A SYNOPSIS OF THE RHODOPHYTA OF THE WESTERN MEDITERRANEAN
PART. I GIGARTINALES, HALYMENIALES, HILDENBRANDIALES AND PLOCAMIALES

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Résumé. Une clé dichotomique pour la détermination des Gigartinales, Halyméniales, Hildenbrandiales et Plocamiales de Méditerranée occidentale est présentée. Elle a pour objectif de faciliter la reconnaissance de ces algues rouges. Ce travail inclut l'ordre des Gigartinales, avec 69 espèces groupées en 19 familles et 35 genres, l'ordre des Halyméniales, avec 13 espèces appartenant à 2 familles et 6 genres, l'ordre des Hildenbrandiales, avec 1 famille, 1 genre et 3 espèces, et l'ordre des Plocamiales, avec 1 famille, 1 genre et 2 espèces. Le genre Wurdermannia Harvey est inclus dans la clé, bien que son appartenance aux Gigartinales reste incertaine. Quelques descriptions morphologiques et anatomiques des structures de reproduction sont aussi inclues, d'après des données de la littérature et de nos propres observations.

Abstract. A synoptic key for identifying the Gigartinales, Halyméniales, Hildenbrandiales and Plocamiales from the Western Mediterranean has been prepared in order to facilitate the recognition of these red algae. The orders Gigartinales, with some 69 species grouped in 19 families and 35 genera, Halyméniales, with 13 species grouped in 2 families and 6 genera, Hildenbrandiales, with 1 family and 1 genus of 3 species, and Plocamiales, with 1 family and 1 genus of 2 species are included. The genus Wurdermannia Harvey is also included in the key, although it has not finally been established whether it belongs to the order Gigartinales or not. Morphological and anatomical descriptions of the reproductive structures, using data from the literature and from personal observations are presented.

Introduction

This is intended to be the first publication in a series of keys to the different orders of benthic marine algal flora from the western Mediterranean (excluding the recently introduced species). The present paper includes the order Gigartinales with 69 species grouped in 19 families and 35 genera, the order Halyméniales with 13 species grouped in two families and six genera, the order Hildenbrandiales with one family and one genus of three species, and the order Plocamiales, with one family and one genus of two species. The genus Wurdermannia Harvey is also included in the key although it has not yet been finally established whether it belongs to the order Gigartinales or not.

The key should serve as a tool to identify genera and species of these groups. An effort has been made to base dichotomies in the key upon more than a single distinction. Vegetative characteristics are used to separate genera and species where appropriate, but as definitive identification can only rarely be obtained from general appearance and form of the Rhodophyta, or from sterile material, reproductive stages have been incorporated in unavoidable cases. Many of the families have a highly distinctive female reproductive system from which they can be recognized, although such characters may often be difficult to observe. The main reproductive characteristics are listed for each genus in Table I. The use of dimensions such as the length and width of thalli is only a guide in the key, since such characteristics tend to be very variable and unstable.

Following the key is a listing of the genera and species currently recognized in the studied area. We have included the order Cryptonemiales (Kylin, 1956) in the order Gigartinales, following Kraft & Robins (1985), because we consider that
Table 1. Type of structure and main reproductive characteristics of the genera treated. (sv = several), (* = usually); (?) = unknown); (grey colour = unattainable characteristics)

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the fact that the Cryptonemiales have auxiliary cells in accessory systems within the thallus, as opposed to Gigartinales supposedly transforming vegetative cells into auxiliary cells, is insufficient basis for placing the Cryptonemiales in a separate order. The Hildenbrandiales (Pueschel & Cole, 1982), Plocamiales (Saunders & Kraft, 1994) and Halymeniales (Saunders & Kraft, 1996) are considered as separate orders, following recent molecular studies, but since their morphology and reproductive structures are similar to the Gigartinales, the families in these orders are not separated in the key. Other taxa have been separated as orders and are not covered in this first part. These taxa included the Ahnfeltiales (Mags & Pueschel, 1989), representatives of which are known in Western Mediterranean, the Corallinales (Silva & Johansen, 1986), which is a clearly distinguishable order, and the Gracilariales (Fredericq & Hommersand, 1989) which requires more investigation in the Mediterranean. The taxonomic arrangement below the level of families follows Silva et al. (1996).

CURRENT KEY

1. Thallus prostrate, with a dorsiventral symmetry. Plants calcified or not. Structure consisting of a single basal layer of branched filaments (hypothallus), with each cell dividing into one or more upper cells (upper coxal cells) and, occasionally, one or more lower cells (lower coxal cells). The upper coxal cells give rise to filaments of apical growth directed to the upper surface (perithallus), erect or slightly inclined towards the margin. In the latter case, they can become erect later (secondary perithallus) due to persistent growth. The species with lower coxal cells can also develop some filaments directed to the undersurface (subhypothallus)

1. Thallus erect (at least the gametophyte), without a dorsiventral symmetry. Plants not calcified. Structure different from above.............................................. 2

2. Plants crustose, not calcified. Cells very small, usually \( \leq 5 \) \( \mu \)m in diameter. Hypothallus with each cell dividing into an erect unbranched or sparsely branched filament. Secondary perithallus and subhypothallus absent. Tetrasporangia developing from spherical or ovate conceptacles.................................................. Family HILDENBRANDIAEAE
   Genus Hildenbrandia.............................................. 3

3. Plants crustose or not, calcified or not. Cells not very small, \( > 5 \) \( \mu \)m in diameter. Hypothallus with each cell dividing into one or more coxal cells, upper cells and, occasionally, one or more lower coxal cells. Perithallus erect or slightly inclined towards the margin. Secondary perithallus and subhypothallus sometimes present. Rhizoids present or absent. Tetrasporangia not developing from conceptacles, scattered or in sort 5

3. Thallus brownish or purplish red. Tetrasporangia elongated, appearing zonate.................................................. 4

4. Thallus brownish red. Conceptacle chamber spheroidal, with a small ostiole. Tetrasporangia with parallel, transverse or oblique cleavage, 5-10 \( \times \) 20-30 \( \mu \)m.................................................. H. crouanii

4. Thallus purplish red. Conceptacle chamber ovoid, with a large ostiole. Tetrasporangia always with transverse cleavage, 10-15 \( \times \) 25-40 \( \mu \)m.................................................. H. occidentalis

5. Hypothallus with some filaments larger than the others, appearing in surface view as a more or less conspicuous percurrent midrib and as a distinct central axis in cross section. Each hypothallial cell giving rise to more than one upper and one lower coxal cell. The filaments of the perithallus and subhypothallus are erect. Thallus not calcified. Gland cells are present, situated in the upper surface of the blade and apparent in surface view as white microscopic rounded spots. Family RHIZOPHYLLIDACEAE
   Genus Contarinia.............................................. 6

5. Hypothallus either sparingly branched and more or less parallel (radially arranged), or much branched to form a polyflabellate layer (polyflabellately arranged), but not appearing as a distinct central axis in cross section. Each hypothallial cell giving rise to no more than one upper and one lower coxal cell. The filaments of the perithallus and subhypothallus are usually inclined towards the margin. Thallus calcified or not. Gland cells are absent.............................. 7

6. Genus Contarinia

6. Plants are flattened, forming reflexed and encrusting fronds, irregularly branched, with sinuous and lobed margins. In longitudinal section, hypothallial cells up to 35 (40) \( \mu \)m long and 20 \( \mu \)m broad. Erect filaments up to 10-25 \( \mu \)m wide at basal parts. Gland cells ovoid or pyriform in cross section. Tetrasporangia cruciately arranged.................................................. C. peyssonneliaeformis

6. Plants range from compressed to flattened, forming band-shaped segments almost regular in width (1-2 mm), irregularly dichotomously-distichously branched, with dentate margins. In longitudinal section, hypothallial cells up to 130 (150) \( \mu \)m long and 60 \( \mu \)m broad. Erect filaments up to 30-45 \( \mu \)m at basal parts. Gland cells spherical. Tetrasporangia irregularly zonate......C. squamariae

   Genus Cruoria
   C. cruoriaeformis

7. Each hypothallial cell cutting off either one single upper coxal cell, or one upper and one lower coxal cell, or one indiscriminately upper or lower coxal cell. Subhypothallus present or absent. Secondary perithallus present or absent. Plants gelatinous or firm and corticaceous. Carpogonial branch 3-6 celled. Tetrasporangia (when present) cruciately or irregularly cruciately arranged.................................................. Family PEYSSONNELIAEAE.... 8

8. Thallus lacking rhizoids. Plants encrusting, entirely calcified. Each hypothallial cell cutting off one upper and one lower coxal cell. Secondary perithallus present..............................Genus Polystrata.... 9
8. Thallus adhering to the substratum by rhizoids which arise along the whole of their undersurface. Plants foli- ose or crustose, existing as calcified or not. Each hypothallial cell dividing into either one upper and one lower coxal cell, or only one single upper coxal cell, or one indiscriminately upper or lower coxal cell. Secondary perithallus present or absent.......................... 10

9. Genus Polystrata
9. Subhypothallus not well developed, sometimes absent near the margins, up to 2 cells long (comprising the coxal cell). Perithallus cohesive after decalcification..................P. compacta
9. Subhypothallus well developed, but a little shorter than perithallus. Perithallus loosely cohesive after decalcification...............................P. foslei
10. In the centre of the thallus, the hypothallus gives rise only to a simple perithallus, but, near the margin, it gives rise also to a subhypothallus, due to the fact that the single coxal cell is situated indiscriminately at the upper or the lower part of the hypothallial cell. Thallus entirely calcified. Hypothallus polyflabellately arranged. Secondary perithallus present. Rhizoids one cell in length...........................................Genus Metapeyssonellia M. feldmannii
10. The hypothallus generates only a single upper coxal cell. Subhypothallus usually absent, but, in some species, a lower coxal cell per hypothallial cell and a few developed subhypothallus can be also present. Thallus calcified or not. Hypothallus radially or polyflabellately arranged. Secondary perithallus present or absent. Rhizoids one or more cells in length.................................Genus Peyssonellia.............. 11
11. Genus Peyssonellia
11. Thallus calcified. Subhypothallus absent. Hypothallus radially or polyflabellately arranged. Rhizoids one or more cells long................... 13
12. Only one subhypothallial cell present (lower coxal cell), Rhizoids branched. Plants between 95 and 295 µm thick. Thallus membranous to cartilaginous in texture..................................P. squamaria
12. Two subhypothallial cells present (including the lower coxal cell). Rhizoids unbranched. Plants between 155 and 385 µm thick. Thallus firm, cartilaginous to coriaceous in texture..................................P. coriacea
13. Thallus entirely calcified. Secondary perithallus present............................................. 14
13. Thallus with hypobasal calcification and with or without cystoliths. Secondary perithallus present or absent......................................................... 14
14. Rhizoids unicellular, unbranched. Plants with concentric growth zones from the marginal thallus meristem. Thallus ≤ 565 µm thick. Hypothallial cells ≤ 90 µm long..................................P. rosa-marina.............. 15
14. Rhizoids more than one cell long, usually branched. Plants without concentric growth zones from the marginal thallus meristem. Thallus ≤ 385 µm thick. Hypothallial cells ≤ 65 µm long............................................P. polymorpha
15. Plants free-living, forming more or less globulous rhodoliths due to the occasional overturning of the plant on itself and the consequent change of its growing direction. The loose wrapping of the thallus delimits large cavities filled up with fine sediments.................................................. P. rosa-marina f. rosa-marina
15. Plants growing on hard bottom, with a planar or slightly undulate frond..............................P. rosa-marina f. sascola
16. Rhizoids one cell long. Cystoliths absent. Hypothallial cells radially or polyflabellately arranged.......................... 17
16. Rhizoids more than one cell long. Cystoliths present or absent. Hypothallial cells radially arranged.................. 17
17. Hypothallus polyflabellate............................................. 18
17. Hypothallus not distinctly polyflabellate............................................. 20
18. Perithallial filaments relatively free. Plants loose and gelatinous. Hypobasal calcification not well developed..............................................................................P. armorica
18. Perithallial filaments laterally cohesive. Plants neither loose nor gelatinous. Hypobasal calcification well developed.............................................................. 19
19. Secondary perithallus present. Thallus 300-500 (– 800) µm thick. Tetrasporangia laterally inserted on the basal cell of the sterile filaments of the sori.................................................P. codana
19. Secondary perithallus absent. Thallus 70-125 µm thick. Tetrasporangia inserted at the apex of the basal cell of the sterile filaments of the sori.............................................P. dubyi
20. Angle of perithallus/hypothallus ≤ 50°......................... 21
20. Angle of perithallus/hypothallus > 50°......................... 23
21. Thallus up to 300 (-500) µm thick. Hypothallial cells usually > 30 µm long. Secondary perithallus present............................................................... 22
22. Hypothallial cells 60-175 µm long. Rhizoids long........................................................................P. atroperpurea
22. Hypothallial cells 25-80 µm long. Rhizoids short and globose..................................................P. magna
23. Thallus ≤ 425 µm thick................................. P. harveyana
23. Thallus ≤ 200 µm thick.................................................. 24
24. Thallus ≥ 140 µm thick. Secondary perithallus present............................................................ 25
24. Thallus < 140 µm thick. Secondary perithallus absent or not well developed.................................. 25
25. Tetrasporangia inserted at the apex of the basal cell of the sterile filaments of the sori..........................P. rara-avis
25. Tetrasporangia laterally inserted on the basal cell of the sterile filaments of the sori.........................P. hongii
26. Hypobasal calcification well developed, to 70-110 µm thick. Secondary perithallus absent. Surface plane. Thallus firm, coriaceous, but fragile and broken easily..............................P. stoechas
26. Hypobasal calcification not well developed, to 45-70 µm thick. Secondary perithallus sometimes present but not well developed. Surface undulated. Thallus membranous to coriaceous, not fragile.............................................P. inamoena
27. Cystoliths present. Thallus ≤ 145 µm thick, membranous to cartilaginous in texture, whitish seen from below. Secondary perithallus absent. Hypobasal calcification up to 70 µm thick..................................P. rubra
27. Cystoliths absent. Thallus ≤ 300 µm thick, firm, coriaceous in texture, not whitish seen from below. Secondary perithallus present. Hypobasal calcification up to 240 µm thick..............................................P. bornetti
28. Structure uniaxial. Growth by a single apical cell or by a small group of them. .......................... 29
28. Structure multiaxial. Growth by a marginal meristem of many apical cells. .......................... 50
29. Growth maintained by transverse division of a single apical cell. Thallus erect and bushy (at least the gametophyte). Tetrasporangia cruciately or zonately arranged ........................................... 30
29. Growth by oblique division of a single apical cell or by a small group of them. Thallus erect, decumbent or prostrate. Tetrasporangia zonately arranged .... 41
30. Thallus is terete to flat. Plants rose pink in colour, mucilaginous and soft in texture. Structure consisting of a very apparent axial filament of elongated cells producing whorls of 3-4 repeatedly branched filaments composed of cells diminishing in size toward the periphery, where they are embedded in mucilage to form a loose cortex. In younger parts the whors are distinct in surface view as annulations, but, in adult parts, the axial filament is usually surrounded by a compact layer of branched rhizoidal filaments produced by the periaxial cells and the bands are not distinct. Procarpic or non-procarpic. Carpogonial branch 3 or more cells long. Carposporophytes lacking involucres and ostiole. Spermatangia grouped on terminals or on subterminal cells of whorled branches. Tetrasporangia cruciately or zonately arranged ................................................... 31
31. Plants are terete or flat. Whors of 4 branched filaments. Procarpic. Auxiliary cell situated on a branch arising from the supporting cell. Outer cells moniliform. .............. Family GLOIOSIPHONACEAE .... 32
31. Plants are terete or slightly compressed. Whors of 3-4 branched filaments. Non-procarpic. Auxiliary cell not situated on a branch arising from the supporting cell. Outer cells moniliform or radially elongated .... 34
32. Plants flattened. Axes branching somewhat pinnate. Carpogonial branch 4-celled ........................................ Genus Schimmelmania S. ornata
32. Plants terete. Axes branching alternately or irregularly. Carpogonial branch 3-celled ....................... 33
33. Outer cells not provided with terminal hair cells. Monocarpogonial. Auxiliary cell branch 2-celled, unbranched, with auxiliary cell intercalated ................................................................. Genus Thuretella T. schousbei
33. Outer cells occasionally provided with terminal hair cells. Mono- or polycarpogonial. Auxiliary branch usually 5-celled, occasionally branched from subtending cells, with auxiliary cell terminal ................................................................. Genus Glaisispionia G. capitellaris
34. Carpogonial branch 3-celled. Auxiliary cells numerous in cortex, indistinguishable before fertilization. Whors of 3-4 branched filaments. Outer cells moniliform............ Family CALOSIPHONACEAE .... 35
34. Carpogonial branches > 3 cells long. Auxiliary cells in special filaments, easily distinguishable before fertilization. Whors of 4 branched filaments. Outer cells moniliform or radially elongated .......... 37
35. Gonimoblast arising from the auxiliary cell. Outer cells always lacking terminal hyaline hairs. .................. Genus Caliosiphonia .... 36
35. Gonimoblast arising from the connecting filament, near the auxiliary cell. Outer cells sometimes provided with hyaline hairs .............. Genus Schmitzia S. neapolitana
36. Genus Caliosiphonia
36. Main axes usually simple, occasionally with some spine-like alternate or unilaterial branches. Plants up to 2 (-4) cm high and 1-2 mm broad ................................................. C. dalmatica
36. Main axes many times branched alternately. Plants up to 1-8 (-12) cm high and 2 mm broad .... C. vermicularis
37. Outer cortical cells moniliform, occasionally provided with terminal hyaline hairs. Carpogonial branches initially unbranched, latter producing opposite laterals to one or two orders, except for the carpogonium and its two subtending cells. Auxiliary cell branch 5-16 cells long, with auxiliary cell terminal ................. Family ACROSYMPHYTACEAE
Genus Acrosymphyton A. purpuriferum
37. Outer cortical cells radially elongated, not provided with hyaline hairs. Carpogonial branches usually simple. Auxiliary cell branch 10-20-cells long, with auxiliary cell larger than the others, very distinct, intercalary, with the cells situated under and over the cortex as nutritive cells ........................................ Family DUMONTIACEAE
Genus Dudresnaya D. verticillata
38. Plants dichotomously or laterally branched. Axial filament distinct throughout, surrounded by rhizoids, and the whole immersed in some layers of large rounded or elongated thick-walled and compacted cells. Cortex consisting of an outer part of several layers of moniliform cells arranged in radial rows, and a subcortex of slightly larger ovoid cells ........ Family SPHAEROCOCCEACEAE
Genus Sphaerococcus ........ 39
38. Plants repeatedly pinnate branched, with alternating groups of 2-5 branchlets. Axial filament sometimes distinct throughout, immersed in some layers of large rounded or elongated thick-walled and compacted cells. Cortex of cells not arranged in radial rows ................. Family PLOCAMIACEAE
Genus Plocamium .......... 40
39. Genus Sphaerococcus
39. Plants up to 4-5 cm broad, with a non conspicuous percurrent midrib. Larger medullary cells up to 60-70 µm in diameter. Outer cortical cells 10-15 µm in diameter in surface view ........ S. rhizophylloides
39. Plants up to 10-15 (-25) cm, lacking a midrib. Larger medullary cells up to 100-130 µm in diameter. Outer cortical cells 5-10 µm in diameter in surface view ............. S. coronopifolius
40. Genus Plocamium
40. Main axis $\approx 2000 \mu m$ broad. Ramuli and secondary branchlets and arrangement of ramuli along axes not always unilateral......P. cartilagineum
40. Main axis $\approx 250 \mu m$ broad. Ramuli, secondary branchlets and arrangement of ramuli along axes unilateral......P. secundatum
41. Thallus flattened, usually complanately branched from the margins, lacking spine-like branchlets. Procarpic. Nutritive cells present.................................
...............Family CYSTOCLONIAEAE........... 42
41. Thallus terete or only slightly compressed, not complanately branched, sometimes bearing numerous spine-like branchlets. Procarpic or non-procarpic. Nutritive cells present or absent............................... 45
42. Thallus erect, growing from a branched holdfast in the Mediterranean species. Plants cartilaginous in texture. Fronds not anastomosing. Growth by a single apical cell. Thallus transversed by a less-conspicuous axial filament, surrounded by several lacunose layers of longitudinally elongated cells.......
...............Genus Calliblepharis............ 43
42. Thallus erect or somewhat prostrate, growing from a discoid holdfast. Plants thin and delicate, membranous when young and more firm in older specimens. Fronds occasionally anastomosed or fixed to other species by rhizoids produced secondarily from the frond surface. Growth by a small group of apical cells. Thallus appearing transverse by a diffuse axial filament in longitudinal section, and scarcely or irregularly celled in transverse section.................................
...............Genus Rhodophyllis........... 44
43. Genus Calliblepharis
43. Thallus lanceolate, $\geq 10 \text{ mm}$ wide. Blade is simple or irregularly branched. Marginal proliferations usually $\leq 5 \text{ mm}$ long, simple. Thallus $\leq 650 \mu m$ thick. Axial filament surrounded by cells up to 50-200 $\mu m$ longitudinally elongated up to 2 times their diameter. Cortex of 2-3 layers of pigmented cells..........................C. ciliata
43. Thallus linear-lanceolate, usually 2-6 $\text{ mm}$ broad. Blade dichotomous or irregularly branched. Marginal proliferations up to 15-30 $\text{ mm}$ long, sometimes hooked, especially those arising from the apex. Thallus up to 350 ($\approx 400$) $\mu m$ thick. Axial filament surrounded by cells from 50 $\mu m$ to over 100 $\mu m$ in diameter, longitudinally elongated up to 5 times their diameter. Cortex of a single layer of pigmented cells.............
...............C. jubata
44. Genus Rhodophyllis
44. Thallus up to 1-5 (-7) $\text{ cm}$ high and 1 $\text{ cm}$ wide, erect or somewhat prostrate.......R. divaricata
44. Thallus $< 1 \text{ cm}$ long and 2 $\text{ mm}$ wide, prostrate.......
...............R. strafforelli
45. Medullary cells with numerous secondary pit-connections. Procarpic. Auxiliary cell branch originating from the supporting cell and adjacent outwards to the carpogonial branch, with intercalary auxiliary cell. Gonimoblast developing adjacent nutritive cells. Carpogonophytes enclosed in a hemispherical poreless pericarp. Spermatangia formed in chains in outer cortical cells of short lateral branchlets. Tetrasporangia grouped in the swollen parts of special short lateral branchlets
...............Family HYPNACEAE
...............Genus Hypnea............. 46
45. Medullary cells lacking secondary pit-connections. Non-procarpic. Auxiliary cell is a nearby cortical cell. Gonimoblast not developing adjacent nutritive cells. Carpogonophytes without pericarp, usually ostiolate. Spermatangia in clusters or rosettes on thallus surface. Tetrasporangia scattered or in sori on thallus surface.......
...............Family CAULACANTHACEAE........... 48
46. Genus Hypnea
46. Thallus $\leq 3 \text{ cm}$ high. Main axes $\leq 800 \mu m$ in diameter....................H. furnariana
46. Thallus $> 3 \text{ cm}$ high. Main axes $\geq 1000 \mu m$ in diameter.............................................. 47
47. Plants without definite main axes, 2-6 (-15) $\text{ cm}$ high and to (10-) 250-660 (-1000) $\mu m$ in diameter. Main branches usually straight. In cross section, axial cells 20-40 (-65) $\mu m$ in diameter, surrounded by cells $\leq 160 \mu m$ wide. In longitudinal section, medullary cells $\leq 250 \mu m$ long.................................H. mucicormis
47. Plants with main axis usually remaining conspicuous, 10-16 (-20) $\text{ cm}$ high and 1000 (-2000) $\mu m$ in diameter. Main branches usually swollen and crozzer-hooked. In cross section, axial cells 25-30 $\mu m$ thick, surrounded by cells $\leq 90 \mu m$ wide. In longitudinal section, medullary cells $\leq 320 \mu m$ long.................................H. mucicormis
48. Branches segmented with elongated-ovoid internodes and constricted nodes. Segments terete to compressed. Cortex 2-5 $\text{ mm}$ thick. Growth by a single apical cell or by a small group of apical cells ..... 49
...............Genus Catenella
...............C. caespitosa
48. Branches not segmented, axes of constant diameter but pointed apices. Plant terete. Cortex one cell thick. Growth by a single apical cell.............
...............Genus Catenella
...............C. ustulatus
49. Medulla lacunose. Two periaxial cells per axial cell. Tetrasporangia scattered........Genus Caulacanthus
...............C. ustulatus
49. Medulla not lacunose. Only one periaxial cell per axial cell. Tetrasporangia grouped in sori..............................Genus Feldmannophyces
...............F. raysiae
50. Plants with a large, much-lubed supporting cell, that gives rise to several sterile (subcaryophyllous) cells, similar in shape to the supporting cell. Carpogonial branch 2-celled, arising from the subsidiary cells. Plants flattened, foliose. Cortex of cells decreasing in size from the medulla outwards, not arranged in radial rows........Family KALLYMENIAEAE... 51
50. Plants without subsidiary cells. Carpogonial branch $\geq 2$-celled, arising from the supporting cell. Plants flattened, compressed or terete. Cortex of cells sometimes arranged in radial rows.............................. 58
51. Medulla compact, composed of large, rounded, thick-walled cells through which a delicate network of cowebby filaments permeates, denser at the basal parts. Inner cortical cells ovoid to angular; outermost rounded. Procarpic. Supporting cell acting as auxiliary cell. Carpogonophytes surrounded by sterile strands from the gametophytes, usually ostiolate
...............Genus Callophyllis
...............C. laciniata
51. Medulla lax, filamentous, interwoven with very obvious stellate or ganglionic cells. Inner cortical cells stellate, the following large and angular or slightly stellate, and the outermost small, ovoid or irregularly shaped. Non-procarpic. Auxiliary cell systems with several subepithelial to ovoid subsidiary cells on an ovoid auxiliary cell. Carposporophytes lacking filamentous involucre and ostiole. ............... 52

52. Gametophytes erect, with a simple or branched stipe from which arise a series of more or less alternately arranged blades. Plants strongly concave and auriculate at the base, the older blades enveloping the younger. Thallus dark red in colour; gelatinous and thin when young, and cartilaginous and thicker in older specimens. Medullar ganglionic cells present, yellow staining; Gametophytes and tetrarospores heteromorphic. Tetrarospangia zonately arranged. .................................. Genus Meredithia M. microphylla

52. Thallus erect or somewhat decumbent, sessile or shortly stalked, broadly expanded above to form a single blade. Plants initially undivided, but adults can be lobed, laciniate or also irregularly dichotomously branched, sometimes perforated (not in Mediterranean species). Thallus rose-pink to dark red in colour, fleshy-membranous in texture. Medullar cells present, either ganglionic and yellow staining, or stellate and hyaline. Gametophytes and tetrarospores isomorphic. Tetrarospangia cruciately or irregularly arranged. .......... Genus Kallymenia ........ 53

53. Genus Kallymenia
53. Inner cortical cells \( \geq 40-60 \mu m \) in diameter. Outer cortical cells rounded in surface view, and developing rosettes around large inner cells. Medullar cells stellate, usually colourless, \( \geq 50 \mu m \) large .................................................. 54

53. Inner cortical cells \( < 60 \mu m \) in diameter. Outer cortical cells ovoid, polygonally or irregularly shaped in surface view, not forming rosettes around larger inner cells. Medullar cells ganglionic or stellate, yellow staining, usually \( < 50 \mu m \) large .................................................. 55

54. Thallus lobed. Inner cortical cells between 40-100 \( \mu m \) in greatest dimension. Medullar stellate cells with a rounded to ovoid body, \( (25-) 50-100 \mu m \) in diameter, and radiating arms \( \leq 300 \mu m \) long. ...................................... K. feldmannii

54. Thallus laciniate and sometimes slightly pinnate at the ends. Inner cortical cells up to 70-185 \( \mu m \) in size. Medullar stellate cells with a very elongated body, to 70-230 \( \mu m \) long and 20-120 \( \mu m \) wide, and arms 20-115 \( \mu m \) in length originating mainly at distal parts of the cell. .......... K. lacerata

55. Frond irregularly, di- or trichotomously branched, reniform when very young. Outer cortical cells irregularly shaped. .................. K. patens

55. Frond simple, lobed or laciniate, sometimes with marginal proliferations. Outer cortical cells rounded, polygonal or irregularly shaped .......... 56

56. Inner cortical cells up to 25-30 \( \mu m \) in diameter. .................................. K. parvula

56. Inner cortical cells up to 40-50 \( \mu m \) in diameter. .................................................. 57

57. Outer cortical cells rounded to ovoid or irregularly shaped in surface view. Medullary cells stellate or ganglionic in shape, with radiating arms \( \leq 320 \mu m \) in length. Polycarpogonial ................................................. K. reniformis

57. Outer cortical cells usually polyhedral in surface view, occasionally irregularly shaped. Medullar cells ganglionic, with radiating arms \( \leq 1000 \mu m \) in length. Monocarpogonial .............. K. requienii

58. Medulla compact, of hyaline cells .................................. 59

58. Medulla lax, filamentous, occasionally with stellate or X-shaped cells (small ganglionic cells with body cell about twice the medullary filament diameter) remaining ........................................ 65

59. Medulla of large cells with a core of small cells within. Plants membranous, terete, consisting of a prostrate and erect system of entangled and irregularly divided branches. Tetrarospangia in small ramuli, zonately arranged. ........ Genus Wurdermannia W. miniata

59. Medulla lacking a core of small cells. Plants cartilaginous, compressed or flattened, erect, usually dichotomously or irregularly dichotomously branched. Tetrarospangia not in small ramuli, cruciately arranged. ....... Family PHYLLOPORACEAE ........ 60

60. Cortex of several layers of small isodiametric cells mostly arranged in radial rows. Plants compressed, shortly stipitate, dividing in one plane. Life history biphasic, with tetrarospophytes hemiparasitic, as pustules on the surface of female gametophytes .... .......... Genus Gymnogongrus ........ 61

60. Cortex of small cells not arranged in radial rows. Plants flattened, with a long stipe, not completely branched. Life cycle triphasic with isomorphic gametophytes and tetrarospophytes .................. 62

61. Genus Gymnogongrus
61. Thallus up to 5-7 (-15) cm high, and 2-4 mm broad. Apices obtuse. Medullar cells 100-250 \( \mu m \) and 2-3 times longer. Pustule small in proportion to branches, scattered over both surfaces ........................................ G. crenulatus

61. Thallus up to 2.5 (-5) cm high and 0.5-0.6 mm broad, except in bifurcations, which are 0.8-1.1 mm wide. Apices acute. Medullar cells 10-20 \( \mu m \), and 4-8 (10) times longer. Pustule large in proportion to branches, sometimes completely encircling them. ......................... G. griffithsiae


63. Genus Phyllopora
63. Stipe short in relation to total length of the plant. Blade more or less parallel-sided. Margin undulated. Thallus with a basal or medium midrib-like thickening formed by secondary growth of the cortical layer ................. P. crispus
63. Stipe long in relation to total length of the plant. Blade more or less fan-shaped. Margin plane. Thallus lacking midrib-like thickening.............64

64. Blade very divided, with acute apices. Stipe usually representing up to half of the total length of the frond. Medullary cells up to 40–50 μm in diameter .........................P. heredia

64. Blade usually with a single dichotomy and oblique apices. Stipe usually less than one third of the total length of the frond. Medullary cells ≤ 90 μm in diameter .........................P. sicula

65. Outer cortex arranged in filamentous fascicles. Non-procarpic .............................................66

65. Outer cortex not arranged in filamentous fascicles. Procarpic or non-procarpic .............................................70

66. Carpogonial branch with adjacent nutritive auxiliary cells (nutritive cells originating from the same branch system of the carpogonial branch) .............................................Family SCHIZYMEMNACEAE. 67

66. Carpogonial branch without adjacent nutritive auxiliary cells .......................Family NEMASTOMATEACEAE. 68

67. Gland cells rounded to ovoid in shape formed in an intercalary position in cortical fascicles. Gametophytes erect or somewhat decumbent, the branching is dichotomous or irregularly lobed or palmate to pinnate. Branches often anastomosing. Carposporophytes lacking a filamentous involucre .........................Genus Platoma P. cyclocolpum

67. Gland cells ellipsoid to ovoid in shape, situated at the end of the cortical filaments. Gametophytes erect, simple or irregularly lobed, sometimes laciniate. Branches not anastomosing. Carposporophytes with a filamentous involucre .........................Genus Schizymenia S. dubyi

68. Gland cells present in gametophytes of Mediterranean species. Fronds gelatinous but cartilaginous at the base. Auxiliary cell without nutritive cells. Gonimoblasts developing from the connecting filament. .........................Genus Nemastoma N. dichotomum

68. Gland cells absent in gametophytes of Mediterranean species. Fronds soft and mucilaginous, very delicate. Auxiliary cell bearing short simple or branched chains of subcylindrical nutritive cells. Gonimoblast developing either on auxiliary cells or on connecting filaments near the point of union with the auxiliary cell .........................Genus Predaea 69

69. Genus Predaea

69. Plants up to 4-5 (-9) cm high, dichotomously or irregularly branched. Outer cortical cells ovoid to cylindrical. Carpogonial branch 2-celled. Nutritive cells originating in groups of 1–5 per bearing cell, in close related cells, but not always in the upper and the lower part of the auxiliary cell. Gonimoblast initially formed on the auxiliary cell, and originating opposite to the connecting filament. Gonimoblast ovoid to lobed ..........................P. pusilata

70. Carpogonial and auxiliary branches in a special compact branch system (ampulla). Non-procarpic. Tetrasporangia cruciately arranged .............................................Family HALYMENIACEAE... 71

70. Carpogonial and auxiliary branches not in a special compact branch system (ampulla). Procarpic or non-procarpic. Tetrasporangia cruciately or zonately arranged .............................................70

71. Cortex of cells arranged in radial rows. Inner cortical cells ovoid to ameboid. Medulla filamentous, with numerous X-shaped cells remaining ..........72

71. Cortex not in radial rows. Inner cortical cells stellate and lying in the plane of the flattened surface. Medulla filamentous but lacking X-shaped cells. 76

72. Margin rolled over one of the sides giving a concave-convex appearance. Plants segmented, rigid, sometimes spirally twisted. Genus Acrodiscus A. vidovichii

72. Margin not rolled over one of the sides. Plants not segmented, not rigid, not spirally twisted ........73

73. Thallus with a canaliculated margin in the Mediterranean species, sometimes distinct only with a magnifying glass. Plants simple, flattened .............................................Genus Aeodes A. marginata

73. Margin not canaliculated. Plants simple or variously divided, flattened or compressed .............................................Genus Grateloupia ...74

74. Genus Grateloupia

74. Thallus flattened, foliolate, simple or deeply divided once to several times, often proliferous from damaged or truncated parts. Plants 2-6 cm wide .............................................G. doryphora

74. Thallus compressed, not foliolate, dichotomously or pinnately branched. Plants ≤ 5 mm broad .............................................75

75. Frond branching repeatedly dichotomous. Plants up to 1.5-3.0 mm wide, attenuated towards the outer surface .............................................G. dichotoma

75. Frond initially dichotomous and becoming largely complanately branched, bi- or trirhizate when old. Plants up to 3 (-5) mm wide .............................................G. filicina

76. Medulla lax in young parts, with filaments forming bridges from cortex to cortex. Thallus simple or variously branched. Stipe filamentous. Thallus usually rose pink in colour, very soft and gelatinous in texture. Carposporophyte and tetrasporangia scattered and immersed in outer cortex .............................................Genus Halymenia...77

76. Medulla usually fairly compact and strong, without filaments forming bridges from cortex to cortex. Thallus leaf-like, with proliferations of the same shape of the main blade, with the thallus appearing catenate. In cross section, the stipe is celled, with a secondary developed cortex arranged in concentric circles. Thallus dark-red in colour, membranous to cartilaginous in texture.
77. **Genus Halymenia**

77. Plants terete or slightly compressed, dichotomously or subdichotomously branched, sometimes whorled. Medulla lax, with occasionally transversely oriented filaments. When the thallus is folded, creases are formed............... **H. trigona**

77. Thallus flattened, simple, pinnate or dichotomously branched. Medulla lax in young parts with many to most filaments transversely oriented, dense and irregular in older parts. When the thallus is folded, creases are not formed. **H. latifolia**

77. Thallus lanceolate, simple or, rarely, divided once dichotomously. Plants up to 180 (-300) μm thick. Medullar filaments unbranched, 8-14 μm thick. Outer cortical cells polyhedral in surface view, compact, ≤ 15 μm in greatest dimension............... **H. florea**

77. Thallus complanately much-branched to 4-5 orders, pinnate or occasionally subdichotomous. Plants ≤ 800 μm thick. Medullar filaments branched, of 2 sizes, 10-15 and 15-20 μm. Outer cortical cells ovoid in surface view, ≤ 10 μm in diameter, and radially elongated (up to 10-15 μm high)............... **N. foliosum**

79. **Genus Cryptonema**

79. Blades ≤ 3 cm broad, into which the stipe extends as an evanescent midrib-like thickening in mature plants............... **C. lomation**

79. Blades ≤ 0.5 cm broad. Midrib absent............... **C. tunaeformis**

80. Cortex of cells arranged in radial rows. Inner cortical cells ovoid to ameboid. Medulla of a network of irregularly oriented filaments and numerous X-shaped cells remaining. Thallus erect or decumbent. Procarpic or non-procarpic............... **H. lobata**

80. Cortex of cells not arranged in radial rows. Inner cortical cells stellate and lying in the plane of the flattened surface. Medulla filamentous, lacking X-shaped cells, but occasionally with some stellate cells remaining. Thallus erect. Non-procarpic............... **H. acicularis**

81. Medulla consisting of primary filaments, usually longitudinally orientated, interlined with some secondary short filaments, 1-3 cells long, thinner, usually transversely oriented. Procarpic. .................. **Familia GIGARTINACEAE**

81. Medulla lacking secondary filaments. Procarpic or non-procarpic............... **H. teedii**

82. **Genus Chondracanthus**

82. Fronds compressed or terete, irregularly branched. Plants erect or decumbent, often arching and reattaching on contact............... **C. scirrhosa**

82. Fronds flattened, regularly pinnately branched. Plants erect, not reattaching............... **C. verruculosa**

83. Margin ribbed and dentate. Thallus leafy and simple or dichotomously branched. Procarpic. Plants midlitoral.................. **Familia RISSOELLAECIAE**

83. Margins smooth or ribbed, but not dentate. Thallus almost as long as it is broad, lobed. Non-procarpic. Plants sublitoral.................. **Genus Chondrymenia**

84. Medulla lax, in younger parts transversed by a network of filaments mostly at right angles to plane of the flattened surface, and dense and transversely oriented in older ones. Cortex thin. Outer cortical cells radially elongated. Gland cells absent............... **Familia FURCELLARIACEAE**

84. Medulla appearing empty in younger part, and transversed by a network of filaments mostly at right angles to plane of the flattened surface in older ones, usually with numerous stellate cells remaining. Cortex thick. Outer cortical cells not radially arranged. Gland cells sometimes present............... **Familia SEBDENIACEAE**

85. Fronds bearing a long, terete and caulescent stipe, usually branched in mature plants, with an inner part filamentous, and an outer part of little and radially elongated cells. Plants flattened, with blades broader than high and peltate. Plants cartilaginous. .................. **Genus Neurochaeta**

86. **Genus Sebdenda**

86. Refringent gland cells present. Medullary stellate cells abundant. .................. **S. monardiana**

87. Gland cells very obvious situated in the center of the stellate cells and 20-30 μm in diameter, or over the medullar filaments, and then 15-20 μm thick. Thallus 400-500 μm thick, cuneiform, thicker at the base and margins, first simple and lanceolate, later divided in large subdichotomous lobes, with deep sinuses. Margin whole. Stellate cortical cells 20-50 (-70) μm in diameter. .................. **S. rodriqueziana**

87. Gland cells not obvious, situated in the center of the stellate cells and 10-15 μm in diameter. Thallus ≤ 1500 μm thick, more or less flattened, but usually cylindrical at the apices, dichotomously or subdichotomously branched, usually with marginal proliferations. Stellate cortical cells up to 15-20 (-25) μm in diameter.............. **S. dichotoma**

**TAXONOMIC ARRANGEMENT OF THE GENERA TREATED**

Order GIGARTINALES Schmitz in Engler

Family ACROSYPHYTACEAE Lindstrom

Genus *ACROSYPHYTON* Sjöstedt; "Acrosyphtyonea" stadium Boudouresque, Perret-Boudouresque & Knoepfler-Péguy

A. purpuriferum (J. Agardh) Sjöstedt

*Tetrarhophe: Acrosyphtyonea breennialiae* Boudouresque, Perret-Boudouresque & Knoepfler-Péguy
Family CALOSIPHONACEAE Kylin
Genus CALOSIPHONIA P.L. Crouan & H.M. Crouan
C. dalmatica (Kützing) G.B. De Toni
C. vermicularis (J. Agardh) Schmitz
Genus SCHMITZIA Lagerheim ex P.C. Silva
S. neapolitana (Berthold) Lagerheim ex P.C. Silva
Family CAULACANTHACEAE Kützing
Genus CATENELLA Greville
C. caespitosa (Withering) Irvine in Parke & P.S. Dixon
Genus CAULACANTHUS Kützing
C. ustulatus (Turner) Kützing
Genus FELDMANNOPHYCUS Augier & Boudouresque
F. rayssiae (J. Feldmann & G. Feldmann) Augier & Boudouresque
Family CRUORIACEAE Kylin
Genus CRUORIA Fries
C. crurariaeformis (P.L. Crouan & H.M. Crouan) Denizot
Family CYSTOCOLUMNACEAE Kützing
Genus CALLIBLEPHARIS Kützing
C. ciliata (Hudson) Kützing
C. jubata (Goodenough & Woodward) Kützing
Genus RHODOPHYLLUS Kützing
R. divaricata (Stackhouse) Papenfuss
R. striiformilii Ardissone
Family DUMONTIACEAE Bory de Saint-Vincent
Genus DUDRENAYA P.L. Crouan & H.M. Crouan
D. verticillata (Withering) Le Jolis
Family FURCELLARIACEAE Greville
Genus HALARACHNION Kützing
H. ligulatum (Woodward) Kützing
Tetrasporophyte: Cruoria rosea P.L. Crouan & H.M. Crouan
Genus NEUROCAULON Zanardini ex Kützing
N. foliosum (Meneghini) Zanardini
Family GIGARTINACEAE Kützing
Genus CHONDRACTHUS Kützing
C. acicularis (Roth) Fredericq in Hommersand, Guiroy, Fredericq & Leister
C. teedii (Mertens ex Roth) Kützing
Family GLOIOSIPHONACEAE Schmitz
Genus GLOIOSIPHONIA Carmichael in Berkeley
G. capillaris (Hudson) Carmichael in Berkeley
Tetrasporophyte: Rhododiscus pulcherrimus P.L. Crouan & H.M. Crouan
Genus THURETTELLA Schmitz
T. schoubehi (Thuret) Schmitz
Genus SCHIMMELMANNIA Schousboe ex Kützing
S. ornata Schousboe ex Kützing
Family HYPRNEACEAE J. Agardh
Genus HYPNEA Lamouroux
H. cervicornis J. Agardh
H. furcariana Cormaci, Alongi & Dinaro
H. musciformis (Wulfen) Lamouroux
Family KALLYMENIACEAE (J. Agardh) Kylin
Genus CALLOPHYLLIS Kützing
C. lacinia (Hudson) Kützing
Genus KALLYMENIA J. Agardh
K. feldmannii Codonier
K. lacerata J. Feldmann
K. patens (J. Agardh) Parkinson
K. reinformis (Turner) J. Agardh
K. requienii J. Agardh
K. sphulata (J. Agardh) Parkinson
Genus MEREDITTHIA J. Agardh
M. microphylla (J. Agardh) J. Agardh
Tetrasporophyte: Rhodochorton haukii (Schifferm) Hamel
Family NEMASTOMATACEAE Schmitz in Engler
Genus NEMASTOMA J. Agardh
N. dichotomum J. Agardh
Genus PREDAEA G. De Toni
P. olivieri J. Feldmann
P. pusilla (Berthold) J. Feldmann
Family PEYSSONNELIACEAE Denizot
Genus METAPEYSSONNELIA Boudouresque, Coppejans & Marcot
M. feldmannii Boudouresque, Coppejans & Marcot
Genus PEYSSONNELIA Decaisne
P. armorica (P.L. Crouan & H.M. Crouan) Börgesen
P. atroporpurea P.L. Crouan & H.M. Crouan
P. bornetii Boudouresque & Denizot
P. codana (Rosenzweig) Denizot
P. coriacea J. Feldmann
P. crispata Boudouresque & Denizot
P. dubyi P.L. Crouan & H.M. Crouan
P. harveyana P.L. Crouan & H.M. Crouan
P. hongii Marcot-Coqueugniot
P. inamoena Pilger
P. magna Ercegovic
P. polymorpha (Zanardini) Schmitz in Falkenberg
P. rara-avis Marcot & Boudouresque
P. rosa-marina Boudouresque & Denizot
P. rosa-minorina Boudouresque & Denizot
P. rubra (Greville) J. Agardh
P. squamaria (Gemlin) Decaisne
P. stoechas Boudouresque & Denizot
Genus POLYSTRATA Heydrich
P. compacta (Foslie) Denizot
P. fosliei (Weber-van Bosse) Denizot
Family PHYLLOPHORACEAE Nägeli
Genus GYMNOGONGRUS Martius
G. crenulatus (Turner) J. Agardh
G. griffithsiæ (Turner) Martius
Genus PHYLLOPHORA Greville
P. crispa (Hudson) Dixon
P. heredia (Clemente y Rubio) J. Agardh
P. sicula (Kützing) Guiroy & Irvine
Genus SCHOTTERA Guiry & Hollenberg
S. nicaevensis (Lamouroux ex Duby) Guiry & Hollenberg
Family RHYZOPHYLLIDACAEAE Schmitz
Genus CONTARINIA Zanardini
C. peyssonneliaeformis Zanardini
C. squamariae (Meneghini) Denizot
Family RISSOELLACEAE Kylin
Genus RISSOELLA J. Agardh
R. verruculosa (Bertoloni) J. Agardh
Family SARCODIACEAE Kylin
Genus CHONDRRYMINIA Zanardini
C. lobata (Meneghini) Zanardini
Family SCHIZYMENIACEAE (Schmitz & Haupt-fleisch) Masuda & Guiry
Genus PLATOMA Schousboe ex Schmitz
P. cyclocolpium (Montagne) Schmitz
Genus SCHIZYMENIA (J. Agardh) J. Agardh
S. dubyi (Chauvin ex Duby) J. Agardh
Tetrasporophyte: *Haematocelis rubens* J. Agardh
Family SPHAEROCOCCEAE Dumortier emend. Searles
Genus *SPHAEOCCOCUS* Stackhouse
* S. coronopifolius* (Goodenough & Woodward) Stackhouse
Tetrasporophyte: *Haematocelis fissurata* P.L. Crouan & H.M. Crouan
* S. rhizophyllodes* Rodríguez Femenías

Order HALYMENIALES Saunders & Kraft
Family HALYMENIAEAE Bory de Saint-Vincent
Genus *ACRODISCUS* Zanardini
A. vidovicthii (Meneghini) Zanardini
Genus *AEODES* J. Agardh
A. marginalis (Rousset ex Montagne) Schmitz
Genus *CRYPTONEMIA* J. Agardh
C. lomatian (Bertoloni) J. Agardh
C. tunaeformis (Bertoloni) Zanardini
Genus *GRATELOUPIA* C. Agardh
G. dicotypa J. Agardh
G. doryphora (Montagne) Howe
G. filicata (Lamouroux) C. Agardh
Genus *HALYMENIA* C. Agardh
H. floresia (Clemente y Rubio) C. Agardh
H. latifolia P.L. Crouan & H.M. Crouan
H. trigona (Clemente y Rubio) C. Agardh

Family SEBDENIACEAE Kylin
Genus *SEBDENIA* (J. Agardh) Berthold
S. dichotoma (J. Agardh) Berthold
S. monardiana (Montagne) Berthold
S. rodergueziana (J. Feldmann) Codonier

Order HILDENBRANDIALES Pueschel & Cole
Family HILDENBRANDIAEAE Rabenhorst
Genus *HILDENBRANDIA* Nardo
H. crouani J. Agardh
H. occidentalis Setchell in Gardner
H. rubra (Sommervelt) Meneghini

Order PLOCAMIALES Saunders & Kraft
Family PLOCAMIAEAE Kützing
Genus *PLOCAMION* Lamouroux
P. cartilaginum (Linnaeus) P.S. Dixon
P. secundatum (Kützing) Kützing
* INCERTAE SEDIS
Genus *WURDERMANNIA* Harvey
W. miniata (Sprengel) J. Feldmann & Hamel

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