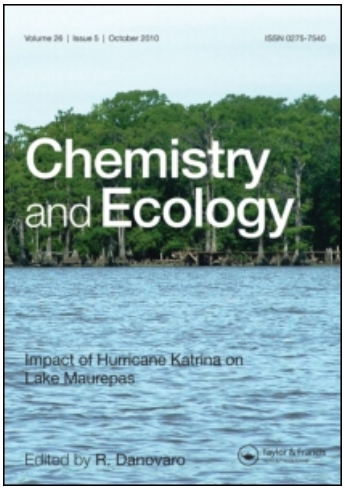

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A review of Mediterranean macrophytobenthos collections present in Italy: a contribution to the Mediterranean Initiative on Taxonomy

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The objective of this paper is to index and evaluate macrophytobenthos (macroalgae and marine angiosperms) collections present in Italy with essential information from Europe and the Eastern and Southern Mediterranean shore. The importance of reference collections in the Mediterranean Initiative on Taxonomy has a double justification: collections objectively document the biodiversity of the Mediterranean macrophytobenthos; information registered on the marine herbaria specimens grants the possibility of reconstructing vegetal biodiversity of the places where specimens were collected, along diachronic series reportable to the environmental dynamic and to the management of the territorial resources of the primary benthonic producers. The most important macroalgae Herbaria present in Italy are inside Universities and the CNR. There are other great important collections for Taxonomy of the Mediterranean vegetal biodiversity present in Europe and in the non European Mediterranean Countries.

Keywords: collections; macrophytobenthos; Mediterranean Sea; Mediterranean Initiative on Taxonomy

1. Introduction

Species vegetal biodiversity is documented by reference collections and in particular by the type specimens in the Herbaria. During the second European Congress on Algology, the Algology Working Group of the Italian Botanic Society (SBI) presented a monograph with 16 contributions to the 'Italian Algological Patrimony' [1]. It reports the essential information on the situation of the principal reference collections of the Mediterranean vegetal marine species, especially represented by algal species, present in the Italian Seas.

Collections documented in this work are mainly kept in University Herbaria Museums and in public institutes of research also working in the field of marine biodiversity. They represent the principal reference collections, but not the entire number of the Italian collections; in fact, almost all specialists in marine botany have private collections which they will probably deposit in the

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Herbaria at the end of their studies. All the Italian Universities with Departments of Botany have an Herbaria with mainly terrestrial vegetal collections, but seats located in those regions with a major coastal development also have more or less important collections of marine plants and in particular of algae.

2. Materials and methods

The adopted methodology is based on the available bibliography, in particular the principal source is the Index Herbariorum [2], completed with the information available on the Herbaria websites.

The evaluation methodology is based on both bibliographic sources and on our experience as users of many of these marine Herbaria for taxonomic studies.

3. Results and discussion

The Index Herbariorum [2] reports the presence in Italy of 69 Herbaria, only 17 of which have algae collections or experts in algology (see Appendix 1).

Briefly presenting the state in Italy of these collections of vegetal marine organisms, we specify that they concern both the marine vegetal biodiversity of the Italian coasts and islands and the marine vegetal geographical areas of the World Ocean.

European reference collections, that very often contain specimens of the Mediterranean marine flora, have been listed but in an incomplete way (as far as Italy is concerned only 2 out of 17 existent Herbaria) in a book edited by the European Commission General Direction of the research program on sciences, R&D and Environment [3], (Appendix 2). This book also reports a list of experts in algal taxonomy in Europe. Another list of specialists is reported in the UNEP – MAP – RAC/SPA [4,5] publications, with information more pertinent to the whole Mediterranean area.

The following paragraphs report news on the Italian collections of marine vegetables which integrate and update those published in the Index Herbariorum [2] in the EEC Algae Directory [3], contained in 'the Italian Phycological Patrimony' [1], published with the contribution of the Ministry of the Environment, Central Inspectorate for the Defence of the Sea.

3.1. *Reference collections of Mediterranean Marine Species in the three Sicilian Universities of Palermo, Catania and Messina*

Sicily has three very ancient Universities with important reference collections in the field of Mineralogy, Palaeontology, Zoology and Botany. With the exception of some important Molluscs collections held in the Mandralisca Museum in Cefalù and in the D'Aumale Mansion in Terrasini 'Regional Museum of Natural History and permanent exposition of the Sicilian handcart' and in other less important museums, the other reference collections are kept in the museums of the three Universities [33]. As far as the marine vegetal collections are concerned, in particular the algae ones, there are three important Herbaria:

The *Herbarium Mediterraneum* of the Department of Botanical Sciences of the University of Palermo (PAL), has an historical collection of 3,856 specimens dated from 1805 to 1910. The majority of the macroalgae specimens come from the Mediterranean Sea, but there is also a great presence of species coming from the Red Sea and from other regions of the World Ocean. Also marine and fresh-water micro-algae are consistently present. The most important algologists of that period are the collectors of these algae: G. De Notaris, F. Ardissone, A. Piccone, A. Borzì, J.J. Rodriguez, P. Titius and so on.

This historical part of the algological collection contains important specimens used to describe new species. The composition of this collection was the subject of a publication [6] which describes its systematic arrangement and its nomenclature updating. In 1960, after approximately a 50 year interval, the University of Palermo started again its algological studies, carried out by G. Giaccone, M. Sortino, S. Calvo, R. Barone, C. Orestano, L. Naselli Flores, A.M. Mannino and D. Drago. Both historical and recent collections are available to taxonomy students.

Documents are indexed on paper and an electronic database is under construction. Important reference collections also exist for animal Biology, they are kept in the Museum of Zoology with an actual presence of taxonomists in the fields of Fishes, Molluscs, Polychaetes and Tanaid. Palermo is also the seat of a Division of the ICRAM (the Central Institute on Sea Research) with specialists in taxonomy of the fishable fauna.

The Herbarium of the Department of Botany of the University of Catania (CAT) houses an important marine macroalgae and Angiosperms reference collection, mainly coming form the Mediterranean Sea and started in 1965, when Proff F. Furnari and B. Scammacca awoke again the interest in marine vegetal biodiversity of the Eastern Sicilian coasts. During the following ten years, research in this field and Herbaria collections received a strong boost thanks to Proff G. Furnari, M. Cormaci and A. Battiato. In 1986, G. Giaccone joined this group and the Laboratory of Algology was definitively set up, under the technical direction of M. Catra and with the presence of researchers. Today, the marine Herbarium has been included in the website of the Department of Botany and it is frequently consulted by specialists from all over the world. Recently, (December 2005), the Regional Activity Center for the Specially Protected Areas (RAC/SPA) of the UNEP has recognized the Algology Laboratory in Catania as a Center of Excellence for the promotion of the Mediterranean Initiative on Taxonomy (MIT) and has created, at the Department of Botany, a training session on reference collections addressed to researchers of Countries located in the southern and western Mediterranean coasts.

The principal collections are:

Algae mediterraneae with nearly 1,000 specimens in exsiccata and 2,000 in test-tubes with sea water and formalin at 3% kept in refrigerated environments. About one hundred specimens, especially Fucophyceae, are fixed in glycerin and kept in plastic bags [7].

The Herbarium Giaccone with 2,304 specimens in exsiccata and 489 under humid conditions; these specimens were collected from 1960 to 2002 and donated by G. Giaccone to the Herbarium of the Department. This collection was the subject of a publication reporting its systematic arrangement and the list of taxonomy and ecology works carried out on specimens and their habitats [8].

Minor collections with nearly 400 specimens come from Antarctica, New Zealand, Australia, Japan, Canada and from other external areas of the Mediterranean Sea.

A small historical collection has specimens assembled by: F. Ardissone from 1862 to 1869; V. Beltrami from 1892 to 1895; J.C.A. Chalon in 1909; G. Cosentini in 1869; A. Mazza from 1899 to 1902; A. Piccone from 1869 to 1897; V. Spinelli from 1897 to 1911; there are also some specimens which are not dated, belonging to F. Tornabene, R. Lenormand, G.A. Thuret and J.B.E. Bornet, F. Cosentino, V. Giacomini, G. Doria, R. Pampanini, G.B. De Toni and D. Levi, P.A. Saccardo, K. Okamura.

F. Cosentino [9] published in the Proceedings of the Gioenia Academy an esteemed monograph on the *Posidonia oceanica*, with four tables illustrating both the vegetative part and the flowers and fruits. Other important algologists of the 19th century are present in the Catania Herbarium as collectors of the specimens and they are listed among the pioneers of the algological studies in the Mediterranean Sea and in particular in the seas surrounding Sicily. The most ancient specimens are dated 1853 and come from exchanges with the Herbaria of Thuret and Bornet. Among the specimens of V. Spinelli and A. Piccone there are various species which are still present along the shores of Catania such as the *Schimmelmannia schousboei* (J. Agardh) J. Agardh, the *Schyzymenia*

dubyi (Chauvin *ex* Duby) J. Agardh, the *Cystoseria amentacea* (C. Agardh) Bory as evidence of the constant presence of these vegetables and of their abundance for more then one century along the western Sicilian shore. Other small collections were donated or purchased in these last decades.

The whole collection is indexed both on paper and electronically in a database and it is available at http://www.dipbot.unict.it/erbari.htm. All the Herbarium sheets were digitalized and images were attached to the relative online forms of the Herbarium.

The two principal collections held in CAT, contain various type specimens deposited by authors who in these last decades described new species; valuable collections are especially those containing specimens of *Cystoseira, Laurencia* and calcareous algae. The photographic archive gathers various micro-shots and coloured pictures in natural environment.

Furthermore, the University of Catania possesses and manages the Laboratory of Marine Biology in the Marine Protected Area named 'Isole Ciclopi'.

As far as animal biology is concerned, important collections are kept in the Zoology Museum (especially Polychaetes) and in the Museum of Paleontology (Polychaetes, Molluscs, Ostracoids, marine plants and Bryozoa). G. Giaccone and others are completing the drawing up of a *Guide for the Identification of the Mediterranean Algae* which includes blue algae, brown algae, red algae, green algae and marine angiosperms.

The Herbarium of the University of Messina (MS) has an important algological division with nearly 8,000 samples both in exsiccata and in sea water with formalin at 3% (about 1,000 specimens). There are both historical and contemporary collections. There are two considerable historical collections (19th century): the L. Rabenhorst's with 2,590 samples in exsiccata and the F. Wolle's with 500 samples in exsiccata. The more recent specimen collection is formed by samples coming both from the Mediterranean sea and from other geographical areas (California, Ireland, Eritrea). A valuable collection is represented by specimens of the genera *Gracilaria*, *Gracilariopsis*, *Halymenia*, *Cordylecladia* and *Porphyra* on which the Messina researchers published important monographs. Apart from exsiccata, the recent collection also includes 1,000 fertile samples in water with formalin for studies of algal taxonomy, kept in refrigerated environments [10]. The University of Messina has different competences and collections on biodiversity of the marine and brackish environments both in the faunal field and in the microbiological one. The most important reference collections have zooplankton specimens both from the Mediterranean and the Antarctic Sea. There are also other interesting faunal collections in particular of molluscs. Another important and active research center for marine biodiversity is the Thalassographic Institute of the CNR in Messina, which gathers recent and historical collections of specimens especially coming from the Messina Strait and the surrounding areas both of the Tyrrhenian and of the high Ionian Sea. On the basis of the above mentioned information, it is possible to envisage the creation in the three above mentioned Universities, of excellence centers for training in taxonomy of the Mediterranean marine organisms.

3.2. *Other Italian locations of marine species reference collections*

Other Italian towns that house important reference collections for marine vegetal biodiversity are: Pisa, Florence, Sassari, Rome and Naples in the Tyrrhenian Sea, Taranto and Porto Cesareo in the Ionian Sea, Bari, Padua, Venice and Trieste in the Adriatic Sea. As far as faunal biodiversity is concerned, important towns are Genoa, Pisa, Florence, Milan, Modena, Leghorn, Naples, Taranto, Lecce, Bari, Ancona, Padua Verona and Trieste.

In Italy, the most important historical collections on algal biodiversity are held in the Museum of Natural History of the University of Florence, Section of Botany 'F. Parlatore' [11]. Samples come from all over the world, even though there is a strong presence of Mediterranean algal species. There is also a valuable pre-Linnean phycological herbarium of A. Micheli made of 784 sheets [11]. The most important collection is held in the Cryptogamic Italian Herbarium.

The Herbarium Museum of the Department of Vegetal Biology of the University "La Sapienza" in Rome has a great importance for algal biodiversity [1,12]. The algological collections of the Herbarium Museum in Rome [12] are prominently historical, even though recently they have been increased with specimens coming from the Latian coast, for the identification of which three CD ROM have been produced containing pictures and electronic determination keys [13]. Algological collections can be found both in the General Herbarium and in the Cesati Herbarium, in the Roman and in the N. A. Pedicino Herbaria. They house collections of high taxonomic interest created by G. De Notaris, G.L. Rabenhorst, J.P.F. Montagne, A.F. Le Jolis, R.F. Hohenacher e W.G. Farlow. There are also specimens of the I and II series of the Cryptogamic Italian Herbarium [35,36]. They contain more than 15,000 specimens. The process of electronic filing of all collections have been started, in some cases these collections need to be re-ordered and restored [14]. Some useful information on all the floral and faunal collections present at the University 'La Sapienza' in Rome, is reported in the tome I *Museums of the* "*University La Sapienza*" edited by Barbanera & Venafro [15]. At present, in the Universities of Florence and Rome, there are few specialists in marine algal taxonomy, but recent collections are significant and there is a qualified taxonomic and algological research activity on species and habitats.

In Pisa and Siena (specialised in marine eco-toxicology), Modena and Leghorn (with a modern Laboratory of Marine Biology managed by a consortium of the Tuscan Universities) there are qualified collections, laboratories and researches on marine biodiversity of species but especially of habitat (algal communities, animal facies, protected areas, marine Angiosperms, alloctonous species, etc.). The University of Pisa organizes annual stages of taxonomic training in the Elbe Island.

Naples has two historical collections fundamental for the study of algal biodiversity in general and for that of the Mediterranean Sea in particular. The Neapolitanum Herbarium of the Department of Vegetal Biology in the "Federico II" University, houses the algological collections of G.B. De Toni, author of the last published algal taxonomy synthesis *Sylloge Algarum omnium hucusque detectarum* (1889–1924). The Herbarium of Naples [16] was documented, along with the rich Algological Library [17], through monographic publications. At present, the University of Naples has just a few algal taxonomists. The Herbarium also contains recent collections of Mediterranean origins. The other algological collection was assembled by G. Funk and it is housed in the Zoological Station of Naples along with the collection of G.D.W. Berthold [18]. This Research Institute also houses recent collections and some researchers who are also interested in the Mediterranean benthonic and planktonic algal marine taxonomy. The Sea Biennial Exhibition houses a rich malacological collection. Recent malacological collections can be found at the University of Naples. Research on Mediterranean biodiversity both on species and habitat is also very active and qualified. The Naples Zoological Station has an equipped benthos Laboratory on the Ischia Island with a staff of taxonomists specialized both in studying species (Polychaetes, Algae, marine Angiosperms, etc.) and habitats. Really important international stages for young researchers and students and thematic congresses are often held in this Laboratory.

The University of Genoa is equipped with qualified laboratories of research on the sea fauna (Cetaceans, Fishes, Sponges, Bryozoans, Echinoderms, etc.), but does not have researchers or trainers in Marine Botany. Reference collections are kept in the DIP.TE.RIS. Museum (Dipartimento per lo Studio del Territorio e delle sue Risorse, University of Genoa) and in the important Genoa Civic Natural History Museum "G. Doria". The Libraries of the Museum and of the University contain many volumes and reviews on marine taxonomy, both on species and habitats. The review called *Mediterranean Marine Biology* is edited in Genoa and it is the official organ of the Italian Society on Marine Biology which has more than 700 members who covers in Italy almost all sectors of the ecology and systematics of the Mediterranean marine organisms and environments.

Milan is the seat of the Civic Hydrobiological Station which houses important collections of the Mediterranean marine fauna (the Menico Torchio collection is really valuable). Also the University of Pavia keeps Mediterranean marine faunal collections.

Thanks to their reference collections, specialised libraries, equipped laboratories, knowledge of their researchers and trainers, the seat of Genoa with its detached seat of Santa Margherita Ligure, of Leghorn (as seat of the Marine Biology Laboratory of the University of Tuscany), of Rome and Naples, are able to house excellence centers for training in taxonomy of organisms and habitats present in the Mediterranean area. Rome also has a qualified marine research center (ICRAM), with a detached division in Palermo, which houses various researchers and coordinates important national and international research projects. Another center leading and coordinating researches in Rome is the ENEA (Italian National Agency for New Technologies, Energies and the Environment), which has equipped marine laboratories also in La Spezia – Liguria. Rome also houses the seat of the CoNISMa (National Interuniversity Consortium for Marine Sciences), which coordinates the most important research and training (Master) activities held at the various Italian Universities, or abroad in cooperation with foreign Research Centers (Chile, Antarctica, etc.).

Taranto houses the CNR Experimental Thalassographic Institute "A. Cerruti" with a group of researchers on algal taxonomy, who since 1984 has assembled an algological collections gathering 319 specimens especially coming from the Gulf of Taranto, but also from other sites in the Mediterranean Sea and in the World Ocean [19]. The algal taxonomy laboratory has a well supplied library. In the same Institute there also are researchers who own benthonic marine fauna collections. Porto Cesareo houses the Marine Biology Station of the Department of Biology of the University of Lecce. This research center keeps important collections of marine fauna (Molluscs) and flora (algae). In particular it holds the faunal and ethnological collections of P. Parenzan and the Herbarium 'Irma Pierpaoli' [20]. It keeps 661 specimens of algae collected in the Gulf of Taranto and in the lower Adriatic Sea. The Taranto and Porto Cesareo collections are indexed and available for specialists.

The Department of Biology of the University of Lecce houses qualified and diversified research groups on taxonomy of marine animal species and habitats. There are rich faunal collections, in particular of Hydrozoas and the library has many texts on taxonomy of marine organisms. The Department can house an excellence center for the training of taxonomists among the competences groups of its researchers and trainers. The University of Bari is, in the lower Adriatic area, the most complete center both as far as researches and training in marine taxonomy of species (fauna and flora) and habitats are concerned. The town also houses a provincial Laboratory of Marine Biology, with interests in research applied to fishery and management of the territory. The University of Bari gives scientific assistance to the protected marine area of the "Tremiti Islands". The algological collection of the Institute of Botany of the University of Bari [21] contains a recent Herbarium with 1,000 specimens, especially coming from the Adriatic Sea. Some systematic groups studied by trainers and researchers of the Institute are present with phenologic series which cover the entire annual period. The collection is indexed on a database which is being completed. Trainers on Animal Biology at the University of Bari are specialists on various taxonomic groups (Fishes, Molluscs, Polychaetes, Sponges, Ascidians, etc.) and they keep rich reference collections of marine species. The University of Bari is able to house an excellence center for training taxonomy of the Mediterranean organisms.

The University of Ancona, in the medium Adriatic area, has been recently established but its Departments have qualified laboratories for research on marine fauna and flora. Furthermore, Ancona houses the CNR's Institute for Fishery Research, with taxonomists qualified on faunal groups of interest for Fishery (Fishes, Molluscs, Crustaceans, etc.). Its laboratories and libraries are well equipped and they also have boats equipped for research.

The University of Bologna, with its detached seat of Ravenna and its Biology laboratory 'Marina di Fano', has qualified research structures and well experienced trainers especially in the field of Phytoplankton and Fishery. There are available reference collections on these fields.

The University of Ferrara has specialists and laboratories, collections and libraries aimed at studying brackish and lagoon environments of the Po Delta.

The University of Padua is among the most ancient European Universities and has a rich series of terrestrial and aquatic flora and fauna collections, both of fresh water and brackish and sea water. All Museums are organized and managed by the International Center of the Scientific Museums. There are numerous Algological collections coming from different places, but Mediterranean species are well represented. The most important historical algological collection is the one of A.I. Forti. It consists of about 7,900 slides of Diatoms: some prepared specimens are new species described by Forti. The macroalgae Herbarium contains about 10,000 sheets. Folders of both Diatoms and macroalgae are the most important in the history of Algology (H.F.Van Heurck, J. Smith, F. Ardissone, etc.). They are indexed on paper and all collections are available [22]. Recent collections are the work of living researchers (S. Pignatti, A. Solazzi, C. Tolomio, C. Andreoli, etc.). The algological collections of Padua are documented in the publications of G. Gola [24], C. Tolomio [25,26] and N. Tornadore [27] and all reference collections are the subject of a publication: Gregolin ed., 1996 - Museums, scientific collections and ancient divisions of the 'Zoppelli' Graphical Libraries, Dosson (Treviso). In Trent, at the Tridentino' Natural Sciences Museum, the fresh water algological material of V. Marchesoni [23] is actually being organized in collections.

The Venice Civic Museum of Natural History keeps the algological collections of the 'G. Zanardini' Herbarium: it is a very interesting collection with specimens coming from the Mediterranean Sea and especially from the Adriatic Sea, the Red Sea and the World Ocean. It also keeps specimens collected by V.F. Schiffner. This collection was the subject of the following publication: G. B. De Toni, D. Levi, 1888 – The Algarium Zanardini. Civic Museum and Correr Collection in Venice. Printing house Fontana, Venice: 1-144. This Herbarium is not indexed and it is difficult to consult it.

In Veneto (Bolca), there is an important collection of fossil algae of the Miocene period, kept in the Civic Natural History Museum of Verona, holding also other important reference collections and in particular collections of Amphipods assembled by Prof. A. Ruffo.

The algological collection or Algarium of the Department of Biology in Trieste is part of the 'Herbarium Universitatis Tergestinae'; it includes historical collections assembled from 1759 to 1900 (Krabler, P. Titius, Accurti, Lucas, E.H.P. Kuckuck and others). Other specimens have been collected by various researchers during the first half of the XX century near the Rovigno Marine Biology Station in Istria, where the Marine Biology Station of Trieste had moved. During the II World War this historical collection was moved from Rovigno to Venice by Prof. A. Vatova and at the end of 1960 it was moved again to Trieste and reordered by S. Pignatti and G. Giaccone. After 1966, with the creation of the Aurisina Marine Biology Institute of Trieste, the majority of the Rovigno library was also moved to this Institute. After its reordering, the historical algological collection was indexed and inserted in the Herbarium of the Institute and Botanical Garden. The recent collection starts after 1960 by S. Pignatti, G. Giaccone, P. De Cristini, W. Simonetti, G. Bressan, V. Kosovel and others and still goes on thanks to A. Falace and others. This collection has a particularly valuable section dedicated to the Corallinales. The algarium includes 4,846 specimens of macroalgae in exsiccata. The collection is electronically indexed and can be consulted at the following website: http://dbiodbs.univ.trieste.it/Algario/algarit.html.

The Department of Biology of the University of Trieste has a library containing many vegetal marine biology texts and a considerable presence of researchers in taxonomy working both with classical methods and with cytological, chemical, ultra structural and other methods.

In the Aurisina Laboratory of Marine Biology, at present part of the Experimental Geophysical Observatory of Trieste, there is also the historical library of the former Institute of Marine Biology of Rovigno.

The Department of Biology houses important collections and specialists in animal species and habitat taxonomy. The most recent collections and specialisations refer to Zooplankton (Ghirardelli and Specchi), Polychaetes, Molluscs (Orel, Valli and Vio), and Coelenterates (Rottini). Researches on Phytoplankton are performed in the Aurisina Laboratory (Fonda-Umani and coll.)

A guide for the identification of the Mediterranean Corallinales was published [28], with a CD in Italian and English and a monograph was edited on the 'Bibliotheca Phycologica' journal on the same group of Mediterranean algae [29]. Another published guide treats the blue algae or Cyanobacteria in cooperation with researchers form Slovenia and Catania [30]. Finally, the Trieste Institute and Botanical Garden published the only existing guide for the identification of the Mediterranean benthonic macroalgae and the study of the vegetal assemblages of this sea [31]. The University of Trieste has the characteristics to house an excellence center for the training of algal taxonomy and of other taxonomic groups of marine fauna. The Trieste Algarium is treated in a publication by Bressan & Coppola di Canzano [32].

4. Conclusions

The project of the Mediterranean Initiative on Taxonomy [34] has underlined the strategic importance of the reference collections for promoting in the Mediterranean Area the Convention on Biodiversity and making effective the Sixth Protocol of the Barcelona Convention on the Sea Protected Areas and on the Biologic Diversity (SPA and BD). In particular, the following recommendation was made: 'Given the importance of reference collections in taxonomic work, it is important to carry out a study of the situation of reference collections of Mediterranean marine species. This study should lead to a programme for their development, continuance and networking as tools to support taxonomic work'. The present review on reference collections of marine vegetables existing in Italy and in the other European and Mediterranean Countries, represents the first concrete response of the scientific Italian community to the above mentioned recommendation of the UNEP/RAC/SPA. Evaluations made on the state, consistency and management of the reference collections kept in the Herbaria Museums of the various Italian Universities, show some institutions as excellence centers both for research in taxonomy and for training taxonomy of vegetal marine biology. Among these centers, the Universities of Florence, Pisa, Sassari, Rome, Naples, Palermo, Messina, Catania, Lecce, Bari, Ancona, Venice, Padua and Trieste distinguish themselves for their excellence (actual and historical collections, equipped laboratories, specialist libraries, expert taxonomists, technicians, foreign students, training courses on diversified taxonomic disciplines of the first, second and third level, and so on). Also these excellence centers need to be renewed and to strengthen their teaching, technical and research staff; they also need adequate fundings for the electronic filing of the collections, their restoration, keeping and further development. Only the Universities of Trieste and Catania have active Herbaria websites, where it is also possible to consult the special sections on marine vegetables. In Italy and in the rest of the European and Mediterranean Countries, it is necessary to create a network of websites linked among them and connected to the world Herbaria network with collections of marine vegetables.

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Appendix 1. List of Italian Herbaria with algae collections or experts in algology as reported by Index Herbariorum [2]

- Ancona (ANC): "Erbario del Dipartimento di Biotecnologie Agrarie ed Ambientali", University of Ancona**;**
- Bologna (BOLO): "Erbario del Sistema Museale d'Ateneo", University of Bologna;
- Camerino (CAME): "Erbario del Dipartimento di Botanica ed Ecologia", University of Camerino (Macerata);
- Catania (CAT): "Erbario del Dipartimento di Botanica e Orto Botanico", University of Catania;
- Florence**: "**Erbario del Centro Studi Erbario Tropicale", University of Firenze (FT)**;** "Herbarium Universitatis Florentinae, Sezione Botanica del Museo di Storia Naturale dell'Università" (FI);
- Messina (MS): "Erbario del Dipartimento di Scienze Botaniche", University of Messina;
- Milan: "Erbario del Dipartimento di Biologia, Sezione Botanica Sistematica", University of Milan (MI); "Erbario Sezione di Botanica del Museo Civico di Storia Naturale di Milano**"** (MSNM);
- Naples (NAP): "Herbarium Neapolitanum del Dipartimento di Biologia Vegetale", University of Naples "Federico II";
- Padua (PAD): "Erbario Patavinum, Centro Interdipartimentale, Musei Scientifici", University of Padua;
- Pisa (PI): "Herbarium Horti Pisani del Dipartimento di Biologia, Orto Botanico e Museo Botanico", University of Pisa;
- Palermo (PAL): "Herbarium Mediterraneum del Dipartimento di Scienze Botaniche"**,** University of Palermo**;**
- Perugia (PERU); "Erbario del Dipartimento di Biologia Vegetale, Sezione Botanica", University of Perugia**;**
- Rome (RO): "Erbario del Dipartimento di Biologia Vegetale", University of Rome "La Sapienza";
- Sassari (SS): "Erbario del Dipartimento di Botanica ed Ecologia Vegetale", University of Sassari;
- Taranto (TAR): "Erbario dell'Istituto Sperimentale Talassografico A. Cerruti", CNR (Consiglio Nazionale delle Ricerche);
- Trento (TR): "Erbario del Museo Tridentino di Scienze Naturali";
- Trieste (TSB): "Erbario del Dipartimento di Biologia", University of Trieste.

Appendix 2. European and non European Herbaria with important Mediterranean algological collections

European Herbaria:

- Barcelona (BCC): Herbarium Departament de Biologia Vegetal (Unitat de Botànica), Universitat de Barcelona, Spain
- Copenhagen (C): Herbarium Botanical Museum and Library, University of Copenhagen, Denmark
- Göteborg (GB): Herbarium Department of Plant and Environmental Sciences, Göteborg University, Sweden
- Izmir (EGE): Herbaryum Botanic Garden and Herbarium Research and Application Center, Ege University, Turkey
- Leiden (L): Nationaal Herbarium Nederland, Leiden University branch, Netherlands
- Ljubliana (LJU): Herbarium Botany Department Biotechnical Faculty, University of Ljubljana, Slovenia
- Madrid (MA): Herbario Real Jardín Botánico, Spain
- Malaga (MGC): Herbario Departamento de Biología Vegetal, Facultad de Ciencias, Universidad de Málaga, Spain
- Floriana (ARG): Herbarium Argotti Botanic Garden, Malta
- Paris (PC): Herbier Cryptogamique Dépt. Systématique et Évolution, Muséum National d'Histoire Naturelle, France
- Rovinj (RI): Herbarium Flora Adriatica Center for Marine Research, Rudjer Boskovic Institute, Croatia
- Thessaloniki (TAU): Herbarium Biology Department Institute of Systematic Botany and Phytogeography, Aristotle University of Thessaloniki, Greece
- Wien (W): Herbarium Department of Botany, Naturhistorisches Museum Wien, Austria

Non European Herbaria:

- Museum Alessandria (ALEX): Herbarium Department of Botany, University of Alexandria, Egypt
- Algers (AL): Herbarium Laboratoire de Botanique de la Faculté des Sciences, Université d'Alger, Algeria
- Beirut (BEI): Post-Herbarium, Biology Department, Natural History Museum, American University of Beirut, Lebanon
- Nicosia (CYP): Herbarium Forestry Department Ministry of Agriculture, Natural Resources and Environment, Cyprus
- Rabat (RAU): Herbarium Faculté des Sciences, Laboratoire de Biologie Végétale, Morocco
- Tel Aviv (TELA): Herbarium Botany Department, Tel Aviv University, Israel
- Tripoli (ULT): National Herbarium, Botany Department, Faculty of Science, Al-Faateh University, Lebanon
- Tunis (TUN): Herbarium Laboratoire de Biologie Végétale Faculté des Sciences, Université de Tunis, Tunisia.