THE SEAWEEDS OF DALE

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THE Dale district (Fig. 1), while not as rich as some more southerly localities, provides in a limited area a number of easily accessible shores whose range of environmental conditions ensures the presence of a varied algal flora. The authors have become familiar with these shores during a number of visits since Dale Fort Field Centre opened in 1947. The local algae have also received attention from numerous other botanists including those who, in 1953, attended the field meeting of the British Phycological Society held at the Fort. A list of species has been built up which is now longer than it was when Miss E. Mary Thomas (1953) produced the preliminary list which has proved of much value to students of marine biology at Dale. We hope the list will encourage visiting botanists to make good the gaps; it records the algal flora of an area in which changes may occur as a result of the increasing use of Milford Haven as a deep-water port.

We should like to acknowledge our debt to the following collectors whose records are included in the Dale Fort flora index: Dr. A. P. Austin, Mr. J. H. Barrett, Dr. Mary E. Gillham, Professor C. T. Ingold, Dr. D. E. G. Irvine, Dr. Joanna M. Jones, Mr. G. C. King, Professor E. W. Knight-Jones, Dr. J. R. K. Savage, Miss E. Mary Thomas and to Dr. Helen Blackler, Dr. Elsie M. Burrows, Dr. P. S. Dixon, Mr. and Mrs. H. T. Powell and the late Dr. Kathleen Drew Baker who identified the species given in the list of algae (Baker *et al.*, 1957), collected during the British Phycological Society meeting. We wish to thank the Council of the Society for permission to incorporate these records in the present list. We also wish to express our gratitude to Professor Lily Newton who pioneered this work at Dale and under whose guidance we developed our interest in the algae.

Throughout this paper, the names of species are as given in the revised check list of Parke and Dixon (1964). As a background to the list, a review of the conditions affecting the life of seaweeds at Dale may be useful, in addition to the relevant information which has already appeared in this journal and elsewhere (Thomas, 1953; Gillham, 1954; Oliver, 1959; Bassindale and Clark, 1960; Ballantine, 1961; Moyse and Nelson-Smith, 1963).

GEOGRAPHICAL POSITION

The area receives Atlantic storms from the south-west; the west-facing part of the coast is therefore exposed to heavy wave action. On the mainland this is

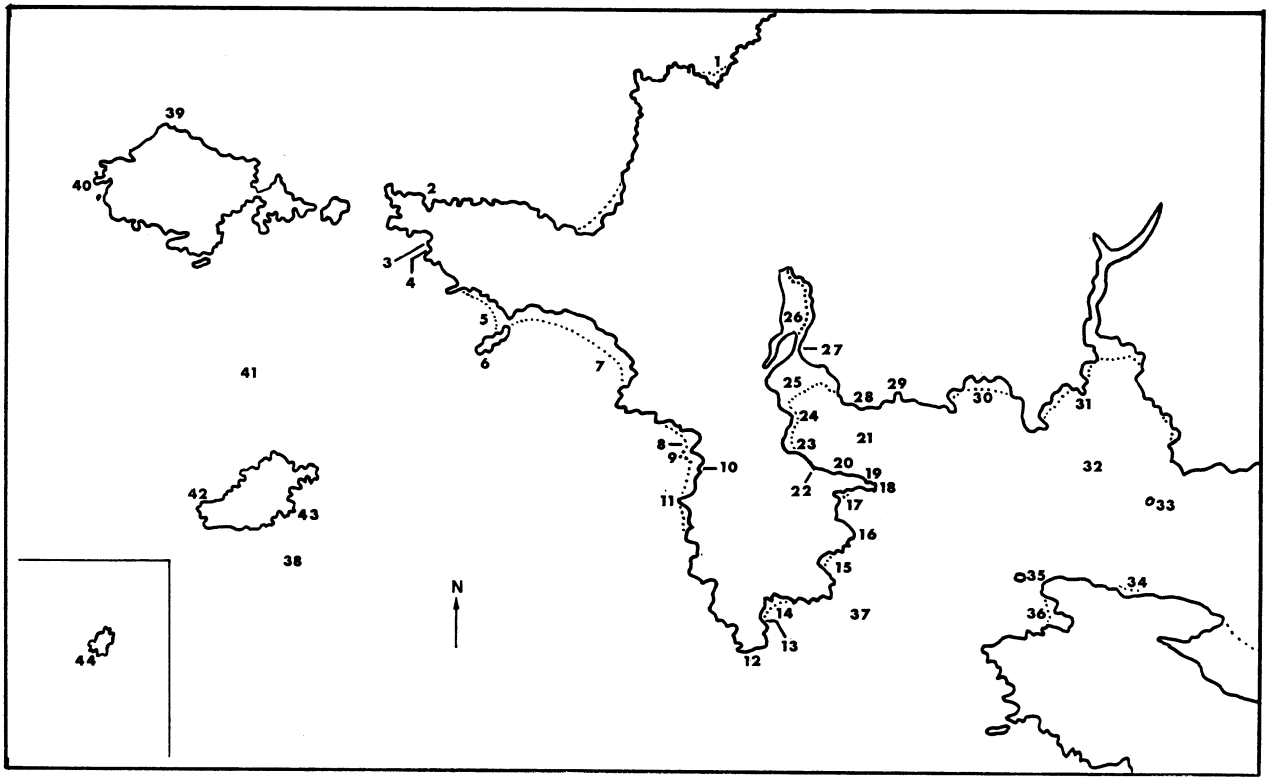

Fig. 1.

Map of the area covered by this survey. Places mentioned in the list of species are indicated by numbers; names in italics indicate places where specimens were obtained by diving or dredging.

1. St. Bride's Haven
2. Martin's Haven
3. Renny Slip
4. Deadman's Bay
5. Gateholm Bay
6. Gateholm Island
7. Marloes Bay
8. West Dale Bay
9. Great Castle Head
10. Iron Point
11. Long Point
12. St. Ann's Head
13. Thorny Pit
14. Mill Bay
15. Watwick Bay
16. Watwick Point
17. Castlebeach Bay
18. Dale Point
19. Slip Pier Beach
20. Fort's raft
21. *Dale Roads*
22. Point Wood Beach
23. Below Griffin Inn
24. Black Rock
25. Gann Flats
26. Gann salt marsh
27. Gann river mouth
28. Musselwick Point
29. Monk Haven
30. Lindsway Bay
31. Little Castle Head
32. *South of Little Castle Head*
33. Stack Rock
34. Chapel Bay
35. Headland opposite Thorn Island
36. West Angle Bay
37. *Off West Blockhouse Point*
38. *Off Skokholm*
39. *Off north end of Skomer*
40. The Spit, Skomer
41. *Between Skomer and Skokholm*
42. The Head, Skokholm
43. Skokholm, recorded by Gillham (1954)
44. Grassholm, recorded by Gillham (1954)

heaviest at St. Ann's Head but reaches still greater intensities on the islands of Skomer and Skokholm. Though exposed to high winds and heavy seas, shores on the west coast of Britain do not experience as great a variation of temperature as do the east or south-east coasts. Summer temperatures can rise to high levels in the littoral zone for short periods but in winter the temperature seldom falls to freezing point. The Dale area also benefits from the further tempering of extremes of temperature which is a feature of peninsulas and islands. This is shown in the distribution of certain species near the northern limit of their distribution: *Bifurcaria bifurcata*, for instance, is plentiful on some shores near Dale and at St. David's Head but is not found north of this except on Bardsey Island at the western extremity of North Wales. The same is true of *Codium fragile*, a plant which has extended northwards in recent years, particularly along the east coast, but in Wales has been found only in Pembrokeshire and on Bardsey.

Substratum

Algae absorb nothing directly from their anchorage and so the rocks on which they grow affect the plants not so much by their chemical composition as by the way in which their surfaces weather. The smoothness and friability of the surface is important in determining the effectiveness of the plant's attachment. The coastline on the northern side of Milford Haven and northwards from St. Ann's Head is mainly formed of Old Red Sandstone. This soft rock forms cliffs which weather quickly to give, at first, broken shores with many large boulders and, later, much shingle and sand. On these shores the abrasion of plants by suspended particles is important, particularly in the early stages of development, and the likelihood of boulders being overturned by the waves is another hazard. However, the more stable masses of sandstone on this coast offer a satisfactory anchorage; the surface does not crumble away so quickly as to result in plants being easily removed by the pull of the waves and does not limit the flora in the way that some more friable surfaces (e.g. chalk and some mudstones) appear to do.

On the southern side of the Haven the shores are also mainly of Old Red Sandstone but a band of Carboniferous Limestone reaches the coast at West Angle Bay and has some influence on the flora. *Cystoseira granulata* is much more plentiful on this shore than elsewhere in the area, occurring in large, shallow pools in a limestone syncline in the upper littoral. It seems to be the form of the pools rather than the nature of the limestone itself which determines this distribution; on St. Ann's Head some *C. granulata* also occurs in broad, shallow, upper-littoral pools but there the rock is sandstone. *Taonia atomaria* also occurs at West Angle, the only record in the area. Again, the determining factor seems to be the weathering of the limestone to produce a deep, vertical-sided cleft in which *Taonia* grows at the bottom, in a permanent pool.

Where the shore is composed of shingle, sand or mud, the flora is limited to those species which can tolerate the special hazards of these mobile substrata. On the more exposed sandy shores, such as West Dale Bay, the number of sand-tolerant species is small; in more sheltered places, such as on the Gann Flats, a much richer flora is to be found. In these sheltered places the finest particles

accumulate in large quantities and there is a shortage of solid anchorages for the plants. Very small particles are in fact sufficient for the attachment and initial development of algal spores but the young plant is unlikely to survive more than a very short time before being buried by more silt or abraded against neighbouring particles. However, many plants do begin development on pebbles, empty mollusc shells, etc. or epiphytically on other plants. On the Gann Flats most of the seaweeds are attached in this way. The survival of this flora depends on the absence, during the growing season, of waves large enough to lift both plant and anchor and carry them upshore; autumn storms frequently cast up large numbers of plants but by then many will have fruited. Even if no longer anchored a plant can continue to grow, provided it is not carried above the level on the shore at which desiccation is too severe. Large plants of *Laminaria saccharina* can often be found in Dale Roads, or washed ashore, in which the holdfast has grown into a tangled ball with each hapteron branch bluntly rounded off at its tip and showing no sign of the flattened attachment surface which develops when such branches make contact with rock; these plants have presumably been living unattached on the sea bed for some time.

A plant drifting across the mud may become anchored if the pebble or shell to which it is attached becomes caught and buried. Plants of *Gracilaria verrucosa* frequently grow anchored in this way on the Gann Flats.

While considering the importance of the substratum, it must be remembered that many plants grow as epiphytes, attached to other seaweeds. Some species are restricted to such habitats: *Ceramium rubrum*, for instance, often obscures its host on sheltered shores; it does not appear to cause much slowing of growth by shading the other plant but greatly increases the total pull on its anchorage when subjected to water currents and so increases the chance of the plant being washed away. *Pylaiella littoralis* is also a common epiphyte: on the Gann Flats this species and *Ceramium rubrum* are major constituents of the large bulk of algal thalli which grows rapidly in summer and can be moved by comparatively gentle wave action. Masses of this weed can be stranded by inshore winds, sometimes to a thickness of several feet, and have acquired the local name "caulker". As a rule the epiphytes are not restricted to particular hosts, though *Polysiphonia lanosa* is seldom found on plants other than *Ascophyllum*, while *Elachista scutulata* occurs only on *Himanthalia* and *E. flaccida* only on *Cystoseira*.

SUB-LITTORAL HABITATS

The algal flora of the Gann Flats extends with gradual change into the deeper water of Dale Roads. The occasional casting up or dredging of unusual species and the occurrence of particularly large specimens of the Laminariales show that growth conditions are favourable despite the layer of silt which is often to be found on the surface of the plants. Other interesting sub-littoral habitats occur in the clear water on the steep submarine cliffs of Skomer and Skokholm. Experience suggests that neither finds in the drift-weed nor the results of dredging are a reliable indication of what the sub-littoral flora contains. Systematic aqua-lung investigations may produce results of considerable interest.

Exposure

This aspect of the algal ecology of Dale has been covered in two recent papers (Ballantine, 1961; Moyse and Nelson-Smith, 1963) and needs little emphasis here. Exposure depends on the severity of wave action which in turn depends not only on the geographical position of the shore in relation to the open sea and prevailing winds but also on the slope of the shore, the presence of off-shore reefs or shoals and the nature of the rock surface. Smooth steep surfaces bear a flora of a more "exposed" character than similarly situated but gentler slopes of unevenly weathered rock. Quite small irregularities can provide limited local shelter and pockets containing species and communities generally regarded as being typical of sheltered conditions can be found even on shores like St. Ann's Head. Figs. 2 to 6 show how the distribution of the littoral fucoid algae is affected by variation in exposure. Some plants are typical of certain conditions of exposure: *Ascophyllum nodosum*, for instance, is restricted to the most sheltered places, *Fucus spiralis* can withstand a little more wave action and *Pelvetia canaliculata* still more.

Other plants are found only in exposed situations: Fig. 7 shows the distribution of *Alaria esculenta*, which follows this pattern. A distribution of this kind is not necessarily directly conditioned by wave action, though the plants must obviously be able to withstand very powerful wave attack; it has been shown (Sundene, 1962) that in more northerly regions *Alaria* is restricted to places where the summer temperature does not rise above 16° C. This is in agreement with its distribution at Dale where the temperature rises higher than this in sheltered places in summer.

Some plants occur on shores intermediate in exposure between the extremes characterized by *Ascophyllum* and *Alaria*; typical of these is *Himanthalia elongata* whose distribution is shown in Fig. 8. It is a plant which appears to be intolerant of much sediment.

Biotic factors

The sparseness of plant cover on exposed shores is largely the result of grazing by browsing molluscs, particularly limpets, as is demonstrated by the virtual limitation of some littoral species (e.g. *Nemalion multifidum*, small *Enteromorpha compressa* and *Ulva lactuca* plants) to limpet shells on these shores. Barnacles are major competitors for space in these places; many spores are probably lost into the forest of beating cirri of an actively feeding barnacle bed, though once settled on a barnacle shell the spore is safer from limpet grazing than on bare rock; *Nemalion*, if not on a limpet shell, is usually found attached to barnacles.

In many cases, mature plants are limited to cracks in the rock partly because limpets feed less effectively on these uneven surfaces and also, perhaps, because of better retention of moisture in the shade in the crack. In such places the weed is often found to be growing not directly attached to the rock but on an encrusting layer of *Lithothamnion* spp. limited to the area of the crack. In pools, and lower downshore, where desiccation is not so severe, *Lithothamnion* forms a complete encrustation over which the limpets feed, the only clear spaces of rock being the limpets' "home bases". The calcareous algae seem to be less affected

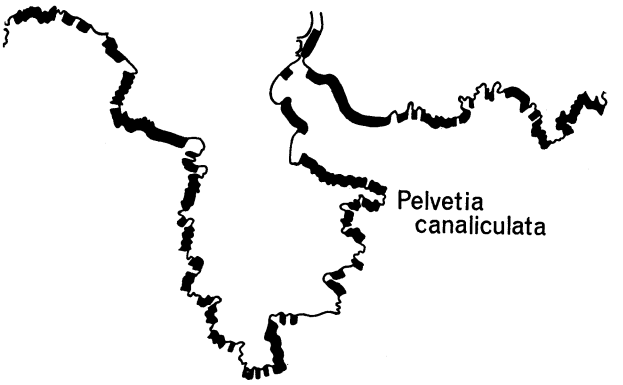

Fig. 2.

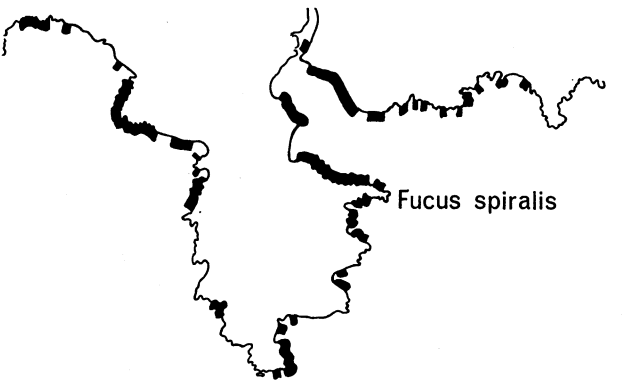

Fig. 3.

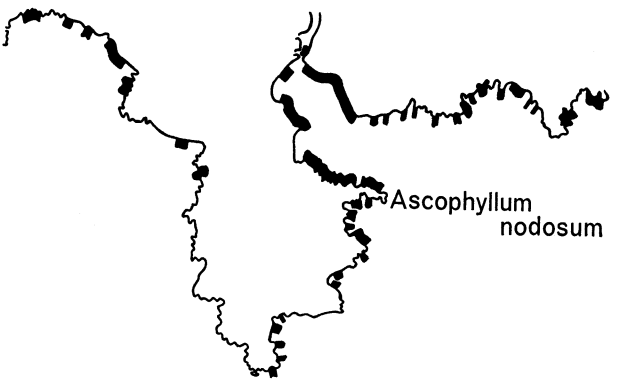

Fig. 4.

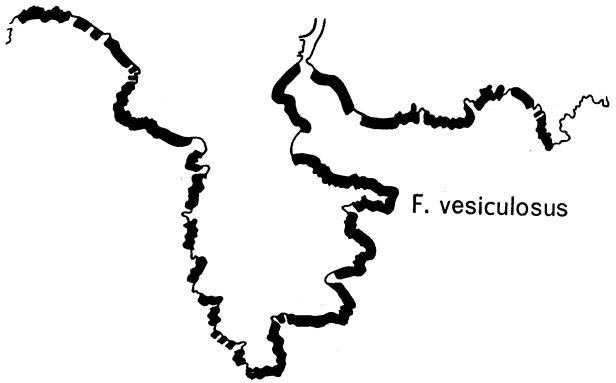

FIG. 5.

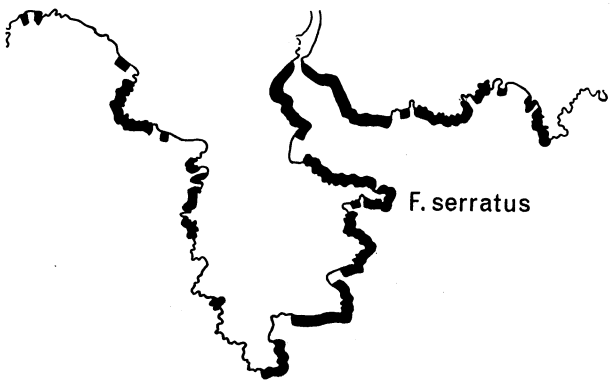

FIG. 6.

FIGS. 2–6.

Distribution of the commoner members of the Fucaceae along the coast between Gateholm Island and the eastern border of Lindsway Bay.

Fucus vesiculosus has the widest distribution; *Ascophyllum* the most restricted. Note, however, that *Ascophyllum*, though typical of sheltered localities, occurs on shores where exposure is generally severe, if local shelter is available. This may be provided by masses of rock or boulders (as at St. Ann's Head and Watwick Point) or result from the dissipation of wave energy on gently sloping beaches seawards of the *Ascophyllum* zone, as at Marloes Bay.

Fucus spiralis extends onto shores receiving more wave action than *Ascophyllum* can tolerate: *Pelvetia* has a still wider range. *Fucus serratus* may be found sub-littorally on shores more exposed than those on which it is recorded here.

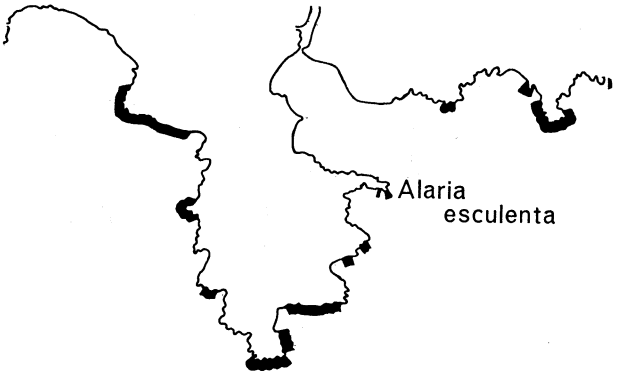

FIG. 7.

Distribution of *Alaria esculenta* along the coast between Gateholm Island and the eastern margin of Lindsway Bay. The species is restricted to exposed shores.

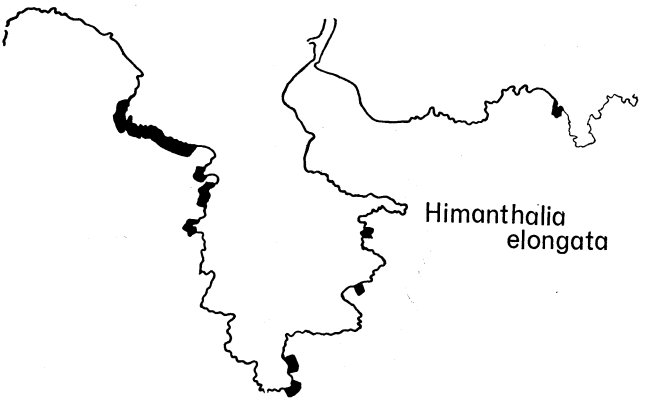

FIG. 8.

Distribution of *Himanthalia elongata* along the coast between Gateholm Island and the eastern margin of Lindsway Bay. The species is found on shores of intermediate exposure where there is deep water close inshore and little sediment.

by limpet grazing though the newly formed cells of their growing edges are presumably vulnerable until they become fully calcified.

One potentially serious biotic danger is the activity of naturalists. The seaweeds no doubt suffer less than do some of the littoral animals and there is seldom the same degree of danger to unusual species as occurs in the flowering plants but students should be wary of indiscriminate collecting, particularly of specimens occurring in small numbers.

Seasonal changes

The majority of those who visit shores around Dale do so in summer and, unless they repeat the visit at other seasons, may not realize the considerable changes which occur in the algal population through the year. Even the casual observer will see changes in the general colour of the shore plants. On the less sheltered shores in winter the upper edge of the littoral zone acquires a slippery, dark purple film, composed of *Bangia fuscopurpurea* and various blue-green algae, which disappears from most places as the drying effect of the sun increases with advancing summer. In late spring and early summer the maturing receptacles of *Ascophyllum* give the shore an orange colour in the mid-littoral.

Once the sun makes itself felt, as early as April or even March in some years, the littoral red algae begin to change colour; the characteristic reds and purples of winter give way to light brown and eventually to straw yellow as the Phycoerythrin is bleached. In this condition the plants often present difficulty to the student seeking to identify them; some comfort may, however, be provided by the knowledge that bleached red algae are still healthy, capable of growth and of fruiting (Jones, 1959a) and will recover their colour when the light decreases in autumn. Even the most bleached, such as *Gigartina stellata* or *Porphyra umbilicalis* on open, rocky shores or *Gracilaria verrucosa* on sandy ones, retain their full colour at the base of the thallus as a result of shading by the upper parts, or by being buried in sand. The full colour is also retained by plants in shady places, such as *Catenella repens* which, though growing in the upper littoral, is usually found in crevices or other shade (Fig. 9). Similarly, plants such as *Lomentaria articulata*, *Plumaria elegans* and *Membranoptera alata* usually grow in the shade of larger plants or under rocky overhangs, etc. and are usually fully pigmented. On the Gann Flats the bleaching action of sun-

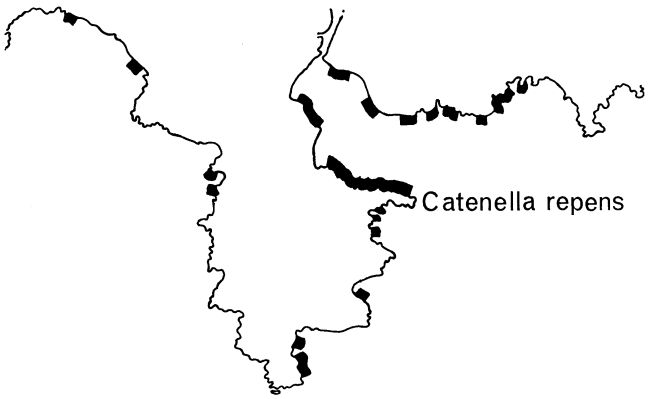

Fig. 9.

Distribution of *Catenella repens* along the coast between Gateholm Island and the eastern margin of Lindsway Bay. The species is restricted to less exposed places; it is well developed on north-facing shores; elsewhere it occurs in local shade.

light is reduced by the silt which coats the plants. Some species seem intrinsically less liable to bleaching, e.g. *Polysiphonia lanosa* on *Ascophyllum*. The general yellowing of the littoral red algae becomes less obvious at the lowest levels of the shore and the sub-littoral algae usually retain their full red colour.

Seasonal changes are also shown in the succession of species on the shore when annual plants develop and die away amongst the perennials. On the Gann Flats, for instance, *Dumontia incrassata* appears in the early spring and reaches maturity in early summer; by August those plants that remain are decaying. On more exposed shores *Dumontia* grows to a smaller size but survives longer. Summer annuals also include *Chorda filum*, *Cystoclonium purpureum*, *Dictyota dichotoma*, *Bryopsis plumosa* and *B. hypnoides*, while others, like the common epiphyte *Ceramium rubrum*, are present to some extent at all seasons but are much more obvious on the shore in summer. Other species reach their best development or are actively fruiting in winter or early spring, e.g. *Polysiphonia elongata*, *Desmarestia aculeata* and *Fucus serratus*. Apart from *Chorda*, the most spectacular annual is *Saccorhiza polyschides* which, in Dale Roads, just below the Fort, grows within the period from February to July to produce plants over 2 metres long and of proportionate bulk; this rate of growth is rivalled in only a few of the largest terrestrial annuals.

UNCOMMON SPECIES

The commonest species found in an area are usually the most valuable as indicators of the ecological conditions but rarities have their interest, not merely as records but because they may provide information on the limits of distribution of a species and of its tolerance of environmental extremes. Several unusual species have been recorded near Dale. Most of these have been found sublittorally and it seems likely that species which occur within the tide marks in the south of the British Isles may extend northwards in water deep enough to avoid the lower temperatures which occur littorally in winter.

Some plants, scarce in many places, occur at Dale in fair numbers; *Schizymenia dubyi*, for instance, occurs on several shores in shaded gullies at the lowest levels, fruiting in late summer. *Stenogramme interrupta* can usually be obtained if dredging in Dale Roads is continued long enough in July or August. Other unusual species in the Roads and further out into Milford Haven, occasionally appearing in the drift-weed on the Gann Flats, include *Arthrocladia villosa*, *Sporochnus pedunculatus*, *Pterosiphonia complanata* and *Dictyopteris membranacea*. The last has also been found once in a lower littoral pool at St. Bride's Haven, a most unusual place for a characteristically sub-littoral plant, though Gillham (1954) recorded it in a similar habitat on Skokholm. Apart from this there are few rarities recorded from the littoral zone, though *Gigartina aculeata* occurs on Great Castle Head.

LIST OF SPECIES

Some records in the Dale Fort index, usually of single finds, are omitted here because, in the absence of a specimen, they could not be checked and seemed open to question in view of the known distribution of the species. To make it as complete as possible the list includes the records of algae from Skokholm and Grassholm previously published, together with an account of the shore ecology of those islands, by Gillham (1954).

Also included here are records from the list compiled by members of the British Phycological Society (Baker *et al.*, 1957). Many of these constitute the only record of the species concerned; these records are starred and are reproduced by permission of the Council of the Society.

There are gaps in the list; records from Skomer are very scarce and some algal groups are under-represented. Records of species which are at present treated with suspicion by phycologists will presumably accumulate as new monographs on difficult genera appear. However, some species which are easily recognized and common enough elsewhere seem to be scarce at Dale. *Colpomenia peregrina* is recorded once only, for instance, and *Sphacelaria bipinnata* not at all. In fact, the list is by no means complete and plenty of work remains to be done by interested botanists.

Within each of the classes which the list includes the species are arranged in the order given in Parke and Dixon (1964). Locations are indicated by numbers; a key to these is given in Fig. 1. Owing to the way in which the zonation on shores is affected by wave action (Burrows *et al.*, 1954; Jones, 1959b; Lewis, 1964) tidal levels are not a good means of indicating the position of plants except on sheltered shores. In this list the terminology used is as shown in Fig. 10.

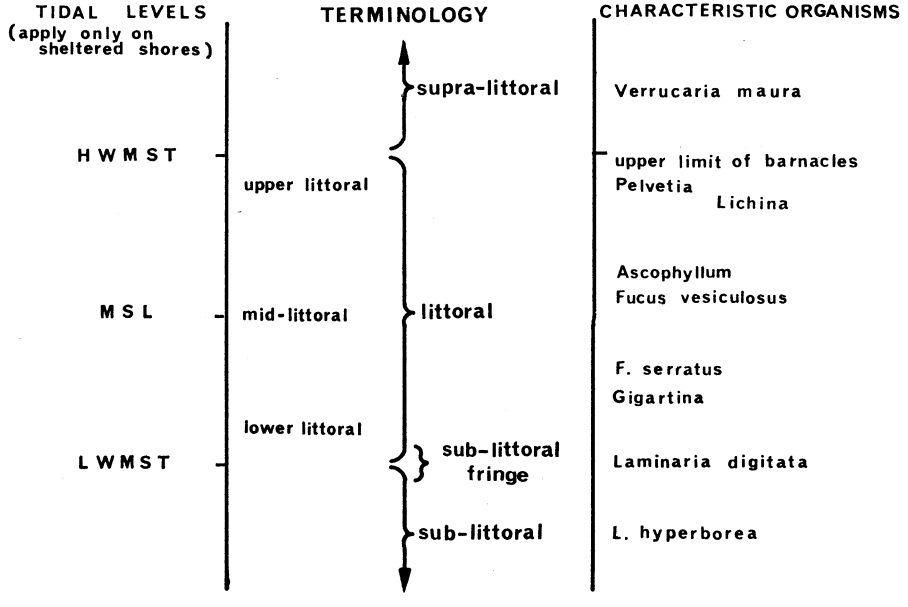

FIG. 10.

Diagram to show the nomenclature used in describing the levels at which plants are recorded on the shore; (modified from the scheme of Stephenson and Stephenson, 1949). On sheltered shores the terms can be related to calm water tidal levels; on more exposed shores the organisms on the shore are a better guide.

The following abbreviations and symbols are used:

* Reproduced by permission of the Council of the British Phycological Society.

1 Some or all species in this genus are of doubtful taxonomic status and this identification must be considered provisional until a revision of the genus is made.

2 There is only a single record of this sp. and it must be treated with caution until confirmed by further finds.

P Perennial.

I–XII Months of the year are indicated by Roman numerals.

ep. Epiphytic.

p.s. Plurilocular sporangia.

u.s. Unilocular sporangia.

t. Tetraspores.

c. Carpospores.

CYANOPHYCEAE

All but a few of the records in this class result from the work of Mr. and Mrs. H. T. Powell during the field meeting of the British Phycological Society at Dale in 1956.

CHROOCOCCALES

Chroococcaceae

APHANOTHECE ELABENS (Bréb.) Elenk.*

35, in supra-littoral cave; IX. First record for Great Britain.

Entophysalidaceae

CHLOROGLOEA TUBERCULOSA (Hansg.) Wille.*

42, upper littoral and supra-littoral ep. on other blue-green algae, *Bangia* and on barnacles; IX.

CHAEMOSIPHONALES

Dermocarpaceae

DERMOCARPA HEMISPHAERICA Setch. et Gardn.*

8, 19; ep. on *Catenella*. IV–IX. First record for Great Britain.

D. PRASINA (Reinsch.) Born.*

14, in pools ep. on *Calithammion polyspermum*; endospores, IX.

ENTOPHYSALIS GRANULOSA Kütz.*

42, on rock in lower supra-littoral; IX.

PLEUROCAPSALES

Pleurocapsaceae

PLEUROCAPSA AMETHYSTEA Rosenv.*

42, supra-littoral, on rock and ep. on *Plectonema*; IX.

P. CREPIDINUM Coll.*

42, on rock in lower supra-littoral.

P. FULIGINOSA Hauck*

7, 42, on supra-littoral rock; IX.

XENOCOCCUS CROUANII Feldm.*

42, ep. on *Porphyra umbilicalis* and *Blidingia*; IX.

X. GILKEYAE Setch. et Gardn.*

8, ep. on *Hildenbrandia* in supra-littoral cave; IX.

NOSTOCALES

Oscillatoriaceae

LYNGBYA AESTUARII Gom.
7*, on supra-littoral rock; 27, at edges of creeks and, with *Microcoleus chthonoplastes*, forming sheets on mud; VII.
L. LUTEA Gom.*
7, ep. on *Gelidium* in upper littoral pool; IX.
L. MAJUSCULA Gom.*
1, ep. on *Polysiphonia nigra* in drift; 7, ep. on *Gelidium* in upper littoral pool; IX.
L. RIVULARIARUM Gom.*
35, in supra-littoral cave.
MICROCOLEUS CHTHONOPLASTES Gom.
26, in sheets, on mud at edges of creeks, with *Lyngbya aestuarii*; VII.
M. TENERRIMUS Gom.*
7, on supra-littoral rock; IX.
OSCILLATORIA LIMOSA Gom.*
7, on barnacles in mid-littoral; IX.
O. NIGROVIRIDIS Gom.
26, common at bases of *Salicornia*.
O. TENUIS Gom.*
7, on barnacle and mussel shells in mid-littoral and on supra-littoral rock; 35, on *Rhodochorton purpureum* in upper littoral.
PHORMIDIUM CORIUM Gom.*
35, ep. on *Rhodochorton purpureum*; IX.
P. FRAGILE Gom.*
8, in supra-littoral cave; 12, ep. on *Rivularia atra* in upper littoral pools; 42, lower supra-littoral; IX.

Rivulariaceae

CALOTHRIX CONFERVICOLA Born. et Flah.*
1, ep. on *Cladophora rupestris* and *Enteromorpha* in upper littoral pools and on *Polysiphonia nigra* in drift; IX.
C. PULVINATA Born. et Flah.
22, ep. on *Cladophora rupestris* in upper littoral pool.
C. SCOPULORUM Born. et Flah.*
42, on exposed supra-littoral rock; IX.
RIVULARIA ATRA Born, et Flah.
8*, 9, 12, 19, in upper littoral pools. III-IX.
R. NITIDA Born. et Flah.*
7, in supra-littoral crevices on large rock masses in sand.

Scytonemataceae

PLECTONEMA BATTERSII Gom.*
7, on mussel shells in mid-littoral; 8, in supra-littoral cave; 42, lower supra-littoral.

RHODOPHYCEAE

BANGIOPHYCIDEAE

GONIOTRICHALES

Goniotrichaceae

GONIOTRICHUM ALSIDII (Zan.) Howe
21, depth 6–8 metres; VIII. 36* upper littoral, ep. on various algae, IX; 43.

BANGIALES

Erythropeltidaceae

ERYTHROTRICHIA CARNEA (Dillw.) J. Ag.
1; 7; 13; 19; 21; 43. Ep. on *Corallina* and other algae, littoral and sub-littoral; IV-IX.

E. WELWITSCHII (Rupr.) Batt.*
1, on limpets.

Bangiaceae

BANGIA FUSCOPURPUREA (Dillw.) Lyngb.
4; 12; 14; 17; 18; 43; 44. Common on upper littoral rock, usually in exposed places; III-IX, but seldom able to survive summer desiccation.

PORPHYRA PURPUREA (Roth) C. Ag.
7; 9; 13; 15; 25; 35. Mid-littoral, on rock and occasionally ep.

P. UMBILICALIS (L.) J. Ag.
1; 3; 4; 7; 8; 9; 12; 13; 14; 15; 17; 25; 27; 30; 33; 40; 43; 44. Very variable in form; on rocks and boulders on sandy beaches (e.g. 7, 8, 30) it grows luxuriantly in large sheets and is collected for making Laver Bread. On exposed rocky shores (e.g. 9, 12, 40) it occurs in the supra-littoral as compact clumps. The *Conchocelis* stage of this sp. (and/or of *Bangia*) also occurs in shells dredged or in the drift.

FLORIDEOPHYCIDAE
NEMALIONALES

Acrochaetiaceae

ACROCHAETIUM BATTERSIANUM Hamel
8; 9, ep. on *Sphacelaria*; IV-VI.

A. DAVIESII (Dillw.) Näg.[2]
43, t. in summer.

A. SECUNDATUM (Lyngb.) Näg.*
1; 7; 13, ep. on *Rhodymenia palmata*; monospores, IX.

ACROCHAETIUM VIRGATULUM (Harv.) J. Ag.
1; 8; 14, ep. on various algae in lower littoral; VIII.

RHODOCHORTON FLORIDULUM (Dillw.) Näg.
3; 5; 7; 8; 13; 14; 43; 44, on lower littoral rocks where its filaments bind sand into a compact mass which covers large areas on some shores, e.g. 7 and 8. P.

R. PURPUREUM (Lightf.) Rosenv.
9; 18; 35; 43; 44. On upper littoral rock in shaded crevices, caves, etc. (= *R. rothii*)

Gelidiaceae

GELIDIUM spp.
1; 8; 9; 17; 19; 43. Most of the Dale records are of *G. corneum* Lamour., a sp. rejected by Feldmann & Hamel (1937) and therefore omitted by Parke & Dixon (1964). The limits of the spp. in this confused genus are obscure; some which fit the Feldmann & Hamel descriptions are listed below:

G. CRINALE (Turn.) Lamour.
1; 7; 8; 18; lower littoral pools; VII.

G. LATIFOLIUM (Grev.) Born. et Thur.
1; 7; 8; 13; 17; 18; 43, in pools. P.

G. PULCHELLUM (Turn.) Kütz.
12, in upper littoral pools; VIII.

G. PUSILLUM (Stackh.) Le Jol.
13; 43 and elsewhere, in upshore shade; mixed with *Catenella* and easily confused with it. P.

PTEROCLADIA CAPILLACEA (Gmel.) Born. et Thur.*
8, IX.

Helminthocladiaceae

NEMALION MULTIFIDUM (Web. et Mohr) Endlicher
1; 8; 9; 40; 43. Lower littoral on exposed shores, usually on limpet or barnacle shells. Summer annual, well developed VIII-X; crop varies greatly from year to year. On exposed shores on 43 occurs in upper littoral.

Chaetangiaceae

SCINAIA FURCELLATA (Turn.) Biv.
1, drift; 21, 25, on small stones in littoral; usual occurrence (as in 21) sub-littoral; VIII.

Naccariaceae

NACCARIA WIGGII (Turn.) Endl.[2]
7; 8.

Bonnemaisoniaceae

BONNEMAISONIA ASPARAGOIDES (Woodw.) C. Ag.[2]
In the drift; VIII.

GIGARTINALES

Cruoriaceae

PETROCELIS CRUENTA J. Ag.
1; 8; 9; 12; 18; 19. On lower littoral rock. P.

Nemastomataceae

SCHIZYMENIA DUBYI (Chauv.) J. Ag.
1; 8; 9; 12; 36; 43. Sub-littoral and sub-littoral fringe; in shady clefts; abundance varies from year to year; in 1960 the sp. was plentiful, particularly at 1 and 9. Summer annual; C, VII-IX.

Furcellariaceae

FURCELLARIA FASTIGIATA (L.) Lamour.
1; 5; 7; 8; 9; 14; 15; 17; 22; 30; 36; 43; 44. Found on most shores in pools, often where sand is present. P.

HALARACHNION LIGULATUM (Woodw.) Kütz.[2]
21; VII.

Rhabdoniaceae

CATENELLA REPENS (Lightf.) Batt.
1; 2; 6; 7; 9; 12; 13; 22; 34. On upper littoral rock, in fairly sheltered, shady places, cracks and crevices and in the shade of *Fucus spiralis* and *Pelvetia*. See Fig. 9.

Rhodophyllidaceae

CALLIBLEPHARIS CILIATA (Huds.) Batt.
Dredged near 35; by diving, 38. A sub-littoral sp. which can, however, often be found in the drift at 25 and is recorded on the shore at 43; VIII-IX.

CALLIBLEPHARIS JUBATA (Good. et Woodw.) Kütz.
1; 3; 8; 9; 17; 43. In lower littoral pools, usually ep. with its spreading basal branches entwined in other plants. Best development in summer.

CYSTOCLONIUM PURPUREUM (Huds.) Batt.
1; 7; 8; 9; 14; 15; 17; 30; 43. Summer annual reaching its greatest development in VIII-IX. c, VIII.
RHODOPHYLLIS DIVARICATA (Stackh.) Papenf.*
21, and littoral at Neyland; IX.

Plocamiaceae

PLOCAMIUM VULGARE Lamour.
3; 4; 5; 7; 8; 9; 12; 13 by diving; 15; 17; 19; 30. Essentially sub-littoral but can be found in deep lower littoral pools. c and t, IX-X; P.

Sphaerococcaceae

SPHAEROCOCCUS CORONOPIFOLIUS (Good. et Woodw.) Stackh.
43, rare in deep, sheltered pools. c in autumn.

Gracilariaceae

GRACILARIA VERRUCOSA (Huds.) Papenf.
1; 7; 8; 9; 13; 15; 17; 25; 43. On rock or pebbles, etc. in sand; attaining great length in some places in summer, e.g. 25, 7, 8. t and c, IV-I; P.

Phyllophoraceae

AHNFELTIA PLICATA (Huds.) Fries.
1; 3; 5; 7; 8; 11; 14; 15; 17; 30; 43. On rock in sandy pools in lower littoral; P.
GYMNOGONGRUS GRIFFITHSIAE (Turn.) Mart.[2]
15; XI.
PETROGLOSSUM NICAEENSE (Lamour.) Schotter*
13, littoral; IX.
PHYLLOPHORA BRODIAEI (Turn.) Endl.*
21; IX.
P. CRISPA (Huds.) Dixon
21; 41; 43. IX.
P. MEMBRANIFOLIA (Good. et Woodw.) J. Ag.
8; 17, in lower littoral pools; 21; 43, IX.
P. TRAILII Holm.[2]
18, in deep, lower littoral pool, VII.
STENOGRAMME INTERRUPTA (C.Ag.) Mont.
23, drift; appears to be fairly widely distributed in Dale Roads. Has been dredged at 21, off Monkhaven and several plants N. of Stack Rock. Fruiting, VII-IX.

Gigartinaceae

CHONDRUS CRISPUS Stackh.
1; 3; 5; 6; 7; 8; 9; 14; 15; 17; 19; 30; 33; 34; 36; 43; 44 and on most shores in pools and sub-littorally. Very variable in form. P.
GIGARTINA PISTILLATA (Gmel.) Stackh.
8, in pools, scarce; probably P.
G. STELLATA (Stackh.) Batt.
1; 2; 3; 4; 5; 7; 8; 9; 12; 14; 15; 16; 17; 18; 33; 34; 36; 40; 43; 44. Very widespread, particularly well developed on the more exposed shores on lower littoral rock; c, VII-X; P.

CRYPTONEMIALES

Hildenbrandiaceae

HILDENBRANDIA PROTOTYPUS Nardo
1; 8; 12; 13; 15; 17; 19; 28; 30; 43. Forming very thin rusty red encrustations on upper littoral rock; t, IX; P.

Corallinaceae

CORALLINA OFFICINALIS L.
1; 4; 5; 6; 7; 8; 9; 12; 13; 14; 15; 16; 17; 18; 19; 28; 33; 36; 43; 44. Very widespread in pools, often in large quantities; also in the lower littoral on more exposed, limpet-grazed rocks as a compact turf. P.

C. SQUAMATA Ellis [2]
43, uncommon.

EPILITHON MEMBRANACEUM (Esper) Heydr.*
8, ep. on *Gigartina*; IX.

JANIA RUBENS (L.) Lamour.
8; 17; 19, ep. on various algae in mid- or lower littoral pools. VI.

LITHOPHYLLUM INCRUSTANS Phil.
9; 17; 28; 43; 44. The British encrusting coralline red algae have been neglected for many years. The records of these must be treated with caution. P.

LITHOTHAMNION LENOMANDII (Aresch.) Fosl.
9; 12; 17; 21; 36; 43; 44. Pools on shores other than the most sheltered frequently have a general covering of the rock surface by encrusting corallines of this, and probably other, species. They also occur on rocks and stones sub-littorally to the greatest depths at which algae can grow. P.

MELOBESIA FARINOSA Lamour.
9, ep. on *Chaetomorpha melagonium*. IV, probably P.

M. ZONALIS (Crouan) Fosl.[2]
43, rare.

MESOPHYLLUM LICHENOIDES (Ellis) Lem.
18; ep. on lower littoral algae. III. Probably P.

SCHMITZIELLA ENDOPHLOEA Born.
1, ep. on *Cladophora pellucida*, VII, and on various algae at 43.

Dumontiaceae

DILSEA CARNOSA (Schmidel) Kuntze
7; 8; 9; 12; 14; 17; 18; 19; 25; 28; 30; 36; 43. Essentially sub-littoral; when found in pools (as at 8 and 9) these are usually shaded, deep and low down the shore.

DUMONTIA INCRASSATA (Müll.) Lamour.
1; 2; 8; 9; 14; 15; 17; 22; 25; 30; 43. Annual, well developed in spring (III-IV) but recorded up to VII-VIII. Most luxuriant on sheltered shores like 25; smaller in pools on more exposed shores.

Polyideaceae

POLYIDES ROTUNDUS (Huds.) Grev.
1; 3; 7; 8; 9; 14; 15; 17; 30; 43. In sandy places, attached to rock in lower littoral pools or sub-littoral. P.

Kallymeniaceae

CALLOCOLAX NEGLECTUS Schmitz.
1; 19; 25. Ep. on drift specimens of *Callophyllis*, VIII, and dredged at 21, IX.

CALLOPHYLLIS LACINIATA (Huds.) Kütz.
8; 12; 14; 19; 21; 34; 43. Lower littoral pools or, more usually, sub-littoral; t in III, c in IX; P.

KALLYMENIA RENIFORMIS (Turn.) J. Ag.*
1, mid-littoral; 21; 41; t and c, IX.

Chloreocolacaceae

HOLMSELLA PACHYDERMA (Reinsch) Sturch.
17, ep. on *Gracilaria*, forming colourless pustules; t, XI.

RHODYMENIALES

Champiaceae

CHYLOCLADIA VERTICILLATA (Lightf.) Bliding.
2; 25. Best developed in summer; c, VII.

GASTROCLONIUM OVATUM (Huds.) Papenf.
1; 3; 4; 8; 9; 13; 15; 18; 43. Annual; small specimens III-IV; larger, straggling ones in VIII.

LOMENTARIA ARTICULATA (Huds.) Lyngb.
1; 2; 6; 8; 9; 12; 14; 15; 17; 18; 33; 36; 40; 43; 44. Widely distributed on lower littoral rock, usually in the shade of larger plants or on the shady side of rocks. P.

L. CLAVELLOSA (Turn.) Gaill.
3; 9; 14; 17; 18; 40; 43. Uncommon; on rock, usually in sandy places.

RHODYMENIA PALMATA (L.) Grev.
1; 2; 3; 4; 6; 8; 9; 12; 14; 15; 17; 18; 19; 33; 34; 36; 43; 44. Very widespread, present in most places as an epiphyte in the lower littoral, particularly on *Fucus serratus* and growing luxuriantly in this way on shores such as 1 and 9 (especially in shade). On more exposed places grows on rock as smaller plants (e.g. 1 and 12). Also commonly ep. on *Laminaria hyperborea* stipes, where, if a zonation can be seen, *Rhodymenia* occupies the highest level. P.

R. PSEUDOPALMATA (Lamour.) Silva
15; 17; 43. Uncommon.

CERAMIALES

Ceramiaceae

ANTITHAMNION CRUCIATUM (C. Ag.) Näg.
25, ep. on various algae in lower littoral; t, VIII.

A. PLUMULA Thur.
25, in the drift.

A. SARNIENSE (Lyle) Feldm.
"Near Dale Fort"; 41*, IX; 43, t in IX and X.

CALITHAMNION ARBUSCULA (Dillw.) Lyngb.
43, t in autumn.

C. CORYMBOSUM (Sm.) Lyngb.
8; VI.

C. GRANULATUM (Ducluz.) C. Ag.
1; 10; 12; 43; 44. Ep. on *Cladostephus* (and other algae) in lower littoral; VII-VIII.

C. HOOKERI (Dillw.) Gray
1, ep. on *Corallina* in shady rock pool; 7; 8; 9; 17; 43; 44. Ep. on algae in lower littoral pools; t, III; c, VIII.

C. POLYSPERMUM C. Ag.
13; 43. In pools; V-IX; t, V.

C. TETRAGONUM (With.) Gray
3; 12. Ep. on algae in pools; IV-X.

C. TETRICUM (Dillw.) Gray
1; 7; 17, t, III; probably P.

CROUANIA sp.*
41, IX.

CERAMIUM CILIATUM (Ellis) Ducluz.
8; 9; 12; 15; 17.

C. ECHIONOTUM J. Ag.
8; 17, VIII-XI; t, VIII.

C. FLABELLIGERUM J. Ag.
1; 43; 44. VIII.

C. RUBRUM (Huds.) J. Ag.
1; 3; 5; 7; 8; 9; 14; 15; 17; 19; 25; 30; 43; 44. Very common epiphyte reaching a large size in places such as 19 and 25. P, but much more obvious on the shore in summer. (Includes *C. arborescens* J. Ag. and *C. pedicellatum* DC.)
C. SHUTTLEWORTHIANUM (Kütz) Silva
8; 12; 17; 43; 44. The commonest of the spiny species of *Ceramium*. On rocks or mussel shells on the less sheltered shores.
C. spp.
5; 7; 8; 43. These records include *Ceramia* with no spines and incomplete cortication, recorded as *C. tenuissimum*, *C. deslongchampsii*, etc.
CORYNOSPORA PEDICELLATA (Sm.) J. Ag.
9; III and VIII.
GRIFFITHSIA FLOSCULOSA (Ellis) Batt.
1; 5; 7; 8; 9; 10; 15; 17; 19; 28; 43. Sub-littoral and in deep lower littoral pools attached to rock, P. Fruiting mainly in spring.
HALURUS EQUISETIFOLIUS (Lightf.) Kütz.
3; 5; 8; 9; 10; 12; 36; 40; 43. In deep lowest littoral pools and on sub-littoral rock. P.
PLEONOSPORIUM BORRERI (Sm.) Näg.
5; 7; 19; 44. III-VI; t, III.
PLUMARIA ELEGANS (Bonnem.) Schm.
3; 8; 9; 13; 14; 15; 18; 19; 28; 34; 36. On rock in shady places in lower littoral and sub-littoral, P. t, III-VII; polyspores, XI.
PTILOTA PLUMOSA (Dillw.) Thur.
9; 43. Sub-littoral, ep. on stipes of *Laminaria hyperborea*; t, III.
PTILOTHAMNION PLUMA (Dillw.) Thur.
17, ep. on *Ceramium rubrum* in mid-littoral pool.
SPERMOTHAMNION REPENS (Dillw.) Rosenv.*
8, ep. on *Ceramium rubrum*, IX.
SPHONDYLOTHAMNION MULTIFIDUM (Huds.) Näg.
9, in the drift; t, VIII.
SPYRIDIA FILAMENTOSA (Wulf.) Harv.
21*; 25; in drift, VIII.

Delesseriaceae

ACROSORIUM REPTANS (Crouan) Kylin*
21, IX.
A. UNCINATUM (Turn.) Kylin*
7; 13; littoral; 41; IX.
APOGLOSSUM RUSCIFOLIUM (Turn.) J. Ag.
8; 17; 18; 43. On rock; t, V-VIII; c, VIII.
CRYPTOPLEURA RAMOSA (Huds.) Kylin
1; 7; 8; 9; 14; 15; 17; 18; 25; 43. On rock in lower littoral pools and sub-littoral, easily confused with *Polyneura* but much the commoner at Dale. P. t, VI-VIII.
DELESSERIA SANGUINEA (Huds.) Lamour.
6; 7; 8; 14; 15; 17; 18; 30; 36; 39; 44. Sub-littoral and in shaded pools in lower littoral. P; t, I-II, in drift.
HYPOGLOSSUM WOODWARDII Kütz.
3; 5; 7; 9; 12; 14; 17; 36; 43. On rock in shady places and sub-littoral; t, III.
MEMBRANOPTERA ALATA (Huds.) Stackh.
1; 3; 5; 7; 8; 9; 13; 17; 18; 22; 30; 33. On rock in shady places in lower littoral and sub-littorally ep. on *Laminaria hyperborea*, usually lower down than *Rhodymenia* and sometimes forming a distinct zone on the stipes.
NITOPHYLLUM BONNEMAISONII (C. Ag.) Grev.
5; 7; 8; 17. In the drift; 43; c, VII.

N. PUNCTATUM (Stackh.) Grev.
5; 7; 17; 19; 25; 43. In the drift; 21, dredged. Perhaps plentiful sub-littorally; t, III. c, VII.

PHYCODRYS RUBENS (L.) Batt.
5; 7; 8; 14; 15; 17; 43. Sub-littoral, often ep. on stipes of *Laminaria hyperborea* where it is usually found in the drift; also in lower littoral pools. P.

POLYNEURA GMELINII (Lamour.) Kylin[2]
8, VIII; uncommon.

Dasyaceae

HETEROSIPHONIA PLUMOSA (Ellis) Batt.
1; 43. In lowest littoral pools; 5; 7; 8; 17. Typically sub-littoral, recorded from the drift. t, X. P.

Rhodomelaceae

BOSTRYCHIA SCORPIODES (Huds.) Mont.
26, found on salt marshes entwined round the bases of perennial plants, usually *Halimione portulacoides* at Dale.

BRONGNIARTELLA BYSSOIDES (Good. et Woodw.) C. Ag.
9; 12; 15. On rock in lowest littoral pools. P; t; VII.

CHONDRIA DASYPHYLLA (Woodw.) C. Ag.
25; 43. On pebbles or in the drift; VII-VIII.

LAURENCIA HYBRIDA (DC.) Lenorm.
1; 3; 8; 14; 15; 17; 18; 22; 43; 44. On lower littoral rock, usually with *L. pinnatifida* but less common than it. P, c, IV-V.

L. PINNATIFIDA (Huds.) Lamour.
1; 3; 5; 6; 7; 8; 9; 12; 14; 15; 17; 18; 19; 28; 36; 43; 44. Very widespread; on lower littoral rock on shores other than the most sheltered and most exposed, characteristically at the upper edge of the *Gigartina* band. Sometimes reduced to a compact turf of very short plants. P. t, VI; c, VI-X.

POLYSIPHONIA BRODIAEI (Dillw.) Grev.
1; 12; 43. t, VI-VII; c, VI-X.

P. ELONGATA (Huds.) Grev.
1; 8; 23; 25; 41; 43. The largest member of this genus found at Dale; common on less exposed shores, usually in sandy places in lower littoral or sub-littoral. Tufts of bright red branches in spring, when plant fruits. P.

P. FIBRATA (Dillw.) Harv.*
1; 13; littoral pools; t, IX; c, V-IX.

P. LANOSA (L.) Tandy
Characteristic epiphyte of *Ascophyllum* found wherever that species occurs but in the largest quantities in the less sheltered localities when the *Ascophyllum* plants suffer more abrasion and damage and so provide more places for successful spore settlement. P.

P. MACROCARPA Harv.
8; 43. Ep. on *Corallina*, etc.

P. NIGRA (Huds.) Batt.
7; 37; 43. On rock in sandy places in lowest littoral or sub-littoral.

P. NIGRESCENS (Huds.) Grev.
6; 7; 8; 9; 14; 15; 19; 43. Common on lower littoral rock and in pools. P.

P. OPACA (C. Ag.) Zan.*
7, in deep crevices in upper littoral; t, IX.

P. URCEOLATA (Lightf.) Grev.
8; 13; 15; 17; 43; 44. Spreading over sandy rocks in pools by creeping basal filaments; lower littoral; t and c, VII.

PTEROSIPHONIA COMPLANATA (Clem.) Falk.
9; 10. In lowest littoral pools; 21.
P. PARASITICA (Huds.) Falk.
10, lowest littoral rocks; 18, lowest littoral pools in shade; t, VII.
P. THUYOIDES (Harv.) Schm.
1; 12. On exposed lower littoral rocks; uncommon; IX.
RHODOMELA CONFERVOIDES (Huds.) Silva
12, in deep, lowest littoral pools; 17; 25, drift; 34, large plants common in lowest littoral in VIII. P; t, VI and VII.

XANTHOPHYCEAE

VAUCHERIALES

Vaucheriaceae

VAUCHERIA THURETII Woron.
26, on surface of mud accompanied by blue-green algae and sometimes forming extensive patches.
VAUCHERIA sp.
22; 43.

PHAEOPHYCEAE

ECTOCARPALES

Ectocarpaceae

ACINETOSPORA CRINITA (Carm.) Kornm.*
7, ep. on *Corallina* in pools; 43; IX.
ECTOCARPUS ARCTUS Kütz.
1; 13; 14; 43. Ep. on *Laminaria* spp., etc. u.s., VI-VII; p.s., V-IX. (Formerly *E. confervoides.*)
E. CROUANII Thur.*
13, ep. on *Scytosiphon*; 43; u.s., VI-VII; p.s., IX.
E. FASCICULATUS Harv.
1; 9; 13; 43. In deep pools and sub-littoral, ep. on *Rhodymenia, Laminaria digitata, Saccorhiza* and *Alaria*; u.s., VI-VII; p.s., VI-IX. (Includes *E. draparnaldioides.*)
GIFFORDIA GRANULOSA (Sm.) Hamel
7; 13; 43. In shallow upshore pools ep. on *Corallina.* u.s. and p.s. IX.
G. HINKSIAE (Harv.) Hamel
1; 9, sub-littoral, ep. on *Saccorhiza* and *Laminaria hyperborea*; E. of 19, on *Saccorhiza*; 12, ep. on *Corallina* on exposed rock. p.s., III-IX; u.s., III, IX.
G. SECUNDA (Kütz) Batt.
43.
HECATONEMA MACULANS (Coll.) Sauv.*
7, ep. on *Polysiphonia nigrescens* and *Corallina*; p.s., IX.
HERPONEMA VELUTINUM (Grev.) J. Ag.*
1; 9, ep. on *Himanthalia*; u.s., IX.
PYLAIELLA LITTORALIS (L.) Kjellm.
1; 7; 8; 9; 12; 13; 14; 15; 17; 19; 25; 36; 43. An extremely common epiphyte on *Ascophyllum, Fucus vesiculosus, F. serratus* and other algae. III-IX, u.s. and p.s. in summer.
SPONGONEMA TOMENTOSUM (Huds.) Kütz.
7; 8; 14; 17; 19; 40; 43. Ep. on *Fucus vesiculosus* and other algae, sometimes common; IV-IX; p.s., VI-IX.
STREBLONEMA PARASITICUM (Sauv.) Levr.*
1, parasitic on *Cystoclonium*, IX.

WAERNIELLA LUCIFUGA (Kuck.) Kylin*
7, W. side of 34, 35, in supra-littoral crevices; p.s., IX.

Ralfsiaceae

RALFSIA VERRUCOSA (Aresch.) J. Ag.
1, on littoral rock and limpet shells; 7; 43, VIII and IX.

Myrionemataceae

MYRIONEMA STRANGULANS Grev.
15; 17; 25. Ep. on *Ulva*; 43, ep. on *Ceramium rubrum*. III.

Elachistaceae

ELACHISTA FLACCIDA (Dillw.) Aresch.
12, ep. on *Cystoseira granulata*, VIII.
E. FUCICOLA (Vell.) Aresch.
1; 7; 13; 14; 15; 17; 19; 20; 25; 28; 43. Ep. on *Fucus* spp. u.s., III, VIII and IX.
E. SCUTULATA (Sm.) Aresch.
1; 43; 44, and other shores bearing *Himanthalia*, on which it is ep. u.s., VIII and IX.
LEPTONEMATELLA FASCICULATA (Reinke) Silva
43, ep. on *Himanthalia*.
SYMPHORIOCOCCUS STELLARIS (Aresch.) Kuck.
43, ep. on *Chorda*.

Corynophlaeaceae

CYLINDROCARPUS BERKELEYI (Grev.) Crouan
1; 7; 43. On lower littoral rock; VIII.
LEATHESIA DIFFORMIS (L.) Aresch.
1; 7; 9; 10; 14; 15; 17; 18; 19; 20; 28; 30. Ep. on various algae, u.s., VIII; p.s., IX; IV-IX.

Chordariaceae

EUDESME VIRESCENS (Carm.) J. Ag.
1; 17; 18; 28. u.s., VI-VII; p.s., IX.
MESOGLOIA LANOSA Crouan
6; 7; 8; 17. VI.
M. VERMICULATA (Sm.) Gray
8. VI.
MYRIOCLADIA TOMENTOSA Crouan
43, ep. on *Chaetomorpha melagonium*.
SAUVAGEAUGLOIA GRIFFITHSIANA (Grev.) Hamel
19, in lower littoral pool.

DICTYOSIPHONALES

Striariaceae

ISTHMOPLEA SPHAEROPHORA (Carm.) Kjellm.
43, ep. on *Laminaria* spp. u.s., IV-V.
STICTYOSIPHON GRIFFITHSIANUS (Le Jol.) Holm. et Batters
13; 28; 30; 40; 43; 44. Ep. on *Rhodymenia*; u.s., VI-VIII.

Punctariaceae

ASPEROCOCCUS COMPRESSUS Griff.
43, on sheltered rocks.
A. FISTULOSUS (Huds.) Hook.
1; 17; 20; 28; 43; 44. In mid-littoral pools; VII.

LITOSIPHON LAMINARIAE (Lyngb.) Harv.
5; 7; 9; 12; 16; 43. Ep. on *Alaria*, plentiful on older plants in VIII.
L. PUSILLUS (Carm.) Harv.*
21, ep. on *Chorda*; IX.
PUNCTARIA LATIFOLIA Grev.
17; 27; 43. u.s., VI-VIII.

Dictyosiphonaceae
DICTYOSIPHON CHORDARIA Aresch.
1, on rock in upper littoral pool; IX.

SCYTOSIPHONALES

Scytosiphonaceae
COLPOMENIA PEREGRINA Sauv.*
1, ep. on various algae in mid-littoral pools; IX.
PETALONIA FASCIA (Müll.) Kuntze
15; 16; 17; 18; 43; 44. On rock and limpet shells; 21, on buoy and boat moored in Dale Roads; IX.
SCYTOSIPHON LOMENTARIUS (Lyngb.) Link
1; 8; 9; 13; 15; 17; 25; 30; 43; 44. On rock and limpet shells in pools; IV-IX.

CUTLERIALES

Cutleriaceae
CUTLERIA MULTIFIDA (Sm.) Grev.
38, on pebbles as the encrusting *Aglaozonia* phase; IX. The larger, haploid *Cutleria* phase has not been recorded locally.

SPOROCHNALES

Sporochnaceae
SPOROCHNUS PEDUNCULATUS (Huds.) C. Ag.
25, in the drift, probably growing sub-littorally in Dale Roads. IX.

DESMARESTIALES

Arthrocladiaceae
ARTHROCLADIA VILLOSA (Huds.) Duby
21, IX; characteristically sub-littoral but has been recorded in lower littoral at 25 in VIII.

Desmarestiaceae
DESMARESTIA ACULEATA (L.) Lamour.
1, in drift, IX; 9; 15; 17; 43. On lower littoral rock, III.
D. LIGULATA (Lightf.) Lamour.
1; 5; 8; 9; 12; 14; 15; 17; 18; 43. May attain a large size in pools well down shore and sub-littorally but has also been found at 9 in an upshore pool in a shaded situation.
D. VIRIDIS (Müll.) Lamour.[2]
18, on rock with *Alaria* and *Laminaria hyperborea*.

LAMINARIALES

Chordaceae
CHORDA FILUM (L.) Stackh.
7; 8; 9; 14; 15; 17; 19; 21; 25; 43. A summer annual becoming abundant in less exposed places (e.g. 21, 25) in VII-XI.

Laminariaceae

LAMINARIA DIGITATA (Huds.) Lamour.

Characteristic plant of the sub-littoral fringe; has a wide range of exposure tolerance and can be found at every locality in the list where there is rock at the appropriate level. Also occurs in pools at higher levels. P. u.s., mainly X-III.

.HYPERBOREA (Gunn) Fosl.

1; 4; 8; 9; 17; 18; 28; 36; 39; 43; 44. Less widespread than *L. digitata*; essentially sub-littoral, occurring down to 40 ft. on the submarine cliffs of Skomer. Not to be found in the more sheltered places. Often with heavy growths of epiphytes (e.g. *Rhodymenia palmata, Membranoptera alata, Phycodrys rubens*) on its stipes. P. u.s., X-III.

L. SACCHARINA (L.) Lamour.

1; 3; 4; 7; 8; 9; 14; 15; 17; 18; 19; 25; 28; 29; 36; 43; 44. Very widespread; absent from the more exposed places but tolerant of silt and reaching great size at 19 and 25; unattached plants with balled holdfasts are often found here and at 21. P. u.s., X-III.

SACCORHIZA POLYSCHIDES (Lightf.) Batt.

1, many large plants, with *L. hyperborea*, on sub-littoral rock in small bay W. of Haven; 4; 9; 14; 16; 17; 18; 21, over 2 m. long below Fort in VII; 43; 44. Sub-littoral summer annual, growing from III to reach large size in VI. Fruiting VII onwards; basal parts sometimes survive winter.

Alariaceae

ALARIA ESCULENTA (L.) Grev.

1; 3; 4; 5; 6; 9; 12; 14 (single plant only, VIII); 16; 18; 30; 40; 43; 44. Found in the more exposed places (see Fig. 7) in the sub-littoral fringe. P. u.s., XI-V.

SPHACELARIALES

Sphacelariaceae

BATTERSIA MIRABILIS Reinke

8, on upper littoral rock; III.

SPHACELARIA PENNATA (Huds.) Lyngb. var. PENNATA Irvine.

18, ep. on *Corallina* in mid-littoral pool; with propagules, VII; 43; 44.

S. PENNATA (Huds.) Lyngb. var. FUSCA (Huds.) Irvine.

17; 18. Ep. on *Corallina* in pools; 43, locally plentiful; propagules, VII.

S. RADICANS (Dillw.) C. Ag.

11, on sandy rocks in lower littoral; VII; 43; 44, common in shelter.

SPHACELLA SUBTILISSIMA Reinke

43, ep. on *Fucus vesiculosus*; u.s., IV.

Stypocaulaceae

HALOPTERIS FILICINA (Grat.) Kütz.

1; 14; 15; 17; 21; 43. Uncommon, sub-littoral or in lower littoral pools, on rock or *Laminaria* stipes. III-IX.

H. SCOPARIA (L.) Sauv.

43, occasional in shelter in autumn.

Cladostephaceae

CLADOSTEPHUS SPONGIOSUS (Huds.) C. Ag.

8; 9; 10; 13; 14; 15; 18; 21; 28. On lower littoral and sub-littoral rock, often with sand nearby P.

C. VERTICILLATUS (Lightf.) C. Ag.

8; 12; 17; 21. Similar situations to *C. spongiosus*.

DICTYOTALES

Dictyotaceae

DICTYOPTERIS MEMBRANACEA (Stackh.) Batt.

Typically sub-littoral; found at a depth of 50 ft. at 39, on a lobster pot at 32 and dredged at 38. Its occurrence in lower littoral pools at 1 and 43 is surprising.

DICTYOTA DICHOTOMA (Huds.) Lamour.

1; 3; 6; 7; 8; 9; 12; 13; 14; 15; 17; 18; 19; 25; 36; 43; 44. Very widespread on rock and ep. Summer annual; small in III, large plants present and fruiting in VII-X. Very variable in form: broad in sub-littoral; narrow and much divided in some pools; small and bushy where it occurs as part of the "shade flora" on shaded rocks or under larger weeds in the lower littoral.

TAONIA ATOMARIA (Woodw.) J. Ag.

36, one locality, on the shaded side of a pool in a deep cleft; oogonia, VIII.

FUCALES

Fucaceae

ASCOPHYLLUM NODOSUM (L.) Le Jol.

See Fig. 4 for distribution. Restricted to the more sheltered places, including limited areas of shelter on shores such as 12 and 36 which are in general too exposed for the species to survive. P. Receptacles, borne on deciduous branches, mature in spring at which time next year's crop begins to form.

FUCUS CERANOIDES L.

25; 27. Typical of habitats where salinity is reduced for at least part of each tidal cycle.

F. SERRATUS L.

See Fig. 6 for distribution. The lowermost species of *Fucus* on the shore; occurs in the sub-littoral fringe and below on shores which are too exposed for it to survive in the littoral. P; fruiting mainly in winter.

F. SPIRALIS L.

See Fig. 3 for distribution. The least exposure-tolerant of the *Fucus* species in this area. A few plants in local shelter at 12 have been found to be twice or three times as large as the usual size, see also Gillham (1954). P; fruiting in summer.

F. VESICULOSUS L.

See Fig. 5 for distribution. Has the greatest exposure tolerance and the widest distribution of any *Fucus* species; bears numerous bladders in sheltered locations, but on exposed shores is much smaller and has no vesicles. P; fruiting mainly in summer.

PELVETIA CANALICULATA (L.) Dcne. et Thur.

See Fig. 2 for distribution. Much more tolerant of exposure than *Fucus spiralis* or *Ascophyllum* but less so than *F. vesiculosus*. The uppermost of the major brown algal bands, its upper limit being an indication of the top of the littoral region, roughly high water mark of spring tides on a fairly sheltered shore. P; fruiting in summer.

Himanthaliaceae

HIMANTHALIA ELONGATA (L.) Gray

1; 2; 4; 6; 7; 8; 9; 12; 43; 44. The vegetative buttons grow through the winter; the fruiting receptacles begin growth in III and may reach a length of 2 m. by VII-IX. The buttons can survive vegetatively higher upshore than the level at which fruiting occurs (lower littoral) and in greater shelter, e.g. buttons in pools above HWM at 9; a single button at 17. See Fig. 8.

Cystoseiraceae

BIFURCARIA BIFURCATA Ross

1; 3; 8; 9; 12; 17. Usually found fringing pools in the lower littoral. At 8 can also be found on rocks and boulders and on this shore some of the pools contain plants with vesicles.

CYSTOSEIRA BACCATA (Gmel.) Silva
7, in the drift, one specimen only. This is considerably further north than the accepted limit of distribution of this species in the U.K. but, having bladders, it may have floated a long way.
C. GRANULATA (L.) C. Ag.
12, occasional plants in mid-littoral pools; 23; 25, on stones in sand; 24, in upper littoral pool; 21, off Musselwick Point; 36, plentiful in large pools. The commonest *Cystoseira* species in this area. P.
C. TAMARISCIFOLIA (Huds.) Papenf.
8; 9; 18; 25. Uncommon, but has sometimes been found in large numbers at 25.
HALIDRYS SILIQUOSA (L.) Lyngb.
1; 3; 9; 12; 15; 17; 19; 25; 36. Grows best sub-littorally on sheltered shores but occurs on most shores in pools. Its characteristic epiphyte, *Sphacelaria bipinnata*, has not been recorded at Dale so far.

PRASINOPHYCEAE

HALOSPHAERALES

Halosphaeraceae

HALOSPHAERA VIRIDIS Schm.
43, rare.

CHLOROPHYCEAE

CHLOROCOCCALES

Characiaceae

CODIOLUM PETROCELIDIS Kuckuck
18, endophytic in *Petrocelis*; IV; more common than this single record indicates.

Endosphaeraceae

CHLOROCHYTRIUM COHNII Wright*
7, endophytic in *Blidingia*; IX.

Phyllosiphonaceae

OSTREOBIUM QUEKETTII Born. et Flah.*
21; growing within mollusc shells; IX.

PRASIOLALES

Prasiolaceae

PRASIOLA CRISPA (Lightf.) Batt.
43; 44, associated with seabird colonies.

ULOTRICHALES

Ulotrichaceae

ULOTHRIX FLACCA (Dillw.) Thur.
7; 9; 10; 12; 17; 25; 26; E. side of 30; 43. III-IV, VIII, but probably present for more of year than this.
U. SUBFLACCIDA Wille
43, sheltered places.

Ulvaceae

BLIDINGIA MINIMA (Näg.) Kylin*
7, on rock, in sand; IX.
ENTEROMORPHA CLATHRATA (Roth) Grev.
17, identifications of this genus are in accordance with Bliding (1963).
E. COMPRESSA (L.) Grev.
6; 7; 9; 19; 43; 44. P.

E. INTESTINALIS (L.) Link.
7, well developed in upshore pools and on beach; 8; 9, with *Porphyra* on rocks in sand; 13; 14; 15; 17; 19; 23; 25; 30; 36; 43; 44, and on most shores, luxuriant where fresh water flows over shore. P. See Christie and Evans (1962) for an account of fruiting.
E. LINZA (L.) J. Ag.
9, in sandy pools; 15; 16, plentiful; 40; 43; 44; VI-X.
E. PROLIFERA (Müll.) J. Ag.
1, in pools; 19; 26, with *Chaetomorpha* on mud; 43; 44; VI-X.
MONOSTROMA GREVILLEI (Thur.) Wittr.
9, ep. on *Ceramium* sp.; 43. VIII; commonest in spring and early summer.
ULVA LACTUCA L.
1; 3; 5; 7; 8; 9; 14; 15; 17; 25; 36; 43; 44, and generally distributed at most levels on shore. P.

CHAETOPHORALES

Chaetophoraceae

PRINGSHEIMIELLA SCUTATA (Reinke) March.
43, ep. on *Enteromorpha*, *Ulva* and *Rhodochorton*.

ACROSIPHONIALES

Acrosiphoniaceae

ACROSIPHONIA ARCTA (Dillw.) J. Ag.
43, in local shelter.
SPONGOMORPHA AERUGINOSA (L.) Hoek.
Ep. on *Fucus* sp.
UROSPORA PENICILLIFORMIS (Roth.) Aresch.
8; 19; 20; 23; 24; 43. Upper littoral, amongst *Porphyra* on exposed rock.

CLADOPHORALES

Cladophoraceae

CHAETOMORPHA CAPILLARIS (Kützing) Børgesson
1, floating in pools and entwined round other algae; 12, on other algae on exposed rock; 43. Summer.
C. LINUM (Müll.) Kütz.
1, in pools; 26, in pans; 43. (Includes *C. aerea*.)
C. MELAGONIUM (Web. et Mohr.) Kütz.
9; 12; 15; 18; 25; 40; 43; 44. IV-IX.
CLADOPHORA ALBIDA (Hudson) Kùtz.[1]
9; 43.
C. FLEXUOSA (Müll.) Harv.[1]
43.
C. GLAUCESCENS (Griffiths) Harvey[1]
25; 43; 44.
C. HIRTA Kütz.[1]
25, plentiful in lower littoral, IX; 43.
C. PELLUCIDA (Huds.) Kütz.
1, ep. on *Furcellaria* in pools; 5. VIII.
C. RUPESTRIS (L.) Kütz.
1; 7; 8; 9; 14; 17; 18; 19; 43; 44, and generally distributed.
C. UTRICULOSA Kütz.[1]
1, on lower littoral rock.

RHIZOCLONIUM IMPLEXUM (Dillw.) Kütz.[1]
26, in pans, rhizoidal branches absent so identity doubtful; 43.
R. RIPARIUM (Roth) Harvey[1]
16, with other algae forming sward round *Pelvetia*; 43.

CAULERPALES

Derbesiaceae

DERBESIA TENUISSIMA (De Not.) Crouan
43, fruiting in autumn.

Bryopsidaceae

BRYOPSIS HYPNOIDES Lamouroux
1; 3; 15; 17–19. In pools, IV-VIII.
B. PLUMOSA (Huds.) C. Ag.
1; 3; 7; 9; 15; 17; 18; 25; 34. In pools; sometimes common. III-XI. Both species of *Bryopsis* are summer annuals; only very small plants are to be found as early as III and IV.
CODIUM FRAGILE (Sur.) Hariot subspecies ATLANTICUM (Cotton) Silva
7; 19; 34, in pools; 26, in *Halimione* zone; at Musselwick Sands. P. Early records of *C. tomentosum* are treated as being of this species to which the recent finds certainly belong.

REFERENCES

BAKER, K. M. DREW, BLACKLER, H., BURROWS, E. M., DIXON, P. S., POWELL, M. T., and POWELL, H. G. (1957). List of algae collected in the district around Dale Fort. *Brit. Phycol. Bull.*, **1** (5), 21–31.

BALLANTINE, W. J. (1961). A biologically defined exposure scale for the comparative description of rocky shores. *Field studies*, **1** (3), 1–19.

BASSINDALE, R., and CLARK, R. B. (1960). The Gann Flat, Dale; studies on the ecology of a muddy beach. *Field Studies*, **1** (2), 1–22.

BLIDING, C. (1963). A critical survey of European taxa in Ulvales. *Op. bot. Soc. bot. Lund.*, **8**, 1–160.

BURROWS, E. M., CONWAY, E., LODGE, S. M., and POWELL, H. T. (1954). The raising of intertidal algal zones on Fair Isle. *J. Ecol.*, **42**, 283–288.

CHRISTIE, A. O., and EVANS, L. V. (1962). Periodicity in the liberation of gametes and zoospores of *Enteromorpha intestinalis*. *Nature, Lond.*, **193**, 193–194.

GILLHAM, M. E. (1954). The marine algae of Skokholm and Grassholm. *N. West. Nat.*, **25**, 204–225.

JONES, W. E. (1959a). Experiments on some effects of certain environmental factors on *Gracilaria verrucosa*. *J. mar. biol. Ass. U.K.*, **38**, 153–167.

JONES, W. E. (1959b). The effect of exposure on the zonation of algae on some shores on Bardsey Island. *Bardsey Obs.* 1959 *Rep.*, 41–46.

LEWIS, J. R. (1964). *The Ecology of Rocky Shores*. 323 pp., London.

MOYSE, J., and NELSON-SMITH, A. (1963). Zonation of animals and plants on rocky shores around Dale. *Field Studies*, **1** (5), 1–32.

OLIVER, J. (1959). The climate of the Dale Peninsula. *Field Studies*, **1** (1), 40–56.

PARKE, M., and DIXON, P. S. (1964). A revised check-list of the British marine algae. *J. mar. biol. Ass. U.K.*, **44**, 499–542.

STEPHENSON, T. A., and STEPHENSON, A. (1949). The universal features of zonation between tidemarks on rocky coasts. *J. Ecol.*, **38**, 289–305.

SUNDENE, O. (1962). The implications of transplant and culture experiments on the growth and distribution of *Alaria esculenta*. *Nytt. Mag. bot.*, **9**, 155–174.

THOMAS, E. M. (1953). A preliminary list of marine algae of south-western Pembrokeshire. *N. West. Nat.*, **24**, 568–579.