KEYS FOR IDENTIFICATION OF MARINE AND ESTUARINE BENTHIC ALGAE

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The following listing gives the main keys and guides to open coastal seaweeds but there are others. There is no specific key to estuarine algae. Most species can be identified with works for marine algae, although there are some works, in German, on the Baltic Sea which are particularly useful. Remember that keys are artificial creations of man and are fallible. ***There is no intrinsic merit in using a key when you can more easily perform an identification by scanning through the pictures in a work. But you must always cross-check any identification reached that way with written descriptions and any reached using a key should be cross-checked with illustrations. If there is any uncertainty cross-check with more than one source***. Please remember that these general keys and guides are not the only sources you may need. Some difficult specimens may need reference to the specialist sources given later in this list.

Identification of Seaweeds

Seaweeds can be identified to genus level using the following key:

Jones, W.E. 1962. A key to the genera of the British seaweeds. ***Field Studies*****, 1 (4), 1-32.**

Easier to use than the genus key in Newton (see below) but still requires Newton or other works to confirm identifications or to take them to species level.

Particularly useful keys to the red and brown seaweeds that will meet many needs are:

Hiscock, S. 1979. A field key to the British brown seaweeds (Phaeophyta). ***Field Studies*****, 5, 1-44.**

Hiscock, S. 1986. A field key to the British red seaweeds (Rhodophyta). Field Studies Council Occasional Publications no 13.

These are easier to use than Jones or Newton. Beware that the brown one really is a field key and does not contain many smaller species. You will need specialist works for these. The red one is more comprehensive and has excellent drawings - probably the best published drawings available for many of the reds!

There is no general field key to the green seaweeds of Britain as a whole, comparable with those of Hiscock. There is however a regional key which can be used reasonably well throughout Britain:

Clokie, J.P. and A.D. Boney. 1980. Key to the green algae of the Firth of Clyde. ***Scottish Field Studies*** **1980.**

There are unpublished trial keys to all three of the seaweed groups –

- keys, illustrations and descriptions of brown seaweeds by Ian Tittley
- keys to green seaweeds by Ian Tittley
- keys to red seaweeds by Ian Tittley
- keys to genera of brown seaweeds by George Russell
- keys to species within genera of browns by Geoge Russell

The brown ones are the only complete up-to-date keys which cover the whole of the British browns and do make up for the lack of coverage in the Seaweeds of the British Isles series. We cannot cite formal references to these keys because they are unpublished typescripts written in preparation for works which have not yet been published. We thank the authors for their use.

Normally you should avoid laymen's guides such as Collin's Pocket Guide or the Hamlyn Guide to the Seashore. They are very misleading and incomplete where seaweeds are concerned. However one layman's book is very good:

Dickenson, C.I. 1963. *British Seaweeds.* Kew Series, London, Eyre & Spottiswoode.

It doesn't have all the microscopic species but for the macroscopic ones it is surprisingly good. Unfortunately it is now out of print but it is in many local libraries.

The only complete standard work covering all the British seaweeds is:

Newton, L., 1931. *A Handbook of the British Seaweeds.* London British Museum (Natural History).

The nomenclature in Newton is out of date, the keys to genera are difficult to use, the illustrations are not always helpful and the notes on distribution of species etc. may be misleading, but some of the keys to species within the genera are useful. When compiled it was a great achievement but now needs updating.

The nomenclatural problems in Newton can be overcome, at least partly, by correcting identifications in accordance with a standard check-list. The most recent one is

Guiry M.D. 1997. *Benthic red, brown and green algae.* In: Howson, C.M. and B.E. Picton (editors) *The species directory of the marine fauna and flora of the British Isles and surrounding seas.* The Ulster Museum and the Marine Conservation Society, Belfast and Ross-on-Wye. pp 341-367.

This checklist is the most up-to-date one for the British Isles and largely follows the species names in the "Seaweeds of the British Isles" series. Many still use the following one which has broader geographical coverage, and gives distribution thorugh major areas of the British Isles, but in which some older names are used – these follow Hiscock's keys but not the later parts of the "Seaweeds of the British Isles" series.

South, G.R. and I.Tittley. 1986. *A checklist and distributional index of the benthic marine algae of the North Atlantic Ocean.* Huntsman Marine Laboratory and British Museum (Natural History), St. Andrews, New Brunswick and London.

This checklist contains all species known from both sides of the North Atlantic and gives their known distribution therein. It lacks the footnotes given in the previous British only checklists, which enable one to follow the history of taxonomic changes for each entity since the time of Newton and hence to enable one to relate them to the names used by Newton. The previous British checklist, superseded by South and Tittley, which contains these notes is:

Parke, M. and Dixon, P.S. 1976. Checklist of British marine algae - third revision. *J. mar. biol. Ass. U.K.*, 56, 527-594.

For scientific acceptability all seaweed names should be cited in accordance with either Guiry's or South & Tittley's check-list wherever possible.

The other objections to Newton can be overcome by the use of additional works. The ***Seaweeds of the British Isles*** is a series of very detailed identification works being published by the British Museum (Natural History) and the British Phycological Society as a much more detailed replacement for Newton. The parts so far published are:

Dixon, P.S. and Irvine, L.M. 1978. *Seaweeds of the British Isles. Vol.1 Rhodophyta. part 1. Introduction, Nemaliales, Gigartinales.*

Irvine, L.M. 1983. ***Seaweeds of the British Isles. Vol 1. Rhodophyta. part 2a. Cryptonemiales (sensu stricto), Palmariales, Rhodymeniales.***

Maggs, C.A. & Hommersand, M. 1993. ***Seaweeds of the British Isles. Vol 1. Rhodophyta. Part 3a. Ceramiales.***

Chamberlain, Y. 1993. ***Seaweeds of the British Isles. Vol 1. Rhodophyta. Part . Corallinales.*** [especially useful for the colour plates of the encrusting corallinales]

Fletcher, R.L. 1987. ***Seaweeds of the British Isles. Vol 3. Fucophyceae (Phaeophyceae). Part 1.***

Burrows, E.M. 1991. ***Seaweeds of the British Isles. Vol 2. Chlorophyta.***

Christensen, T. 1987. ***Seaweeds of the British Isles, Vol 4. Tribophyceae (Xanthophyceae).***

Further parts are in preparation to cover the remaining red and brown algae.

There are other useful works published for areas outside Britain which may help you when the British ones do not seem to be getting you anywhere. include. But remember that because they relate to areas outside Britain you must beware of mistakenly identifying species which have not been found in Britain - refer to the check-list. They include the following:

Pankow, H. 1971. ***Algenflora der Ostsee. I. Benthos. (Blau-, Grun-, Braun- un Rotalgen).*** **Stuttgart, Gustav Fischer Verlag.**
[A pity this book is in German! I have really found it to be one of the most useful books for brackish-water algae; partly because it is written specifically for a brackish sea (The Baltic) and partly because Pankow seems to have a knack of simplifying the taxonomically-difficult microscopic species without losing scientific validity].

Cabioch, J., Floc'h, J.Y. & Toquin, A. 1992. ***Guide des algues des mers d'Europe.*** **Delachaux et Niestle.**

Gams, H. 1974. ***Keine Kryptogamenflora Band Ib. Makroskopische Meeresalgen.*** **Stuttgart, Gustav Fischer Verlag.**
[Another German language work. This is occasionally very useful as it is simple and specifically includes the Baltic brackish flora but beware on three counts: It also includes other European locations with subtropical species e.g. the Mediterranean, it excludes microscopic species, it is only a key - not a complete flora so results *must* be checked elsewhere. On the whole it is *occasionally* useful for a non-specialist but not recommended as a main source key.]

Kornmann, P. & Sahling, P-H. 1977. ***Meeresalgen von Helgoland. Benthische Grun-, Braun- und Rotalgen.*** **Hamburg, Biologische Anstalt Helgoland.**
Originally published as a lengthy paper in *Helgolander Wissenschaftliche Meeresuntersuchungen* (vol 29, 1-289, 1977). This was reissued as a separate book and has since had a supplement issued:

Kornmann, P. and P-H, Sahling. 1983. Meeresalgen von Helgoland: Erganzung. ***Helgolander Wiss. Meeresunters.*****, 36, 1-65.**
[This does not contain keys, nor does it contain every species. Its great value is that all species named are represented by high quality photographs and/or photomicrographs rather than line drawings, so it's good for checking you've got something right when Newton's or Pankow's drawings are inadequate. Beware that Kornmann has a nasty habit of using a different set of names for species than most other European phycologists so cross-refer to Parke & Dixon's or South & Tittley's or Guiry's check-lists.]

Taylor, W.R. 1957. *Marine Algae of the North Eastern coast of North America.* Ann Arbor, The University of Michigan Press, 2nd edition.
[This is the definitive work for its area - their equivalent of Newton. Since our flora is similar to that of N.E. America it can be used for its illustrations, keys and descriptions many of which are superior to those of Newton. Again you must beware that it doesn't have all our species and it has some which are not present here - so cross-refer to Parke & Dixon's or South & Tittley's check-lists.]

South, G.R. and Cardinal, A. 1973. Contributions to the flora of marine algae of Eastern Canada. 1. Introduction, historical review and key to the genera. *Naturaliste, can.*, 10, 605-630.
[As for Taylor, above, this key to genera covers some but not all of our species and contains some extra ones. It should only normally be used as a last resort when West European keys fail, and you must cross-refer to the check-list.]

The major seaweed books and keys that are in print can be obtained from Natural History Book Service – see website: www.nhbs.com. Cheap secondhand copies of the major seaweed books, including out of print ones such as Newton and Dickenson can usually be obtained from Little Holcombe Books, 10 Lumb Carr Avenue, Ramsbottom, Bury, BL0 9QG - tel. 01706(825322). As a guide Newton can be bought for about £25-30 but price varies up or down according to condition and edition number as they are collectors' items.

Specialist works on particular groups or genera

1. Chlorophyta

Normally Newton, Jones, Hiscock, Pankow and the check-list should be enough for your needs. If you are doing algal work seriously the following specialist works on selected groups which include species found in brackish waters may be particularly valuable.

Bliding, C. 1963. A critical survey of European taxa in Ulvales. Part I. *Capsosiphon, Percursaria, Blidingia, Entermorpha. Opera Botanica, 8* (3), 1-160.

Bliding, C. 1968. A critical survey of European taxa in Ulvales. Part II. *Ulva, Ulvaria, Kornmannia, Monostroma. Botaniska Notiser, 121,* 553-629.

[The two Bliding papers do not contain keys but are lavishly illustrated with macro- and micro-photographs.]

Koeman, R.P.T. and C. van den Hoek, 1980. The taxonomy of *Ulva* (Chlorophyceae) in the Netherlands. *Br. phycol. J.*, 16, 9-53.

Koeman, R.P.T. and C. van den Hoek. The taxonomy of *Enteromorpha.* Link, 1920, (Chlorphyceae) in the Netherlands.
I. *Arch. Hydrobiol. Suppl.* 63, 279-330 (1982).
II. *Cryptogamie Algol.* 3, 37-70 (1982).
III. *Cryptogamie Algol.* 5, 21-61 (1984).

Lokhorst, G.M. and B.J. Trask. 1981. Taxonomic studies on *Urospora* (Acrosiphoniales, Chlorophyceae) in Western Europe. *Acta Bot. Neerl.*, 30, 353-431.

Kornmann, P. and P-H Sahling. 1974. Prasiolales (Chlorophyta) von Helgoland. *Helgolander Wiss. Meeresunters.*, 26, 99-133.

Ramanathan, R. 1963. *Ulotrichales.* New Dehli, Indian Council of Agricultural Research.

[Although primarily Indian it includes species from all over the world. This book is particularly important since we have found many apparently fresh-water Ulotrichales, not included in marine works, living in estuaries.]

Van den Hoek, C. 1963. *Revision of the European Species of Cladophora.* Leiden. (Reprinted 1976 by Otto Koeltz Science Publishers, Koenigstein, FRG.)

Soderstrom, J. 1963. Studies in *Cladophora. Botanica Gothoburgensia,* 1, 1-147.

Lokhorst, G.M. 1978. Taxonomic studies on the marine and brackish water species of Ulothrix (Ulotricales, Chlorophyceae) in Western Europe. *Blumea*, 24, 191-299.

Excellent illustrations, but not keys, of some only of the species particularly important in estuaries are to be found in:

Carter, N. 1933. A comparative study of the algal flora of two salt-marshes II. *J. Ecol., 21,* 128-208.

An annotated check-list of marine and estuarine algae of the Clyde, while apparently of local interest, contains a tremendous amount of algal natural-history information of the behaviour and distribution of many species. It is possible that such a list could be very useful to the partly-trained worker in assessing whether or not a problematical identification is likely to be correct. One must however be careful as behaviour of the plants may be different a long way from the Clyde e.g. the South coast of England. The reference is:

Clokie, J.J.P. & Boney, A.D. 1979. Check-list of marine algae of the Firth of Clyde. *Scottish Field Studies.* 1979, 3-13.

2. Chrysophyta

The principal chrysophytes to be found in estuaries and sometimes on the open coast, particularly on mud or in salt-marsh are:

(a) mats of *Vaucheria* spp. (Xantophyceae)
(b) epilithic films of diatoms and benthic sediment dwelling diatoms (Bacillariophyceae)
(c) benthic filamentous phases in the life histories of otherwise planktonic forms in the Haptophyceae and Chrysophyceae, found in salt-marshes or on mud.

(a) ***Vaucheria*** spp. This coenocytic filamentous plant forms distinct ruffled or velvety cushions in a wide range of habitats and can often be identified to genus level with the naked eye in the field. Species identification is very difficult. It is based on the structure and position of sexual organs and consequently cannot be done on non-reproductive specimens. The normal practice is to excise a small area, say 1 or 2 sq. cm., of algal mat and to maintain it in the laboratory at about $15^{O}C$ and under a long-day length in a closed petri-dish without added culture medium. This appears to induce the formation of sex organs. Specimens collected in the summer are quite likely to be reproductive at the time of collection.

In addition to Christensen's Tribophyceae volume in the "Seaweeds of the British Isles" other identification works for *Vaucheria* are:

Knutzen, J. 1973. Marine species of *Vaucheria* (Xanthophyceae) in South Norway. *Norw. J. Bot., 20,* 163-181.

This key is specifically on North-West European material and includes useful habitat notes. Two more general works which include species from elsewhere (hence reference to check-lists needed to confirm likely identifications) are:

Blum, J.L. 1972. ***Vaucheriaceae. North American Flora Series II, Part 8.*** **New York Botanical Garden.**

Venkataraman, G.S. 1961. ***Vaucheriaceae.*** **New Dehli, Indian Council of Agricultural Research.**

A good key (but not very good illustrations) to West European species is included in Pankow (see reference earlier).

(b) ***Diatoms***. Detailed identification of the massive range of diatoms found in benthic samples is probably beyond the capabilities of most workers - even macrophycologists! It requires detailed microscopic examination of the structure of the siliceous frustule after protoplasm has been cleared away by vigorous treatment with acids and oxidising agents. It is however possible to identify some of the commonest estuarine diatoms without clearing.

For all diatoms three works are particularly useful:

Hendey, N.I. 1964. ***An introductory account of smaller algae of British coastal waters. Part V. Bacillariophyceae (Diatoms).*** **Fishery Investigations Series. London, H.M.S.O.**

Van Heurck, H. 1896. ***A treatise on the Diatomaceae.*** **London, Wesley. Reprint, 1962 by Wheldon & Wesley and J. Cramer.**

Hustedt, F. 1930. ***Bacillariophyta.*** **In:** ***Die Susswasserflora Mitteleuropas.*** **Vol. 10. Ed. A. Pascher. Publ. Fisher Verlag, Jena.** [Since issued as a reprint - a freshwater work but still useful]

In addition there is a very useful key to the diatoms commonly grouped under the form genus name "***Schizomena***". These diatoms are naviculoid forms which live in colonies in mucilaginous tubes and resemble filamentous brown algae to the naked eye. The key is:

Cox, E.J. 1977. The distribution of tube-dwelling diatom species in the Severn estuary. ***J. mar. biol. Ass. U.K.,*** **57, 19-27.**

Diatoms are not included in Parke and Dixon's check-list and nomenclature should be revised in accordance with their own check-list:

Hendey, N.I. 1974. A revised check-list of British marine diatoms. ***J. mar. biol. Ass. U.K.,*** **54, 277-300.**

(c) ***Benthic forms of planktonic chrysophytes.***

The most likely ones to be found include members of the genera *Apistonema, Chrysomeris* and *Ruttnera.*

Descriptions are to be found in Pankow, Carter (references given earlier) and a further reference to Carter:

Carter, N. 1937. New or interesting algae from brackish-water. ***Arch. Protistenk.,*** **90, 1-68 Figs. 1-8.**

3. ***Blue-green algae***

These are a major component of the epilithic and epibenthic flora of the upper reaches of estuaries. Identification is difficult because of their incredible morphological plasticity and the high level of disagreement between authors. There are at least two very different taxonomic schemes in regular use. One is based solely on earlier morphological descriptions and a more recent one on laboratory culture work by Drouet & Dailly who claimed a substantial reduction in the number of taxa by interconverting even quite dissimilar forms into each other by manipulation of culture conditions. This has been popular with some workers because it makes it easy for them to give a name to memebers of a group that they do not enjoy having to include in their species lists. My personal preference is not to accept the over-simplification proposed by Drouet & Dailly. Even if the original recognised taxa have often been shown not to be genuine species in the "higher-plant" sense, it seems preferable to continue to use them for the time-being for two reasons; a particular morphological form or ecophene may indicate a particular set of environmental conditions; the high level of disagreement among phycologists about Drouet and Dailly's ideas makes it desirable to record data in the more complete older format.

A good key to brackish blue-greens is found in Pankow (reference given earlier).

Keys to genera of blue-greens together with keys to species within genera and, very usefully, tables showing equivalent names between Drouet and Dailly's taxonomy and the traditional taxonomy are given in:

Humm, H.J. and S.R. Wicks. 1980. *Introduction and guide to the marine blue-green algae.* Wiley.

This probably all that is needed. It is arguable whether or not more detailed treatment is desirable from non-expert phycologists. If more detailed works are needed the following are particularly recommended:

Desikachary, T.V. 1959. *Cyanophyta.* New Dehli, Indian Council of Agricultural Research.

Fremy, P. 1972. *Cyanophycees des Cotes d'Europe.* Asher and Co. BV., Amsterdam. Reprint of original series of articles published 1929-33 in *Mem. Soc. Nat. Math. Cherbourg.*

Geitler, L. 1932. *Cyanophyceae* in *Rabenhorsts Kryptogamen-Flora.* Leipzig. Akademische Verlagagesell-schafft m.b.H. Reprinted 1971, Johnson Reprint Corporation. New York and London.

You should note that Parke & Dixon's check-list is of limited value for blue-greens because it is based on Drouet and Dailly's revised taxonomy and blue-greens are not even included in South & Tittley's check-list.

4. Euglenophyceae

Green patches of benthic euglenoids are common on intertidal muds of some estuaries, particularly in Summer, interspersed with diatoms. The commonest ones appear to be *Euglena obtusa* and *E. vermiformis.*

A good key is:

Butcher, R.W. 1961. *An introductory account of the smaller algae of the British coastal waters. Part VIII Euglenophyceae.* Fishery Investigations Series. London, H.M.S.O.

Many of these references are out of print but second-hand or reprint copies can usually be obtained from: Koeltz Scientific Books, P.O. Box 1360, D-6240 Koenigstein, Germany. Ask for their catalogue on Algae & Phytoplankton, issued every year or two, which contains many hundreds of algal books – now available on line. They are expensive.

Martin Wilkinson; April 1984 - 6th revision September 2002; wshpalgkeys.doc.