina*, are at present the producers which exhibit the highest biomass distribution and production in the lagoon (Rismondo et al. 2003, Sfriso and Facca 2007). Conversely, information on *R. cirrhosa* and *R. maritima* is scarce since those species are confined in salt marshes where they show a patchy distribution. Moreover, the erosion of salt marshes, the reinforcement of their edges and many other works carried out in the lagoon have furtherly reduced the presence of those species to rare and occasional populations ranging from <1m² to some square meters.

This paper aims at providing general information on the studies concerning macroalgae and submerged angiosperms in the Venice Lagoon. It supplies a complete check-list of the macrophytes recorded since 1983 which are considered the taxa that at present populate the lagoon. Lists of the species which have disappeared or have never found after that date, of the taxa inquirenda, the taxa excludenda and the taxa nuda have been also provided. Information on macrophyte standing crop and biomass production in the whole lagoon is also reported. Particular attention has been paid to space and time changes and to the introduction of new species into the lagoon which in some cases have almost completely substituted the native species.

2 Description of the site

2.1 Morphological characteristics

The Venice Lagoon, located in the Northern Adriatic Sea, is the largest transitional environment of the Mediterranean Sea (Fig. 1). Its total surface is ca. 549 km^2 but, excluding islands and tidal marshes, only ca. 432 km² are free waters. The lagoon is divided into three main hydrological basins (southern, central and northern basins) by the Lido and Pellestrina watersheds the edges of which depend on tidal excursions and winds. The lagoon is a very polymorphous environment; it exhibits a mean depth of ca. 1.0-1.2 m, but in the main canals and the lagoon inlets depth ranges between 10 and 20 m with an exception in the Malamocco inlet which is the deepest site of the Northern Adriatic Sea (ca. 50 m). The tidal sea-water exchange through three inlets is approximately 1.46 x 10^9 m^3 at each tidal cycle (12 hr), which is more than a half of the entire water loading, although the water renewal in the inner areas may take ca. 10-20 days. The mean annual freshwater input from 24 tributaries is ca. 35.5 m^3 s^{-1}, but under particularly adverse conditions, freshwater outfalls can increase up to 344 and 273 m^3 s^{-1} on a hourly and daily basis, respectively (Zuliani et al. 2005). In the past, other authors had measured outfalls up to 600 m^3 s^{-1} (Cavazzoni 1973). The lagoon exhibits an annual mean water difference of ± 31 cm (Pirazzoli 1974) but, under particular tidal events and/or meteorological conditions, the water fluctuations can be remarkably higher: from -80 cm to +160 cm (up to +196 cm in 1966) on the mean tide level.

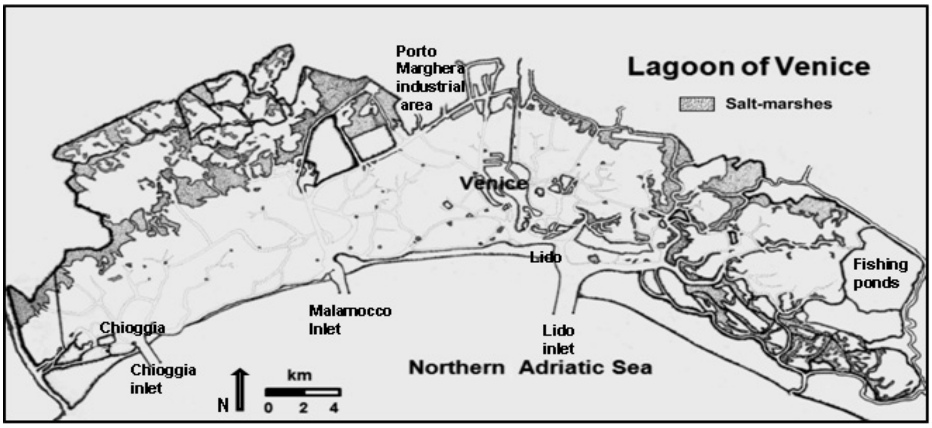

Fig 1 – Map of the Venice Lagoon.

2.2 Anthropic pressures

After the 2nd post–war period, the lagoon of Venice was affected by a number of anthropic pressures which frequently caused the change of the environmental conditions. The development of the industrial area and the digging of deep (12-20 m) and large (100-200 m) commercial canals, between the ’60s and the ’70s, caused the increase of eutrophication and pollution in the lagoon. Large amounts of eutrophic substances were released from Porto Marghera industrial area and mono-cultural practices of the hinterland (drainage basin: ca. 1880 km^2). Ammonium in the industrial canals ranged between 2500 and 3800 µM, ca. 3 orders of magnitude higher than the present concentrations and reactive phosphorus (RP) exhibited values between 2 and 16 µM. These changes favoured quick Ulvacean growth with biomasses and growth rates up to 20 kg fwt m^{-2} and 10-30% per day, replacing angiosperms. The maximum macroalgal diffusion was reached in the ’80s when, after the high spring production, extensive anoxia followed causing the death of fish and benthic organisms and a marked reduction of the lagoon biodiversity.

To contrast macroalgal proliferation, since the late ‘80s, the Municipality of Venice had planned harvesting actions by ca. 20 reaping machines which collected a biomass ranging between 9.000 and 50.000 m^3 yr^{-1} (Consorzio Venezia Nuova 1994). However, due to administrative delays, each year the biomass harvesting occurred in May-June when macroalgae had already reached the highest biomass values so results were not as good as expected. Biomass harvesting produced positive effects only after that macroalgae had naturally decreased (Sfriso 1996, Sfriso and Marcomini 1996c), as a consequence of climatic changes; so, the reaping machines were able to collect the total biomass of entire lagoon areas.

After the natural macroalgal decrease, recorded in the early ‘90s, the lagoon was affected by other anthropic stressors, mainly due to the free-harvesting of the Manila clam *Tapes philippinarum* Adams & Reeve introduced in the lagoon in 1983 (Cesari and Pellizzato 1985) for aquaculture purposes. The harvesting of that clam, carried out by 120 big boats equipped with large (ca. 2.7 m) and heavy (ca. 6-700 kg) hydraulic and mechanical dredges and 600 small boats provided with 1-2 50-60 cm large dredges, caused the disruption of the sediment texture, reducing the macrofauna biodiversity, the fish resources and causing the re-suspension of high amounts of sediments (Orel et al. 2000). The environmental consequences were dramatic, sediment re-suspension and water turbidity increased more than one order of magnitude (Sfriso et al. 2005a) contributing to a further reduction not only of the macrophyte biomass but also of phytoplankton and microphytobenthos (Facca et al. 2002a, b).

At present, the local authorities “Province of Venice” and “Water Management Authority” have promoted a Master Fishing Plan in order to regulate the clam-harvesting in the lagoon and transform clam-fishermen into clam-farmers (Orel et al. 2000).

2.3 Physico-chemical parameters

It is very difficult to provide a panoramic view of the lagoon variability because its surface is quite extended and its environment displays a polymorphous fragmentation. The literature dealing with the most common environmental parameters and the nutrient concentrations in the water column, surface sediments, particulate matter and macrophyte tissues and their time, space and seasonal changes has been very conspicuous and exhaustive, especially since the late ‘80s.

On average, the lagoon water temperature ranges from (-1)-5 to 30-(33) °C with an almost marine salinity (28-33 psu) which can lower considerably in the areas close to river outflows and reach ca. 43 psu in some tidal marshes during summer. Oxygen saturation fluctuates from (0)-70% to 150-(360)%; water pH from (6.9)-7.8 to 8.3-(9.5); water E_h from (0)-200 to 300-(400) mV according to the conditions of the primary producers. Water transparency has reduced markedly in the last decade so that visibility by the Secchi Disk ranges between (0.15)-0.5 and 2-3-(9) meters. The suspended solids range between 10-20 mg dwt L^{-1} in the areas colonised by angiosperms or macroalgae and 60-80-(130) mg dwt L^{-1} in areas deprived of vegetation. Similarly, sedimentation rates range between (34)-100-300 and 700-900-(1400) kg dwt m^{-2} y^{-1}. In the past, sedimentation rates were up to 140 kg dwt m^{-2} y^{-1} at most then, because of the macroalgal biomass reduction and the clam-harvesting effects, they increased of about one order of magnitude (Sfriso et al. 2005a, f). The concentrations of reactive phosphorus (RP) and dissolved inorganic nitrogen (DIN = sum of ammonium, nitrite and nitrate) are also very changeable, but except for NOx (nitrates + nitrites), they have been on the decrease during the last decade (Sfriso et al. 2005d). On average, RP ranges from (0.1)-0.3 to 0.8-2.0-(7) µM whereas DIN from (0.3)-5 to 50-80-(200) µM. At present, nitrates usually show the highest concentrations whereas ammonium shows a decreasing trend.

The concentrations of nutrients in the surface sediments depend mostly on grain-size and the presence/absence of macrophytes. On average, total phosphorus (TP) ranges between (220)-300 and 500-(740) µg g^{-1} dwt, total nitrogen (TN) between (0.10)-1.0 and 2.0-(2.98) mg g^{-1} dwt (Sfriso et al. 2003b) and organic carbon (OC) between 1.9 to 18.5 mg g^{-1} dwt, accounting for 12-14% of the total carbon (TC) (Sfriso et al. 2005g). Significant changes can be observed during one year, especially in sediments colonised by macrophytes. The concentrations found in the particulate matter settled in sedimentation traps, usually, exhibit nutrient concentrations 2-3 times higher than surface sediments (Sfriso et al. 1988a, Sfriso and Marcomini 1999a).

Nutrient concentrations have been determined also in a number of macroalgae (especially, *Ulva rigida*, *Gracilaria* spp., *Fucus virsoides*) and angiosperms (*Z. marina*, *C. nodosa*, *N. noltii*), both on time and space basis, in order to highlight possible nutrient limiting factors. Concentrations vary considerably depending on species, season, sampling sites and, in the case of the angiosperms, on shoots, roots-rhizomes, the dead parts and the different leaves (1^{st}, 2^{nd}, 3^{rd} and 4^{th}). On average, the tissue concentrations of TP range between (0.53)-1.0 and 2.0-(4.43) mg g^{-1} dwt, the concentrations of TN between (8.8)-20 to 30-(41.2) mg g^{-1} dwt and those of OC between (112)-200 and 300-(410) mg g^{-1} dwt (Sfriso et al. 1994, Sfriso and Marcomini 1999a).

3 Macroalgae

3.1 Nomenclatural changes

The nomenclature of the species reported in the text was revised according to the most recent literature such as the papers by Furnari et al. (1999, 2003), the work by Sfriso and Curiel (2007), which reports also the nomenclatural changes of the species recorded in the lagoon since the 18^{th} century, and the web-site AlgaeBase of Guiry and Guiry (2009). Moreover, it was revised by Profs Giovanni Furnari and Mario Cormaci of the Catania University. However, we think that the nomenclatural changes of some taxa of the Cladophorales proposed by Brodie et al. (2007) on the basis of the observations by Silva et al. (1996), can generate confusion. Taking into account the morphology, seasonality and ecology of these taxa, which are both common and abundant in the Venice Lagoon, and the nomenclatural doubts of Brodie et al. (2007) we prefer to report the old nomenclature according to Womersley (1984), Burrows (1991), Coppejans (1995) etc. Indeed, *Chaetomorpha mediterranea* (Kützing) Kützing, *Rhizoclonium lubricum* Setchell *et* N.L. Gardner and *Rhizoclonium tortuosum* (Dillwyn) Kützing have been included in the taxon *Chaetomorpha ligustica* (Kützing) Kützing even though those taxa are very different both in the diameter of the filaments and structure. *Rhizoclonium tortuosum* produces lateral rhizoids and exhibits a diameter of 18-35 µm. The other two taxa are deprived of lateral rhizoids but differ in the filament diameter: 30-50 µm in *Rhizoclonium lubricum* and (30)-60-80-(100) µm in *Chaetomorpha mediterranea*. Similarly, Brodie et al. (2007) included in the "*Rhizoclonium riparium* (Roth) Harvey complex" also *Lola implexa* (Dillwyn) G. Hamel a species which has a completely different reproductive cycle (Cabioc'h et al. 1992) but also morphology and habitat. *Lola implexa* colonises only the sea-coasts during summer whereas *Rhizoclonium riparium* is a lagoon species present during the whole year. The same observation refers to *Chaetomorpha linum* (O. F. Müller) Kützing and *Chaetomorpha aerea* (Dillwyn) Kützing. In the Venice Lagoon those taxa are well distinct. They can coexist, but usually *C. aerea* colonizes bad and poor-quality environments and forms only 5-30 cm long filaments, whereas *C. linum* prefers good, high-quality environments developing mat filaments which are some meters long (Sfriso et al. 2007a, 2009).

Doubts concern also the conspecificity of *Gracilaria bursa-pastoris* (S.G. Gmelin) Silva and *Gracilaria compressa* (C. Agardh) Greville (Silva et al. 1996) which in the Venice Lagoon show a very different morphology and a different autoecology. In fact, the species indicated as *G. compressa*, exhibits more thicker (up 3 mm) and more compressed (up to 6-7 mm) thalli, and the medullar cells in the transversal section are very different. In addition, that taxon is prevalently marine, it grows between the late winter and the early summer and then disappears. On the contrary, *G. bursa-pastoris* grows prevalently in the shallow bottoms of the lagoon during the whole year. Therefore, waiting for the results of the molecular and genetic analyses of our samples, we prefer to keep the two taxa distinct.

3.2 Flora and vegetation

Most of the studies on macroalgae deal with the citation, description and distribution of macroalgae in the Venice Lagoon. They were carried out during the 19th and almost all the 20th centuries. It was in the ‘80s that environmental aspects began to be considered, i.e. the distribution and production of biomass and their relationship with some environmental variables, nutrient (mainly phosphorus and nitrogen compounds) and inorganic (metals) and organic micropollutant concentrations, and stressing factors (e.g. biomass harvesting, grazing pressure, clam-harvesting etc.) .

The first citation of the Venice macroalgae is by Olivi (1794) with an essay on a new species of *Ulva* recorded in the lagoon. In the 19th century, the most conspicuous information on the flora of the Venice Lagoon is by Zanardini who, between 1841 and 1871, wrote 6 monographies on the Mediterranean-Adriatic flora where many species found in the lagoon were quoted. Other contributions are by Agardh (1824, 1842), Naccari (1828), Meneghini (1841, 1842a, b, c, 1843, 1846), Bertoloni (1862) and Ardissone (1867) who wrote extensive monographies with some Venice citations.

Between the 19th and 20th century, De Toni and Levi (1885-1888b) and De Toni (1889-1924) wrote 13 big monographies quoting a number of species found in the Venice Lagoon. In particular, the books by De Toni and Levi dealt with the flora of the Venice Lagoon and its marine coastal areas reorganising the macroalgal collections of Zanardini which were kept in the Civic Museum of Natural History in Venice (De Toni and Levi 1888b).

During the first half of the 20th century, the papers by Forti (1931), Sighel (1838), Schiffner and Vatova (1838), Vatova (1940) were written. With the exception of Forti, who studied the distribution of *Fucus virsoides* in the northern

Adriatic only, those authors addressed their studies to the Venice Lagoon and its marine coasts describing all the species found in those environments. Sighel (1938) studied the species found along a transect from the historical centre of Venice to the Lido sea-inlet for the first time, providing also some information on the different species habitats, whereas Schiffner and Vatova (1940) supplied a description of all the species recorded in the whole lagoon.

Later studies were carried out by Pignatti (1962), Pignatti and Wikus (1962) and Pignatti and Pignatti (1966). In particular, Pignatti (1962) supplied a description of all the species found in the lagoon and along the marine coastlines of Chioggia, Punta Sabbioni and the islands of Lido and Pellestrina. For the first time those authors studied the vegetation of those areas according to the phytosociological method of Braun-Blanquet (1952), but they also took into consideration their distribution over the different vegetational zones. Moreover, Pignatti (1962) provided a description of the environmental characteristics and information on some environmental variables.

Successively, La Rocca (1976) wrote a book with photos and descriptions of some Mediterranean macroalgae some of which had been collected in the Venice Lagoon.

However, most of the literature was produced in the ’80s. The first check-list of that period was compiled by Sfriso (1987) who studied the macroalgae found in the lagoon and on the coastline of the Lido island according to their vertical distribution in the different vegetational zones. This study was followed by that by Solazzi et al. (1991-1994) who reported mainly the taxa found on the soft bottoms of the central lagoon and by a number of papers by Curiel, Marzocchi, Bellemo and Sfriso who studied the flora of limited areas of the lagoon and reported many new species and new introductions in the lagoon for the first time.

A complete revision of the species found in the lagoon of Venice up to 2004 is by Sfriso and Curiel (2007) who reported 277 taxa.

On the whole, the papers which have dealt with the macrophytes of the Venice Lagoon from Olivi (1794) until January 2009 productions, are ca. 242. Table 1 reports the new species found for the first time in the Venice Lagoon (one asterisk) and in the Mediterranean Sea (two asterisks) since 1983. One or two asterisks mark also the first author citation. In Tab. 2 the species which have never been recorded since 1983 are shown. Tabs. 3, 4, 5 report the taxa excludenda, the taxa inquirenda and the taxa nuda, respectively.

3.3 Environmental aspects

After Pignatti (1962), the first ecological paper on the macroalgae of the Venice Lagoon was by Sfriso et al. (1987). In that paper, growth, biomass production and biomass collapse of some macroalgae (mainly *Ulva rigida* and *Gracilaria* spp.), in relation to the nutrient availability in the water column and surface sediments, were analysed. An interrupted series followed which correlates the growth and the presence of the most widespread species of macroalgae to the trophic and pollution levels of the lagoon. The most studied species were *Ulva rigida,* although it would be more correct to refer to the complex *Ulva rigida* and *Ulva laetevirens* because the two species are not distinguishable when they are in the unattached form (Sfriso 2006c), and the species belonging to the *Gracilaria verrucosa* (Hudson) Papenfuss complex (i.e. *Gracilaria longa*, *G. gracilis* and *Gracilariopsis longissima*). With reference to those species a number of papers were written. Some studies analysed in the field growth and production both in natural (Sfriso et al. 1988b, 1993 and so on) and cage (Sfriso 1995, Balducci et al. 2001) conditions and took into account the nutrient availability in the environment and their concentrations in the macrophyte tissues. Moreover, the relation between environment contamination and tissue concentrations of both metals and organic pollutants [DDT (Pesticides), PCBs (polychlorinated biphenyls), PAH (polyaromatic hydrocarbons) LAS (Linear alchilbenzen sulphonate), NPEO (nonilphenol polyethoxilates), PCDD/F (Polychloro-dibenzo-dioxins/furans)] was investigated (Pavoni et al. 1990, Maroli et al. 1993, Sfriso et al. 1995, Caliceti et al. 2002, Pavoni et al. 2003).

3.4 Biomass distribution, production and collapse

In the last three decades these ecological aspects, have been the most studied in the Venice Lagoon because of the abnormal blooms of nuisance macroalgae which have occurred in the lagoon since the ‘70s. Therefore, many papers dealing with growth, production and decomposition of the dominant species have been integrated with many others that show the temporal and spatial changes of macroalgal distribution.

The first macroalgal standing crop measurement carried out in the whole lagoon dates back to 1980, but data have been processed only recently (Sfriso 2005a, Sfriso et al. 2005b, Sfriso and Facca, 2007).

Successively, since the late ‘80s, many papers which report the biomass changes in the central (Sfriso et al. 2003a, Curiel et al. 2004b) and the whole lagoon (Sfriso et al. 2005b, c, Miotti et al. 2007, Sfriso and Facca 2007) with information on the total standing crop (SC), the net (NPP) and gross (GPP) production, the distribution and annual variation of the main species (Miotti et al. 2007) have been produced. A lot of papers also deal with the causes of the biomass and production changes (Sfriso 1996, Sfriso and Marcomini 1996c, Sfriso et al. 2003a, 2005b).

All those papers show the progressive decrease of macroalgal biomass and production which have occurred since the early ‘90s. Maps of sampling campaigns carried out in summer 1980 (ca. 2500 sites), and in summer 2003 (ca. 460 sites), show that the SC, and the annual NPP and GPP estimated by means of P/B ratios, which had been measured in some stations at different biomass densities, had decreased from 841, 2912, 18499 ktonnes fwt to 89, 472 and 2358 ktonnes fwt, respectively. The highest macroalgal reduction was observed in the central lagoon where the SC, NPP and GPP recorded in summer 1980 had decreased from 558, 1502 and 9720 ktonnes fwt, respectively, to 11, 63 and 301 ktonnes fwt in summer 2003.

The total angiosperm and seaweed biomass distribution (SC: ca. 298 ktonnes fwt) and production (NPP: ca. 1273 ktonnes fwt y^{-1}; GPP: ca. 3950 ktonnes fwt y^{-1}) in the whole lagoon in 2003 is displayed in Tab. 6. The angiosperm biomass and production were mainly due to *Cymodocea nodosa* (SC: 52%; NPP: 51%, of total angiosperms) which was the most productive species of the lagoon. *Zostera marina* displayed a biomass and production a bit lower (SC: 43%; NPP: 46%, of total angiosperms) although that species covered a higher lagoon surface (47% versus 42%). Conversely, *Nanozostera noltii* showed a biomass and a production which were 5% and 3% of the total angiosperms, only.

Tab. 6 - Venice lagoon total macrophyte production in 2003. NPP = Net Primary Production, GPP = Gross Primary Production.

Angiosperms							
Species	Coverage		Standing Crop		NPP		GPP
	km²	%	Ktonnes, fwt	%	Ktonnes, fwt	%	Ktonnes, fwt
C. nodosa	23,6	42	109	52	406	51	812
Z. marina	26,0	47	90	43	369	46	737
Z. noltii	6,2	11	10	5	22	3	43
Total	55,9	100	209	100	796	100	1592
Macroalgae							
Total taxa	150		89		477		2358
Total macrophytes			298		1273		3950

Total macroalgae showed a SC lower than that of *C. nodosa* and *Z. marina,* but the NPP was as high (477 ktonnes fwt y^{-1} versus 406 and 369 ktonnes fwt y^{-1}, respectively). Indeed, macroalgae display higher growth rates than angiosperms.

The GPP for macroalgae was ca. 2358 ktonnes fwt. It was estimated by applying the annual balance of phosphorus in a lagoon area placed in the Lido watershed where no water losses occurred (Sfriso and Marcomini 1994). The GPP for angiosperm, estimated by applying literature GPP/NPP mean ratios was significantly lower: ca. 1592 ktonnes fwt y^{-1}.

Moreover, papers dealing with the sampling procedures both in soft (Sfriso et al. 1991) and hard bottoms (Curiel et al. 2000) were also written in order to determine the proper number of subsamples for each biomass density value (floating seaweeds) as well as the minimal area (attached seaweeds).

3.5 Space and time macroalgal dynamics

3.5.1 The macroalgae of soft substrata

The studies of the macroalgal distribution were performed by means of *in situ* measurements, aerial photo surveys and recently also satellite images.

The most important taxa involved in the space-temporal distribution of macroalgae in the period between the ‘70s and ‘90s were: the complex *Ulva rigida-Ulva laetevirens*, *Enteromorpha* spp. (at present transferred to the genus *Ulva*), *Chaetomorpha* spp., *Cladophora* spp. and the *ex Gracilaria verrucosa* complex. However, because of the environmental implications, only the biomass dynamic and production have been mainly studied. At the end of the ‘80s, nitrophilous macroalgae colonized almost entirely soft substrata of the Venice Lagoon and the maximum biomass values ranged between 20 and 25 kg fwt m^{-2}. In that period, repeated local anoxic crises occurred and macroalgal decomposition released a quantity of harmful substances (Sfriso et al. 1989, Solazzi et al. 1991). Since the ‘90s, a progressive decrease of nitrophilic biomass coverage with a partial replacement by *Gayralia oxysperma* (Solazzi et al. 1994, Curiel et al. 1997b, 2004b) and *Vaucheria submarina* (Sfriso and Facca 2007) has been reported. In the angiosperm meadows, the genus *Chaetomorpha* prevailed on Ulvaceae. In the period 2002-2005, the macroalgal decreasing trend was confirmed (Miotti et al. 2007) but *Ulva* was still the prevailing genus, although its coverage and biomass were lower than in the ‘80s. In the last surveys aiming to to map the macrophyte distribution, the DGPS technology, integrated with a GIS software, allowed to distinguish 6 taxa: *Gracilariopsis longissima, Gracilaria* spp., *Chaetomorpha* spp., *Ulva* spp., assemblages of Ectocarpales of the genus *Ectocarpus* and *Hinksia* and *Vaucheria* spp.

In 2002, those taxa had a total coverage of 4.976 ha, ca. 16% of the lagoon basin. *Ulva* spp. (2.706 ha) was over 50%, particularly in the southern basin. An interesting genus was *Vaucheria,* for both its wide coverage, which had never reached before, and the ecological implications. Indeed, that genus, which partially develops into the sediments, favours the sediment cohesion and reduces re-suspension and water turbidity.

In 2005, the macroalgal coverage decreased again (2.476 ha) while *Vaucheria* was on the increase in the whole lagoon. In that survey only three dominant genera were recorded: laminar *Ulva* spp., *Chaetomorpha* and *Vaucheria*, with a mean biomass value of 0.1 kg fwt m^{-2}.

During the investigation carried out in spring and autumn 2002 on 90 soft sampling sites covering all the environmental lagoon typologies, except fishing-farms, 117 macroalgal taxa were recorded: 63 Rhodophyceae (55%), 2 Xanthophyceae (1%), 25 Phaeophyceae (21%) and 27 Chlorophyceae (23%) (Curiel et al. 2006a). The highest floristic diversity (over 80% of the whole species identified) was recorded in the southern and central basins. The northern basin had a less diversified floristic composition which was characterized mostly by *Ulva flexuosa*, *U. intestinalis*, *U. laetevirens*, *U. rigida*, *Cladophora* spp., *Gracilariopsis longissima* and *Polysiphonia* spp.

The high species richness (215 taxa) was confirmed by a survey carried out in ca. 460 stations of the whole Venice Lagoon characterized by soft and hard substrata (Sfriso and La Rocca 2005). A comparison among the surveys carried out in the period between the ‘30s and the ‘90s shows on the one hand the decrease or the disappearance of many species which had been mainly caused by local anoxic crises and eutrophic waters, on the other hand the presence of new taxa, due to both a more accurate species identification and the occurrence of NIS (non-indigenous species).

As for fishing-farms, except for the investigations by Schiffner and Vatova (1937) and Vatova (1940), there are a few data on the macroalgal communities of closed environments such as private areas where public navigation is forbidden. According to the present nomenclature, Vatova (1940) recorded 59 taxa in 11 fishing-farms. Nowadays, there are few studies on the areas where fish-farms are present due to the difficulty to sample them. However, during a survey carried out in “Valle Averto” in the ’90s, 8 macroalgae (i.e. *Chaetomorpha linum*, *C. aerea*, *Cladophora sericea*, *Rhizoclonium tortuosum*, *Lamprothamnion papulosum*, *Bangia atropurpurea*, *Chondria capillaris* and *Polysiphonia denudata*) and 1 angiosperm (*Ruppia maritima*) were recorded (Curiel et al. 1996c). The algal coverage ranged from 80% to 100% of the study area, and *Chaetomorpha* was the most important genus, showing biomass values ranging from 4.1 to 8.4 kg fwt m^{-2}.

During a further study carried out in 2004 in some fishing-farms in both the northern and the southern basins, 41 macroalgae were recorded (24 Rhodophyceae, 1 Phaeophycea, 15 Chlorophyceae, 1 Xanthophycea) and 4 angiosperms (*Cymodocea nodosa*, *Ruppia maritima*, *R. cirrhosa* and *Nanozostera noltii*) (Curiel et al. 2008a). In some fishing-farms of the northern basin (Valle Dogà and Valle Cavallino) the coverage and biomass were due mainly to *Valonia aegagropila* (with biomass values ranging from 2 to 10 kg fwt m^{-2}), *Chaetomorpha* spp. and the angiosperms *C. nodosa* and *Ruppia* spp. In the southern basin fishing-farms (Valle Pierimpiè, Valle Averto and Valle Contarina), macroalgae were mainly represented by *Chaetomorpha* spp., *Cladophora* spp. and *Ulva* spp. with biomass reaching 1-5 kg fwt m^{-2}. In those fishing-farms, samples of the Chlorophycea *Lamprothamnion papulosum* were also recorded. Because of the presence of muddy sediments and low salinities, angiosperms were represented only by *Ruppia* spp. and *N. noltii*, whereas *C. nodosa*, which had been recorded in the past, had disappeared. However, the presence of *L. papulosum*, which is characteristic of low salinity and high-ecological-status environments, and the abundance of both *Valonia aegagropila* and angiosperms confirm that the environmental conditions in the confined fishing-farms are better than in the free lagoon areas.

3.5.2 The macroalgae of hard substrata

For many years the hard substrata communities have been disregarded because of the proliferation of nitrophilous macroalgae and their socio-ecological implications. Then, after their decline and the record of some alien species, researchers included in their studies also those substrata focussing their attention to both the taxonomic and environmental aspects.

With reference to the geographical location, there are three hard substrata typologies in the Venice Lagoon: a) breakwaters, b) crushed stone and/or stone banks delimiting the islands c) wooden or stony infrastructures placed by man on the tidal mudflat borders and in shallow waters.

Breakwaters are artificial structures made of limestone blocks mainly placed between the sea and the lagoon, to protect the three wide sea inlets. The floristic composition observed before the ‘90s (Pignatti 1962, 108 taxa after revision; Sfriso 1987, 106 taxa after revision) was compared to that detected in the ‘90s (Curiel et al. 1999d, only lagoon breakwaters; Curiel et al. 2008b, lagoon and marine breakwaters): 109 and 134 taxa were reported, respectively with a slight increase of Rhodophyceae (from 51% to 52%) and Phaeophyceae (from 17% to 22%) and a reduction of Chlorophyceae (from 31% to 26%). The total number of taxa and their density is quite low in comparison with other port areas of the Mediterranean Sea. (Cormaci et al. 1985, Giaccone et al. 1985, Cormaci and Furnari 1991, Giaccone 1994). The low biodiversity is due to the eutrophicated and turbid waters of both the northern Adriatic Sea and the Venice Lagoon in particular.

Recent surveys carried out in breakwaters placed offshore the lagoon inlets have displayed an intense re-colonization by some species (*Cystoseira compressa*, *C. barbata*, *Dictyopteris polypodioides*) which had disappeared during Ulvacean overgrowth period (the ‘70s-‘90s) confirming that the lagoon and its sea littoral have been recovering. Nevertheless, they also show the photophilic algal community impoverishment both in the upper and lower littoral zone, because of the prevalence of taxa characteristic of slightly polluted and eutrophic waters and a significant light attenuation. Moreover, already at a depth of 7-8 m, the coverage reduction of the photophilous species is not counterbalanced by a coverage increase of sciaphilous species, except for *Rhodymenia ardissonei*. The general coverage reduction, in contrast with the relatively high species richness, is due to the presence of environmental stressors that limit the development of well balanced algal communities.

The taxa colonising the hard substrata of the Venice Lagoon islands were investigated mainly at the end of ‘90s. Some surveys were carried out in the Venice historical centre, Murano, Burano, S. Giorgio Maggiore and Giudecca islands (Curiel et al. 1998b, 1999b, 1999c, 2001a, 2001b, 2004a, 2006g, Marzocchi et al. 2003). The updating of a study carried out by Sighel (1938) along the gradient from the mainland to the sea showed a taxa increase from 64 to 105, but at the same time also the decrease of some species such as *Cystoseira barbata*, *Fucus virsoides*, *Ceramium ciliatum*, *Pleonosporium borreri*, *Gracilaria bursa-pastoris*, *G. dura*, *Dasya elegans*, *Lomentaria clavellosa*, *Halymenia floresii*. The records of new species concerned species which were not present in the Adriatic Sea or had never been recorded before along the Italian coasts (i.e. *Polysiphonia morrowii*, *Sorocarpus* sp., *Ectocarpus siliculosus var. hiemalis* and *Punctaria tenuissima*). As for soft substrata, taxa increase is due to the occurrence of NIS, accurate sampling methods and precise species identification, especially concerning minute taxa. In particular, each site was charaterized by some species always present at a depth ranging from +40 to -100 cm on the mean tidal level. *Ulva laetevirens, U. rigida, U. intestinalis*, *Blidingia minima* and *Gelidium pusillum* characterized the upper and mid-littoral whereas *Rhodymenia ardissonei* was the most important species in the deeper waters. The sites which are most affected by the tidal water exchange showed a number of species and a total coverage which is higher between 0 and -60 cm on the mean tidal level than above the mean tide level (i.e. between 0 and +40 cm) or below -60 and -100 cm), where algal assemblages are negatively affected by air exposure or water turbidity, respectively (mean Secchi Disk value: 30-40 cm). The mean number of species per sample ranged from 40 to 45 with a total mean coverage of 100-130%. The sites close to the mainland, which are less affected by tidal exchanges and have a lower water quality, showed a lower both number of taxa and coverage at all the depths (mean taxa number: 10-20; total mean coverage: 40%).

3.5.3 *Presence of alien macrophytes in the Venice Lagoon*

In the last 1-2 decades the recurrent records of non-indigenous species (NIS) are one of the most important events about the flora and vegetation of the Venice Lagoon. NIS are species present into ecosystems, outside their normal range of occurrence (Cormaci et al. 2004) and with reference to the lagoon of Venice, they involve not only macroalgae, but also invertebrate species (Occhipinti-Ambrogi 2002; Mizzan 1999). Lagoon ecosystems in the northern Adriatic Sea are considered hot spot areas for alien species.

Among the different taxa recorded in the last 2-3 decades in the Venice Lagoon (Sfriso and Curiel 2007), a lot of macroalgae were probably present also in the past, but they were not reported for many reasons: few studies, old taxonomic keys, misidentification of species, small size or poor distribution, unsuitable sampling methods. However, many other species have the characteristics of the NIS. *Undaria pinnatifida*, *Sargassum muticum*, *Desmarestia viridis*, *Agardhiella subulata*, *Antithamnion nipponicum*, *Grateloupia turuturu*, *Lomentaria hakodatensis*, *Polysiphonia morrowii*, *Soliera filiformis* and *Heterosiphonia japonica* are the most important NIS for range extension occurrence, degree of coverage and biomass. Among them, *U. pinnatifida* and *S. muticum* are, at present, the most important NIS in the Venice Lagoon because of the extension and coverage degree and the high biomass recorded in late spring when the highest sporophyte development is observed (10-15 kg fwt m^{-2}).

Undaria pinnatifida, *Sargassum muticum* and *Polysiphonia morrowii*, endemic species from the seas of Japan, China and Korea have a wide distribution on the vertical banks of the islands. The quick diffusion of *U. pinnatifida* and *S. muticum* is due to different factors: a) the capacity of adaptation to eutrophic waters and turbidity, b) the presence of an effective reproduction strategy and c) the lack of both competitors among seaweeds (e.g. *Laminaria*, *Saccorhiza*, *Alaria* present in other sites) and potential grazers such as *Helcion*, *Haliotis*, *Aplysia* or *Paracentrotus*.

Undaria pinnatifida was at first recorded in the basin of Chioggia in 1992 (Rismondo et al. 1993, 1994) and subsequently in the islands of the central basin (Curiel et al. 1994a). Its phenology and seasonality as well as its spreading in the lagoon and competition phenomena have been extensively studied. In short, sporophyte recruitment occurs in winter and early-spring.

Large and mature thalli are observed in late spring; they undergo senescence until disappearance in late June-July because of the increase of water temperature (Curiel et al. 1998c, 2001a, 2003). Nowadays *Undaria pinnatifida* colonizes the hard substrata of the lagoon islands in a linear extension of over 25 km, with a standing crop of ca. 175-200 tonnes fwt, between April and May (5-10 kg fwt m^{-2}).

Sargassum muticum was first recorded along the banks of Chioggia island in 1992 (Gargiulo et al. 1992). In the last years it has quickly spread on the whole lagoon, colonising mainly areas with high water exchanges and well oxygenated waters such as the main canals and the lagoon inlets so being a proper bio-indicator of good environmental conditions. In May 2007, thalli up to 8 m long were measured in some Venice canals. In addition, that species overwhelmes the native seaweeds since its blades reduce light by 70-80% for understory species (Curiel et al. 1998c).

Polysiphonia morrowii is a Rhodophycea up to 40-50 cm high which was firstly recorded in Chioggia canals in 1992 (Curiel et al. 2002) and subsequently also in Venice historical centre and its nearest islands. Currently, it colonizes the vertical banks of the canals and the wooden structures delimiting the navigable canals of the basin.

In the Venice Lagoon, the presence of NIS is probably due to industrial and tourist ship lines (ca. 4998 commercial and/or touristic ships arrived in Venice in 2006) that let the introduction of allochtonous species by both ballast water discharge and fouling on the ship keels. Moreover, at Chioggia there are fish-import activities and aquaculture fishing-farms and the importation of shellfish (*Tapes*, *Crassostrea*, *Mytilus*) is the most important NIS vector. Fishery operations may favour NIS dissemination. Observations performed during the sampling and mapping of the NIS distribution suggest that fouling can be considered the most important local transport vector in that *Undaria*, *Polysiphonia* and *Grateloupia* thalli are often settled on the keels of small boats.

However, the lagoon environmental conditions are not always optimal for NIS settlement and spreading in the lagoon. Indeed, some NIS were recorded only few times and only in the first record area (*Prasiola crispa*, *Sorocarpus* sp.) (Curiel et al. 1999e, Sfriso and La Rocca 2005).

In addition, some NIS quoted by Sfriso (1987) since the early ‘80s (i.e. *Ulva fasciata, Codium fragile* subsp. *tomentosoides*, *Grateloupia filicina*), or species previously present and only recently quoted, such as *Monostroma obscurum* (Sfriso and La Rocca 2002, Sfriso 2007) and *Neosiphonia harveyi* (Bellemo et al. 1999), are now considered integral part of the local macrophyte community.

4 Angiosperms

In the Venice Lagoon 5 marine and freshwater angiosperms are present, three of them are common species and exhibit abundant biomasses: *Cymodocea nodosa*, *Zostera marina*, *Nanozostera noltii*, the others: *Ruppia cirrhosa* (Petagna) Grande and *Ruppia maritima* Linnaeus are rare and rarely studied.

Angiosperm meadows play an important role in the ecology of the Venice Lagoon, in that they provide habitats for many species (den Hartog 1977, Fonseca 1990), favour the stabilization of sediments, enhance their deposition and prevent their resuspension (Sfriso et al. 2004a, 2005c).

4.1 Distribution

The past literature concerning submerged angiosperms in the Venice Lagoon is scarce and fragmentary (Benacchio 1938, Simonetti 1973). Conversely, since the early '90s angiosperms have been studied from both the qualitative and quantitative point of view, including their phenology, the variations of meadow extension and their net production. At first, map of submerged angiosperms was drawn in 1990 (Caniglia et al. 1992) in the framework of a monitoring programme of the Venice Water Management Authority (Magistrato alle Acque). During that period, as well as 20 years earlier, the lagoon was dominated by nuisance macroalgae, especially Ulvaceae (Sfriso and Facca 2007). In the early '90s, a gradual decrease of Ulvaceae followed by the resettlement of some angiosperms was recorded. Spatial dynamics seemed to change frequently affecting the Venice Lagoon meadows. Indeed, angiosperms were mapped again in 2002 (Rismondo et al. 2003, 2005) and in 2003 (Sfriso et al. 2005c, Sfriso and Facca 2005a, 2007). A comparison with the '90s map shows a new angiosperm coverage pattern with a marked decrease of *N. noltii* in the inner parts of the lagoon and an increase of *Z. marina* in the central basin after macroalgal bloom decrease. This did not occurr in the southern basin where *Z. marina* is still the most widespread species.

In the last decade, *C. nodosa* showed a positive trend, except for strong losses in some areas close to Chioggia due to the artificial removal and general pressures induced by clam-harvesting and clam-farming. In 2002, *C. nodosa* spread over ca. 2946 ha (1634 ha in 1990) in the lagoon, *Z. marina* over ca. 3443 ha (3643 in 1990) and *N. noltii* over 634 ha (4144 in 1990). In Tab. 7 the changes of pure and mixed beds in the whole lagoon are also reported showing that the extension of angiosperm meadows decreased of ca. 62 ha (-1.1%), although a high variability on a reduced scale was observed (Rismondo et al. 2005).

The northern lagoon showed a higher decrease in comparison with the 1990 map, with a loss of 584 ha of meadows. Higher losses are related to the disappearance of *N. noltii* (ca. 88 % of the total loss). This phenomenon is probably due to the direct uprooting by fishermen and works to reinforce tidal-lands and their consequent environmental effects, such as water turbidity, bottom grain-size changes, etc. (Sfriso and Facca 2007).

The main angiosperm increase was recorded in the central lagoon where *Zostera marina* spread over 747 ha. A similar trend was observed for *N. noltii* and *C. nodosa* which increased of ca. 88 and 60 ha, respectively.

The changes in the distribution of the three species in the southern lagoon (net loss ca. 237 ha) were less remarkable than those observed in the central lagoon. *N. noltii* showed a loss of 727 ha for pure stands and of 2253 ha for mixed populations (total loss ca. 2980 ha). A decrease of 924 ha concerned *Z. marina.*

Tab. 7 - Comparison between 1990 and 2002 seagrass coverage.

Species		1990	2002	Difference
		ha		
Pure beds	*Cymodocea nodosa*	391	1777	1386
	Zostera marina	266	2195	1929
	Nanozostera noltii	1436	70	-1366
Mixed beds	*Z. marina - C.nodosa*	692	825	133
	N. noltii - C. nodosa	23	141	118
	N.noltii - Z. marina	2157	220	-1937
	N. noltii - Z. marina - C. nodosa	528	203	-325
Total		5493	5431	-62
Total	*Cymodocea nodosa*	1634	2946	1312
	Zostera marina	3643	3443	-200
	Nanozostera noltii	4144	634	-3510

An overview of the literature on Mediterranean and European Atlantic sites points out that the *N. noltii* decrease in salt marsh environments can be explained by both the increased turbidity due to erosion phenomena and the desiccation stress during summer low tide events (Sfriso and Ghetti 1998, Brun et al. 2003). However, Hamminga and Duarte (2000) found that angiosperms may counteract turbidity to a high extent, by optimizing their light absorption capacity. Therefore, it is possible that physical phenomena (direct uprooting, erosion, sediment grain-size changes) are the main responsible factors for *N. noltii* reduction in the Venice Lagoon. Referring to *Z. marina*, Frederiksen et al. (2004) simply suggest that even wide changes of coverage distribution in shallow water populations are equivocal and seem more stochastic.

Ruppia cirrhosa and *Ruppia maritima* also show a patchy pattern in the Venice Lagoon, especially in some fishing ponds along the mainland border (Tagliapietra et al. 1998). Samples of *R. maritima* were recorded in 2004 and 2006 in some tidal lands near the Dese river outfall and Torcello islands. Plants were 20-25 cm high and presented female and male inflorescences on short stalks and some characteristic asymmetric fruits (Sfriso 2008a).

4.2 Dispersion strategies

Zostera marina and *N. noltii* spread in the lagoon mainly by sexual reproduction, whereas *C. nodosa* beds increase almost exclusively by vegetative propagation (Caniglia et al. 1992). Seed dispersion by currents favours both *Z. marina* and *N. noltii* rooting in new sites. *Nanozostera noltii* produces inflorescences from the end of May until October; it spreads especially in slightly colonized areas or in conditions of environmental stress, such as tidal pools, where temperature and salinity are highly changeable. Conversely, *Z. marina* produces inflorescences from (late February) April to June (Rismondo et al. 1995, Sfriso and Ghetti 1998), colonizes deeper sites and only rarely emerges. It keeps leaf canopy all over the year with leaf production even in winter.

The starting of *Z. marina* flowering appears to be well in advance (February-March) in comparison with some Atlantic European sites, where sexual reproduction starts from June onwards (Jacobs and Pierson 1981).

The high number of reproductive shoots (up to 15% of total shoots) (Sfriso and Ghetti 1998), together with data concerning biomass, density and production, indicate that leaf and rhizome growth occurs constantly during all the seasons, and suggest that *Z. marina* is perennial in the Venice Lagoon (Jacobs 1982, Phillips et al. 1983, Rismondo et al. 1995).

In contrast, in the Venice Lagoon, *C. nodosa* spreads mainly by rhizome growth and rhizome fragment dissemination whereas sexual reproduction has been observed to occur very rarely and only at the margins of the colonized areas (Bellato et al. 1995). Male and female flowers of *C. nodosa* have been rarely found (Curiel et al. 1999) and only seeds have been recorded (Rismondo et al. 1997b, Sfriso et al. 2004a).

The importance of the below-ground compartment (rhizomes and roots) of *C. nodosa* and the high biomass recorded in the Venice Lagoon was already pointed out (Curiel et al. 1994c, Rismondo et al. 1997b, Sfriso and Ghetti 1998, Sfriso et al. 2004a). Comparisons between 1990 and 2002 and further observations recently carried out indicate a high adaptive capacity of *Cymodocea nodosa* which let it to recover after stress events such as oxygen depletion, erosion of the canal edges or uprooting by clam-harvesting. This adaptive capacity has to be taken into consideration together with its marked seasonality which is much higher in the lagoon than in other Mediterranean localities, as indicated by the strong seasonal biomass variations (Caniglia 1992, Scarton et al. 1995, Sfriso and Ghetti 1998; Sfriso et al. 2004a). Dense and wide summer beds almost disappear in winter but start growing again in May-June. Both low depth and the variability of the lagoon morphology furtherly accentuate this marked seasonality, which is affected by periods of strong water heating in summer (up to 27-30°C), rapid cooling (down to 6-7°C) and wave motion due to winter-spring winds (Rismondo et al. 1997b). Changes of biomass (Tab. 8) shoot number and length (Tab. 9) exhibit a typical temperate region pattern, based on seasonal changes of both temperature and irradiance. The well developed below-ground apparatus of *C. nodosa* populations and their high growth rates (Tab. 10) make this species tolerant to the strong physical and hydro-morphological variations and the species more suitable to contrast sediment compactness and erosive phenomena.

4.3 Growth and production of **Z. marina***,* **C. nodosa** *and* **N. noltii**

Although before the '70s submerged angiosperms were the main primary producers of the lagoon, no information on their distribution and production in the whole lagoon is available till Caniglia et al. (1992) and Sfriso and Ghetti (1998), respectively. Similarly, the first studies on the morphometric parameters of the three species which colonise the lagoon and their reproductive phenology date back to Sfriso and Marcomini (1997, 1999a), Rismondo et al. (1997a), Sfriso and Ghetti (1998), whereas the first primary production measurements, carried out in selected areas of the lagoon over one year, are by Sfriso and Marcomini (1997) Sfriso and Ghetti (1998), Sfriso (2000), Zharova et al. (2001) for *Z. marina*; Rismondo et al. (1997b) and Sfriso et al. (2004a) for *C. nodosa* and Sfriso (2007b), Sfriso et al. (2008) for *N. noltii*.

Tab. 8 - Seagrass biomass ranges (Sfriso and Ghetti 1998, Sfriso 1999, Sfriso 2000b, Sfriso et al. 2004, Sfriso et al. 2008).

Station	**Species**	**Biomass (kg fwt m^{-2} y^{-1})**					
		shoots	**rhizomes-roots**	**dead parts**	**total**		
		mean				**total**	
						max	**min**
Petta di Bò	*Z. marina*	1.42	0.65	1.0	3.07	6.28 (Jun)	1.92 (Dec)
	N. noltii	1.05	0.65	0.89	2.59	5.4 (Aug)	1.15 (Jan)
	C. nodosa	1.81	1.74	0.44	3.99	7.6 (Aug)	1.98 (Mar)
S. Maria del Mare	*C. nodosa*	1.08	1.66	0.31	3.05	4.99 (Jul)	1.47 (Dec)
Alberoni	*Z. marina*	0.81	0.42	0.5	1.74	3.57 (May)	0.95 (Dec)
S. Nicolò	*C. nodosa*	1.26	1.45	0.31	3.01	5.27 (Aug)	1.96 (Apr)
Lido watershed	*N. noltii*	0.22	0.22	0.20	0.64	1.15 (Jan)	0.20 (Dec)
Petta di Bò		0.57	0.80	0.49	1.86	2.94 (Sep)	1.01 (Nov)

		% DWT/FWT			
		shoots	**rhizomes-roots**	**dead parts**	**total**
		monthly mean			
Petta di Bò	*Z. marina*	14.8	13.3	12.4	12.85
	N. noltii	15.7	14.7	12.4	13.6
	C. nodosa	17.6	19.5	15.5	17.5
S. Maria del Mare	*C. nodosa*	17.8	19.8	12.9	16.4
Alberoni	*Z. marina*	14.6	13.9	11.0	12.5
S. Nicolò	*C. nodosa*	21.5	17.5	14.8	16.2
Lido watershed	*N. noltii*	15.3	13.2	12.3	12.75
Petta di Bò		15.5	13.5	12.6	13.1

Zostera marina was the first species studied from both the growth and biomass production point of view (Tabs 8-10). The above and below-ground biomass, shoot density, shoot length, leaf number, leaf area, the relative growth rate (%RGR) and shoot and rhizome-root daily, monthly and annual increase have been studied in relation with the nutrient availability in the water column, surface sediments, SPM and the internal quota variations, with a monthly or biweekly sampling frequency. Studies were performed in an area of the southern lagoon (Petta di Bò) from February 1994 to February 1995 (Sfriso and Marcomini 1997, Sfriso and Ghetti 1998) and in an area of the central lagoon (Alberoni) close to Malamocco inlet (Sfriso 2000) from July 1998 to July 1999. On average, at

Petta di Bò, the *Z. marina* biomass was 3.1±1.3 kg fwt m^{-2}, with the highest biomass (6.3 kg fwt m^{-2}) in June whereas the number of shoot m^{-2} was 618±213 with a peak of 1093. The mean shoot and rhizome increases were 3.6±1.2 and 0.16±0.07 cm d^{-1}, respectively (maxima: 5.7 and 0.28 cm d^{-1}). The %RGR ranged from 1.1% to 4.5% d^{-1} with a mean value of 1.87% d^{-1}. The total net primary production (NPP) was ca. 20.9 kg fwt m^{-2} y^{-1}, accounting for a total carbon production of 1093 g C m^{-2} y^{-1} with a peak of 5.6 g C m^{-2} d^{-1} in June (Tab. 10). The P/B ratio of that species was 3.3. At Alberoni the biomass was lower and production was not measured.

Tab. 9 - Seagrass morphometric parameters (Sfriso and Ghetti 1998, Sfriso 1999, Sfriso 2000b, Sfriso et al. 2004, Sfriso et al. 2008).

Station	Species	Shoot height (cm)			Shoots m^{-2}		
		Monthly mean		Yearly	Monthly mean		Yearly
		max	min	mean	max	min	mean
Petta di Bò	*Z. marina*	63 (Apr)	32 (Sep-Dec)	43	1093 (Jun)	393 (Mar)	618
	N. noltii	47,5 (Aug)	8,4 (Apr)	23,7	14617 (May)	2030 (Jan)	7135
	C. nodosa	60,1 (Aug)	11,1 (Jan)	25,4	3377 (July)	1650 (Feb)	2144
S. Maria del Mare	*C. nodosa*	56 (Sep)	9,8 (Dec)	23,2	3333 (Jul)	1213 (Mar)	1953
Alberoni	*Z. marina*	45,2 (Apr)	21,5 (Sep)	30,9	592 (Aug)	220 (Dec)	346
S. Nicolò	*C. nodosa*	98,4 (Aug)	13,8 (Apr)	45,4	1860 (Jun)	640 (Dec)	1080
Lido watershed	*N. noltii*	22,3 (Sep)	10,3 (Dec)	16,9	4821 (May)	533 (Dec)	2447
Petta di Bò		26,1 (Aug)	14,9 (Apr)	20,3	5675 (May)	2293 (Jan)	3655

Station	Species	Leaves $shoot^{-2}$		
		Monthly mean		Yearly
		max	min	mean
Petta di Bò	*Z. marina*	6,9 (Apr)	2,8 (Dec)	4,0
	N. noltii	3,3 (Aug)	0,9 (Dec)	2,2
	C. nodosa	3,8 (Jul)	1 (Jan)	2,1
S. Maria del Mare	*C. nodosa*	3,9 (Jan)	1,2 (Nov)	2,0
Alberoni	*Z. marina*	2101 (Apr)	656 (Jan)	3,9
S. Nicolò	*C. nodosa*	3,6 (Aug)	1,1 (Feb-Mar)	2,2
Lido watershed	*N. noltii*	2,92 (Aug)	1,49 (Dec)	2,2
Petta di Bò		3,09 (May)	1,97 (Feb)	2,6

Studies on the phenology and growth of *C. nodosa* were carried out by Rismondo et al. (1997b) in an area near the Ottagono S. Pietro close the Malamocco inlet and by Sfriso and Marcomini (1997) at Petta di Bò. Measurements of NPP were carried out from June 2000 to May 2001 in a shallow population at Santa Maria del Mare (SMM) near Malamocco inlet and from July 2001 to June 2002 in a deeper population at San Nicolò (SN) near Lido inlet (Sfriso et al. 2004). The mean *C. nodosa* biomass was 3.0±1.1 kg fwt m^{-2} both at SMM and SG but it peaked to ca. 5.0 kg fwt m^{-2} at SMM in September and to ca. 5.3 kg fwt m^{-2} at SN in August (Tab. 8). The mean number of shoots m^{-2} ranged from 1953±673 at SMM to 1082±343 at SN. Peak shoot numbers were 3333 and 1860, respectively (Tab. 9). The mean shoot increase ranged from 1.28±1.61 cm d^{-1} at SMM to 1.95±2.86 cm d^{-1} at SN with peaks of ca. 4.8 and 7.9 cm d^{-1}. The total NPP ranged from ca. 16.0±3.1 to 13.7±1.6 kg fwt m^{-2} y^{-1} at SMM and SN, respectively, accounting for a total carbon production of ca. 1289 and 1147 g C m^{-2} y^{-1} and production peaks of ca. 11.0 and 17.9 g C m^{-2} d^{-1} in August and July, respectively (Tab. 10). The P/B ratio was 3.93 at SMM and 2.90 at SN.

Between January 2005 and January 2006, *N. noltii* was studied on a monthly and annual basis in a natural population at Petta di Bò where the species phenology had been also recorded in 1994-95, and in a population transplanted in a purpose-built sandy bar placed in the Lido watershed to avoid stagnant waters and Ulvaceae growth. Unfortunately, the *N. noltii* population in the sandy substratum decreased rapidly, because sand is not suitable for the growth of that species, and the production measurements were possible only at Petta di Bò. However, the mean annual biomass in the two stations was 1.86±0.48 kg fwt m^{-2} at Petta di Bò and 0.64±0.33 kg fwt m^{-2} at Lido with peaks of 2.9 and 1.2 kg fwt m^{-2}, respectively. The number of shoots at Petta di Bò was the highest with a mean of 3655±944 and a peak of 5675 in May (Tab. 9). That value was much lower than the one measured in the same area in May 1994 (14617 shoots m^{-2}). The mean shoot increase was 0.79±0.49 cm d^{-1} with a peak of 1.61 cm d^{-1} in July. The total production was 5.7 kg fwt m^{-2} y^{-1}, accounting for ca. 245 g C m^{-2} y^{-1} (Tab. 10). The highest NPP occurred in September with 1.4 g C m^{-2} d^{-1}. The P/B ratio was 1.91.

The knowledge of the annual growth of the three species, their distribution and standing crop and the P/B ratios allowed the estimation of the net angiosperm production (NPP) in the whole lagoon. Results show that *C. nodosa* was the most productive marine macrophyte of the lagoon with ca. 25431 C tonnes (44% of the total macrophyte NPP) in 2003. In the same year, the production of *Z. marina* was ca. 13180 C tonnes (23% of the total macrophyte NPP) whereas *N. noltii* with 1133 C tonnes contributed with 2% only. The remaining NPP, accounting for ca. 18031 C tonnes (31% of the total macrophyte NPP), was due to macroalgae (Sfriso 2007b).

Conclusions

The Venice Lagoon is a polymorphous environment affected by several anthropic pressures and very different trophic and contamination levels that allow the presence of an extraordinary variety of habitats. The lagoon exhibits areas with hyperaline, mesoaline or hypoaline conditions, but also areas affected by river outfalls, urban sewage, agricultural drainage, industrial effluents, harbour activities, clam-harvesting, clam and fish-farming and areas flooded by seawaters during high tide. That environmental variety, which includes wide shallow areas, but also deep canals and port-entrances, accounts for the presence of both rich angiosperm and macroalgal assemblages which can predominate depending on the different ecological conditions. As a consequence, in the lagoon the flora is richer than in any other transitional area of the Mediterranean Sea and, as reported by literature (ca. 242 papers, where one or more macrophytes are reported), its biodiversity continuously changes. At present, eutrophication and its environmental effects are decreasing just like the huge biomasses of nitrophilic macroalgae observed between the ’70s and the ‘80s. Concurrently, the number of taxa of the local flora is increasing. That is due not only to the recovery of the lagoon environment and to the ability of the researchers to identify all the taxa but also to the high number of new taxa and NIS that, year by year, are added to the local check-list, even though a conspicuous number of species characteristic of high quality environments have disappeared.

Tab. 10 - Net Primary Production (NPP) (Sfriso and Ghetti 1998, Sfriso 1999, Sfriso 2000b, Sfriso et al. 2004, Sfriso et al. 2008).

Station	Species	kg fwt m^{-2}		
		shoots	**rhizomes-roots**	**total**
Lido	*U. rigida*	-	-	12,6
Sacca Sessola	*U. rigida*	-	-	19,6
Petta di Bò	*Z. marina*	15,0	5,9	20,9
S. Maria del Mare	*C. nodosa*	16,0	3,1	19,1
S. Nicolò	*C. nodosa*	13,7	1,6	15,3
Petta di Bò	*N. noltii*	4,0	1,7	5,7

Station	Species	g C m^{-2} y^{-1}			g C m^{-2} d^{-1}	P/B
		shoots	**rhizomes-roots**	**total**	**max**	
Lido	*U. rigida*	-	-	646	30,5 (April)	1,59
Sacca Sessola	*U. rigida*	-	-	625	34,2 (May)	1,55
Petta di Bò	*Z. marina*	835	258	1093	5,6 (May)	3,30
S. Maria del Mare	*C. nodosa*	1061	228	1289	10,97 (Aug)	3,93
S. Nicolò	*C. nodosa*	1044	103	1147	17,9 (Jul)	2,90
Petta di Bò	*N. noltii*	181	64	245	1,2 (Sep)	1,91

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Tab. 1- List of macrofitobenthos taxa recorded in the Venice lagoon. m = male gametophyte, f = female gametophyte, s = sporophyte, p = propagules, e = epiphyte, a = attached, u = unattached. New for Venice. First record (*). New of extramediterranean origin. First record (**). i = invasive, ni = non-invasive.

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
RHODOPHYTA										
Acrochaetium humile (Rosenvinge) Børgesen*					+				ni	96, 98*, 190
Acrochaetium microscopicum (Nägeli *ex* Kützing) Nägeli					+					42, 59, 67, 95, 113, 114, 157, 171, 186, 190, 204, 208, 231
Acrochaetium savianum (Meneghini) Nägeli					+					42, 59, 67, 79, 95, 113, 157, 171, 186, 190, 204, 208
Acrochaetium secundatum (Lyngbye) Nägeli					+					42, 82, 95, 113, 114, 190
Acrochaetium virgatulum (Harvey) Batters			+		+					39, 40, 95, 96, 114, 171, 186, 190, 204, 208, 231
Acrosorium ciliolatum (Harvey) Kylin						+				43, 52, 95, 96, 186, 190, 198, 204, 208, 224, 225, 232
Agardhiella subulata (C. Agardh) Kraft *et* M.J. Wynne*		+	+			+			ni	59, 61*, 67, 115, 171, 186, 190, 204, 208
Aglaothamnion caudatum (J. Agardh) Feldmann-Mazoyer*					+				ni	190, 198*, 204, 206, 208
Aglaothamnion feldmanniae Halos*			+		+	+			ni	58*, 103, 171, 186, 190, 204, 208
Aglaothamnion tenuissimum (Bonnemaison) Feldmann-Mazoyer	+	+	+		+	+				27, 42, 95, 96, 99, 133, 157, 186, 190, 204, 231
Aglaothamnion tenuissimum (Bonnemaison) Feldmann-Mazoyer var. *mazoyerae* G. Furnari, L'Hardy-Halos, Rueness *et* Serio	+	+	+		+	+				25, 79, 95, 113, 190, 198, 208, 223, 232
Aglaothamnion tripinnatum (C. Agardh) Feldmann-Mazoyer*					+	+			ni	62*, 190
Alsidium corallinum C. Agardh			+	+		+				79, 82, 95, 186, 190, 204, 205, 206, 208
Anotrichium furcellatum (J. Agardh) Baldock*			+		+	+			ni	42, 59, 65, 67, 102, 186, 190, 198*, 204, 205, 206, 208
Anothrichium tenue (C. Agardh) Nägeli						+				75, 79, 82, 122, 157
Antithamnion cruciatum (C. Agardh) Nägeli			+		+	+				22, 25, 27, 35, 37, 39, 40, 42, 51, 53, 55, 57, 59, 67, 79, 95, 96, 108, 113, 114, 123, 133, 135, 157, 159, 171, 180, 186, 190, 198, 204, 208, 211, 224, 225, 231

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Antithamnion nipponicum Yamada et Inagaki**	+		+		+	+		i	i	7, 8, 19, 21, 22**, 25, 27, 35, 37, 38, 39, 40, 42, 51, 53, 54, 55, 57, 58, 59, 60 ,64, 65, 67, 95, 96, 98, 102, 103, 113, 114, 123, 171, 181, 186, 190, 198, 204, 208,
Antithamnionella elegans (Berthold) J.H. Price *et* D.M. John*					+	+			ni	95, 96, 159*, 190, 205, 206,
Antithamnionella spirographidis (Schiffner) E.M. Wollaston	+	+			+	+				8, 21, 22, 25, 27, 35, 37, 38, 39, 40, 53, 55, 95, 96, 114, 171, 186, 190, 198, 204, 208
Bangia fuscopurpurea (Dillwyn) Lyngbye		+			+	+				25, 26, 27, 31, 32, 35, 37, 38, 39, 40, 42, 43, 52, 53, 55, 59, 64, 65, 67, 73, 79, 82, 95, 96, 108, 113, 114, 133, 135, 159, 180, 186, 190, 198, 204, 208, 211, 223, 224, 225, 231
Boergeseniella fruticolosa (Wulfen) Kylin					+	+				1, 79, 122, 126
Bonnemaisonia hamifera Hariot*					+	+			ni	8, 21*, 27, 35, 53, 55, 95, 96, 190
Bostrychia scorpioides (Hudson) Montagne					+	+				59, 67, 95, 105, 157, 190, 231
Callithamnion corymbosum (J.E. Smith) Lyngbye	+	+	+		+	+				26, 31, 35, 37, 39, 40, 42, 43, 53, 55, 59, 75, 79, 82, 95, 96, 102, 113, 114, 133, 135, 157, 159, 171, 186, 190, 198, 204, 208, 223, 224, 225, 231, 233
Callithamnion tetragonum (Withering) S.F. Gray*		+				+			ni	95, 96, 159*, 186, 190, 198, 204, 208
Catenella caespitosa (Withering) L.M. Irvine						+				79, 95, 96, 157, 186, 190, 204, 208, 231, 232
Caulacanthus ustulatus (Turner) Kützing			+			+				59, 67, 95, 96, 171, 186, 190, 198, 204, 208, 223
Centroceras clavulatum (C. Agardh) Montagne*						+			ni	59, 67, 170, 171, 186, 190, 198*, 204, 205, 206, 208
Ceramium ciliatum (J. Ellis) Ducluzeau var. *ciliatum*		+	+		+	+				27, 35, 37, 39, 40, 42, 53, 55, 59, 67, 75, 79, 82, 95, 96, 108, 133, 135, 157, 159, 160, 180, 186, 190, 198, 204, 205, 206, 208, 211, 223, 224, 231
Ceramium ciliatum (J. Ellis) Ducluzeau var. *robustum* (J. Agardh) Feldmann-Mazoyer		+	+		+	+				8, 21, 27, 95, 96, 99, 133, 159, 171, 186, 190, 198, 204, 205, 206, 208, 223, 224
Ceramium cimbricum H.E. Petersen			+		+					79, 82, 171, 205, 206, 208, 223
Ceramium circinatum (Kützing) J. Agardh					+	+				79, 82, 95, 157, 186, 190, 198, 204, 205, 206, 208, 231
Ceramium codii (H. Richards) Feldmann-Mazoyer*					+				ni	186*, 190, 204, 205, 206, 208

Taxa	Reproductive phenology				Settlement status			New for		References
								Medit.	Venice	
	m	f	s	p	e	a	u	i/ni	i/ni	
Ceramium deslongchampsii Chauvin ex Duby		+	+		+	+				82, 95, 96, 133, 135, 157, 159, 171, 186, 190, 198, 204, 205, 206, 208, 223, 224, 225, 231
Ceramium diaphanum (Lightfoot) Roth					+	+				25, 26, 27, 31, 34, 35, 37, 39, 40, 42, 43, 52, 53, 55, 57, 59, 64, 65, 67, 79, 82, 95, 96, 113, 115, 123, 126, 190, 205, 206, 224, 225, 231
Ceramium siliquosum (Kützing) Maggs *et* Hommersand var. *siliquosum*		+	+		+	+				95, 96, 99, 133, 135, 157, 159, 171, 186, 190, 198, 204, 208, 224, 225, 231, 232
Ceramium siliquosum (Kützing) Maggs *et* Hommersand var.*elegans* (Roth) G. Furnari					+	+				75, 79, 82, 95, 96, 157, 159, 190, 231
Ceramium siliquosum (Kützing) Maggs *et* Hommersand var. *zostericola* (Feldmann-Mazoyer) G. Furnari			+		+					95, 96, 171, 186, 190, 198, 204, 208, 224
Ceramium tenerrimum (G. Martens) Okamura					+					95, 96, 159, 186, 190, 204, 205, 206, 208, 224, 225
Ceramium virgatum Roth		+	+		+	+				25, 27, 35, 37, 39, 40, 42, 43, 52, 53, 55, 57, 59, 64, 65, 67, 79, 82, 95, 96, 102, 113, 114, 158, 159, 171, 182, 185, 186, 190, 196, 198, 204, 208, 212, 213, 214, 223, 224, 225, 234
Chondrachantus acicularis (Roth) Fredericq			+			+				27, 30, 35, 39, 40, 51, 53, 55, 79, 95, 96, 102, 133, 157, 159, 186, 190, 198, 204, 205, 206, 208, 223, 224, 225, 231
Chondrachantus teedei (Roth) Kützing						+				79, 95, 96, 133, 135, 186, 190, 198, 204, 205, 206, 208
Chondria capillaris (Hudson) M.J. Wynne	+	+	+	+	+	+				26, 27, 29, 31, 32, 34, 35, 42, 46, 53, 55, 59, 64, 65, 67, 75, 79, 82, 95, 96, 133, 137, 157, 171, 186, 190, 198, 204, 208, 223, 224, 231, 232
Chondria coerulescens (J. Agardh) Falkenberg			+	+		+				8, 21, 27, 35, 53, 55, 95, 96, 102, 186, 190, 198, 204, 205, 206, 208
Chondria dasyphylla (Woodward) C. Agardh			+	+		+				27, 31, 35, 42, 53, 55, 59, 67, 75, 79, 95, 96, 113, 133, 157, 159, 186, 190, 198, 204, 205, 206, 208, 223, 224, 231, 232
Chylocladia verticillata (Lightfoot) Bliding		+	+			+				79, 82, 95, 96, 133, 135, 157, 159, 171, 186, 190, 204, 205, 206, 208, 231, 232
Colaconema daviesii (Dillwyn) Stegenga			+		+					8, 27, 42, 53, 55, 59, 67, 96, 98, 113, 171, 186, 190, 204, 208
Colaconema garberyi P.W. Gabrielson**					+			ni	ni	198**, 190

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Compsothamnion thuyoides (J.E. Smith) Nägeli					+					3 ,27, 35, 53, 55, 75, 79, 82, 95, 96, 157, 190, 231
Corallina elongata J. Ellis *et* Solander			+			+				27, 95, 96, 101, 108, 114, 133, 135, 157, 159, 171, 180, 186, 190, 198, 204, 205, 206, 208, 211, 231
Corallina officinalis Linnaeus			+			+				22, 27, 30, 35, 39, 40, 51, 53, 55, 79, 82, 95, 96, 102, 159, 186, 190, 198, 204, 205, 206, 208, 223, 224
Cruoria cruoriaeformis (P. et H. Crouan) Denizot*			+		+				ni	170, 171, 186*, 190, 204, 208
Cryptonemia lomation (A. Bertoloni) J. Agardh *			+			+			ni	8, 21*, 27, 35, 53, 55, 95, 96, 186, 190, 198, 204, 205, 206, 208
Dasya baillouviana (S. G. Gmelin) Montagne	+	+	+			+				37, 43, 59, 65, 67, 79, 95, 96, 108, 129, 133, 157, 159, 171, 180, 186, 190, 198, 204, 208, 211, 223, 224, 231
Dasya corymbifera J. Agardh						+				27, 35, 53, 55, 82, 95, 96, 133, 190
Dasya hutchinsiae Harvey						+				27, 35, 42, 53, 55, 59, 67, 79, 82, 95, 96, 102, 113, 133, 135, 186, 190
Dasya ocellata (Grateloup) Harvey					+	+				27, 133
Dasya punicea (Zanardini) Meneghini *ex* Zanardini			+			+				75, 79, 82, 95, 96, 133, 157, 171, 186, 190, 198, 204, 205, 206, 208, 223, 231
Dasya rigidula (Kützing) Ardissone						+				22, 95, 96, 99, 190
Dipterosiphonia rigens (C. Agardh) Falkenberg						+				61, 67, 79, 115, 190
Dohrniella neapolitana Funk*						+			ni	95, 96, 159*, 190 206
Erythrocladia irregularis Rosenvinge					+					25, 27, 35, 37, 38, 39, 40, 42, 53, 55, 59, 64, 65, 67, 95, 96, 98, 113, 114, 171, 186, 190, 198, 204, 208
Erythropeltis discigera (Berthold) F. Schmitz					+					95, 96, 133, 157, 171, 190, 208, 224, 231
Erythrotrichia bertholdii Batters*					+				ni	171*, 208
Erythrotrichia carnea (Dillwyn) J. Agardh			+		+					27, 35, 37, 39, 40, 53, 55, 95, 96, 114, 133, 157, 159, 171, 186, 190, 198, 204, 208, 231
Erythrotrichia investiens (Zanardini) Bornet			+		+					73, 82, 133, 157, 171, 208, 231
Gastroclonium clavatum (Roth) Ardissone						+				27, 39, 40, 53, 55, 74, 95, 96, 157, 190, 231
Gastroclonium reflexum (Chauvin) Kützing		+	+			+				27, 35, 53, 55, 79, 95, 96, 157, 186, 190, 204, 205, 206, 208

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Gayliella flaccida (Harvey *ex* Kützing) T.O. Cho *et* L. McIvor					+	+				8, 21, 79, 82, 95, 186, 190, 198, 204, 205, 206, 208
Gelidium crinale (Turner) Gaillon						+				95, 96, 133, 135, 157, 159, 186, 190, 198, 204, 205, 206, 208, 223, 231
Gelidium pusillum (Stackhouse) Le Jolis			+			+				25, 27, 35, 37, 39, 40, 42, 53, 55, 59, 67, 95, 96, 113, 114, 133, 157, 159, 171, 186, 190, 198, 204, 208, 231
Gelidium spathulatum (Kützing) Bornet			+			+				25, 95, 96, 108, 114, 133, 135, 157, 159, 171, 180, 186, 190, 198, 204, 208, 211, 231
Gracilaria armata (C. Agardh) Greville	+		+			+				43, 59, 67, 82, 89, 95, 96, 133, 157, 159, 186, 190, 193, 198, 204, 208, 216, 224, 231
Gracilaria bursa-pastoris (S.G. Gmelin) P.C. Silva			+			+	+			27, 35, 54, 55, 59, 67, 85, 95, 96, 108, 125, 171, 186, 190, 193, 198, 204, 208
Gracilaria cfr. *compressa* (C. Agardh) Greville	+	+	+			+				133, 157, 159, 208, 223, 231
Gracilaria dura (C. Agardh) J. Agardh						+	+			82, 95, 96, 125, 159, 182, 186, 190, 193, 204, 208, 223, 234
Gracilaria longa Gargiulo, De Masi *et* Tripodi		+	+			+	+			95, 96, 98, 101, 102, 107, 108, 110, 125, 129, 131, 145, 158, 159, 161, 168, 171, 180, 182, 185, 186, 190, 193, 194, 196, 198, 199, 204, 208, 211, 212, 213, 214, 218, 223
Gracilaria gracilis (Stackhouse) M. Steentoft, L.M. Irvine *et* W.F. Farnham		+	+		+	+	+			12, 107, 108, 110, 132, 159, 161, 168, 171, 180, 182, 185, 186, 190, 193, 194, 196, 198, 204, 208, 211, 212, 213, 214, 218, 223
Gracilaria sp.		+	+		+	+			ni	175*, 208
Gracilariopsis longissima (S.G. Gmelin) M. Steentoft, L.M. Irvine *et* W.F. Farnham		+	+			+	+			25, 27, 28, 29, 30, 31, 34, 35, 37, 39, 40, 42, 43, 45, 46, 51, 52, 53, 55, 59, 61, 63, 66, 67, 95, 96, 113, 114, 115, 123, 126, 133, 140, 147, 157, 168, 171, 190, 196, 204, 208, 223, 224, 225, 231, 232
Grateloupia cosentinii Kützing*						+			ni	95, 96, 159*, 190
Grateloupia dichotoma J. Agardh*			+			+			ni	27, 53*, 55, 95, 96, 186, 190, 204, 205, 206, 208, 224
Grateloupia filicina (J.V. Lamouroux) C. Agardh		+	+			+				25, 26, 27, 35, 39, 40, 42, 53, 55, 59, 67, 79, 82, 95, 96, 99, 101, 102, 108, 113, 114, 133, 135, 157, 159, 180, 186, 190, 198, 204, 205, 206, 208, 211, 224, 232

Taxa	Reproductive phenology				Settlement status			New for		References
								Medit.	Venice	
	m	f	s	p	e	a	u	i/ni	i/ni	
Grateloupia turuturu Yamada**		+	+		+	+		i	i	7, 12, 19, 21, 22, 25, 27, 29, 30, 35, 39, 40, 42, 51, 53, 55, 95, 96, 97, 98, 102, 103, 113, 114, 125, 132, 158, 161, 171, 180, 181, 185, 186, 190, 196, 198, 204, 208, 224, 230**
Griffithsia schousboei Montagne*		+	+			+	+		ni	167, 171, 186, 190, 198*, 204, 205, 206, 208, 218
Gymnogongrus griffithsiae (Turner) Martius		+	+		+	+				25, 27, 35, 39, 40, 42, 53, 55, 59, 67, 79, 82, 95, 96, 108, 114, 133, 135, 157, 159, 171, 180, 186, 190, 198, 204, 208, 211, 223, 231, 232
Halarachnion ligulatum (Woodward) Kützing*		+			+	+			i	175*
Halymenia floresii (Clemente y Rubio) C. Agardh		+	+			+				27, 35, 53, 55, 79, 82, 95, 96, 101, 102, 108, 133, 134, 157, 159, 171, 180, 186, 190, 198, 204, 205, 206, 208, 211, 223, 231
Heterosiphonia japonica Yendo**			+			+		ni	ni	167, 186, 190, 198**, 204, 205, 206, 208
Hildenbrandia rubra (Sommerfelt) Meneghini			+		+					39, 40, 79, 82, 95, 96, 99, 114, 133, 159, 186, 190, 198, 204, 205, 206, 208, 232
Hydrolithon boreale (Foslie) Y.M. Chamberlain**					+				i	59, 62, 64, 65, 67, 113**, 190, 205, 208
Hydrolithon cruciatum (Bressan) Y.M. Chamberlain**		+			+			ni	ni	8**, 26, 64, 171, 186, 190, 205, 206, 208
Hydrolithon farinosum (J.V. Lamouroux) D. Penrose *et* Y.M. Chamberlain		+			+					22, 25, 27, 29, 31, 34, 35, 39, 40, 42, 53, 55, 59, 65, 67, 79, 95, 96, 99, 113, 114, 123, 133, 157, 159, 171, 186, 190, 198, 204, 208, 223, 224, 231
Hypnea musciformis (Wulfen) J.V. Lamouroux			+		+	+				82, 95, 96, 99, 133, 135, 157, 159, 186, 190, 198, 204, 205, 206, 208, 232
Hypnea spinella (C. Agardh) Kützing*			+			+	+		i	205, 206*, 208
Hypnea valentiae (Turner) Montagne*			+			+			ni	186, 190, 198*, 204, 206
Jania squamata (Linnaeus) J.H. Kim, Guiry *et* H.G. Choi*			+			+			ni	186*, 190, 204, 205, 206, 208
Laurencia obtusa (Hudson) J.V. Lamouroux			+							26, 59, 67, 79, 82, 95, 96, 99, 126, 133, 135, 157, 186, 190, 204, 205, 206, 208, 223, 231
Lithophyllum pustulatum (J.V. Lamouroux) Foslie			+		+					25, 26, 27, 34, 39, 40, 42, 53, 55, 59, 64, 65, 67, 79, 95, 96, 99, 113, 114, 157, 159, 171, 186, 190, 198, 204, 205, 206, 208, 224, 231

Taxa	Reproductive phenology				Settlement status			New for		References
								Medit.	Venice	
	m	f	s	p	e	a	u	i/ni	i/ni	
Lomentaria articulata (Hudson) Lyngbye*					+	+			ni	95, 96, 159*, 186, 190, 205, 206
Lomentaria chylocladiella Funk*					+	+			ni	8*, 27, 53, 55, 96, 190
Lomentaria clavaeformis Ercegović*						+			ni	8, 21*, 27, 39, 40, 53, 55, 95, 96, 190
Lomentaria clavellosa (Turner) Gaillon		+	+		+	+				27, 35, 39, 40, 43, 52, 53, 55, 79, 82, 95, 96, 99, 101, 102, 108, 133, 157, 159, 171, 180, 186, 190, 204, 208, 211, 223, 224, 231
Lomentaria clavellosa (Turner) Gaillon var. *conferta* (Meneghini) Feldmann*						+			ni	8*, 39, 40, 96, 186, 190
Lomentaria clavellosa (Turner) Gaillon f. *reducta* Ercegović*						+			ni	186, 190, 198*, 204, 208
Lomentaria ercegovicii Verlaque, Boudouresque, Meinesz, Giraud *et* Marcot-Coqueugniot*						+			ni	8*, 39, 40, 96, 186, 190, 198, 204, 205, 206, 208
Lomentaria hakodatensis Yendo*		+	+			+			i	19, 42*, 62, 123, 186, 190, 204, 205, 206, 208
Lomentaria uncinata Meneghini *ex* Zanardini		+	+		+	+				74, 79, 82, 95, 96, 99, 133, 157, 171, 186, 190, 198, 204, 208, 231, 232
Melobesia membranacea (Esper) J.V. Lamouroux					+					8, 25, 27, 39, 40, 42, 59, 67, 79, 96, 190, 205, 206
Monosporus pedicellatus (J.E. Smith) Solier					+					8, 27, 53, 55, 95, 96, 159, 190, 206
Nemalion helminthoides (Velley) Batters		+			+					79, 82, 95, 96, 133, 157, 186, 190, 198, 204, 205, 206, 208, 232
Neosiphonia elongella (Harvey) M.S. Kim *et* I.K. Lee	+	+	+		+	+				27, 38, 53, 55, 59, 67, 95, 96, 99, 102, 157, 171, 186, 190, 198, 204, 208, 224, 231
Neosiphonia harveyi (J.W. Bailey) M.S. Kim*	+	+	+		+	+			i	8*, 25, 27, 39, 40, 42, 58, 59, 64, 65, 67, 96, 103, 113, 114, 171, 186, 190, 204, 208
Nitophyllum punctatum (Stackhouse) Greville		+	+			+				27, 31, 35, 39, 40, 42, 43, 53, 55, 57, 59, 67, 82, 95, 96, 101, 102, 113, 157, 159, 186, 190, 198, 204, 205, 206, 208, 214, 224, 225, 232, 234
Osmundea truncata (Kützing) K.W. Nam et Maggs		+				+				79, 95, 96, 99, 126, 133, 157, 159, 186, 198, 204, 205, 206, 208, 223, 231, 232
Palisada papillosa (C. Agardh) K.W. Nam						+				27, 79, 95, 96, 126, 133, 135, 157, 161*, 181, 186, 190, 204, 205, 206, 208, 223, 231, 232
Palisada patentiramea (Montagne) Cassano, Sentíes, Gil-Rodriguez *et* M.T. Fujii*	+					+			ni	176*

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Peyssonnelia dubyi P. *et* H. Crouan*						+			ni	27, 31, 59, 67, 95, 96, 113, 205, 206, 224*
Phyllophora sicula (Kützing) Guiry *et* L.M. Irvine						+				95, 96, 99, 159, 186, 198, 204, 205, 206, 208
Phymatolithon lenormandii (Areschoug) W.H. Adey		+			+					47
Pleonosporium borreri (J.E. Smith) Nägeli					+	+				27, 53, 55, 79, 82, 95, 96, 99, 133, 157, 186, 198, 204, 205, 208, 223, 231
Pneophyllum fragile Kützing		+			+					26, 39, 40, 59, 64, 65, 67, 95, 96, 123, 157, 159, 171, 186, 198, 204, 205, 208
Polysiphonia arachnoidea (C. Agardh) Zanardini						+				75, 79, 82, 95, 96, 99, 136, 157, 159, 205, 224, 225, 231, 232
Polysiphonia breviarticulata (C. Agardh) Zanardini	+	+	+		+	+				27, 35, 37, 38, 39, 40, 53, 55, 75, 79, 82, 95, 96, 99, 108, 114, 133, 159, 171, 180, 186, 196, 198, 204, 205, 208, 211, 223, 224
Polysiphonia denudata (Dillwyn) Greville *ex* Harvey		+	+		+	+				25, 27, 32, 34, 35, 37, 38, 39, 40, 42, 53, 55, 59, 67, 75, 79, 82, 95, 96, 99, 113, 114, 133, 137, 157, 171, 186, 198, 204, 205, 208, 223, 224, 231, 232
Polysiphonia deusta (Roth) Sprengel*		+	+			+			ni	171, 186, 198*, 204, 205, 208
Polysiphonia elongata (Hudson) Sprengel		+	+			+				26, 27, 37, 39, 40, 42, 53, 55, 59, 65, 67, 75, 77, 79, 82, 95, 96, 114, 123, 157, 171, 186, 198, 204, 205, 208, 223, 231, 232
Polysiphonia fibrillosa (Dillwyn) Sprengel						+				34, 43, 52, 59, 65, 67, 79, 82, 95, 96, 186, 204, 205, 208, 224, 232, 234
Polysiphonia flexella (C. Agardh) J. Agardh*						+			ni	27, 59, 67, 115*
Polysiphonia flocculosa (C. Agardh) Endlicher*						+			ni	186, 198*, 204, 205, 206, 208
Polysiphonia fucoides (Hudson) Greville						+				95, 96, 126, 186, 204, 205, 206, 208, 223
Polysiphonia furcellata (C. Agardh) Harvey*	+		+			+			ni	8*, 39, 40, 96, 186, 204, 205, 208
Polysiphonia morrowii Harvey**		+	+		+	+		i	i	7, 19, 25, 39**, 42, 46, 56, 57, 58, 59, 67, 96, 102, 103, 113, 114, 123, 171, 186, 198, 204, 205, 208, 218

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Polysiphonia sanguinea (C. Agardh) Zanardini						+				43, 52, 75, 77, 79, 82, 95, 96, 99, 101, 108, 133, 135, 136, 157, 158, 159, 180, 185, 186, 196, 198, 204, 205, 208, 211, 213, 223, 224, 225, 231, 232, 235
Polysiphonia scopulorum Harvey*						+			ni	8*, 26, 27, 39, 40, 42, 59, 67, 113, 205
Polysiphonia sertularioides (Grateloup) J. Agardh			+		+	+				79, 82, 99, 133, 135, 157, 175, 223, 231
Polysiphonia spinosa (C. Agardh) J. Agardh						+				26, 34, 59, 67, 75, 79, 82, 95, 96, 99, 126, 133, 157, 205, 224, 231, 232
Polysiphonia stricta (Dillwyn) Greville		+	+		+	+				25, 39, 40, 79, 95, 96, 114, 205
Polysiphonia subulata (Ducluzeau) P. et H. Crouan						+				32, 37, 82, 95, 96, 137, 157, 205, 224, 231
Porphyra leucosticta Thuret	+	+			+	+				12, 25, 27, 38, 39, 40, 42, 43, 53, 54, 55, 59, 65, 67, 73, 79, 82, 95, 96, 99, 102, 106, 107, 108, 110, 113, 114, 127, 132, 133, 158, 159, 161, 171, 180, 185, 186, 193, 194, 196, 198, 199, 204, 205, 208, 211, 212, 213, 214, 223, 224, 225
Porphyra linearis Greville	+	+			+	+				39, 40, 95, 96, 99, 133, 171, 186, 198, 204, 205, 208, 231
Porphyridium purpureum (Bory) K.M. Drew *et* R. Ross**					+				ni	176**
Pterothamnion crispum (Ducluzeau) Nägeli			+		+	+				27, 35, 53, 55, 95, 96, 99, 157, 159, 186, 204, 205, 206, 208
Pterothamnion plumula (J. Ellis) Nägeli					+	+				27, 35, 53, 55, 75, 79, 82, 95, 96, 99, 101, 133, 157, 159, 186, 198, 204, 205, 206, 208, 223, 224, 231
Radicilingua reptans (Kylin) Papenfuss*			+		+	+			ni	7, 21*, 22, 27, 53, 55, 95, 96, 181, 186, 198, 204, 205, 206, 208
Radicilingua thysanorhizans (Holmes) Papenfuss*	+		+		+	+			i	8, 22, 27, 29, 30, 31*, 35, 39, 40, 42, 53, 55, 59, 65, 67, 95, 96, 98, 171, 181, 186, 198, 204, 205, 208
Rhodophyllis divaricata (Stackhouse) Papenfuss						+				27, 35, 39, 40, 42, 53, 55, 59, 67, 79, 82, 95, 96, 99, 133, 157, 159, 171, 186, 198, 204, 205, 208, 223, 224, 231, 232,
Rhodymenia ardissonei Feldmann		+			+	+				25, 27, 35, 37, 39, 40, 42, 46, 51, 53, 54, 55, 57, 59, 67, 95, 96, 99, 101, 102, 108, 113, 114, 133, 135, 157, 159, 171, 180, 186, 198, 204, 205, 208, 211, 218, 231

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Rhodymenia ligulata Zanardini						+				79, 95, 96, 133, 159, 171, 186, 204, 205, 208, 232
Rhodymenia pseudopalmata (J.V. Lamouroux) P.C. Silva						+				22, 27, 79, 82, 95, 96, 157, 205, 224, 231
Rytiphlaea tinctoria (Clemente) C. Agardh						+				75, 79, 95, 186, 198, 204, 205, 206, 208, 224, 232
Sahlingia subintegra (Rosenvinge) Kornmann			+		+					59, 65, 67, 95, 99, 157, 171, 186, 198, 204, 205, 208, 231
Seirospora apiculata (Meneghini) Feldmann-Mazoyer					+					59, 67, 82, 95, 105, 205
Seirospora sphaerospora Feldmann*					+				ni	95, 96, 205, 224*
Solieria filiformis (Kützing) P.W. Gabrielson*		+				+			i	61*, 205
Spermothamnion flabellatum Bornet*					+	+			ni	55*, 205
Spermothamnion repens (Dillwyn) Rosenvinge		+			+	+				26, 27, 35, 39, 40, 53, 55, 59, 67, 79, 82, 95, 96, 99, 113, 133, 157, 159, 186, 204, 205, 208, 231
Spermothamnion strictum (C. Agardh) Ardissone					+	+				8, 21, 25, 27, 35, 39, 40, 53, 95, 96, 205
Spyridia filamentosa (Wulfen) Harvey			s		+	+				26, 29, 31, 34, 46, 59, 65, 67, 79, 82, 95, 96, 99, 126, 133, 157, 171, 186, 198, 204, 205, 208, 223, 224, 231, 232
Spyridia hypnoides (Bory) Papenfuss *					+				ni	95, 96, 159*, 182, 205, 206
Stylonema alsidii (Zanardini) K.M. Drew			+		+					26, 27, 31, 37, 38, 39, 40, 42, 53, 55, 59, 65, 67, 79, 95, 96, 98, 99, 113, 114, 157, 171, 186, 198, 204, 205, 208, 224, 231
Stylonema cornu-cervi Reinsch			+		+					95, 96, 98, 133, 186, 198, 204, 205, 208
TOTAL RHODOPHYTA=162										
OCHROPHYTA										
Phaeophyceae										
Ascocyclus orbicularis (J. Agardh) Kjellman			+		+					59, 64, 65, 67, 95, 96, 98, 99, 123, 133, 157, 190, 231
Asperococcus bullosus J.V. Lamouroux			+			+				72, 80, 186, 190, 198, 204, 208
Asperococcus ensiformis (Delle Chiaje) M.J. Wynne			+		+	+				27, 31, 42, 53, 55, 59, 67, 95, 96, 99, 113, 133, 157, 159, 171, 186, 190, 198, 204, 208, 214, 224, 231
Asperococcus fistulosus (Hudson) Hooker			+		+	+				8, 21, 27, 42, 53, 55, 59, 67, 95, 96, 102, 103, 186, 190, 198, 204, 208

Taxa	Reproductive phenology				Settlement status			New for		References
								Medit.	Venice	
	m	f	s	p	e	a	u	i/ni	i/ni	
Botrytella sp.**			+		+	+	+	ni	ni	7, 8**, 19, 25, 39, 40, 54, 57, 96, 114, 123, 186, 190, 208
Cladosiphon irregularis (Sauvageau) Kylin*					+				ni	176*
Cladosiphon zosterae (J. Agardh) Kylin*	+	+	+		+				i	46, 59, 61, 65, 67, 95, 96, 115, 161*, 170, 171, 181, 186, 190, 198, 204, 205, 206, 208
Colpomenia sinuosa (Mertens *ex* Roth) Derbès *et* Solier			+		+					80, 95, 96, 159, 186, 190, 204, 208, 225, 232
Corynophlaea umbellata (C. Agardh) Kützing					+					95, 98, 99, 157, 186, 190, 198, 204, 208
Cystoseira barbata (Stackhouse) C. Agardh	(+)	(+)	+			+				12, 26, 34, 37, 80, 82, 95, 96, 99, 102, 103, 116, 132, 133, 135, 157, 171, 186, 190, 198, 204, 208, 223, 231
Cystoseira compressa (Esper) Gerloff *et* Nizamuddin	(+)	(+)	+			+				80, 95, 96, 117, 133, 135, 157, 180, 186, 190, 198, 204, 205, 206, 208, 224, 231
Desmarestia viridis (O.F. Müller) J.V. Lamouroux*			+			+			ni	7*, 19, 42, 56, 57, 58, 59, 67, 96, 102, 103, 113, 171, 186, 190, 204, 208
Dictyopteris polypodioides (A.P. De Candolle) J.V. Lamouroux			+			+				27, 53, 55, 59, 67, 79, 95, 96, 99, 102, 118, 133, 157, 161, 180, 181, 186, 190, 198, 204, 205, 206, 208, 231, 232
Dictyota dichotoma (Hudson) J.V. Lamoroux var. *dichotoma*	+	+				+				22, 25, 39, 40, 42, 43, 51, 52, 59, 67, 95, 96, 99, 101, 102, 107, 108, 110, 118, 133, 135, 158, 159, 161, 171, 180, 185, 186, 190, 193, 194, 196, 198, 199, 204, 208, 211, 212, 213, 214, 224, 225, 231, 232
Dictyota dichotoma (Hudson) J.V. Lamoroux var. *intricata* (C. Agardh) Greville			+			+				7, 25, 27, 35, 39, 40, 42, 46, 53, 55, 59, 67, 79, 95, 96, 113, 159, 171, 186, 190, 198, 204, 208, 224
Dictyota linearis (C. Agardh) Greville			+			+				25, 27, 35, 42, 53, 55, 59, 67, 79, 95, 96, 113, 159, 186, 190, 198, 204, 208
Ectocarpus fasciculatus Harvey			+		+	+	+			95, 159, 186, 190, 204, 208, 224, 225
Ectocarpus siliculosus (Dillwyn) Lyngbye var. *siliculosus*	+	+	+		+	+	+			7, 22, 25, 27, 31, 37, 38, 39, 40, 42, 43, 52, 53, 55, 57, 59, 64, 65, 67, 95, 96, 99, 107, 108, 113, 114, 126, 133, 135, 157, 159, 171, 180, 186, 190, 193, 194, 198, 204, 208, 211, 213, 223, 224, 225, 231, 232
Ectocarpus siliculosus (Dillwyn) Lyngbye var. *arctus* (Kützing) Gallardo			+		+	+	+			27, 53, 55, 72, 80, 95, 96, 99, 133, 135, 159, 186, 190, 204, 208, 223

Taxa	Reproductive phenology				Settlement status			New for: Medit.	New for: Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Ectocarpus siliculosus (Dillwyn) Lyngbye var. *crouaniorum* (Thuret) Gallardo*			+		+	+	+		ni	171, 186, 190, 198*, 204, 208
Ectocarpus siliculosus (Dillwyn) Lyngbye var. *dasycarpus* (Kuckuck) Gallardo			+		+	+	+			8, 21, 27, 53, 55, 95, 96, 190
Ectocarpus siliculosus (Dillwyn) Lyngbye var. *hiemalis* (P. *et* H. Crouan *ex* Kjellman) Gallardo			+		+	+	+			8, 39, 40, 58, 96, 113, 186, 190, 198, 204, 208
Ectocarpus siliculosus (Dillwyn) Lyngbye var. *pygmaeus* (Areschoug) Gallardo			+		+	+				7, 21, 25, 27, 35, 39, 40, 53, 55, 64, 65, 95, 96, 113, 114, 190
Feldmannia irregularis (Kützing) Hamel*			+		+	+	+		ni	8*, 27, 96, 171, 186, 190, 204, 208
Fucus virsoides J. Agardh	(+)	(+)	+			+				12, 30, 42, 46, 51, 72, 80, 94, 95, 96, 99, 101, 102, 103, 107, 117, 132, 133, 135, 157, 159, 171, 186, 190, 193, 194, 198, 204, 205, 206, 208, 223, 224, 225, 231, 232
Giraudia sphacelarioides Derbès *et* Solier*						+			ni	8*, 27, 59, 64, 65, 67, 96, 190
Halothrix lumbricalis (Kützing) Reinke*						+			ni	98*, 190
Hincksia granulosa (J.E. Smith) P.C. Silva			+		+	+				8, 21, 27, 39, 40, 53, 55, 95, 96, 126, 159, 186, 190, 198, 204, 208, 232
Hincksia mitchelliae (Harvey) P.C. Silva			+		+	+				27, 39, 40, 95, 96, 99, 157, 171, 186, 190, 198, 204, 208, 231
Hincksia ovata (Kjellman) P.C. Silva	+	+	+		+	+				8, 21, 27, 39, 40, 53, 55, 59, 65, 67, 72, 95, 96, 186, 190, 204, 208, 224
Hincksia sandriana (Zanardini) P.C. Silva			+		+	+				7, 25, 27, 31, 39, 40, 42, 53, 55, 59, 65, 67, 72, 95, 96, 102, 113, 114, 159, 171, 186, 190, 204, 208, 224
Hincksia secunda (Kützing) P.C. Silva*			+		+	+			ni	95, 96, 159*, 186, 190, 198, 204, 208
Kuckuckia spinosa (Kützing) Kornmann*			+		+	+	+		ni	8, 21*, 27, 35, 39, 40, 53, 55, 95, 96, 171, 186, 190, 198, 204, 208
Leathesia difformis (Linnaeus) Areschoug*					+				ni	8*, 19, 39, 40, 96, 186, 190
Leptonematella fasciculata (Reinke) P.C. Silva *			+		+				ni	8*, 39, 40, 65, 96, 98, 186, 190, 198, 204, 208
Myriactula stellulata (Harvey) Levring*			+		+				ni	64, 65, 104*, 190
Myrionema liechtensternii Hauck*			+		+				ni	8*, 39, 40, 96, 190

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Myrionema strangulans Greville			+		+					25, 72, 80, 95, 96, 99, 113, 133, 157, 186, 190, 204, 208
Petalonia fascia (O.F. Müller) Kuntze	+	+				+				7, 25, 27, 39, 40, 53, 55, 80, 95, 96, 99, 102, 103, 106, 107, 108, 113, 114, 117, 157, 159, 171, 180, 186, 190, 193, 194, 198, 204, 208, 211, 213, 214, 223, 224, 231, 232
Petalonia zosterifolia (Reinke) Kuntze*	+	+				+			ni	95, 96, 159*, 171, 186, 190, 198, 204, 208
Pilayella littoralis (Linnaeus) Kjellman	+	+	+		+	+	+			27, 39, 40, 53, 55, 65, 80, 99, 95, 96, 133, 171, 186, 190, 198, 204, 208, 232
Protectocarpus speciosus (Børgesen) Kornmann*			+		+				ni	8*, 25, 39, 40, 59, 65, 67, 96, 98, 113, 114, 186, 190, 204, 208
Pseudolithoderma adriaticum (Hauck) Verlaque*					+				ni	8, 21*, 25, 27, 35, 37, 39, 40, 42, 53, 55, 59, 67, 95, 96, 190
Punctaria latifolia Greville			+			+				7, 25, 27, 39, 40, 42, 43, 53, 55, 59, 67, 72, 80, 95, 96, 99, 102, 103, 108, 113, 114, 118, 157, 159, 171, 180, 186, 190, 198, 204, 208, 211, 224, 225, 231, 232
Punctaria tenuissima (C. Agardh) Greville*					+				ni	8*, 25, 39, 40, 42, 58, 59, 67, 96, 113, 186, 190, 198, 204, 205, 206, 208
Ralfsia verrucosa (Areschoug) Areschoug						+				8, 39, 40, 96, 190
Sargassum muticum (Yendo) Fensholt**	+	+	+			+		i	i	7, 19, 22, 27, 29, 30, 35, 42, 46, 51, 53, 55, 57, 58, 59, 95, 96, 97**, 98, 102, 103, 123, 161, 163, 171, 180, 181, 186, 190, 198, 204, 205, 208, 224, 230
Scytosiphon dotyi M.J. Wynne*	+	+			+	+			i	8, 21*, 25, 27, 39, 40, 42, 53, 55, 59, 67, 95, 96, 113, 114, 171, 186, 190, 198, 204, 208
Scytosiphon lomentaria (Lyngbye) Link	+	+				+				25, 27, 34, 37, 42, 43, 52, 53, 55, 80, 82, 95, 96, 99, 101, 102, 108, 113, 114, 118, 133, 157, 159, 171, 180, 186, 190, 198, 204, 208, 211, 214, 223, 224, 225, 231, 232
Sphacelaria cirrosa (Roth) C. Agardh*						+			ni	8, 21*, 27, 35, 53, 55, 95, 96, 190, 206
Sphacelaria rigidula Kützing*						+			ni	8*, 27, 96, 190, 206
Stictyosiphon adriaticus Kützing			+		+	+	+			27, 39, 40, 53, 55, 59, 65, 67, 95, 96, 99, 102, 113, 133, 157, 161, 171, 181, 186, 190, 198, 204, 208, 231

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Stictyosiphon soriferus (Reinke) Rosenvinge*			+		+	+	+		ni	167, 186*, 190, 204, 205, 206, 208
Stilophora tenella (Esper) P.C. Silva					+	+	+			29, 31, 34, 72, 82, 95, 96, 118, 190, 224
Striaria attenuata (Greville) Greville			+		+	+	+			1, 72, 80, 82, 95, 96, 98, 99, 117, 126, 133, 157, 190, 204, 223, 231, 232, 235, 237
Taonia pseudociliata (J.V. Lamouroux) Nizamuddin *et* Godeh*		+				+			ni	167, 186*, 190, 198, 204, 205, 206, 208
Undaria pinnatifida (Harvey) Suringar**			+			+		i	i	7, 8, 12, 19, 21, 22, 25, 28, 29, 30, 39, 40, 42, 46, 51, 54, 57, 58, 59, 95, 96, 98, 102, 103, 113, 114, 132, 149*, 154, 161, 163, 180, 181, 186, 190, 204, 208, 224
Total Phaeophyceae=57										
Xanthophyceae										
Vaucheria submarina (Lyngbye) Berkeley	+	+				+				26, 31, 34, 43, 52, 59, 63, 66, 67, 71, 81, 102, 108, 121, 157, 159, 166, 171, 180, 186, 187, 188, 189, 190, 198, 203, 208, 211, 223, 224, 225, 232
Vaucheria piloboloides Thuret*						+			ni	59, 62*, 63, 66, 67, 115, 121, 190
Total Xanthophyceae=2										
TOTAL OCHROPHYTA=59										
CHLOROPHYTA										
Blidingia marginata (J. Agardh) P.J.L. Dangeard *ex* Bliding			+		+	+				27, 37, 39, 40, 53, 55, 95, 96, 99, 157, 159, 171, 186, 190, 198, 204, 208, 231
Blidingia minima (Nägeli *ex* Kützing) Kylin			+		+	+				25, 27, 31, 37, 38, 39, 40, 42, 53, 55, 95, 96, 99, 108, 113, 114, 133, 157, 159, 171, 180, 186, 190, 204, 208
Blidingia ramifera (Bliding) Garbary *et* Barkhouse*					+	+			ni	27, 37, 39, 40, 42, 95, 96, 113, 114, 159*, 171, 186, 190, 204, 208
Blidingia subsalsa (Kjellman) Kornmann *et* Sahling *ex* Scagel *et al.**			+		+	+			ni	95, 96, 159*, 171, 186, 190, 198, 204, 208
Bryopsis corymbosa J. Agardh				+	+	+				95, 96, 99, 159, 171, 186, 190, 198, 204, 208, 223, 224, 225
Bryopsis cupressina J.V. Lamouroux var. *cupressina*		+		+	+	+				95, 171, 186, 190, 204, 208, 223
Bryopsis cupressina J.V. Lamouroux var. *adriatica* (J. Agardh) M.J. Wynne		+		+	+	+				27, 53, 55, 95, 96, 171, 186, 190, 198, 204, 208, 234

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Bryopsis duplex De Notaris		+		+	+	+				27, 35, 39, 40, 43, 52, 53, 55, 95, 96, 99, 101, 108, 113, 133, 157, 159, 180, 186, 190, 198, 204, 205, 206, 208, 211, 223, 224, 225, 231
Bryopsis feldmannii Gallardo *et* G. Furnari				+	+	+				95, 96, 159, 171,186, 190, 198, 204, 208, 223
Bryopsis hypnoides J.V. Lamouroux		+		+	+	+				27, 95, 96, 99, 108, 133, 157, 159, 171, 180,186, 190, 198, 204, 208, 211, 224, 225, 231, 232
Bryopsis muscosa J.V. Lamouroux				+	+	+				95, 96, 186, 190, 204, 208, 223
Bryopsis plumosa (Hudson) C. Agardh		+		+	+	+				25, 27, 31, 35, 37, 38, 39, 40, 42, 43, 51, 52, 53, 55, 57, 59, 67, 95, 96, 99, 101, 102, 108, 113, 114, 126, 133, 135, 157, 159, 171, 180, 186, 190, 198, 204, 208 , 211, 223, 224, 225, 231, 232
Bryopsis secunda J. Agardh*		+			+	+			ni	96, 186*, 190, 198, 204, 208
Chaetomorpha aerea (Dillwyn) Kützing	+	+			+	+	+			25, 29, 31, 32, 39, 40, 43, 52, 53, 81, 82, 95, 96, 113, 137, 145, 157, 171, 186, 190, 198, 204, 208, 223, 224, 225
Chaetomorpha linum (O.F. Müller) Kützing	+	+					+			1, 4, 22, 26, 27, 29, 31, 32, 34, 35, 41, 42, 43, 44, 45, 46, 53, 55, 59, 61, 65, 66, 67, 81, 82, 95, 96, 99, 100, 102, 108, 114, 115, 121, 123, 126, 133, 137, 157, 159, 165, 171, 180, 182, 184, 186, 187, 188, 189, 190, 193, 198, 203, 204, 205, 206, 208, 211, 223, 224, 225, 231, 232
Chaetomorpha mediterranea (Kützing) Kützing*			+		+	+	+		ni	171, 186, 190, 198*, 204, 208
Cladophora aegagropila (Linnaeus) Trevisan					+	+	+			99, 175
Cladophora albida (Nees) Kützing					+	+				26, 27, 37, 38, 39, 40, 42, 43, 52, 53, 55, 59, 64, 65, 67, 71, 81, 82, 95, 96, 99, 113, 123, 133, 186, 190, 198, 204, 208, 224, 232
Cladophora coelothrix Kützing					+	+				27, 53, 55, 81, 82, 95, 99, 114, 157, 190, 231, 234
Cladophora dalmatica Kützing	+				+	+				27, 43, 53, 55, 59, 65, 67, 95, 96, 99, 113, 114, 123, 157, 186, 190, 224, 231
Cladophora echinus (Biasoletto) Kützing	+				+	+	+			71, 81, 82, 99, 175*, 223

Taxa	Reproductive phenology				Settlement status			New for		References
								Medit.	Venice	
	m	f	s	p	e	a	u	i/ni	i/ni	
Cladophora fracta (O.F. Müller *ex* Vahl) Kützing			+		+	+	+			71, 81, 95, 157, 186, 190, 198, 204, 208, 223, 231
Cladophora glomerata (Linnaeus) Kützing					+	+				95, 99, 186, 190, 204, 208, 223, 231
Cladophora hutchinsiae (Dillwyn) Kützing					+	+				25, 26, 27, 31, 35, 39, 40, 42, 43, 52, 53, 55, 59, 65, 67, 71, 82, 95, 96, 99, 113, 114, 157, 159, 186, 190, 204, 205, 206, 208, 223, 224, 225, 231
Cladophora laetevirens (Dillwyn) Kützing			+		+	+				27, 37, 39, 40, 43, 52, 53, 55, 59, 65, 67, 81, 82, 95, 96, 99, 114, 126, 157, 171, 186, 190, 198, 204, 208, 223, 231, 232
Cladophora lehmanniana (Lindenberg) Kützing			+		+	+				27, 35, 39, 40, 43, 52, 53, 55, 81, 95, 96, 99, 157, 159, 186, 190, 198, 204, 208, 224, 231
Cladophora liniformis Kützing					+	+	+			39, 40, 59, 67, 71, 95, 96, 99, 157, 171, 186, 190, 204, 205, 206, 208, 231
Cladophora prolifera (Roth) Kützing					+	+				71, 95, 96, 99, 102, 133, 157, 159, 181, 186, 190, 198, 204, 205, 206, 208, 223, 231
Cladophora ruchingeri (C. Agardh) Kützing					+	+				1, 52, 81, 82, 95, 96, 99, 126, 157, 186, 198, 204, 208, 223, 224, 225, 231, 232
Cladophora rupestris (Linnaeus) Kützing			+		+	+				26, 27, 35, 37, 38, 39, 40, 42, 43, 52, 53, 55, 59, 64, 65, 67, 82, 95, 96, 113, 114, 159, 186, 190, 198, 204, 208, 224, 232
Cladophora sericea (Hudson) Kützing	+	+			+	+	+			25, 26, 27, 31, 32, 35, 37, 38, 39, 40, 42, 43, 52, 53, 55, 59, 67, 71, 81, 94, 95, 96, 99, 113, 114, 123, 126, 133, 137, 157, 159, 171, 186, 190, 198, 204, 208, 223, 224, 225, 231
Cladophora vadorum (Areschoug) Kützing					+	+	+			27, 39, 40, 95, 96, 99, 171, 186, 190, 198, 204, 208
Cladophora vagabunda (Linnaeus) C. Hoek			+		+	+	+			27, 39, 40, 53, 55, 67, 71, 81, 82, 95, 96, 99, 108, 123, 126, 133, 135, 157, 159, 171, 180, 182, 186, 190, 198, 204, 208, 211, 231, 232
Codium fragile (Suringar) Hariot subsp. *tomentosoides* (Goor) P.C. Silva*	+	+			+	+			ni	27, 30, 39, 40, 42, 43, 51, 52, 53, 55, 95, 96, 98, 102, 103, 107, 108, 113, 158, 159*, 180, 186, 190, 193, 194, 198, 204, 208, 211, 214, 224, 225, 230
Derbesia tenuissima (Moris *et* De Notaris) P. *et* H. Crouan*			+		+	+			ni	27, 35, 53, 55, 95, 96, 171, 186, 190, 204, 208, 224*
Entocladia leptochaete (Huber) Burrows*	+	+			+				ni	8*, 27, 96, 171, 186, 190, 198, 204, 208

Taxa	Reproductive phenology				Settlement status			New for		References
								Medit.	Venice	
	m	f	s	p	e	a	u	i/ni	i/ni	
Entocladia viridis Reinke	+	+			+					8, 25, 26, 27, 31, 32, 35, 39, 40, 42, 53, 55, 59, 64, 65, 67, 95, 96, 99, 113, 114, 133, 157, 171, 186, 190, 198, 204, 208, 224, 231
Epicladia flustrae Reinke*					+				ni	8*, 26, 27, 39, 40, 59, 67, 96, 190
Gayralia oxysperma (Kützing) K.L. Vinogradova ex Scagel *et al.*					+	+	+			27, 35, 39, 40, 42, 43, 53, 55, 59, 67, 71, 82, 95, 96, 99, 113, 114, 126, 136, 157, 186, 190, 198, 204, 208, 231
Lamprothamnion papulosum (Wallroth) J. Groves*						+			ni	26, 32*
Lola implexa (Dillwyn) G. Hamel*						+	+		ni	127*, 129e
Monostroma grevillei (Thuret) Wittrock					+	+				95, 96, 181, 190, 224
Monostroma obscurum (Kützing) J. Agardh*					+	+	+		ni	170, 186, 190, 198*, 204, 205, 206, 208
Pedobesia simplex (Meneghini *ex* Kützing) M.J. Wynne *et* Leliaert										27, 53, 55, 95, 96, 99, 157, 159, 171, 186, 190, 198, 204, 208, 224, 231
Phaeophila dendroides (P. *et* H. Crouan) Batters*			+		+				ni	175*
Prasiola crispa (Lightfoot) Kützing*					+				ni	26, 46, 59, 62*, 67, 115, 123, 190
Pringsheimiella scutata (Reinke) Höhnel *ex* Marchewianka					+					25, 59, 67, 95, 96, 99, 114, 157, 190, 204, 231
Pseudobryopsis myura (J. Agardh) Berthold						+				95, 96, 186, 190, 204, 223
Rhizoclonium tortuosum (Dillwyn) Kützing					+		+			25, 27, 31, 32, 37, 38, 39, 40, 42, 43, 53, 55, 59, 64, 65, 67, 95, 96, 99, 114, 133, 137, 157, 159, 186, 190, 208, 224, 225, 231, 232
Stromatella monostromatica (P.J.L. Dangeard) Kornmann *et* Sahling*					+				ni	175*
Tellamia sp.*					+				ni	59, 61*, 67, 115, 190
Ulothrix flacca (Dilllwyn) Thuret	+	+			+	+	+			26, 43, 82, 95, 96, 99, 108, 133, 159, 171, 180, 186, 190, 198, 204, 208, 211, 224
Ulothrix implexa (Kützing) Kützing	+	+			+	+	+			27, 31, 37, 38, 39, 40, 81, 95, 96, 99, 108, 114, 133, 157, 159, 171, 180, 186, 190, 198, 204, 208, 211, 223, 224, 231
Ulothrix subflaccida Wille*					+	+	+		ni	65, 95, 96, 190, 224*
Ulva clathrata (Roth) C. Agardh			+		+	+	+			42, 43, 59, 65, 67, 82, 95, 96, 99, 126, 133, 157, 159, 171, 186, 190, 198, 204, 208, 224, 225, 231, 232

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Ulva compressa Linnaeus			+		+	+				27, 53, 55, 82, 95, 96, 99, 101, 102, 103, 107, 108, 126, 133, 157, 159, 171, 177, 180, 186, 190, 198, 204, 208, 211, 213, 223, 224, 225, 231, 232
Ulva curvata (Kützing) De Toni	+	+	+		+	+	+			95, 96, 99, 113, 114, 186, 190, 204, 208
Ulva fasciata Delile**			+			+		i	i	95, 96, 102, 103, 108, 159**, 171, 180, 186, 190, 198, 204, 208, 211, 224, 225
Ulva flexuosa Wulfen						+	+			25, 26, 27, 37, 39, 40, 42, 43, 67, 95, 96, 99, 113, 114, 133, 135, 157, 159, 171, 186, 190, 198, 204, 208, 224, 225, 231
Ulva flexuosa Wulfen subsp. *biflagellata* (Bliding) Sfriso *et* Curiel**	+	+					+	ni	ni	95, 96, 159**, 190
Ulva flexuosa Wulfen subsp. *paradoxa* (C. Agardh) M.J. Wynne						+	+			95, 96, 99, 157, 159, 186, 190, 231
Ulva flexuosa Wulfen subsp. *pilifera* (Kützing) M.J. Wynne.*						+	+		ni	59, 65, 95, 96, 159*, 171, 186, 190, 208
Ulva kylinii (Bliding) H.S. Hayden			+		+	+	+		ni	95, 96, 159*, 186, 190, 204, 208, 224, 225
Ulva intestinalis Linnaeus	+	+	+		+	+				13, 25, 26, 27, 30, 31, 34, 35, 37, 38, 39, 40, 42, 43, 46, 51, 52, 53, 55, 57, 59, 64, 65, 67, 81, 95, 96, 99, 107, 108, 113, 114, 126, 133, 136, 147, 157, 159, 171, 177, 180, 186, 190, 198, 208, 211, 213, 223, 224, 225, 231, 232
Ulva intestinalis Linnaeus var. *asexualis* (Bliding) E. Taskin**			+			+		ni	ni	95, 96,159**, 190
Ulva intestinalis Linnaeus f. *cornucopiae* (Lyngbye) Sfriso et Curiel			+			+				95, 96, 157, 159, 171, 190, 208
Ulva laetevirens Areschoug	+	+	+			+	+			22, 26, 27, 29, 30, 31, 42, 45, 46, 57, 59, 63, 65, 66, 67, 81, 82, 95, 96, 98, 111, 112, 115, 121, 126, 133, 139, 157, 165, 169, 171, 187, 188, 190, 204, 208, 223, 224, 225, 231, 242
Ulva linza Linnaeus			+			+				13, 27, 53, 55, 81, 82, 95, 96, 99, 108, 114, 126, 133, 157, 159, 171, 180, 186, 190, 198, 204, 208, 211, 223, 224, 231, 232
Ulva prolifera O.F. Müller			+			+	+			13, 25, 27, 35, 37, 38, 39, 40, 42, 43, 53, 55, 57, 59, 65, 67, 95, 96, 99, 101, 107, 108, 113, 114, 133, 157, 159, 171, 180, 186, 190, 198, 204, 208, 211, 213, 224, 225, 231

Taxa	Reproductive phenology				Settlement status			New for Medit.	New for Venice	References
	m	f	s	p	e	a	u	i/ni	i/ni	
Ulva prolifera O.F. Müller subsp. *gullmariensis* (Bliding) E. Taskin*						+	+		ni	171, 186, 190, 198*, 208
Ulva ralfsii (Harvey) Le Jolis			+		+	+	+			31, 43, 52, 95, 96, 159, 186, 190, 204, 208, 224
Ulva rigida C. Agardh	+	+	+			+	+			4, 5, 8, 10, 12, 13, 17, 18, 20, 25, 34, 35, 37, 38, 39, 40, 41, 43, 44, 51, 52, 53, 54, 55, 69, 83, 84, 85, 86, 87, 88, 89, 90, 93, 99, 100, 101, 102, 103, 106, 107, 108, 109, 110, 113, 114, 124, 128, 129, 130, 131, 132, 136, 140, 141, 142, 143, 144, 145, 147, 158, 159, 160, 161, 163, 169, 171, 173, 174, 177, 178, 179, 180, 181, 182, 184, 185, 186, 189, 191, 192, 193, 194, 195, 196, 197, 198, 199, 201, 203, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 219, 221, 222, 226, 229, 238, 239, 240
Ulva rotundata Bliding*					+	+			ni	42, 59, 65, 67, 95, 96, 113, 114*, 171, 186, 190, 204, 208, 224
Ulvella lens P. *et* H. Crouan			+		+					27, 31, 35, 39, 40, 42, 53, 55, 56, 59, 64, 65, 67, 95, 96, 99, 113, 114, 157, 171, 186, 190, 198, 204, 208, 224
Ulvella setchellii P.J.L. Dangeard*					+				ni	56*, 96, 114, 190
Urospora penicilliformis (Roth) J.E. Areschoug*					+	+			ni	175*
Valonia aegagropila C. Agardh			+			+	+			26, 34, 71, 81, 95, 96, 99, 102, 108, 115, 145, 157, 163, 165, 186, 187, 190, 193, 204, 205, 206, 208, 211, 224, 225, 231, 232
TOTAL CHLOROPHYTA=77										
Taxa Invalida										
Enteromorpha multiramosa Bliding*						+	+		ni	171, 186*, 190, 204, 208
Erythrotrichia rosea P.J.L. Dangeard**					+			ni	ni	8, 27, 37**, 39, 40, 96, 190
Total Taxa Invalida=2										
TOTAL SPECIES=300										
ANGIOSPERMAE										
Cymodocea nodosa (Ucria) Ascherson	+	+				+				6, 9, 14, 15, 16, 23, 24, 26, 31, 41, 44, 16, 48, 49, 50, 68, 70, 85, 122, 138, 143, 146, 150, 152, 148, 153, 155, 156, 162, 174, 183, 200, 202, 205, 206, 207, 208, 228, 241

Taxa	Reproductive phenology				Settlement status			New for		References
								Medit.	Venice	
	m	f	s	p	e	a	u	i/ni	i/ni	
Nanozostera noltii (Hornemann) Tomlinson *et* Posluzny	+	+				+				9, 14, 16, 23, 26, 30, 41, 44, 46, 48, 49, 50, 68, 70, 91, 92, 143, 146, 153, 155, 156, 166, 174, 183, 200, 202, 205, 206, 207, 208, 227, 228
Ruppia cirrhosa (Petagna) Grande	+	+				+				26, 170, 174, 208, 227
Ruppia maritima Linnaeus	+	+				+				26, 170, 174
Zostera marina Linnaeus	+	+				+				9, 14, 15, 16, 23, 31, 36, 41, 44, 46, 48, 50, 68, 70, 143, 146, 151, 153, 155, 156, 164, 166, 174, 181, 196, 200, 202, 205, 206, 207, 208, 219, 228
TOTAL ANGIOSPERMAE=5										

Tab. 2 – List of phytobenthic taxa disappeared from the Venice Lagoon.

Taxa	References
RHODOPHYTA	
Aglaothamnion scopulorum (C. Agardh) Feldmann-Mazoyer	133
Antithamnion decipiens (J. Agardh) Athanasiadis	133
Balliella cladoderma (Zanardini) Athanasiadis	223
Bonnemaisonia asparagoides (Woodward) C. Agardh	79, 82, 133, 135, 157
Botryocladia botryoides (Wulfen) Feldmann	82
Callithamnion granulatum (Ducluzeau) C. Agardh	82, 133
Ceramium inconspicuum Zanardini	82
Ceramium secundatum Lyngbye	75, 82, 133, 157, 231
Ceramium siliquosum (Kützing) Maggs *et* Hommersand var. *lophophorum* (Feldmann-Mazoyer) Serio	135
Champia parvula (C. Agardh) Harvey	74, 79, 157
Chondrophycus thuyoides (Kützing) G. Furnari	79, 99, 133, 135, 157, 231, 232
Chroodactylon ornatum (C. Agardh) Basson	157, 231
Crouania attenuata (C. Agardh) J. Agardh	79, 157, 231
Dudresnaya verticillata (Withering) Le Jolis	79
Erythrotrichia reflexa (P. *et* H. Crouan) Thuret *ex* De Toni	133
Eupogodon spinellus (C. Agardh) Kützing	133, 198
Gastroclonium ovatum (Hudson) Papenfuss	126, 232
Gloiocladia repens (C. Agardh) N. Sánchez *et* Rodríguez-Prieto	234
Griffithsia opuntioides J. Agardh	82

Taxa	References
Haliptilon virgatum (Zanardini) Garbary *et* H.W. Johansen	79
Herposiphonia secunda (C. Agardh) Ambronn	79
Herposiphonia tenella (C. Agardh) Ambronn	223
Hypoglossum hypoglossoides (Stackhouse) Collins *et* Hervey	234
Jania longifurca Zanardini	79
Jania rubens (Linnaeus) J.V. Lamouroux var. *corniculata* (Linnaeus) Yendo	82
Laurencia microcladia Kützing	79, 99, 126, 157
Lomentaria articulata (Hudson) Lyngbye var. *linearis* Zanardini	79, 82
Lomentaria firma (J. Agardh) Falkenberg f. *firma*	157, 231
Lophosiphonia obscura (C. Agardh) Falkenberg	75, 79, 99, 133, 157, 223, 231, 232
Microcladia glandulosa (Solander *ex* Turner) Greville	99, 133
Nemastoma dichotomum J . Agardh	79, 99, 133, 223
Peyssonnelia polymorpha (Zanardini) F. Schmitz	234
Peyssonnelia squamaria (S.G. Gmelin) Decaisne	79
Phyllophora heredia (Clemente) J. Agardh	79
Pneophyllum confervicola (Kützing) Y.M. Chamberlain	157
Polysiphonia atra Zanardini	75, 79, 82
Polysiphonia brodiei (Dillwyn) Sprengel	99
Polysiphonia foeniculacea (C. Agardh) Sprengel	99, 157, 231
Polysiphonia opaca (C. Agardh) Moris *et* De Notaris	75, 79, 82, 99, 133, 157, 223, 231, 232
Polysiphonia ornata J. Agardh	77, 82, 99, 133, 157, 231
Polysiphonia pulvinata (Roth) Sprengel	79, 223
Polysiphonia subulifera (C. Agardh) Harvey	75, 79, 82
Porphyra atropurpurea (Olivi) De Toni	71, 79, 231
Porphyra dioica J. Brodie *et* L.M. Irvine	157, 231
Porphyra purpurea (Roth) C. Agardh	79, 82, 126, 223, 232
Porphyra umbilicalis (Linnaeus) Kützing	99, 157
Porphyrostromium boryanum (Montagne) P.C. Silva	99, 133
Pterocladiella capillacea (S.G. Gmelin) Santelices *et* Hommersand	79, 223
Pterocladiella melanoidea (Schousboe *ex* Bornet) Santelices *et* Hommersand	99, 133, 157, 231
Rhodochorton purpureum (Lightfoot) Rosenvinge	79, 82
Schottera nicaeensis (J. V. Lamouroux *ex* Duby) Guiry *et* Hollenberg	157, 231
Scinaia furcellata (Turner) J.Agardh	232
Seirospora interrupta (J.E. Smith) F. Schmitz	99, 157, 231
Wrangelia penicillata (C. Agardh) C. Agardh	99, 133, 232
TOTAL RHODOPHYTA=54	
OCHROPHYTA	

Taxa	References
Phaeophyceae	99
Acinetospora crinita (Carmichael) Sauvageau	
Arthrocladia villosa (Hudson) Duby	72, 80, 82, 99, 157
Bachelotia fulvescens (Bornet) Kuckuck *ex* G. Hamel	157, 231
Cladosiphon mediterraneus Kützing	80, 82, 119, 120, 157
Cladostephus spongiosum (Hudson) C. Agardh f. *verticillatum* (Lightfoot) Prud'homme van Reine	99, 133, 135, 157, 231
Compsonema minutum (C. Agardh) Kornmann	232
Cutleria multifida (Turner) Greville	72
Cystoseira amentacea (C. Agardh) Bory	80, 116
Cystoseira corniculata (Turner) Zanardini	72, 82, 116, 237
Cystoseira foeniculacea (Linnaeus) Greville f. *tenuiramosa* (Ercegović) Gómez Garreta *et al.*	72, 80, 82 , 99, 117
Cystoseira tamariscifolia (Hudson) Papenfuss	82
Dictyota fasciola (Roth) J.V. Lamouroux	118
Ectocarpus siliculosus (Dillwyn) Lyngbye var. *venetus* (Kützing) Gallardo	82, 99, 133, 157, 231
Feldmannia caespitula (J. Agardh) Knoepffler-Péguy	223
Feldmannia paradoxa (Montagne) Hamel	72
Herponema velutinum (Greville) J. Agardh	72, 82
Hincksia fuscata (Zanardini) P.C. Silva	82, 99, 157, 231
Mesogloia vermiculata (J.E. Smith) S.F. Gray	72, 80, 119
Nereia filiformis (J. Agardh) Zanardini	72, 234
Padina pavonica (Linnaeus) J.V. Lamouroux	82, 118
Sargassum acinarium (Linnaeus) Setchell	80, 82, 116
Sargassum hornschuchii C. Agardh	72, 80, 82, 99, 116, 133
Sargassum vulgare C. Agardh, *nom. illeg.*	82, 116
Stypocaulon scoparium (Linnaeus) Kützing	80, 119, 126
Taonia atomaria (Woodward) J. Agardh	79, 99, 118, 133
TOTAL OCHROPHYTA=25	
CHLOROPHYTA	
Bryopsis pennata J.V. Lamouroux	232
Cladophora flexuosa (O.F. Müller) Kützing	71, 81, 157, 223, 231
Cladophora pellucida (Hudson) Kützing	81
Codium bursa (Linnaeus) C. Agardh	81
Flabellia petiolata (Turra) Nizamuddin	81, 126
Halimeda tuna (J. Ellis *et* Solander) J.V. Lamouroux	71, 81
Percursaria percursa (C. Agardh) Rosenvinge	133, 223
Valonia utricularis (Roth) C. Agardh	71, 81, 99, 157, 231
TOTAL CHLOROPHYTA=8	
TOTAL SPECIES=86	

Tab. 3 - Taxa inquirenda.

RHODOPHYTA

Laurencia nana (C. Agardh) Greville, *Lomentaria implexa* Auctorum (82)

Acrochaetium virgatulum (Harvey) Batters var. *luxurians* (J. Agardh) Rosenvinge, *Antithamnion cruciatum* (C. Agardh) var. *tenerum* (“*tenera*”) Schiffner (99, 157)

Antithamnion plumula f. *laxa* Schiffner (157)

Ceramium pleurosporum Schiffner, *C. pseudostrictum* Schiffner, *C. radiculosum* Hauck, *C. vatovai* Schiffner, *Gelidium venetum* Schiffner (99, 157, 231)

Polysiphonia béguinotii Schiffner (99, 133, 157, 231)

Polysiphonia pulvinata (Roth) Sprengel (223, 232)

Porphyra autumnalis Zanardini (235)

OCHROPHYTA

Phaeophyceae

Cystoseira montagnei J. Agardh (80)

Ectocarpus cymosus Zanardini, *E. exilis* Zanardini, *E. kellneri* Meneghini, *E. lutescens* Zanardini, *E. myurus* Zanardini, *E. multifurcus* Zanardini, *E. natans* Zanardini, *E. pumilus* Zanardini, *E. radicans* Zanardini, *E. ramentaceus* Zanardini, *E. rudis* Zanardini, *E. saxatilis* Zanardini, *E. strigosus* Zanardini (82)

Ectocarpus siliculosus (Dillwyn) Lyngbye var. *divergens* Schiffner, *E. siliculosus* (Dillwyn) Lyngbye var. *elongatus* Schiffner, *E. siliculosus* (Dillwyn) Lyngbye var. *megacarpus* Schiffner (157)

CHLOROPHYTA

Cladophora nudiuscula (Zanardini) Zanardini (71), the same taxon as *Conferva nudiuscula* (82)

Chaetomorpha fibrosa (Kützing) Kützing (157), the same taxon as *C. fibrosa* Kützing (81, 223)

Chaetomorpha monilina (Zanardini) Zanardini, C*ladophora aequalis* Zanardini *ex* Frauenfeld, *C. crinalis* Kützing, *C. racemifera* Auctorum?, *Conferva confervicola* Zanardini (*nom. illeg.*) (82)

Blidingia marginata var. *longior* Kützing (99), the same taxon as *E. marginata* J. Agardh var. *longior* Kützing (157)

Blidingia minima var. *capillaris* Schiffner, *B. minima* var. *elongata* Schiffner, *B. minima* var. *ramosa* Schiffner (99)

Bryopsis duplex De Notaris var. *pseudoderbesia* Schiffner, *B. hypnoides* J.V. Lamouroux var. *arbuscula*, *B. hypnoides* J.V. Lamouroux var. *flagellata* (Kützing) Schiffner, *B. hypnoides* J.V. Lamouroux [var. *lagunarum* Schiffner], *B. hypnoides* J.V. Lamouroux var. *lagunarum* Schiffner f. *subnuda* Schiffner, *Chaetomorpha breviarticulata* Hauck (*nom. illeg*.), *Cladophora rudolphiana* (C. Agardh) Harvey f. *subpatula* Schiffner, *C. subnitida* Schiffner, *E. minima* Nägeli *ex* Kützing [var. *capillaris* Schiffner] f. *elongata* Schiffner, *E. minima* Nägeli *ex* Kützing var. *elongata* Schiffner, *E. prolifera* (O.F. Müller) J. Agardh var. *guttulata* Schiffner, *E. prolifera* (O.F. Müller) J. Agardh var. *crispatissima* Schiffner, *E. prolifera* (O.F. Müller) J. Agardh var. *setosa* Schiffner, *E. prolifera* (O. F. Müller) J. Agardh var. *tenuis* Schiffner, *E. prolifera* (O.F. Müller) J. Agardh [var. *tenuis*] f. *capillaris* Schiffner, *E. prolifera* (O.F. Müller) J. Agardh [var. *tenuis*] f. *ramosa* Schiffner, *E. prolifera* (O.F. Müller) J. Agardh [var. *tenuis*] f. *setulosa* Schiffner, *E. prolifera* (O.F. Müller) J. Agardh var. *trichoclada* Schiffner, *E. prolifera* (O.F. Müller) J. Agardh [var. *trichoclada*] f. *ramis longissimis* Schiffner (this is an invalid name because of the form is composed by two adjectives), *E. tubulosa* Kützing var. *ramosa* (157).

Cladophora crystallina (Roth) Kützing (71, 81, 82 157), the same taxon as *Conferva crystallina* Roth (232).

Bryopsis implexa De Notaris, *Conferva bombycina* C. Agardh (223).

Conferva subdivisa Roth (232).

Tab. 4 - Taxa excludenda.

RHODOPHYTA

Ahnfeltia plicata (Hudson) Fries. (232)

Aglaothamnion hookeri (Dillwyn) Maggs *et* Hommersand (198, 224).

Aglaothamnion roseum (Roth) Maggs *et* L'Hardy-Halos (82).

Ceramium gaditanum Clemente (8, 21, 53, 198). (This species already present in the Mediterranean Sea probably is a misidentification).

Heterosiphonia plumosa (J. Ellis) Batters (79, 223).

Gelidiopsis intricata (C. Agardh) Vickers (82).

Gracilaria divergens (C. Agardh) J. Agardh (157).

Polysiphonia nigra (Hudson) Batters (8).

OCHROPHYTA

Phaeophyceae

Cystoseira abies-marina (S. G. Gmelin) C. Agardh (72). (This species already present in the Mediterranean Sea probably is a misidentification).

Desmarestia confervoides (Bory) M. Ramírez *et* A. Peters (57).

CHLOROPHYTA

Cladophora subsimplex Kützing (157).

Tab. 5 - Nomina nuda.

RHODOPHYTA

Ceramium affine Zanardini, *C. breviarticulatum* Zanardini, *C. caespitosum* Zanardini, *C. elongatum* Zanardini, *C. inflatum* Zanardini, *C. obscurum* Zanardini, *C. pilosum* Zanardini, *C. rosarium* Meneghini, *Lomentaria corymbosa* Zanardini, *Polysiphonia elegans* Zanardini, *P. leptoclonia* Zanardini, *P. megarthra* Zanardini, *P. piligera* Zanardini (82)

Ceramium barbatum Kützing f. *nanum*, *C. pseudostrictum* Schiffner f. *majus* ("*major*"), *C. pseudostrictum* Schiffner f. *minus* ("*minor*"), *C. pseudostrictum* Schiffner f. *nanum* ("*nana*"), *C. strictum* Greville *et* Harvey *nanum* ("*nana*"), *Chondria dasyphylla* (Woodward) J. Agardh [var. *piriclada* Schiffner] f. *gracilis* Schiffner, *Dasya elegans* (G. Martens) C. Agardh var. *ramosissima* Schiffner, *D. punicea* Meneghini f. *majus* ("*major*"), *Gastroclonium kaliforme* (Goodenough *et* Woodward) Ardissone f. *nanum* [*nana*], *Gelidium affine* Schiffner f. *laxius* ["*laxior*"] (157)

OCHROPHYTA

Phaeophyceae

Ectocarpus acicularis Zanardini, *E. cornigerus* Meneghini, *E. glomeratus* Zanardini, *E. patens* Zanardini, *E. scoparius* Meneghini, *E. secundatus* Zanardini (82)

Ectocarpus fuscatus Zanardini f. *nanus* ["*nana*"], *Fucus virsoides* (Donati) J. Agardh var. *subnudus* ["*subnuda*"] Schiffner (157)

CHLOROPHYTA

Conferva coriacea Zanardini (82)

Bryopsis duplex De Notaris f. *luxurians* Schiffner, *Cladophora ruchingeri* Kützing var. *elongata* Schiffner, *C. crystallina* (Roth) Kutzing [var. *patula* Schiffner] f. *laxa* Schiffner, *E. compressa* (Linnaeus) Greville [var. *torta* Schiffner] f. *valde elongata* Schiffner, *E. crinita* (Roth) J. Agardh f. *latior* Schiffner, *E. crinita* (Roth) J. Agardh f. *rothiana* Schiffner, *E. intestinalis* (Linnaeus) Link var. *cornucopiae* Lyngbye f. *bullosa*, *E. linza* (Linnaeus) Nees f. *minor* Schiffner, *E. prolifera* (O. F. Müller) J. Agardh [var. *setosa* Schiffner] f. *subsimplex*, *E. prolifera* (O. F. Müller) J. Agardh [var. *tenuis* Schiffner] f. *supraeramosa* Schiffner, *E. tubulosa* Kützing f. *tenuis* Schiffner (157)