



## Marine algal flora of Hainan Island: a comprehensive synthesis

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## Abstract

The present report contributes to the knowledge of the marine algal flora in northern part of the South China Sea. On the basis of literature data and own sampling, an annotated account of the seaweeds of Hainan Island and nearby islets is presented. Three sets of algal collections are involved: the first series of collection by Tseng and colleagues between the 1930s and 1970s (344 species), the second collection through two German-Chinese expeditions in October–December 1990 and March–April 1992 (214 species) and the third by the authors in 2008–2012 (251 species). Decadal changes in the benthic flora between the 1930s–1970s and 1990s resulted in a decline of epilithic algae with voluminous forms mainly of the families Liagoraceae (Rhodophyta, Rh), Sargassaceae (Ochrophyta, Oc), Caulerpacae and Codiaceae (Chlorophyta, Ch) and in an increase of epiphytic species with fine filamentous and membranous thalli forms: the families Ceramiaceae, Rhodomelaceae (Rh), Ulvaceae, Cladophoraceae (Ch). Changes in marine flora from the 1990s to 2008–2012 showed the same tendency. It is suspected that these historical changes in the marine flora occurred due to human impacts on the coastal ecosystems (in particular, coral reefs) of the island, including over-exploitation of resources and eutrophication of shallow waters, as well as natural catastrophes such as coral bleaching events of 1998.

**Keywords:** decadal changes, Rhodophyta, Ochrophyta, Chlorophyta, human impact

## Introduction

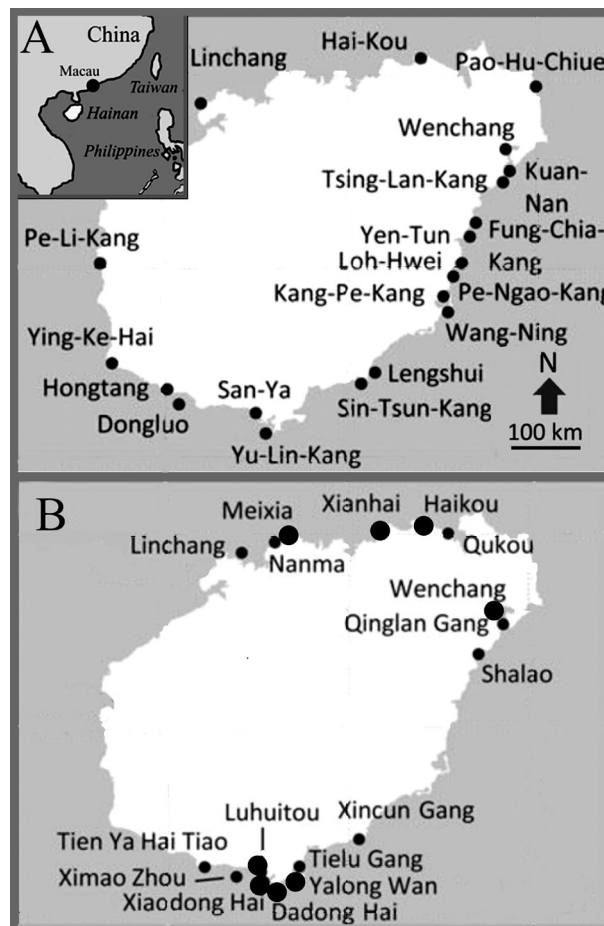
Hainan Island (Fig. 1) is located in the tropical northern periphery of the Indo-Pacific Ocean in the South China Sea, between 20°10'N, 110°41'E and 18°9'N, 109°34'E. Climate is subequatorial; the annual mean temperature is +24°C, with sunny weather during more than 300 days in a year. The annual mean sea surface temperature (SST) is 26°C with an average seasonal range of 12.1°C. The annual SST maximum (30.8°C) and minimum (18.7°C) commonly occur in July and January, respectively. Mean sea surface salinity

(SSS) fluctuates between 33.3 and 34.0 psu. However, SSS is strongly seasonal at Hainan Island, decreasing to a mean value of 26.5 psu owing to freshwater run-off and rain during the wet summer season. The mean tidal range is generally less than 1.5 m. The rainy season in the southern part of Hainan occurs from May to October and accounts for 95% of the yearly rainfall; the dry season occurs from November to April. The island has an area of 33.920 km<sup>2</sup> and a coastline of more than 1600 km (after Titlyanov *et al.* 2011a, 2014a). Four main marine ecosystems such as coral reefs, seagrass beds, estuaries and mangrove swamps border the coasts of

Hainan Island. Coral reefs are the major coastal ecosystem in the intertidal and shallow subtidal zones of exposed and semiprotected areas along the shore. Seagrass beds mainly occupy the soft bottom of semi-protected bays, and mangrove swamps occupy brackish water lagoons connected with the sea. The highest biodiversity of the main coastal ecosystems was recorded between the 1950s and 1960s (Gurianova 1959) but decreased severely during the next 20 years (Hutchings & Wu 1987, Zhang *et al.* 2006). Almost 80% of the fringing reefs along the coastline of Hainan Island have been damaged due to human activities during the 1970s–1990s (fishing with dynamite, removal of corals for lime and construction). Recently, the eutrophication of Hainan coastal waters, particularly in the shallow bays, has increased due to greater tourist numbers, construction works along the coast, and mariculture in coastal ponds and pools with wastes draining into the sea (Hutchings & Wu 1987, Fiege, Neumann & Jinhe 1994, Zhang 1996, Zhang *et al.* 2004, Tadashi *et al.* 2008, Titlyanov *et al.* 2011b).

Three major algal collections were conducted on Hainan Island between the 1930s and 2012. The first sampling campaign of marine seaweeds was performed by Tseng and colleagues in the 1930s at 19 localities on Hainan Island, followed by another series of sampling in Hainan including Xisha Islands between the late 1950s and the 1970s (Fig. 1A). This collection was processed by Chinese phycologists and deposited in the herbarium of the Institute of Oceanology of the Chinese Academy of Sciences (Tseng 2004). All publications relating to these collections were considered here: Tseng 1935, 1936, 1937, 1938, 1941a, b, 1942a, b, 1983, 2004, 2009, Tseng & Gilbert 1942, Tseng & Chang 1962, Tseng *et al.* 1962, 1980, 2001, 2005, 2011, Chang & Xia 1963, 1976, Tseng & Dong 1978, Zhang & Xia 1979, 1980, 1981, 1983, 1984, 1988a, b, c 1991, 1994, Zheng 1980, Zhu & Liu 1980, Lu & Tseng 1980, Xia & Zhang 1982, 1999, Tseng & Lu 1983, 1988, 1992, 1995a, b, c, 1997, 1999, 2000, 2002a, b, c, d; Xia & Abbott 1985, 1987, Xia 1985, 2004, Dong & Tseng 1985, Xia & Yamamoto 1985, Doty 1988, Abbott, Zhang & Xia 1991, Chiang *et al.* 1992, Masuda, Zhang & Xia 1994a, b, Luan & Luan 1995, Xia & Wang 1997, 1999a, b, 2000a, b, 2002, Millar & Xia 1999, Tseng & Xia 1999, Zheng *et al.* 2001, Xia, Tseng & Wang 2004, Xia *et al.* 2004), Xia *et al.* 2002, Zeng *et al.* 2005, Ding *et al.* 2007, Liu 2008, Zheng & Li 2009.

In October–December 1990 and March–April 1992, the second major sampling campaign was conducted in the shallow waters of 16 localities (Fig. 1B) through two German-Chinese expeditions. Algal samples were prepared as herbarium specimens by B. Xia, I. Bartsch and B. Bischoff and one set of herbarium samples each (for all species/forms) was deposited at the Alfred-Wegener-Institute for Polar and Marine Research (Germany) and at the Institute of Oceanology in Qingdao (China). Herbarium samples were



**Figure 1.** Collection sites at Hainan Island. A. Collection sites of Tseng and coworkers in 1933–1935 with old spellings of names (after Tseng, 1936). B. Collection sites during 1990/1992 (small dots, after Titlyanov *et al.* 2011a) and 2008–2012 (large dots).

identified by B. Xia and I. Bartsch in 1990–1994 and by T. Titlyanova and E. Titlyanov in 2007–2009. On the basis of these materials, the following papers were published: Bischoff *et al.* 1994, Fiege, Neumann & Jinhe 1994, Titlyanov *et al.* 2011a, Titlyanova *et al.* 2012 and one paper is in press (Titlyanov *et al.* 2014b).

The third series of collection was conducted in October 2008, April 2009, December 2010 and February–April 2012 by T. Titlyanova, E. Titlyanov and Li Xiu Bao on the southern, eastern and northern shores of Hainan Island, including 8 localities: Luhuitou, Xiaodong Hai, Dadong Hai, Yalong Wan, Wenchang, Haikou, Meixia and Xianhai (Fig. 1B). Algae were sampled from the splash, intertidal and shallow subtidal (up to 5 m depth) zones. Results were partially published (Titlyanov *et al.* 2011a, b, 2014 a, b, c, Titlyanov & Titlyanova 2012, 2013).

The purpose of the present study is to make an annotated account of the seaweeds (Chlorophyta,

Ochrophyta and Rhodophyta) of Hainan Island and nearby islets using all published information (1935–2014) plus our unpublished data of the last investigation in 2012. On the basis of earlier published works and this annotated account, some features of decadal changes in the marine flora of the island are noted, with a discussion of possible reasons behind the changes.

### Materials and Methods

#### Characteristic of sampling locations

In earlier publications on the marine flora of Hainan Island, descriptions of sampling locations were practically absent. For the 1990/1992 collection, sampling localities were partially described (Titlyanov *et al.* 2011a) according to the materials of the German-Chinese expeditions and personal communications of the expedition participants (Inka Bartsch and Xia Bangmei). During the 1990/1992 the intertidal/infralittoral reef flats (Linchang, Yalong Wan, Dadong Hai, Xiaodong Hai and Luhuitou) were characterized by unstable blocks of dead corals; sometimes stones or boulders were interspersed with sandy areas. The offshore island of Ximao Zhou was the only place where the amount of living corals increased with depth in the shallow subtidal, and was

generally rich in species. The low water mark, however, was characterized by dead coral blocks. Sandy beaches with interspersed dead coral blocks were present at Xianhai. Poorly developed mangrove areas with extensive mudflats and seagrass fields were present at Qukou and Qinglan Gang. Near Haikou, algae were collected from fishponds with variable salinity. At Meixia in the north of the island, extensive stony intertidal areas with offshore reef flats mostly comprising dead corals were dominant. An extensive reef flat with many living corals above or between dead corals was located at Nanmai, a few hundred meters west of Meixia.

In 2008–2012, Luhuitou and Dadong Hai were characterized by damaged coral reefs (projective cover of live corals amounted from 30 to 50%, respectively), whereas Xiaodong Hai was characterized mainly by dead coral reefs and seagrass beds. The most studied site during this period was the Luhuitou coral reef, situated opposite the Marine Biological Station (South China Sea Institute of Oceanology, Chinese Academy of Sciences) (Fig. 2–4).

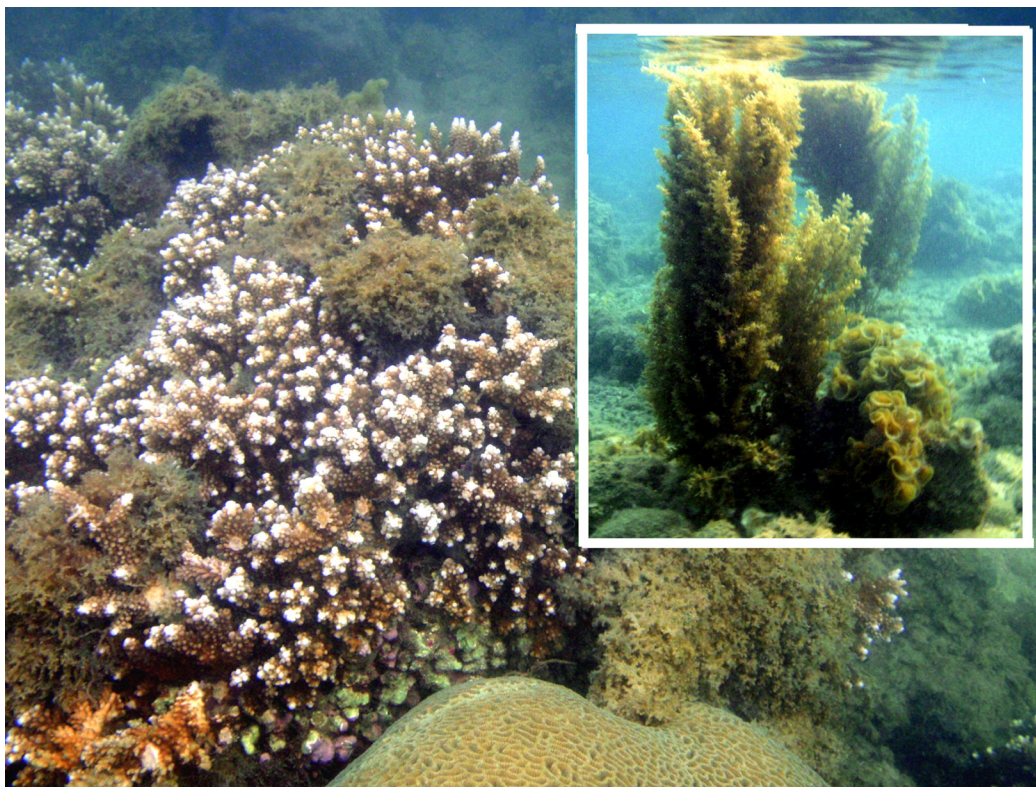
The Xipai site (small rocky islet) in Yalong Wan Bay was characterized by sandy substrates with unstable blocks of dead corals, stones or boulders and rocky substrates near the islet. Algae were collected from intertidal rocks at Wenchang and from materials cast ashore and fishery nets which were placed on (mostly dead) coral reefs at Xianhai. The Meixia site was characterized by an extensive stony



**Figure 2.** The intertidal zone at Luhuitou Peninsula, April 2009. Inset: algal turf community in the middle intertidal zone (see Titlyanov *et al.* 2014d for details).



**Figure 3.** The intertidal zone of coral reef at Luhuitou Peninsula, April 2009.  
Inset: algal turf community at low intertidal (for details, see Titlyanov *et al.* 2014d).



**Figure 4.** The upper subtidal zone at coral reef of Luhuitou Peninsula, March 2012. Inset: *Sargassum* spp. community (for details, see Titlyanov *et al.* 2014a)

intertidal area (cape site), a sandy beach and the upper intertidal fringed by offshore reef flat mostly comprising dead corals and rare live colonies. In March 2012, during sampling at Meixia, a green algal bloom (*Monostroma nitidum* and *Ulva* spp.) forming an extensive band on the beach was observed. At Haikou (very polluted area with green algal blooms), algae were collected from intertidal rocks and sandy beaches where seaweeds were washed ashore.

#### Conservation and identification of marine plants

Herbarized specimens (from 1990 and 1992 collections) and freshly collected algal samples (2008–2012) were identified using monographic publications, floristic studies and systematic articles by Børgesen 1913, 1914, 1915–1920, 1924, 1940, 1948, Setchell & Gardner 1930, Yamada 1934, Tanaka 1938, Shen & Fan 1950, Taylor 1950, 1960, 1966, Egerod 1952, Dawson 1954, 1956, 1957, 1961, 1962, Durairatnam 1961, Zinova 1967, Womersley 1967, 1981, 1984, 1987, 1994, Hollenberg 1968a, b, Trono 1968, 1969, 1997, Pham 1969, Womersley & Bailey 1970, Itono 1972,

Jaasund 1976, Reyes 1976, Abbott & Hollenberg 1976, Vinogradova 1979, Perestenko 1980, Trono & Put 1982, Lewis & Norris 1987, Santelices, 1988, Trono & Ganzon-Fortes 1988, Kornmann 1989, Luan 1989, Price & Scott 1992, Wynne 1993, 1995, Lewis & Mei-Lan 1996, Draisma et al., 1998, Abbott 1999, Huang 1999, Littler & Littler 2000, 2003, Leliaert & Coppejans 2003, Skelton 2003, Abbott & Huisman 2004, Saunders & Hommersand 2004, Skelton & South 2004, 2007, South & Skelton 2003, Tsuda 2006, Brodie, Maggs & John 2007, Dawes & Mathieson 2008, Tadashi et al. 2008, and also the above mentioned publications of the Chinese authors (see Introduction).

The systematics and nomenclature followed Guiry & Guiry (AlgaeBase, searched in 2014). The previously known and newly recorded species for Hainan and China were verified using Algaebase, the Catalogue of Life China (2010), Annual Checklist and The checklist of marine biota of China seas (Liu 2008). Hierarchical classification of the Phylum Rhodophyta is from Saunders and Hommersand (2004). The classification system of the Phyla Chlorophyta and Ochrophyta basically follows Tsuda (2006).

## Results

The results of the present study are shown in Table 1, which documents 506 species of red, brown and green marine algae in Hainan Island. The Phylum Rhodophyta comprised 4 classes, 19 orders, 37 families, 103 genera and 289 species (57% of all species). Ochrophyta comprised 2 classes, 8 orders, 10 families, 24 genera and 92 species (18%) and Chlorophyta comprised 5 classes, 8 orders, 20 families, 40 genera and 125 species (25%).

A total of 39 new taxa were found in 2008–2012 on Hainan Island (17 reds, 10 browns and 11 greens). Of these, 16 are new for China (8 reds, 3 browns and 5 greens): *Acrochaetium chaetomorphae*, *Pneophyllum confervicola*, *Chondria minutula*, *Ch. pygmaea*, *Polysiphonia exilis*, *P. pseudovillum*, *Peyssonnelia boergesenii*, *Peyssonnelia inamoena* (Rh); *Chilionema ocellatum*, *Sargassum miyabei*, *Turbinaria ornata* var. *cordata* (Oc); *Ulothrix subflaccida*, *Ulva rigida*, *Cladophoropsis membranacea*, *Siphonocladus rigidus*, *Caulerpa fastigiata*.

In the 1990–2012 survey, high algal species richness was recorded at Luhuitou (222 taxa), Xiaodong Hai (148), Yalong Wan (122 taxa), Dadong Hai (89 taxa), Shalao (83 taxa), Wenchang (76 taxa), Ximao Zhou (63 taxa), while other localities had much less species. Thus, more algal species occurred in coral reef localities.

## Discussion

In terms of species richness, Hainan Island was close to Taiwan where 476 species of algae were found (Zhang 1996, Lewis & Norris 1987). We consider that the reason of such high similarity is the geographical closeness of these islands, and the intensity of study of their marine floras in comparison with other subtropical and tropical areas of China.

The floristic composition of macrophytes in Hainan Island (Rhodophyta 57%, Chlorophyta 25% and Ochrophyta 18%) was also similar to that of Taiwan (55%, 24% and 21%, respectively) and the southern coasts of China (56%, 23% and 19%, respectively) (Zhang 1996, Lewis & Norris 1987).

The first marine floristic study in Hainan was conducted in 1933 and the subsequent studies were carried out in the 1950s–1970s, 1990/1992 and after 2000 up to now. Floristic similarity between the periods of the 1930s–1970s and 2008–2012 amounted to 33% (Rh), 41% (Oc) and 53% (Ch), while that between 1990/1992 and 2008–2012 was 65% (Rh), 55% (Oc) and 53% (Ch) (Titlyanov et al. 2014c).

These results suggest that conspicuous changes in algal species diversity and composition occurred from the 1930s to 2012, as exemplified by a decline in species richness and the appearance of new algal species. The largest numbers of taxa losses were recorded for families

**Table 1.** Algal species recorded from Hainan Island, from the 1930s to 2010s.

Taxa recorded during three periods are shown. Locality abbreviations: Baishamen (Haikou fish pond), **Bh**; Dadong Hai, **Dh**; Haikou, **Hk**; Linchang, **Lc**; Lingao Jiao, **Lj**; Luhuitou, **Lh**; Nanmai, **Nm**; Meixia, **Mx**; Qinglan Gang, **Qg**; Qukou, **Qk**; Shalao, **Sl**; Tian Ya Hai Tiao, **Ty**; Tielu Gang, **Tg**; Wenchang, **Wc**; Yalong Wan, **Yw**; Xianhai, **Xn**; Xiaodong Hai, **Xh**; Xincun, **Xc**; Ximao Zhou, **Xz**. For the 1930s-70s, + denotes occurrence (locality not known). \* - New records for Hainan island; \*\* - new records for China.

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<b>Division RHODOPHYTA</b>				
<b>CLASS RHODELLOPHYCEAE</b>				
<b>ORDER STYLOMEMATALES</b>				
<b>Family Stylomemataceae</b>				
<i>Chroodactylon ornatum</i> (C. Agardh) Basson		Lc, Yw, Dh, Xh, Lh, Ty	Xh, Lh	1; 14
<i>Stylonema alsidii</i> (Zanardini) K.M. Drew		Lc, Nm, Lj, Mx, Qk, Sl, Xc, Yw, Dh, Xh, Xz, Ty	Wc, Mx, Yw, Dh, Lh	1; 14
<b>CLASS COMSPOGONOPHYCEAE</b>				
<b>ORDER ERTHROPELTIDALES</b>				
<b>Family Erythrotrichiaceae</b>				
<i>Erythrotrichia carnea</i> (Dillwyn) J. Agardh		Lc, Nm, Mx, Qk, Sl, Yw, Dh, Xh, Lh, Xz, Ty	Mx, Wc, Yw, Dh, Xh, Lh	1; 14
<i>Erythrocladia irregularis</i> Rosenvinge		Xh, Ty	Wc, Yw, Lh	1
<i>Porphyrostromium japonicum</i> (Tokida) Kikuchi		Qk		3
<i>Sahlvingia subintegra</i> (Rosenvinge) Kormmann		Sl, Xc, Xh, Ty	Mx, Wc, Yw, Lh	1; 14
<b>CLASS BANGIOPHYCEAE</b>				
<b>ORDER BANGIALES</b>				
<b>Family Bangiaceae</b>				
<i>Porphyra crispata</i> Kjellman	+			4
<i>Pyropia vietnamensis</i> (T. Tanaka & P.H. Ho) J.E. Sutherland & Monotilla	+			4; 5; 6 (as <i>Porphyra vietnamensis</i> )
<b>CLASS FLORIDEOPHYCEAE</b>				
<b>ORDER HILDENBRANDIALES</b>				
<b>Family Hildenbrandiaceae</b>				
<i>Hildenbrandia rubra</i> (Sommerfelt) Meneghini			Mx, Xh, Dh, Lh	2
<b>ORDER NEMALIALES</b>				
<b>Family Galaxauraceae</b>				
<i>Actinotrichia fragilis</i> (Forsskål) Børgesen	+	Sl, Yw, Lh, Xz, Ty	Yw, Lh	4; 5; 7; 8; 9; 14
<i>Dichotomaria apiculata</i> (Kjellman) Kurihara & Masuda	+			4 (as <i>Galaxaura apiculata</i> ); 9
<i>Dichotomaria falcata</i> (Kjellman) Kurihara & Masuda		Xz		3
<i>Dichotomaria marginata</i> (J. Ellis & Solander) Lamarck	+		Lh	4, (as <i>Galaxaura ventricosa</i> , <i>G. veprecula</i> ) 5; 9
<i>Dichotomaria obtusata</i> (J. Ellis & Solander) Lamarck	+			7; 9 (as <i>Galaxaura obtusata</i> )
<i>Dichotomaria spathulata</i> (Kjellman) A. Kurihara & Huisman	+	Dh		5; 7; 9 (as <i>Galaxaura arborea</i> ); 10; 12
<i>Galaxaura divaricata</i> (Linnaeus) Huisman & R.A. Townsend	+			7; 5 (as <i>G. fasciculata</i> )
<i>Galaxaura filamentosa</i> R. Chou in W.R. Taylor	+			5; 7 (as <i>G. rudis</i> ); 9
<i>Galaxaura rugosa</i> (J. Ellis & Solander) J.V. Lamouroux	+		Lh	9 (as <i>G. glabriuscula</i> , <i>G. pacifica</i> , <i>G. subfruticulosa</i> )
<i>Tricleocarpa cylindrica</i> (J. Ellis & Solander) Huisman & Borowitzka*			Xh, Lh	This paper

Species, varieties and forms		1930s - 1970s	1990, 1992	2008 - 2012	References
<i>Tricleocarpa fragilis</i> (Linnaeus) Huisman & R.A. Townsend		+	Dh, Xh, Xz	Wc, Lh	5; 7; 9 (as <i>Tricleocarpa oblongata</i> ); 12 (as <i>Galaxaura oblongata</i> ); 14
<b>Family Liagoraceae</b>					
<i>Dermonema pulvinatum</i> (Grunow ex Holmes) Fan		+	Sl		4; 9
<i>Dermonema virens</i> (J. Agardh) Pedroche & Avila Ortiz		+			4; 9
<i>Dotyophycus hainanensis</i> Tseng & Li		+			4; 9
<i>Ganonema farinosum</i> (Lamouroux) Fan et Wang		+	Sl	Lh	4 (as <i>Ganonema farinosa</i> ); 5; 9; 13 (as <i>Liagora farinosa</i> )
<i>Ganonema papenfussii</i> (I.A. Abbott) J.M. Huisman, I.A. Abbott, & A.R. Sherwood		+			4 (as <i>Liagora papenfussii</i> ); 9
<i>Ganonema pinnatifidum</i> (Yamada) K.C. Fan & Y.C. Wang		+			4; 9
<i>Ganonema pinnatum</i> (Harvey) Huisman		+			4 (as <i>Liagora pinnata</i> ); 9
<i>Ganonema samaense</i> (C.K. Tseng) Huisman		+			4; 9 (as <i>Liagora samaensis</i> ); 13
<i>Helminthocladia australis</i> Harvey		+			4; 5; 9
<i>Helminthocladia hainanensis</i> Tseng & Li		+			4; 9
<i>Helminthocladia pinnata</i> Tseng & Li		+			4; 9
<i>Izziella formosana</i> (Yamada) S.M. Lin, S.-Y. Yang & Huisman		+			13 (as <i>Liagora formosana</i> )
<i>Izziella orientalis</i> (J. Agardh) Huisman & Schils		+	Xh		4 (as <i>Liagora orientalis</i> ); 9
<i>Liagora albicans</i> J.V. Lamouroux		+			4; 9
<i>Liagora boergesenii</i> Yamada		+			4; 9
<i>Liagora ceranoides</i> J.V. Lamouroux		+	Xh	Lh	4; 5; 9; 13; 14
<i>Liagora clavata</i> Yamada		+			4; 9
<i>Liagora dongdaoensis</i> Tseng & Li		+			4; 9
<i>Liagora fanii</i> Tseng & Li		+			4; 9
<i>Liagora filiformis</i> Fan & Li		+			4; 9; 5
<i>Liagora hainanensis</i> C. K. Tseng & Li		+			5; 9
<i>Liagora paniculata</i> Tseng & Li		+			4; 9
<i>Liagora qishuiwanensis</i> Li		+			4; 9
<i>Liagora rhizophora</i> Tseng & Li		+			4; 9; 4
<i>Liagora robusta</i> Yamada		+			5; 9; 4
<i>Liagora rubra</i> C.K. Tseng & Li		+			9; 4
<i>Liagora segawae</i> Yamada		+			5; 9
<i>Liagora sinensis</i> K.C. Fan, Y.C. Wang & K.Y. Pan		+			4; 9
<i>Liagora subdichotoma</i> Tseng & Li		+			4; 9
<i>Liagora wicensis</i> Tseng & Li		+			4; 9
<i>Liagora wilsoniana</i> Zeh		+			4; 9
<i>Macrocarpus perennis</i> (I.A. Abbott) S.M. Lin, S.-Y. Yang & Huisman		+			4 (as <i>Liagora perennis</i> ); 9
<i>Neozziella divaricata</i> (C.K. Tseng) S.M. Lin, S.-Y. Yang & Huisman		+			4 (as <i>Liagora divaricata</i> ); 9; 13
<i>Sinocladia divergenscata</i> Tseng & Li		+			4; 9
<i>Sinocladia dongjiaoensis</i> Tseng & Li		+			4; 9
<i>Sinocladia flabelliformis</i> Tseng & Li		+			4; 9
<i>Sinocladia hainanensis</i> Tseng & Li		+			4; 9
<i>Sinocladia paniculata</i> C.K. Tseng & W. Li		+			4; 9
<i>Sinocladia pinnata</i> Tseng & Li		+			4; 9
<i>Sinocladia qionghaiensis</i> Tseng & Li		+			4; 9
<i>Sinocladia ramosissima</i> Tseng & Li		+			4; 9
<i>Titanophycus setchellii</i> (Yamada) S.-M. Lin, S.-Y. Yang & Huisman		+			4; 9
<i>Titanophycus validus</i> (Harvey) Huisman, G.W. Saunders & A.R. Sherwood		+			4 (as <i>Liagora valida</i> ); 9
<i>Trichogloeopsis hawaiiensis</i> I.A. Abbott & Doty		+			4; 9
<i>Trichogloeopsis mucosissima</i> (Yamada) I.A. Abbott & Doty		+	Xh		4; 9



Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<i>Yamadaella caenomyce</i> (Decaisne) I.A. Abbott	+			4; 9; 13 (as <i>Liagora caenomyce</i> )
<b>Family Scinaiaaceae</b>				
<i>Scinaia boergesenii</i> C.K. Tseng	+	Sl, Yw		4; 5; 7; 9
<i>Scinaia chinensis</i> (C.K. Tseng) Huisman	+	Sl		5 (as <i>Gloiofovea chinensis</i> ); 7
<i>Scinaia latifrons</i> M.A. Howe	+			4; 5 (as <i>S. coltonii</i> )
<i>Scinaia tsinglanensis</i> C.K. Tseng	+			4; 5; 7; 9
<b>ORDER ACROCHAETIALES</b>				
<b>Family Acrochaetiaceae</b>				
<i>Acrochaetium catenulatum</i> M.A. Howe		Xh		3
<i>Acrochaetium chaetomorphae</i> (Tanaka & Pham-Hoàng Hô) Heerebout**			Dh, Lh	This paper
<i>Acrochaetium globosum</i> Børgesen	+			4 (as <i>Audouinella globosa</i> ); 9
<i>Acrochaetium macula</i> (Rosenvinge) G. Hamel	+			4; 9
<i>Acrochaetium microscopium</i> (Nägeli ex Kützing) Nægeli	+	Lc, Sl, Yw, Dh, Xh, Ty	Wc, Yw, Lh	4; 9; 14
<i>Acrochaetium netrocarpum</i> Børgesen	+			4 (as <i>Audouinella netrocarpa</i> ); 9
<i>Acrochaetium robustum</i> Børgesen	+	Nm, Mx, Sl, Yw	Wc, Lh	4 (as <i>Audouinella robusta</i> ); 14
<i>Acrochaetium ryukyense</i> (Nakamura) Papenfuss	+			4 (as <i>Audouinella ryukyensis</i> ); 9
<i>Acrochaetium secundatum</i> (Lyngbye) Nægeli	+	Nm, Yw		3
<i>Acrochaetium subseriatum</i> Børgesen		Xh		3
<i>Acrochaetium virgatulum</i> (Harvey) Batters		Nm, Yw	Yw, Lh	3
<i>Acrochaetium yamadae</i> (Garbary) Y. Lee & I.K. Lee	+			4 (as <i>Liagorophila endophytica</i> ); 9
<b>ORDER COLACONEMATALES</b>				
<b>Family Colaconemataceae</b>				
<i>Colaconema bonnemaisoniae</i> Batters	+	Xh		3
<i>Colaconema daviesii</i> (Dillwyn) Stegenga		Xh	Lh	3
<i>Colaconema dictyota</i> (Collins) I.-K. Hwang & H.-S. Kim	+			4 (as <i>Audouinella dictyota</i> ); 9
<i>Colaconema gracile</i> (Børgesen) Atewberhan & Prud'homme van Reine	+	Sl, Xh	Mx, Yw, Lh	4 (as <i>Audouinella gracilis</i> ); 9; 14
<i>Colaconema hypneae</i> (Børgesen) A.A. Santos & C.W.N. Moura	+	Dh, Xh, Lh	Wc, Xh, Lh	4 (as <i>Audouinella hypneae</i> , <i>A. seriata</i> ); 9
<b>ORDER CORALLINALES</b>				
<b>Family Corallinaceae</b>				
<i>Amphiroa anastomosans</i> Weber-van Bosse	+			4; 5
<i>Amphiroa beauvoisii</i> J.V. Lamouroux	+		Lh	5 (as <i>Amphiroa zonata</i> )
<i>Amphiroa foliacea</i> J.V. Lamouroux		Sl, Lh	Wc, Dh, Xh, Lh	1; 14
<i>Amphiroa fragilissima</i> (Linnaeus) J.V. Lamouroux	+	Sl, Yw	Xh, Lh	5; 14
<i>Amphiroa fragilissima</i> f. <i>cyathifera</i> (J.V. Lamouroux) Weber-van Bosse	+	Sl	Lh	5
<i>Hydroolithon boreale</i> (Foslie) Y.M. Chamberlain		Sl	Lh, Yw	1; 14
<i>Hydroolithon farinosum</i> (J.V. Lamouroux) D. Penrose & Y.M. Chamberlain		Qk, Qg, Sl, Yw, Dh, Xh, Lh, Xz, Ty	Wc, Yw, Xh, Lh	1; 14
<i>Hydroolithon onkodes</i> (Heydrich) D. Penrose & Woelkerling	+			4; 5 (as <i>Porolithon onkodes</i> )
<i>Hydroolithon reinboldii</i> (Weber-van Bosse & Foslie) Foslie	+		Wc	4; 5
<i>Jania acutiloba</i> (Decaisne) J.H. Kim, Guiry & H.-G. Choi	+	Ty		5 (as <i>Cheilosporum jungermannioides</i> ); 4 (as <i>Cheilosporum acutilobum</i> )
<i>Jania adhaerens</i> J.V. Lamouroux	+	Mx, Qk, Sl, Xh, Lh, Xz	Wc, Mx, Yw, Xh, Lh	4; 14
<i>Jania capillacea</i> Harvey		Nm, Mx, Sl, Xh, Yw, Dh, Lh, Xz, Ty	Mx, Yw, Lh	1; 14
<i>Jania crassa</i> J.V. Lamouroux	+			5
<i>Jania pumila</i> J.V. Lamouroux		Xc, Dh, Xh, Xz	Lh, Yw	1; 14
<i>Jania unguilata</i> f. <i>brevior</i> (Yendo) Yendo		Xh, Lh	Wc, Yw, Dh, Xh, Lh	1; 14
<i>Jania verrucosa</i> J.V. Lamouroux	+			4

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<i>Mastophora pacifica</i> (Heydrich) Foslie	+			4; 5 (as <i>Lithoporella pacifica</i> )
<i>Mastophora rosea</i> (C. Agardh) Setchell	+		Wc	4; 5
<i>Lithophyllum kotschyannum</i> Unger	+			4; 5
<i>Lithophyllum pygmaeum</i> (Heydrich) Heydrich	+		Yw	4; 5 (as <i>Lithophyllum moluccense</i> )
<i>Lithophyllum tumidulum</i> Foslie*			Wc, Lh	This paper
<i>Lithoporella melobesoides</i> (Foslie) Foslie	+		Lh	4; 5
<i>Neogoniolithon megalocystum</i> (Weber-van Bosse & Foslie) Setchell & L.R. Mason*			Lh	This paper
<i>Pneophyllum confervicola</i> (Kützing) Y.M. Chamberlain**		Mx, Nm, Sl, Yw, Dh, Xh, Lh, Xz, Ty	Wc, Lh	This paper
<i>Pneophyllum fragile</i> Kützing			Wc, Mx, Yw, Lh	1; 14
<b>Family Hapalidiaceae</b>				
<i>Lithothamnion intermedium</i> Kjellman*			Yw	This paper
<i>Lithothamnion phymatodeum</i> Foslie			Lh	2
<i>Mesophyllum mesomorphyum</i> (Foslie) Adey	+			4; 5 (as <i>M. simulans</i> )
<b>Order SPOROLITHALES</b>				
<b>Family Sporolithaceae</b>				
<i>Sporolithon erythraeum</i> (Rothpletz) Kylin	+			4
<b>ORDER AHNFELTIALES</b>				
<b>Family Ahnfeltiaceae</b>				
<i>Ahnfeltia yinggehaiensis</i> B.-M. Xia & Y.-Q. Zhang	+			4; 15; 16
<b>ORDER BONNEMAIISONIALES</b>				
<b>Family Bonnemaisoniaceae</b>				
<i>Asparagopsis taxiformis</i> (Deile) Trevisan de Saint-Léon ( <i>Falkenbergia hillebrandii</i> . Stage of <i>Asparagopsis taxiformis</i> )	+	Sl	Wc, Mx, Yw, Dh, Xh, Lh	4; 9; 10; 12
<b>ORDER CERAMIALES</b>				
<b>Family Ceramiaceae</b>				
<i>Anthamnon antillarum</i> Børgesen		Sl	Dh, Lh	3
<i>Anthamnonella spirographidis</i> (Schiffner) E.M. Wollaston		Sl		3
<i>Anthamnonella elegans</i> (Berthold) J.H. Price & D.M. John			Lh, Yw	3
<i>Centroceras clavulatum</i> (C. Agardh) Montagne	+	Lc, Mx, Sl, Yw, Xh	Mx, Wc, Dh, Xh, Lh Yw, Lh	4; 5; 17; 14
<i>Centroceras japonicum</i> Itono		Sl, Xh, Lh, Xz	Lh	1
<i>Centroceras minutum</i> Yamada		Nm, Xh	Lh	1; 14
<i>Ceramium aduncum</i> Nakamura		Xh	Lh	3
<i>Ceramium borneense</i> Weber-van Bosse			Yw, Xh, Lh	3; 14
<i>Ceramium carouii</i> E.Y. Dawson			Xh, Lh	2
<i>Ceramium cimbriicum</i> H.E. Petersen		Xh	Xn, Wc, Xh, Lh	1; 14
<i>Ceramium cingulatum</i> Weber-van Bosse		Lc, Nm, Sl, Yw, Dh, Xh, Lh, Xz, Ty	Yw, Lh	1; 14
<i>Ceramium codii</i> (H. Richards) Mazoyer			Lh	1
<i>Ceramium comptum</i> Børgesen			Lh	1; 14
<i>Ceramium macilentum</i> J. Agardh		Sl, Xh, Xz	Xh, Lh	3
<i>Ceramium marshallense</i> E.Y. Dawson			Yw, Xh, Lh	1
<i>Ceramium procumbens</i> Setchell & N.L. Gardner			Xh, Lh	3
<i>Ceramium tenerimum</i> (G. Martens) Okamura		Nm, Xn, Sl, Xh Xh	Lh	1; 14
<i>Ceramium vagans</i> P.C. Silva			Wc, Yw, Lh	2
<i>Coralophila kleiwegii</i> Weber-van Bosse		Xh, Lh, Xz	Wc, Yw, Xh, Lh	1; 14
<i>Gayliella fimbriata</i> (Setchell & N.L. Gardner) T.O. Cho & S.M. Boo*			Lh	This paper
<i>Gayliella flaccida</i> (Harvey ex Kützing) T.O. Cho & L.J. McIvor		Lj, Sl, Qk, Yw, Dh, Xh	Wc, Yw, Dh, Xh, Lh	1; 14

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<b>Family Callithamniaceae</b>				
<i>Crouania attenuata</i> (C. Agardh) J. Agardh		Nm	Lh	3
<b>Family Delesseriaceae</b>				
<i>Acrosorium ciliolatum</i> (Harvey) Kylin	+			4 (as <i>A. venulosum</i> ); 17
<i>Taenioma perpusillum</i> (J. Agardh) J. Agardh		Mx, Xh, Xz	Lh	3; 4
<b>Family Rhodomelaceae</b>				
<i>Acanthophora muscooides</i> (Linnaeus) Bory de Saint-Vincent	+		Wc, Lh	18; 19; 14
<i>Acanthophora spicifera</i> (M. Vahl) Børgesen	+	Nm, Ok, Sl, Yw, Xh, Xz	Lh	4; 5; 19; 20 (as <i>A. orientalis</i> ); 14
<i>Acrocystis nana</i> Zanardini	+			4; 5
<i>Melanansia glomerata</i> (C. Agardh) R.E. Norris	+	Xh, Lh	Lh	4; 5 (as <i>Amansia glomerata</i> ); 19
<i>Bostrychia tenella</i> (J.V. Lamouroux) J. Agardh	+	Nm, Dh, Xh	Dh	4; 5; 12 (as <i>B. binderi</i> , <i>B. tenella</i> ); 19; 21
<i>Chondria armata</i> (Kützinger) Okamura	+		Yw, Lh	4; 5; 19
<i>Chondria minutula</i> Weber-van Bosse**			Lh	This paper
<i>Chondria pygmaea</i> Garbary & Vandermeulen**			Lh	This paper
<i>Chondria repens</i> Børgesen		Dh, Xh, Xz	Mx, Yw, Xh, Lh	1; 14
<i>Chondrophycus cartilagineus</i> (Yamada) Garbary & J.T. Harper	+	Nm, Yw, Xh, Xz		4 (as <i>Chondrophycus cartilagineus</i> ); 19
<i>Chondrophycus undulatus</i> (Yamada) Garbary & Harper	+			4; 19 (as <i>Chondrophycus undulata</i> )
<i>Herposiphonia parca</i> Setchell		Yw, Xh, Xz	Yw, Lh	3
<i>Herposiphonia secunda</i> (C. Agardh) Ambron		Yw, Xh, Lh, Xz, Ty	Wc, Yw, Xh, Lh	1; 14
<i>Herposiphonia secunda</i> f. <i>tenella</i> (C. Agardh) M.J. Wynne		Yw, Xh, Lh	Dh, Xh, Lh	1; 14
<i>Laurencia decumbens</i> Kützinger			Lh	1
<i>Laurencia majuscula</i> (Harvey) A.H.S. Lucas	+			4; 19
<i>Laurencia mariannensis</i> Yamada	+			4; 19
<i>Laurencia nanhaiense</i> L. Ding, B. Huang, B. Xia & C.K. Tseng	+			19; 23
<i>Laurencia okamurae</i> Yamada	+			4
<i>Laurencia pinnata</i> Yamada*			Lh	This paper
<i>Laurencia similis</i> Nam & Saito	+			4; 19
<i>Laurencia tropica</i> Yamada	+			4; 5; 19; 24; 25 (as <i>L. flexilis</i> var. <i>tropica</i> )
<i>Leveillea jungermannioides</i> (K. Hering & G. Martens) Harvey	+	Mx, Yw, Dh, Xh, Xz	Yw, Dh, Xh, Lh	4; 5; 19; 14
<i>Lophosiphonia cristata</i> Falkenberg			Lh	3
<i>Lophosiphonia reptabunda</i> (Suhr) Kylin		Ty		3
<i>Neosiphonia ferulacea</i> (Suhr ex J. Agardh) S.M. Guimaraes & M.T. Fujii		Dh, Xh	Yw, Lh	1; 14
<i>Neosiphonia harlandii</i> (Harvey) M.S. Kim & I.K. Lee	+			4; 5
<i>Neosiphonia harveyi</i> (J. Bailey) M.-S. Kim, H.-G. Choi, Guiry & G.W. Saunders	+			4; 14
<i>Neosiphonia sphaerocarpa</i> (Børgesen) M.S. Kim & I.K. Lee	+	Dh, Xh	Wc, Yw, Lh	4; 19; 14
<i>Neosiphonia tongtensis</i> (Harvey ex Kützinger) M. S. Kim & I.K. Lee	+	Yw, Xh, Xz	Yw, Lh	1; 19; 14
<i>Palisada parvipapillata</i> (C.K. Tseng) K.W. Nam	+	Nm, Sl, Yw, Lh, Xz	Yw, Lh	3; 19
<i>Palisada perforata</i> (Bory de Saint-Vincent) K.W. Nam	+	Nm, Sl, Xh, Lh	Dh, Xh, Lh	1; 19 (as <i>P. papillosa</i> )
<i>Polysiphonia blandii</i> Harvey	+			19
<i>Polysiphonia crassa</i> Okamura	+			19
<i>Polysiphonia exilis</i> **			Lh	This paper
<i>Polysiphonia ferulacea</i> Suhr ex J. Agardh f. <i>implicata</i> Tseng	+			19
<i>Polysiphonia howei</i> Hollenberg	+		Lh	4; 19
<i>Polysiphonia japonica</i> var. <i>savatieri</i> (Hariot) Yoon			Lh	1; 14
<i>Polysiphonia pseudovillum</i> Hollenberg**			Lh	This paper
<i>Polysiphonia scopulorum</i> Harvey		Sl, Yw, Xh, Lh, Ty	Lh	3
<i>Polysiphonia scopulorum</i> var. <i>villum</i> (J. Agardh) Hollenberg		Sl, Dh, Xh, Lh, Xz	Yw, Xh, Lh	1; 14
<i>Polysiphonia subtilissima</i> Montagne		Lc, Lj, Sl, Yw, Dh, Xh, Xz, Ty	Yw, Dh, Xh, Lh	1

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<i>Tolyoplocia condensata</i> (Weber-van Bosse) P.C. Silva		Xh		3
<i>Tolyoplocia glomerulata</i> (C. Agardh) F. Schmitz	+	Qk, Dh, Xh, Lh, Xz	Yw, Lh	4; 5; 19; 14
<b>Family Spyridiaceae</b>				
<i>Spyridia filamentosa</i> (Wulfen) Harvey	+	Qk, Xh, Lh	Lh	26; 14
<b>Family Wrangelaceae</b>				
<i>Anotrichium tenue</i> (C. Agardh) Nägeli	+	Nm, Xh	Wc, Yw, Dh, Xh, Lh	4; 5; 11 (as <i>Griffithsia tenuis</i> ); 14
<i>Gordoniella yonakuniensis</i> (Yamada & T. Tanaka) Itono		Dh, Xz		3
<i>Griffithsia heteromorpha</i> Kützing	+		Lh	4; 11 (as <i>G. rhizophora</i> ); 26; 14
<i>Griffithsia metcaiffii</i> C.K. Tseng	+		Yw, Lh	4; 5; 11; 26; 27; 14
<i>Griffithsia metcaiffii</i> f. <i>subsecunda</i> C.K. Tseng	+			11; 26
<i>Griffithsia subcylindrica</i> Okamura	+		Yw, Lh	4; 5; 11; 26
<i>Wrangella argus</i> (Montagne) Montagne		Qk	Yw, Lh	1; 14
<i>Wrangella hainanensis</i> C.K. Tseng	+	Qk		4; 5; 26; 28
<b>ORDER GELIDIALES</b>				
<b>Family Gelidiaceae</b>				
<i>Gelidium crinale</i> (Hare ex Turner) Gaillon		Mx, Qk, Qg, Yw, Xh, Lh, Xz	Wc, Lh	3
<i>Gelidium divaricatum</i> G. Martens		Mx, Sl	Wc, Lh	3
<i>Gelidium pusillum</i> (Stackhouse) Le Jolis	+	Lc, Nm, Mx, Yw, Lh	Wc, Yw, Xh, Lh	29; 30; 14
<i>Gelidium pusillum</i> var. <i>cylindricum</i> W.R. Taylor	+	Xh, Lh	Wc, Lh	31; 32; 33
<i>Gelidium pusillum</i> var. <i>pacificum</i> W.R. Taylor	+		Wc, Lh	4; 31 32; 33
<b>Family Gelidiellaceae</b>				
<i>Gelidiella acerosa</i> (Forsskål) Feldmann & G. Hamel	+	Lc, Nm, Qk, Sl, Yw, Dh, Xh, Lh, Xz, Ty	Wc, Dh, Xh, Lh	4; 5; 29; 31; 32; 33; 34; 14
<i>Gelidiella bornetii</i> (Weber-van Bosse) Feldmann & C. Hamel (Hainan)	+	Xh		33
<i>Gelidiella lubrica</i> (Kützing) Feldmann & G. Hamel		Xh		3
<i>Parviphycus adnatus</i> (E.Y. Dawson) B. Santelices		Sl, Xh, Lh	Lh	3; 14
<i>Parviphycus pannosus</i> (Feldmann) G. Fumar		Xh, Xz, Lh	Wc, Yw, Dh, Xh, Lh	3; 14
<b>Family Pterocliadiaceae</b>				
<i>Pterocliadiella caerulea</i> (Kützing) Santelices & Hommersand	+		Wc, Xh, Lh	4; 30; 33 (as <i>Gelidium pusillum</i> var. <i>conchicola</i> )
<i>Pterocliadiella capillacea</i> (S.G. Gmelin) Santelices & Hommersand		Xh	Lh	3
<i>Pterocliadiella yinggehaiensis</i> B.M. Xia & C.K. Tseng	+			4; 33
<b>ORDER GIGARTINALES</b>				
<b>Family Cystocloniaceae</b>				
<i>Hypnea boergesenii</i> T. Tanaka	+			4; 16; 35
<i>Hypnea cenomyce</i> J. Agardh*			Mx, Yw, Lh	This paper
<i>Hypnea charoides</i> J.V. Lamouroux	+	Hk, Xh		4; 16; 17
<i>Hypnea cornuta</i> (Kützing) J. Agardh	+	Nm		4; 35; 36
<i>Hypnea esperi</i> Bory de Saint-Vincent			Yw, Lh	1; 14
<i>Hypnea japonica</i> Tanaka	+			2; 4; 5; 16; 35
<i>Hypnea musciformis</i> var. <i>esperii</i> J. Agardh		Lc, Nm, Dh, Xh		3
<i>Hypnea nidulans</i> Setchell*			Lh	This paper
<i>Hypnea pannosa</i> J. Agardh	+	Lc, Nm, Sl, Dh, Xh	Yw, Dh, Xh, Lh	4; 5; 16; 35; 14
<i>Hypnea spinella</i> (C. Agardh) Kützing	+	Lj, Mx, Xn, Sl, Dh, Xh, Lh, Xz, Ty	Mx, Yw, Dh, Lh	4; 5; 16; 35; 37; 14

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<i>Hypnea valentiae</i> (Turner) Montagne			Mx, Lh	1, 14
<b>Family Gigartinales</b>				
<i>Chondracanthus intermedius</i> (Suringar) Hommersand*			Mx, Xn	This paper
<b>Family Peyssonneliaceae</b>				
<i>Peyssonnelia boergesenii</i> Weber-van Bosse**	+		Yw, Lh	This paper
<i>Peyssonnelia conchicola</i> Piccone & Grunow			Yw, Dh, Xh, Lh	32; 4; 14
<i>Peyssonnelia inamoena</i> Pilger			Yw, Lh	14
<i>Peyssonnelia orientalis</i> (Weber-van Bosse) Cormaci & G. Furnari	+	Mx, Si, Xn	Yw, Lh	4; 5 (as <i>P. rubra</i> var. <i>orientalis</i> ); 32
<i>Peyssonnelia rubra</i> (Greville) J. Agardh		Si	Mx, Wc, Yw, Lh	1, 14
<b>Family Phylloporaceae</b>				
<i>Ahnfeltiopsis flabelliformis</i> (Harvey) Masuda	+		Xn	4; 16
<i>Ahnfeltiopsis hainanensis</i> B.-M. Xia & Y.-Q. Zhang	+			4; 16; 37
<i>Ahnfeltiopsis pygmaea</i> (J. Agardh) P.C. Silva & DeCew	+			4; 16; 38
<b>Family Rhizophyllidaceae</b>				
<i>Portieria hornemannii</i> (Lyngbye) P.C. Silva		Si		3
<b>Family Solieriaceae</b>				
<i>Betaphycus gelatinum</i> (Esper) Doty ex P.C. Silva	+	Si		5 (as <i>Euclidean gelatinum</i> ); 16
<i>Euclidean edule</i> (Kützinger) Weber-van Bosse	+			20
<i>Euclidean serra</i> (J. Agardh) J. Agardh	+			4; 16
<i>Kappaphycus alvarezii</i> (Doty) Doty ex P.C. Silva	+			4; 16
<i>Kappaphycus cottonii</i> (Weber-van Bosse) Doty ex P.C. Silva	+			4; 16; 39
<i>Sarcocnema filiforme</i> (Sonder) Kylin	+			4; 5; 16
<i>Sarcocnema gracilarioides</i> Zhang & E.Z. Xia	+			4; 5; 16; 40
<i>Soleria pacifica</i> (Yamada) Yoshida	+			4; 5 (as <i>S. robusta</i> ); 16
<i>Wurdemannia miniata</i> (Sprengel) Feldmann & G. Hamel	+			4; 16
<b>ORDER GRACILARIALES</b>				
<b>Family Gracilariaceae</b>				
<i>Gracilaria arcuata</i> Zanardini	+			4; 5; 16; 41; 42; 44
<i>Gracilaria articulata</i> C.F. Chang & B.M. Xia	+			4; 5; 16; 41; 43; 44;
<i>Gracilaria blodgettii</i> Harvey	+		Xn	4; 5; 16; 43; 41; 42; 45; 46
<i>Gracilaria bursa-pastoris</i> (Gmelin) P.S. Silva	+			46; 12; 5; 41; 42
<i>Gracilaria canaliculata</i> (Kützinger) Sonder	+			5 (as <i>G. crassa</i> ); 41
<i>Gracilaria changii</i> (B.M. Xia & I.A. Abbott) I.A. Abbott, J. Zhang & B.M. Xia	+	Nm		3
<i>Gracilaria chondracantha</i> (Kützinger) Millar	+			4 (as <i>G. bangmeiana</i> ); 5 (as <i>Polycaavernosa ramulosa</i> ); 16; 43; 44; 47; 48
<i>Gracilaria chorda</i> Holmes	+			4; 5; 16; 41; 42; 43
<i>Gracilaria coronopifolia</i> J. Agardh	+	Xn	Lh	4; 5; 16; 41; 43
<i>Gracilaria cuneifolia</i> (Okamura) I.K. Lee & Kurogi	+	Xn		4; 16; 44; 49
<i>Gracilaria glomerata</i> Zhang & Xia	+			4; 16; 44; 49
<i>Gracilaria hainanensis</i> C.F. Chang & B.M. Xia	+			4; 5; 16; 41; 44; 43
<i>Gracilaria mixta</i> I.A. Abbott, J. Zhang & B.M. Xia	+			16; 49
<i>Gracilaria rubra</i> (C. Agardh) J. Agardh	+			4; 5; 16; 41; 43
<i>Gracilaria salicornia</i> (C. Agardh) E.Y. Dawson	+	Nm, Si, Yw, Dh, Xh, Lh, Ty	Lh	4; 5; 16; 41; 43
<i>Gracilaria spinulosa</i> (Okamura) Chang & B.M. Xia	+			4; 5; 16; 41; 43
<i>Gracilaria tenuispirata</i> var. <i>liui</i> Zhang & Xia	+	Hk		15; 29; 14
<i>Gracilaria yamamotoi</i> Zhang & B.M. Xia	+			4; 16; 41; 49;
<i>Gracilaria yinggehaiensis</i> Xia et Wang	+			4; 50

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<i>Gracilariocolax deformans</i> (Weber van Bosse) Gerung & Yamamoto	+			4 (as <i>Gracilariophila deformans</i> ); 16
<i>Gracilariocolax infidellis</i> (Weber van Bosse) Gerung & Yamamoto	+			4; (as <i>Gracilariophila infidellis</i> ); 16
<i>Gracilariocolax setchellii</i> (Weber van Bosse) Gerung & Yamamoto	+			4 (as <i>Gracilariophila setchellii</i> ); 16
<i>Gracilariopsis bailiniae</i> Zhang & B.M. Xia	+	Hk		16 (as <i>Gracilaria bailiniae</i> ); 29 (as <i>Gracilaria heteroclada</i> ); 51 (as <i>Gracilariopsis bailiniae</i> )
<i>Gracilariopsis longissima</i> (S.G. Gmelin) M. Seentoft, L.M. Irvine & W.F. Farnham	+			20 (as <i>Gracilaria confervoides</i> )
<i>Hydropuntia edulis</i> (S.G. Gmelin) Gurgel & Fredericq	+	Xn		4 (as <i>Gracilaria edulis</i> ); 5; 16; 47; 52; 53 (as <i>Polycavernosa fastigiata</i> )
<i>Hydropuntia eucheumatoides</i> (Harvey) Gurgel & Fredericq	+	Sl, Dh, Xh, Xz	Wc, Dh, Xh, Lh	4 (as <i>Gracilaria eucheumatoides</i> ); 5; 16; 41; 42; 43; 44; 54; 14
<b>ORDER HALYMENIALES</b>				
<b>Family Halymeniaceae</b>				
<i>Carpopeltis mailletii</i> (Montagne & Millardet) Chiang	+		Wc	4; 33
<i>Cryptonemia basineris</i> B.M. Xia & Wang	+			4; 33
<i>Cryptonemia seminervis</i> (C. Agardh) J. Agardh	+			4 (as <i>Cryptonemia luxurians</i> ); 33
<i>Cryptonemia xinhalensis</i> B.M. Xia & Wang	+			4; 33
<i>Halymenia maculata</i> J. Agardh	+	Xz	Lh	4; 33; 55; 14
<i>Grateloupa asiatica</i> S. Kawaguchi & H.W. Wang*	+		Xn	This paper
<i>Grateloupa filicina</i> (J.V. Lamouroux) C. Agardh	+		Xn, Lh	1; 14
<i>Grateloupa hainanensis</i> W.-X. Li & Z.-F. Ding	+			4; 33
<i>Grateloupa kurogii</i> Kawaguchi	+			4; 33
<i>Grateloupa livida</i> (Harvey) Yamada	+		Lh	4; 12; 20 (as <i>G. ligulata</i> ); 33
<i>Grateloupa ramosissima</i> Okamura	+			4; 33
<i>Isabbotia ovalifolia</i> (Kyllin) Balakrishnan	+			4 (as <i>Cryptonemia ovalifolia</i> ); 33
<i>Yonagunia formosana</i> (Okamura) Kawaguchi & Masuda	+	Sl	Wc	4 (as <i>Prionitis formosana</i> ); 33
<b>ORDER SEBDENIALES</b>				
<b>Family Sebdeniaceae</b>				
<i>Sebdenia flabellata</i> (J. Agardh) P.G. Parkinson	+			4; 16
<b>ORDER PLOCAMIALES</b>				
<b>Family Sarcodiaceae</b>				
<i>Sarcodia montagneana</i> (J.D. Hooker & Harvey) J. Agardh	+			4 (as <i>Sarcodia ceylonensis</i> ); 16
<i>Trematocarpus pygmaeus</i> Yendo	+			4; 16
<b>ORDER RHODYMENIALES</b>				
<b>Family Champiaceae</b>				
<i>Champia parvula</i> (C. Agardh) Harvey		Yw, Xh, Xz,	Yw, Dh, Lh	1; 14
<i>Champia viallidii</i> Kützting		Lh	Dh, Xh, Lh	1; 14
<i>Coelothrix irregularis</i> (Harvey) Børgesen	+			4; 16
<b>Family Hymenocliaceae</b>				
<i>Asteromenia anastomosans</i> (Weber-van Bosse) G.W. Saunders, C.E. Lane, C.W. Schneider & Kraft		Qg		3
<b>Family Lomentariaceae</b>				
<i>Ceratodictyon intricatum</i> (C. Agardh) R.E. Norris	+	Lc, Nm, Sl, Tg, Yw, Xh, Lh	Mx, Yw, Dh, Xh, Lh	5 (as <i>Geliopsis intricata</i> ), 14
<i>Ceratodictyon scoparium</i> (Montagne & Millardet) R.E. Norris			Wc, Dh, Xh, Lh	1
<i>Ceratodictyon spongiosum</i> Zanardini	+	Lc, Nm, Mx, Sl, Xc, Tg, Yw, Xh, Lh, Xz	Wc, Dh, Xh, Lh	4; 10; 12; 16; 14
<i>Lomentaria corallicola</i> Børgesen		Sl, Xh	Dh, Lh	1; 14
<b>Family Rhodymeniaceae</b>				
<i>Rhodymenia hainanensis</i> B.-M. Xia & Y.-Q. Zhang	+			4; 16; 37

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<b>Division OCHROPHYTA</b>				
<b>CLASS XANTHOPHYCEAE</b>				
<b>ORDER VAUCHERIALES</b>				
Family Vaucheriaceae				
<i>Pseudochotomosiphon constricta</i> var. <i>minor</i> Tseng	+			5; 46
<b>CLASS PHAEOPHYCEAE</b>				
<b>ORDER SCYTOHAMNALES</b>				
Family Scytohamnaceae				
<i>Asteronema breviarcticulatum</i> (J. Agardh) Ouriques & Bouzon		Yw		This paper
<i>Asteronema rhodochoortonoides</i> (Børgesen) D.G. Müller & E.R. Parodi	+			22 (as <i>Ectocarpus rhodochoortonoides</i> )
<b>ORDER ECTOCARPALES</b>				
Family Acinetosporaceae				
<i>Ectocarpus simpliciusculus</i> C. Agardh	+			22
<i>Ectocarpus tamarinii</i> Børgesen	+			22
<i>Feldmannia irregularis</i> (Kützinger) G. Hamel	+	Xc, Yw, Xh, Lh	Lh	This paper
<i>Feldmannia mitchelliae</i> (Harvey) H.-S. Kim	+	Lc, Lj, Qk	Dh, Xh, Lh	4 (as <i>Hinckesia mitchelliae</i> ); 14
<i>Hinckesia confiera</i> (Børgesen) I.A. Abbott	+		Lh	22 (as <i>Giffordia confiera</i> ); 14
<i>Kuetzingiella elachistaeformis</i> (Heydrich) M. Balakrishnan & Kinkar	+		Dh, Lh	22 (as <i>Ectocarpus elachistaeformis</i> ); 14
Family Chordariaceae				
<i>Chilonema ocellatum</i> (Kützinger) Kornmann**			Lh	This paper
<i>Myrionema strangulans</i> Greville			Lh	1; 14
<b>ORDER RALFSIALES</b>				
Family Neoralfsiaceae				
<i>Neoralfsia expansa</i> (J. Agardh) P.-E. Lim & H. Kawai ex Kraft			Wc, Xh, Lh	1; 14
<b>ORDER SCYTOSIPHONALES</b>				
Family Scytosiphonaceae				
<i>Chnoospora implexa</i> J. Agardh	+	Lc, Nm, Lj, Sl, Dh, Xh, Xz	Lh	4; 5; 14
<i>Chnoospora minima</i> (K. Hering) Papenfuss	+			4; 5
<i>Colpomenia sinuosa</i> (Mertens ex Roth) Derbès & Solier in Castagne	+	Lc, Nm, Mx, Qk, Qg, Sl, Dh, Xh, Lh, Xz	Mx, Xn, Wc, Lh	4; 14
<i>Hydroclathrus clathratus</i> (C. Agardh) M.A. Howe	+	Lc, Nm, Sl, Yw, Dh, Xh, Xz Ty	Lh	4; 5; 14
<i>Hydroclathrus tenuis</i> C.K. Tseng & Lu			Lh	1; 14
<i>Rosenvingea intricata</i> (J. Agardh) Børgesen	+	Lc, Lj, Dh	Lh	4; 5; 14
<i>Rosenvingea orientalis</i> (J. Agardh) Børgesen	+			4; 5
Family Pyliatellaceae				
<i>Pyliatella littoralis</i> (Linnaeus)*			Lh	This paper
<b>ORDER SPHACELARIALES</b>				
Family Sphacelariaceae				
<i>Sphacelaria carolinensis</i> Trono			Lh	2
<i>Sphacelaria novae-hollandiae</i> Sonder		Mx, Yw, Dh, Xh, Lh, Xz, Ty	Mx, Wc, Yw, Xh, Lh	1; 14
<i>Sphacelaria rigidula</i> Kützinger		Lc, Nm, Sl, Xc, Yw, Dh, Xh, Lh, Xz, Ty	Wc, Yw, Xh, Lh	1; 14
<i>Sphacelaria tribuloides</i> Meneghini	+	Yw, Xh, Lh, Xz	Xh, Lh	4; 14
<i>Sphacelaria tsengii</i> Draisma, Keum, Prud'homme van Reine & Lokhorst	+			56

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<b>ORDER DICTYOTALES</b>				
<b>Family Dictyotaceae</b>				
<i>Canistrocarpus cervicornis</i> (Kützting) De Paula & De Clerck	+	Nm, Qk, Qg, Sl, Yw, Xh, Xz, Ty	Mx, Wc, Lh	4 (as <i>Dictyota cervicornis</i> ); 5; 14
<i>Dictyopteris pacifica</i> (Yendo) I.K.Hwang, H.-S.Kim & W.J.Lee		Ty	Xn	This paper
<i>Dictyopteris repens</i> (Okamura) Bergesen		Nm, Yw, Xh	Wc, Lh	This paper
<i>Dictyota bartayresiana</i> J.V. Lamouroux		Xh	Xn	14
<i>Dictyota dichotoma</i> (Hudson) J.V. Lamouroux	+	Sl, Yw, Xz, Ty	Wc, Yw, Dh, Xh, Lh	4; 5
<i>Dictyota dichotoma</i> var. <i>intricata</i> (C. Agardh) Greville	+	Xh	Lh	4; 5; 14
<i>Dictyota friabilis</i> Setchell	+	Lc, Nm, Mx, Sl, Yw, Dh, Xh, Lh, Ty	Mx, Wc, Yw, Dh, Xh, Lh	4 (as <i>Dictyota linearis</i> ); 5; 14
<i>Dictyota implexa</i> (Desfontaines) J.V.Lamouroux	+		Lh	4; 5; 14
<i>Lobophora variegata</i> (J.V. Lamouroux) Womersley ex Oliveira			Mx	This paper
<i>Padina arborescens</i> Holmes*	+	Nm, Sl, Dh, Xz	Mx, Wc, Lh	4; 14
<i>Padina australis</i> Hauck	+	Lc, Sl, Dh, Xh, Lh, Xz	Lh	4
<i>Padina boyana</i> Thivy	+	Sl		This paper
<i>Padina jonesii</i> Tsuda	+	Mx, Dh, Xh, Lh, Ty	Lh	4; 14
<i>Padina minor</i> Yamada	+			4; 5
<i>Padina tetrastrumata</i> Hauck	+			This paper
<i>Spatoglossum dichotomum</i> C.K. Tseng & Lu*			Xn	This paper
<b>ORDER FUCALES</b>				
<b>Family Sargassaceae</b>				
<i>Hormophya cuneiformis</i> (J.F. Gmelin) P.C. Silva	+	Nm		5 (as <i>H. articulata</i> )
<i>Sargassum agaviforme</i> Tseng & Lu	+			This paper
<i>Sargassum argustifolium</i> (Turner) C. A. Agardh	+			57
<i>Sargassum aquifolium</i> (Turner) C. Agardh	+	Dh		4 (as <i>S. binderi</i> , <i>S. crassifolium</i> ); 59 (as <i>S. binderi</i> ), 60 (as <i>S. crassifolium</i> ), 61 (as <i>S. binderi</i> , <i>S. crassifolium</i> )
<i>Sargassum bacularia</i> (Mertens) C. Agardh	+			4; 61, 62
<i>Sargassum carpophyllum</i> J. Agardh	+			5
<i>Sargassum cervicorne</i> Greville	+			4; 58; 61;
<i>Sargassum cinctum</i> J. Agardh	+			4; 61, 64;
<i>Sargassum crispifolium</i> Yamada	+			4; 61
<i>Sargassum cystophyllum</i> var. <i>parcespinosa</i> Grunow	+			4; 64; 61
<i>Sargassum dazhouense</i> Tseng & Lu	+			4; 60; 61
<i>Sargassum dotyi</i> Trono	+			4; 61; 64
<i>Sargassum erumpens</i> Tseng & Lu	+			4; 59; 61
<i>Sargassum euryphyllum</i> (Grunow) Tseng & Lu	+			4; 61; 65
<i>Sargassum feidmannii</i> Pham-Hoang Hô	+			4; 59; 61
<i>Sargassum fusiforme</i> (Harvey) Setchell*	+		Wc	This paper
<i>Sargassum glaucescens</i> J. Agardh	+			5; 57
<i>Sargassum granuliferum</i> C. Agardh	+			4; 60; 61
<i>Sargassum hainanense</i> Tseng & Lu	+			4; 58; 61
<i>Sargassum hemiphyllum</i> (Turner) C. Agardh		Mx		This paper
<i>Sargassum henslowianum</i> C. Agardh		Lc		This paper
<i>Sargassum herklotsii</i> Setchell	+	Lc		4; 5
<i>Sargassum heterocystum</i> Montagne	+			63
<i>Sargassum horneri</i> (Turner) C. Agardh*			Xn, Hk, Wc	This paper



Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<i>Sargassum ilicifolium</i> (Turner) C. Agardh	+	Qg, Dh, Xh	Xn, Wc, Lh, Hk	4: 5 (as <i>S. cristaefolium</i> , <i>S. duplicatum</i> , <i>S. ilicifolium</i> ); 60 (as <i>S. ilicifolium</i> , <i>S. duplicatum</i> ); 61 (as <i>S. duplicatum</i> , <i>S. cristaefolium</i> ); 64; 14
<i>Sargassum ilicifolium</i> var. <i>conduplicatum</i> Grunow	+			61; 64
<i>Sargassum intermedium</i> Tseng & Lu	+			59; 61
<i>Sargassum moclurei</i> Setchell	+		Lh	4; 5; 61
<i>Sargassum megalocystum</i> Tseng & Lu	+			4; 60; 61
<i>Sargassum microcystum</i> J. Agardh*			Mx	This paper
<i>Sargassum miyabe</i> Yendo**			Wc	This paper
<i>Sargassum oligocystum</i> Montagne	+	Dh		4; 5; 59; 61
<i>Sargassum parvifolium</i> (Turner) C. Agardh	+			4; 60; 63
<i>Sargassum phyllocystum</i> Tseng & Lu	+			4; 5
<i>Sargassum polycystum</i> (C. Agardh)	+	Lc, Nm, Mx, Sl, Qg, Xc, Yw, Dh, Xh, Lh, Xz, Ty	Wc, Dh, Xh, Lh, Hk	57; 61; 66; 14
<i>Sargassum primitivum</i> Tseng & Lu	+			4; 58; 61
<i>Sargassum pseudolanceolatum</i> Tseng & Lu	+			4; 61; 64
<i>Sargassum qionghalense</i> Tseng & Lu	+			4; 59; 61
<i>Sargassum sanyaense</i> Tseng & Lu	+		Wc, Lh	4; 60; 61; 14
<i>Sargassum siliquosum</i> J. Agardh	+			61; 62
<i>Sargassum silvae</i> Tseng & Lu	+			4; 61; 67
<i>Sargassum spinifex</i> C. Agardh	+			4; 60; 61; 67
<i>Sargassum swartzii</i> C. Agardh	+	Xh, Lh		4 (as <i>S. acutifolium</i> , <i>S. swartzii</i> and <i>S. wightii</i> ); 58; 61
<i>Sargassum symphyorhizoideum</i> Tseng & Lu	+			4; 61; 63
<i>Sargassum tenerimum</i> J. Agardh	+	Xc, Dh		4; 57; 61
<i>Sargassum thunbergii</i> (Mertens ex Roth) Kuntze*			Wc	This paper
<i>Sargassum wicense</i> Tseng & Lu	+			4; 58; 61
<i>Sargassum yinggehalense</i> Tseng & Lu	+			61; 63; 64
<i>Turbinaria conoides</i> (J. Agardh) Kützing	+			4; 5; 61
<i>Turbinaria ornata</i> (Turner) J. Agardh	+	Lc, Qg, Sl, Yw, Dh, Xh, Lh, Xz, Ty	Xn, Hk, Wc, Yw, Dh, Xh, Lh	4; 5; 61; 14
<i>Turbinaria ornata</i> (Turner) var. <i>cordata</i> **			Lh	This paper
<i>Turbinaria ornata</i> f. <i>hainanensis</i> W.R. Taylor	+		Lh	4; 61
<b>Division CHLOROPHYTA</b>				
<b>CLASS CHLOROPHYCEAE</b>				
<b>ORDER CHLOROCOCCALES</b>				
Family Chlorochytriaceae				
<i>Chlorochytrium cohnii</i> Wrigh		Sl, Xh, Lh, Ty	Yw, Lh	68; 70; 14
<b>ORDER CHAETOPHORALES</b>				
Family Chaetophoraceae				
<i>Uronema marinum</i> Womersley*			Lh	This paper
<b>CLASS ULVOPHYCEAE</b>				
<b>ORDER ULOTRICHALES</b>				
Family Gomontiaceae				
<i>Gomontia polyrrhiza</i> (Lagerheim) Bornet & Flahault	+		Lh	71
<i>Monostroma nitidum</i> Wittrock	+	Lc, Nm, Lj, Mx, Qk, X	Mx	72; 4; 68

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<b>Family Ulotrachaceae</b>				
<i>Ulotrinx flacca</i> (Dillwyn) Thuret*			Yw, Lh	This paper
<i>Ulotrinx implexa</i> (Kützting) Kützting			Lh	68; 14
<i>Ulotrinx subflaccida</i> Wille**			Lh	This paper
<b>ORDER ULVALES</b>				
<b>Family Phaeophiliaceae</b>				
<i>Phaeophila dendroides</i> (P.L. Crouan & H.M. Crouan) Batters	+		Lh	71
<b>Family Ulvellaceae</b>				
<i>Acrochaete geniculata</i> (N.L. Gardner) O'Kelly		Sl, Xh, Ty	Lh	68; 70; 14
<i>Ulvella leptochaete</i> (Huber) R. Nielsen, C.J. O'Kelly & B. Wyssor		Yw, Xh	Lh	68; 70; 14
<i>Ulvella viridis</i> (Reinke) R. Nielsen, C.J. O'Kelly & B. Wyssor		Qg, Sl, Yw, Dh, Xh	Yw, Lh	68; 70; 14
<i>Ulvella lens</i> P.L. Crouan & H.M. Crouan	+	Nm, Yw, Dh, Lh, Ty	Lh	72; 68
<i>Ulvella scutata</i> (Reinke) R. Nielsen, C.J. O'Kelly & B. Wyssor		Qg, Xh, Dh	Lh	68; 70; 14
<b>Family Ulvaceae</b>				
<i>Ulva chaetomorphaeoides</i> (Börjesen) Hayden, Blomster, Maggs, P.C. Silva, M.J. Stanhope & J.R. Waaland		Qk		68; 70
<i>Ulva clathrata</i> (Roth) C. Agardh	+	Lc, Nm, Lj, Mx, Qk, Bh, Sl, Dh, Xh, Lh	Yw, Dh, Xh, Lh, Hk	4 (as <i>Enteromorpha clathrata</i> ); 5; 14
<i>Ulva compressa</i> Linnaeus		Lc, Nm, Lj, Mx, Bh, Qg, Sl, Yw, Dh, Xh, Lh, Xz, Ty	Lh	68; 70
<i>Ulva conglobata</i> Kjellman	+	Nm, Xn, Xh, Xz	Lh	4; 68; 70
<i>Ulva flexuosa</i> Wulfen	+	Lc, Bh, Dh, Xh	Wc, Yw, Lh, Hk	4 (as <i>Enteromorpha flexuosa</i> ); 20 (as <i>Enteromorpha tubulosa</i> ); 72; 14
<i>Ulva intestinalis</i> Linnaeus		Nm, Qg, Lh, Xz	Mx, Xn, Lh	68; 70
<i>Ulva kyllini</i> (Bilding) Hayden, Blomster, Maggs, P.C. Silva, M.J. Stanhope & J.R. Waaland		Lc, Lj, Mx, Qk, Tg, Yw, Xh, Xz, Ty		68; 70
<i>Ulva lactuca</i> Linnaeus	+	Lc, Lj, Mx	Mx, Xn, Wc, Lh, Hk	20; 46; 68
<i>Ulva linza</i> Linnaeus	+	Xz	Lh	4 (as <i>Enteromorpha linza</i> ); 68
<i>Ulva pertusa</i> Kjellman				68; 70
<i>Ulva prolifera</i> O.F. Müller	+	Lc, Lj, Bh, Dh, Xh	Xh, Lh	68; 72 (as <i>Enteromorpha prolifera</i> ); 14
<i>Ulva ralfsii</i> (Harvey) Le Jollis		Lc, Yw, Dh, Xh, Lh	Lh	68; 70
<i>Ulva reticulata</i> Forskål*			Xn, Wc	This paper
<i>Ulva rigida</i> C. Agardh*			Wc	This paper
<b>ORDER CLADOPHORALES</b>				
<b>Family Anadyomenaceae</b>				
<i>Anadyomene wrightii</i> Harvey ex J.E. Gray	+	Nm, Mx, Sl, Yw, Dh, Xh, Ty	Xh, Lh	72; 68; 14
<i>Microdictyon japonicum</i> Setchell	+		Lh	46; 68
<b>Family Cladophoraceae</b>				
<i>Chaetomorpha antennina</i> (Bory de Saint-Vincent) Kützting	+			46, 68, 72
<i>Chaetomorpha brachygona</i> Harvey	+			46; 68
<i>Chaetomorpha capillaris</i> (Kützting) Bergesen*			Xh, Lh	This paper
<i>Chaetomorpha gracilis</i> Kützting	+		Lh	46; 68; 14
<i>Chaetomorpha javanica</i> Kützting		Mx, Yw	Wc	68; 70
<i>Chaetomorpha ligustica</i> (Kützting) Kützting			Lh	68
<i>Chaetomorpha linum</i> (O.F. Müller) Kützting	+	Mx, Xn, Qk, Qg, Sl, Dh, Ty	Mx, Wc, Lh	46 (as <i>C. crassa</i> ); 68; 72; 14

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<i>Chaetomorpha minima</i> F.S. Collins & Hervey		Bh, Xh		68, 70
<i>Chaetomorpha spiralis</i> Okamura	+			5; 4; 46 (as <i>C. torta</i> ), 68
<i>Cladophora albida</i> (Nees) Kützing		Sl		68; 70
<i>Cladophora aokii</i> Yamada	+			5; 4; 46; 68
<i>Cladophora catenata</i> (Linnaeus) Kützing	+	Ty		4; 5 (as <i>Cladophora fuliginosa</i> ), 46; 68
<i>Cladophora coelothrix</i> Kützing		Qg		68; 70
<i>Cladophora flexuosa</i> (O.F. Müller) Kützing	+		Wc, Lh	4; 68; 69
<i>Cladophora herpestica</i> (Montagne) Kützing		Lc, Sl, Xh, Xz, Ty	Lh	68; 70
<i>Cladophora laetevirens</i> (Dillwyn) Kützing		Bh, Dh, Xh	Mx, Wc, Yw, Lh	68; 70; 14
<i>Cladophora pateniramea</i> (Montagne) Kützing		Xh		68; 70
<i>Cladophora perpusilla</i> Skottsberg & Levring in Levring		Xh		68; 70
<i>Cladophora prolifera</i> (Roth) Kützing	+			4; 5 (as <i>C. rugulosa</i> ); 46
<i>Cladophora sibogae</i> Reinbold		Sl		68; 70
<i>Cladophora socialis</i> Kützing		Lc, Sl, Tg, Xh	Wc, Xh, Lh	68; 70
<i>Cladophora vagabunda</i> (Linnaeus) Hoek	+	Nm, Mx, Sl	Mx, Wc, Xh, Lh	68; 70; 72 (as <i>Cladophora fasciculata</i> ); 14
<i>Pseudocladophora horii</i> (C. Hoek & Chihara) Boedeker & Lellaert		Yw	Lh	68; 70 (as <i>Cladophora horii</i> )
<i>Rhizoclonium grande</i> Børgesen	+	Nm, Mx, Sl, Yw	Lh	46; 68
<i>Rhizoclonium riparium</i> (Roth) Harvey		Bh, Xh, Lh	Yw, Lh	68; 70
<i>Rhizoclonium riparium</i> var. <i>implexum</i> (Dillwyn) Rosenvinge	+		Yw, Lh	46 (as <i>R. kochianum</i> ); 68; 14
<b>CLASS SIPHONOCLOADOPHYCEAE</b>				
<b>ORDER SIPHONOCLOADALES</b>				
<b>Family Boodleaceae</b>				
<i>Boodlea composita</i> (Harvey) F. Brand	+	Qk, Dh, Xh, Xz	Lh	46; 68; 14
<i>Cladophoropsis fasciculatus</i> (Kjellman) Wille	+		Lh	68; 72 (as <i>C. fasciculata</i> )
<i>Cladophoropsis membranacea</i> (Hofman Bang ex C. Agardh) Børgesen			Lh	14
<i>Cladophoropsis sundanensis</i> Reinbold	+	Xh, Lh, Ty	Dh, Lh	4; 5; 46; 68
<i>Phyllocladon anastomosans</i> (Harvey) Kraft et al. & M.J. Wynne	+	Nm, Dh, Xh, Lh, Xz, Ty	Yw, Dh, Xh, Lh	5 (as <i>Struvea anastomosans</i> ), 46; 68; 14
<i>Struvea enomata</i> Chihara	+			4; 68
<b>Family Siphonocladaceae</b>				
<i>Boergesenia forbesii</i> (Harvey) Feldmann	+	Sl, Yw, Dh, Xh		4; 46 (as <i>Valonia forbesii</i> ), 68
<i>Dictyosphaeria cavernosa</i> (Forsskål) Børgesen	+	Nm, Sl, Yw, Dh, Xh, Lh, Xz, Ty	Yw, Dh, Xh, Lh	4; 46; 73; 68; 14
<i>Dictyosphaeria intermedia</i> Weber-van Bosse	+			73; 68
<i>Dictyosphaeria versluisii</i> Weber-van Bosse	+	Dh, Xz, Ty	Dh, Lh	4; 46; 68; 73 (as <i>D. bokotensis</i> , <i>D. versluisii</i> )
<i>Siphonocladus rigidus</i> M.A. Howe**			Wc	
<b>Family Valontiaceae</b>				
<i>Valonia aegagropila</i> C. Agardh	+	Lj, Sl, Dh, Xh, Ty	Xh, Lh	4; 46; 68
<i>Valonia fastigiata</i> Harvey ex J. Agardh*			Wc, Yw	This paper
<i>Valonia utricularis</i> (Roth) C. Agardh		Lh	Yw, Lh	68; 70
<i>Valonia ventricosa</i> J. Agardh		Nm	Yw, Lh	68; 70; 14
<i>Valoniopsis pachynema</i> (G. Martens) Børgesen	+	Yw, Xh, Xz, Ty	Lh	4; 46; 68
<b>CLASS BRYOPSIDOPHYCEAE</b>				
<b>ORDER BRYOPSIDALES</b>				
<b>Family Bryopsidaceae</b>				
<i>Bryopsis australis</i> Sonder		Sl, Lh	Lh	68; 70
<i>Bryopsis pennata</i> J.V. Lamouroux			Wc, Yw, Dh, Xh, Lh	68; 70; 14

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<i>Bryopsis plumosa</i> (Hudson) C. Agardh*			Wc	This paper
<i>Pseudobryopsis hainanensis</i> C.K. Tseng	+	Xh		4 (as <i>Trichosolen hainanensis</i> ); 46; 68
<b>Family Ostreobiaceae</b>				
<i>Ostreobium quekettii</i> Bornet & Flahault	+		Lh	71
<b>Family Caulerpaceae</b>				
<i>Caulerpa brachypus</i> Harvey	+			46 (as <i>C. parvifolia</i> ), 68
<i>Caulerpa cupressoides</i> (Vahl) C. Agardh	+			5; 68
<i>Caulerpa cupressoides</i> var. <i>lycopodium</i> f. <i>amicorum</i> Weber-van Bosse	+			46
<i>Caulerpa cupressoides</i> var. <i>typica</i> (Vahl) C. Agardh	+			4
<i>Caulerpa fastigiata</i> Montagne**			Lh	This paper
<i>Caulerpa nummularia</i> Harvey ex J. Agardh	+		Yw	4; 5; 68
<i>Caulerpa peltata</i> J.V. Lamouroux	+	Sl	Dh, Xh, Lh	4; 68
<i>Caulerpa racemosa</i> (Forsskål) J. Agardh	+	Dh, Xh, Xz	Wc, Yw, Dh, Xh, Lh	4 (as <i>C. racemosa</i> var. <i>typica</i> ); 5 (as <i>C. racemosa</i> var. <i>clavifera</i> ); 68; 14
<i>Caulerpa racemosa</i> var. <i>macrophyssa</i> (Zonder ex Kützing) W.R. Taylor	+	Xh, Xz	Wc, Lh	46 (as <i>C. racemosa</i> var. <i>clavifera</i> f. <i>macrophyssa</i> )
<i>Caulerpa racemosa</i> var. <i>occidentalis</i> (J. Agardh) Bergesen	+			46; 68
<i>Caulerpa serrulata</i> (Forsskål) J. Agardh	+	Dh, Xh	Dh, Xh, Lh	4; 46; 68; 14
<i>Caulerpa sertularioides</i> (Gmelin) M.A. Howe	+			46; 68
<i>Caulerpa sertularioides</i> f. <i>longipes</i> (J. Agardh) Collins	+			4
<i>Caulerpa sertularioides</i> f. <i>longiseta</i> (Bory) de Saint-Vincent Svedelius	+			5; 68
<i>Caulerpa taxifolia</i> (M. Vahl) C. Agardh	+	Xn		4; 5; 46; 70
<i>Caulerpa verticillata</i> J. Agardh	+			4; 5; 46; 68
<i>Caulerpella ambigua</i> (Okamura) Prud'Homme van Reine, Lokhorst	+	Yw	Lh	68; 70; 14
<b>Family Udoteaceae</b>				
<i>Avrainvillea erecta</i> (Berkeley) A. Gepp & E.S. Gepp	+	Qk, Sl		4; 5; 68; 72
<i>Avrainvillea lacerata</i> Harvey ex J. Agardh	+	Qk		4; 5; 68; 72
<i>Chlorodesmis caespitosa</i> J. Agardh	+			46 (as <i>Rhipidodesmis caespitosa</i> ); 68
<i>Chlorodesmis hildebrandtii</i> A. Gepp & E.S. Gepp	+	Qk, Sl		4; 68
<i>Chlorodesmis sinensis</i> C.K. Tseng & M.L. Dong	+			68; 70
<i>Penicillus sibogae</i> A. Gepp and E.S. Gepp	+		Yw, Lh	68; 70
<i>Rhipidosiphon javensis</i> Montagne	+	Sl, Xh	Yw, Dh, Lh	4 (as <i>Udotea javensis</i> ); 5; 46; 68; 14 (as <i>Udotea javensis</i> )
<i>Udotea flabellum</i> (Ellis & Solander) M.A. Howe	+			5; 46; 68
<i>Udotea fragilifolia</i> C.K. Tseng & M.L. Dong	+			4; 68
<b>Family Codiaceae</b>				
<i>Codium arabicum</i> Kützinger	+	Yw		4; 5; 46; 68; 72 (as <i>C. coronatum</i> )
<i>Codium bartlettii</i> C.K. Tseng & W.J. Gilbert	+			4; 5; 68; 74
<i>Codium decorticatum</i> (Woodward) M.A. Howe	+			46 (as <i>Codium elongatum</i> ); 68
<i>Codium geppiorum</i> O.C. Schmidt	+	Yw	Wc	4 (as <i>C. geppii</i> ); 5; 68; 72
<i>Codium intricatum</i> Okamura	+		Lh	46; 68
<i>Codium papillatum</i> var. <i>hainanense</i> C.K. Tseng	+			4; 5; 68; 74;
<i>Codium repens</i> P.L. Crouan & H.M. Crouan	+	Yw	Lh	46; 68
<i>Halimeda incrassata</i> (J. Ellis) J.V. Lamouroux	+			4; 5; 68
<i>Halimeda macroloba</i> Decaisne	+		Dh, Lh	4; 5; 46; 68
<i>Halimeda opuntia</i> (Linnaeus) J.V. Lamouroux	+	Sl		4; 5 (as <i>H. opuntia</i> f. <i>triloba</i> ), 68

Species, varieties and forms	1930s - 1970s	1990, 1992	2008 - 2012	References
<b>Family Derbesiaceae</b>				
<i>Pedobesia ryukyensis</i> (Yamada & T. Tanaka) Kobara & Chihara		Lc		68; 70
<b>CLASS DASYCLADOPHYCEAE</b>				
<b>ORDER DASYCLADALES</b>				
<b>Family Dasycladaceae</b>				
<i>Bornetella capitata</i> (Harvey ex E.P. Wright) J. Agardh	+		Yw, Lh	75
<i>Bornetella nitida</i> Munier-Chalmas ex Sonder	+	Yw, Dh, Xh, Xz	Yw, Lh	14
<i>Bornetella oligospora</i> Solms-Laubach	+	Xh, Xz	Yw, Lh	4; 68; 75; 14
<i>Bornetella sphaerica</i> (Zanardini) Solms-Laubach	+	Xh, Xz	Yw, Lh	4; 5; 68; 75; 14
<i>Neomeris annulata</i> Dickie	+		Yw, Lh	4; 46; 68; 7; 14
<i>Neomeris mucosa</i> M.A. Howe	+			75
<i>Neomeris vanbosseae</i> M.A. Howe	+			75
<b>Family Polyphysaceae</b>				
<i>Acetabularia calyculus</i> J.V. Lamouroux in Quoi & Gaimard	+	Qk		4; 46; 68; 75
<i>Parvocaulis clavatus</i> (Yamada) S. Berger, U. Fetzweiss, et al.	+		Mx, Wc, Yw, Xh, Lh	46 (as <i>Acetabularia clavata</i> ), 68; 14
<i>Parvocaulis exiguus</i> (Solms-Laubach) S. Berger, U. Fetzweiss, et al.	+		Xh, Lh	68; 75 (as <i>Acetabularia exigua</i> ); 14
<i>Parvocaulis parvulus</i> (Solms-Laubach) S. Berger, U. Fetzweiss, et al.	+	Nm, Yw, Xh	Mx, Wc, Yw, Dh, Xh, Lh	4 (as <i>A. parvula</i> ); 46 (as <i>Acetabularia moebii</i> ); 68; 75; 14
<i>Parvocaulis pusillus</i> (M. Howe) S. Berger, U. Fetzweiss, et al.	+		Yw, Lh	46; 68; 75 (as <i>Acetabularia pusilla</i> )

Localities: Baishamen (Haikou fish pond), Bh; Dadong Hai, Dh; Haikou, Hk; Linchang, Lc; Lingao Jiao, Lj; Luhuitou, Lh; Nanmai, Nm, Meixia, Mx; Qinglan Gang, Qg; Qukou, Qk; Shalao, Si; Tian Ya Hai Tiao, Ty; Tielu Gang, Tg; Wenchang, Wc; Yalong Wan, Yw; Xianhai, Xn; Xiaodong Hai, Xh; Xincun, Xc; Ximao Zhou, Xz.

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Liagoraceae, Gracilariaceae (Rh), Caulerpaceae, Codiaceae (Ch) and Sargassaceae (Oc).

The majority of lost species (not found in subsequent/recent studies) were low productive, annual or perennial representatives inhabiting hard substrata (epilithic algae) with voluminous form of thalli (fleshy, leathery, coarse articulated, foliose, etc.). At the same time, the following families contributed to taxa increases: Ceramiaceae (20 taxa), Rhodomelaceae (18 taxa) (Rh), Sphacelariaceae (3 taxa), Dictyotaceae (5 taxa) (Oc), Cladophoraceae (14 taxa) and Ulvaceae (7 taxa) (Ch). Representatives of these families are mainly high productive ephemeral and epiphytic algae with fine filamentous forms and high surface area-volume ratios (Titlyanov *et al.* 2011a, 2014b, c, Titlyanov & Titlyanova 2012).

The present work, in combination with previous studies dealing with the marine flora of Hainan Island (pointed out above), suggests that serious changes occurred in the benthic flora, due probably to: (1) over-exploitation of the reef ecosystems, especially in the 1950s–1970s; (2) eutrophication of shallow waters (bays) in the 1990–2010s, most notably sewage disposal (coastal urbanization, agriculture, mariculture, and tourism industry, etc.); (3)

consequences of natural catastrophes, probably coral mass mortality after bleaching episodes in the South China Sea in the summer of 1998.

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••• Editor's note •••

This contribution is categorised as Data Paper, given the importance of its extensive checklist of species.