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OBSERVATIONS ON THE LITTORAL ALGAE OF THE ISLE OF WIGHT

By JOANNA M. KAIN

Marine Biological Station, Port Erin, Isle of Man

(Text-figs. 1–4)

As a result of the geological formation of the Isle of Wight there is a great variety in the type of shore. Although much of the coastline is unsuitable for the establishment of algal communities there are some parts where a few species can exist, and others where full zonation is achieved. It therefore seemed worth making some study of the algal distribution. Towards this end a general survey was made of the south coast of the island in April 1955, with more detailed studies of the places of interest by means of transects in April and July 1955.

Previous observations on the algal flora include a list of records given by Morey (1909), and additions to it made by Delf & Grubb (1923) and Norkett (1947). In the present investigation the nomenclature used is that given in the Check Lists of Parke (1953) and of Hendey (1954). The observations presented are limited to the most common algae.

The behaviour of the tide around the Isle of Wight is unusual. In the English Channel the shallow water produces a quarter-diurnal harmonic curve superimposed on the semi-diurnal. From Swanage to the Nab Tower the phases are in a relationship such that a double or prolonged high water is produced. In the Isle of Wight the effect is strongest in the west, where also the tidal range is lowest. At Freshwater there is a distinct double high water at springs but a single prolonged one at neaps. In the east, at Bembridge, the effect is hardly apparent, high water at springs being only slightly prolonged. As low water is always about 6 h after the first high water in these areas, it follows that the ebb, once it has begun, is faster than the flood.

GEOLOGICAL STRUCTURE

The main geological regions of the Isle of Wight are shown in Fig. 1. The southern half of the island is composed of Cretaceous beds affected by two anticlines which run roughly east and west and overlap west of the centre. The uppermost beds, which are of Chalk, rise steeply as a ridge across the centre of the island. The Chalk thus extends to the coast at the Needles and at Culver Cliff. On the south-west coast the Upper, Middle and Lower Chalk are followed south-eastwards by Upper Greensand, Gault, Lower Greensand

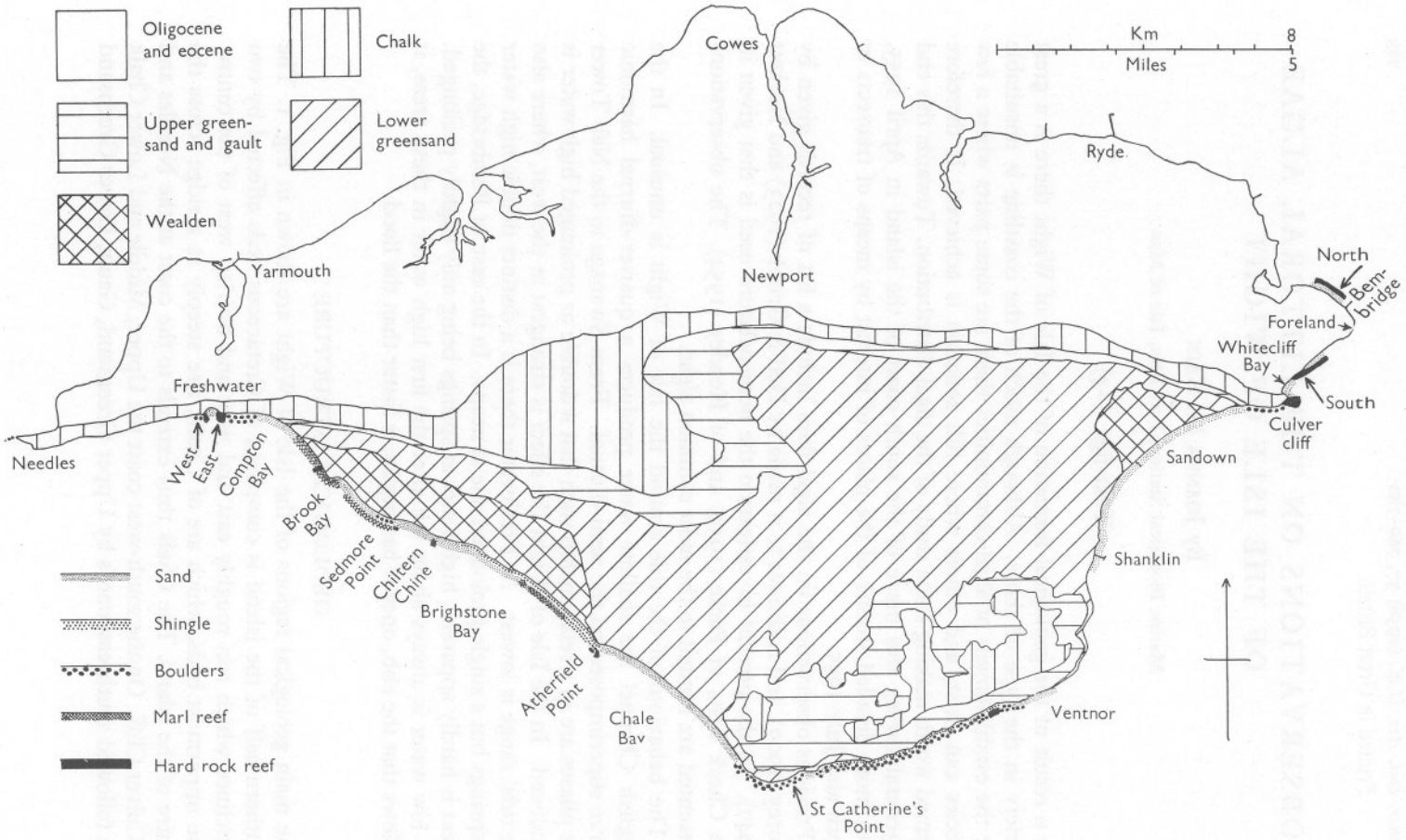

Fig. 1. Map of the Isle of Wight showing the geological structure (taken mainly from Chatwin, 1948) and the nature of the shore along the south coast. The arrows indicate the positions of transects.

and Wealden, the lowest beds being exposed at about Sedmore Point. The series then ascends to St Catherine's Point. The south-east coast shows a similar sequence passing north-eastwards, the lowest beds being exposed in Sandown Bay. The southern limb of the anticline has a gentle slope, and where the Chalk reappears inland of St Catherine's Point the beds are almost horizontal. The soft underlying Gault has resulted in large sections of these Downs slipping down.

GENERAL SURVEY

A general survey of the type of shore and the distribution of the principal algae was made by walking along the shore and noting the substrata and the species present. Only the southern coast was studied. The northern shores are mostly of mud or sand, with some boulders in places.

From the Needles to Freshwater the cliffs of hard Upper Chalk drop almost sheer down to the sea. On either side of Freshwater Bay there are hard Chalk reefs which support fairly rich algal communities. These were studied with the use of transects (p. 775). The Middle and Lower Chalk cliffs of Compton Bay have boulders at their bases. Below the narrow belts of Upper Greensand, Gault and Lower Greensand the shore is sand or shingle. From the centre of Compton Bay to Sedmore Point most of the shore is occupied by a grey and purple Wealden Marl reef. This rock is smooth and very soft, but a number of algae are able to colonize it. The most common are *Polysiphonia nigrescens*, *Corallina officinalis* and *Cladostephus spongiosus*. *Cladophora*, *Fucus vesiculosus*, *F. serratus*, *Ceramium rubrum*, *Ulva lactuca*, *Rhodochorton* and some diatoms are also present. From Sedmore Point to the centre of Brighstone Bay is mostly sand except for a hard reef opposite Chiltern Chine. This supports a flora similar to that on the Marl, with the exception of *Polysiphonia nigrescens*, but with the addition of *Lomentaria articulata*, *Chondrus crispus*, *Rhodymenia palmata*, *Laurencia pinnatifida*, *Furcellaria fastigiata* and *Ptilota plumosa*. The Marl reefs of Brighstone Bay are for the most part covered with sand and support no algae. The hard reef off Atherfield Point was not accessible when it was visited but clearly supported fucoids. Chale Bay has a beach of fine sand and shingle.

Between St Catherine's Point and Ventnor the shore is strewn with boulders, sometimes forming a complete covering and sometimes mainly in the bays, in patches alternating with sand or shingle. There is usually a band of shingle at the top of the beach just below the cliff. The boulders support fairly extensive algal communities. The more detailed study of St Catherine's Point was of a fairly representative section (p. 775).

The shore between Ventnor and Shanklin was not visited. From there to the beginning of Culver Cliff, where the Chalk reappears on the shore, is sandy. Boulders lie at the base of the cliff and a Chalk reef extends from it. This supports a fairly extensive flora. Just north of the sand of Whitecliff Bay

the ledges of Bembridge Limestone around the Foreland begin. These are more extensive on the south side than the north, where there is a greater proportion of sand. Both places were studied in more detail (p. 776).

Of the 25 miles of coast visited, 9 miles have hard reefs or boulders and 3 miles have Marl reefs. The rest of the coast is sandy.

SHORE TRANSECTS

Five shores were selected for more detailed study by means of transects: the Chalk boulders west of and the Chalk reef east of Freshwater Bay, the boulders below St Catherine's Point lighthouse, some limestone reefs north of Whitecliff Bay ('Bembridge South') and limestone reefs at Bembridge Point ('Bembridge North'). These are marked in Fig. 1.

Levelling apparatus

A simple form of levelling apparatus was developed for the use of the single-handed worker. As it is very cheap to assemble it will be described in some detail.

The sighting level is shown in Fig. 2A–D. It consists of a carpenter's level with wooden sides added to support a partly silvered piece of glass (to reflect the bubble) in the centre, a fine wire horizontally across one end and a brass plate, with a pinhole, across the other end. In order to adjust the sighting line between the hole and the wire so that it is parallel to the level itself, the brass plate is moved up or down until readings of height taken in opposite directions with the instrument are identical.

It is usual with this type of instrument to have it at a fixed height and to read the height on a staff in the position to be measured. But as this involves another worker holding the staff the proceeding has been reversed: the staff is fixed in one position with a clear triangular marker, and the heights of the positions to be measured are determined by sliding the instrument up or down a graduated movable staff until it is level with the marker and then reading its height on the movable staff.

The fixed staff is shown in Fig. 2E, F. It is constructed mainly of 0·6 m lengths of 1·2 × 2 cm wood bolted together in such a way that it can be folded to a length of 0·7 m. The staff is 2·1 m high and is marked at 0·5 m intervals from the ground. The pointer can be attached at any of the four marks by means of a bulldog clip. The staff is held upright by two legs, each a metre long and with a hinge at the top end which can be bolted through any of a number of alternative holes. It can thus be set up on uneven ground. The bottom ends of the legs and the staff itself have strap hinges with flat pieces of leather attached. Stones can be placed on these so that the whole is stable and rigid. The movable staff is shown in Fig. 2G, H. It is marked in centimetres.

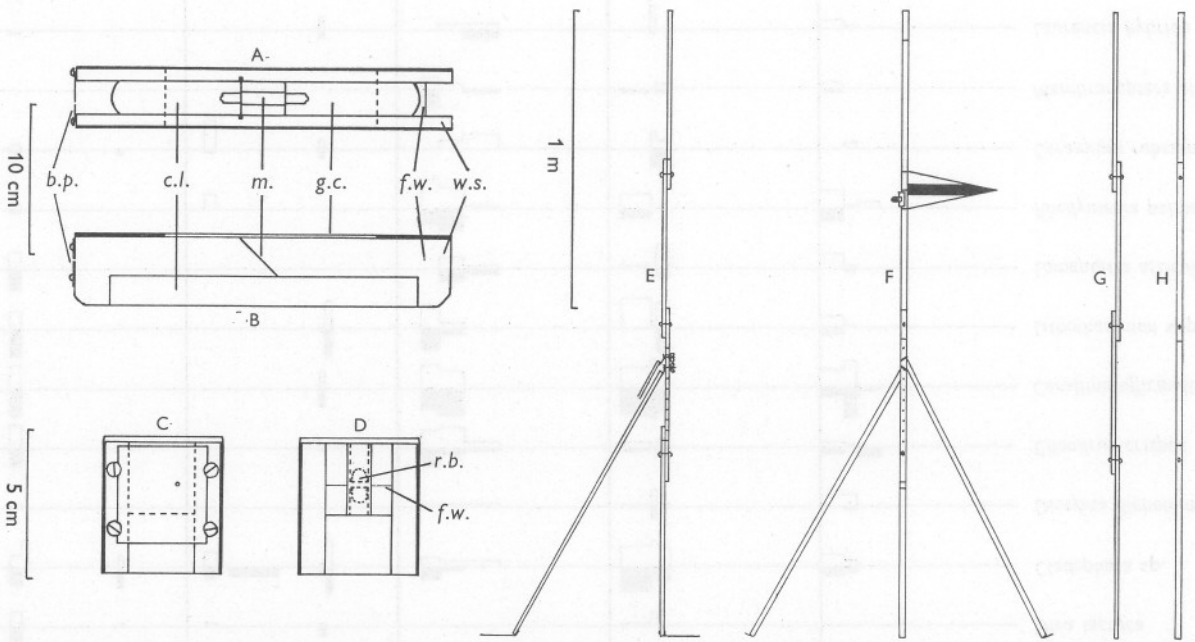

Fig. 2. Diagrams of the sighting level (A–D), fixed staff (E and F) and movable staff (G and H). A, top view of level; B, side view; C, end view with brass plate in place; D, end view with plate removed; E, side view of fixed staff; F, front view; G, side view of movable staff; H, front view. *b.p.*, brass plate; *c.l.*, carpenter's level; *f.w.*, fine wire; *g.c.*, glass cover; *m*, mirror; *r.b.*, reflexion of bubble; *w.s.* wooden sides.

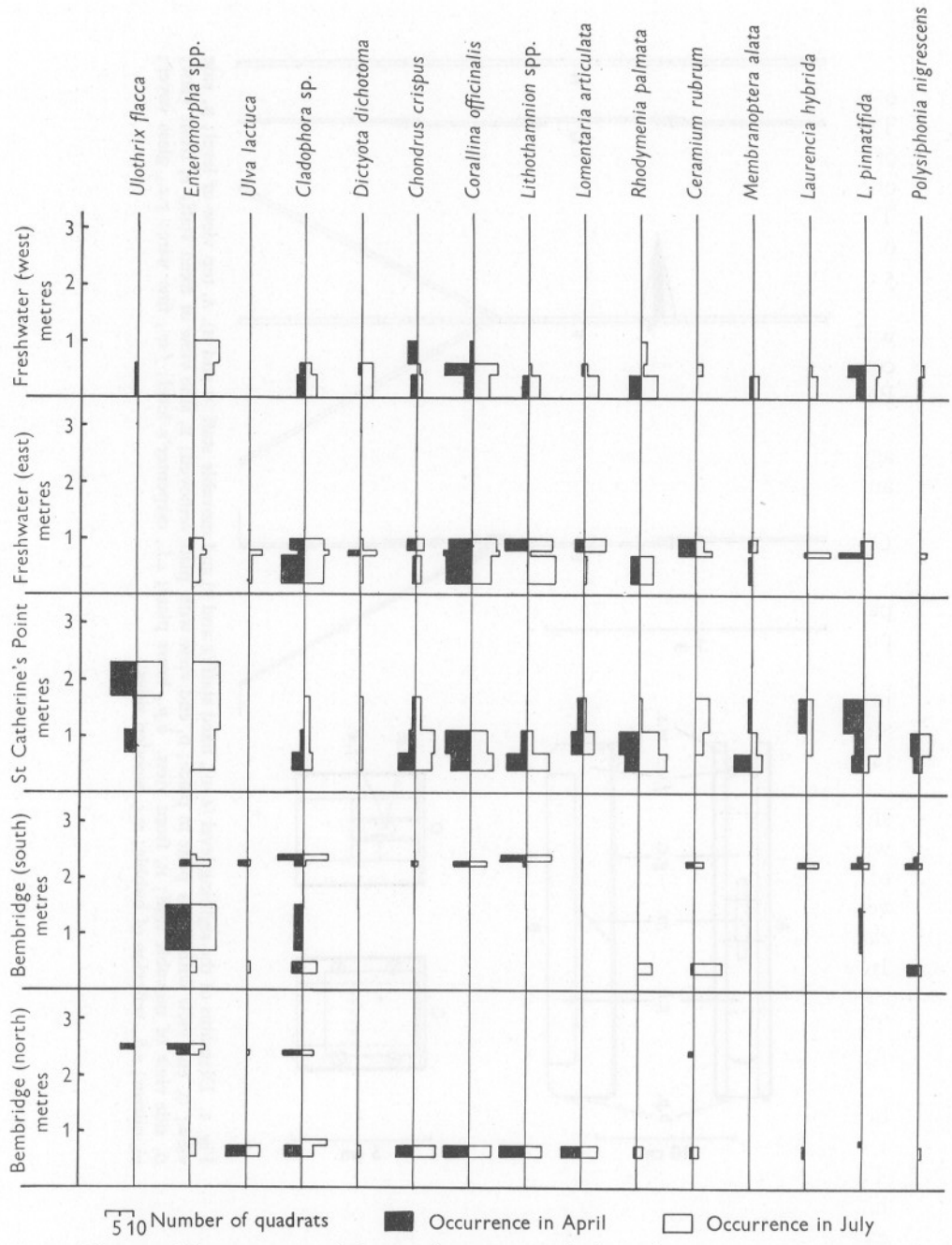

Fig. 3. Diagram of the occurrence of the most important species in quadrats at various levels in the five localities, in April and July.

Method of survey

A marked line was run out down the selected part of the shore. The level of each major irregularity was determined and sketches made of the profile. The limits of the main algal communities were noted and at about the centre of each a 10 m line was placed at right angles to the profile line. At each metre on this line a 25^2 cm quadrat was placed and the species present in it noted. The limits of the *Fucus* and *Laminaria* were determined by taking the level of the highest and lowest (if accessible) plant in each metre-wide band for 5 m on one side of the profile line.

The heights were referred to chart datum by measuring the level of low water and calculating its height from the predicted low water for the locality corrected for the deviation on that particular day, shown by the tide gauge at Portsmouth.

The original survey was made in April. In July the same line was visited again, quadrats taken in the same places to the nearest metre, and the *Fucus* and *Laminaria* zones similarly noted.

Observations

The nature of the transect method resulted in a very limited area of a particular shore being studied. Although it was made as representative as possible it clearly cannot be taken as a description of the whole shore.

A total of sixty-five macroscopic and twenty-five diatom species occurred in the quadrats, in April and July together. There were more brown and red species in July than in April, and this was the true for all the five locations taken individually.

The most important species, other than *Fucus* and *Laminaria* spp., are shown in Fig. 3. The levels over which they extended are approximate and were determined from the levels (given by the profile diagram) of the limits of the communities noted on the shore. It is clear that *Enteromorpha* was very much more abundant in July than April. *Dictyota dichotoma*, *Ceramium rubrum* and possibly *Laurencia hybrida* were also more abundant in July. In addition to these *Leathesia difformis*, *Cystoclonium purpureum*, *Ceramium ciliatum* and *C. diaphanum* occurred in a number of quadrats only in July. The distribution of the other species shown was similar in July to that in April, especially that of *Corallina officinalis* and *Lithothamnion*.

At Freshwater the height to which the species could extend seems to have been limited by the nature of the substratum, which was sheer cliff above 1 m. The exposed nature of the shore probably rendered this uninhabitable. The species therefore all had similar ranges. At St Catherine's Point the higher boulders were occupied by *Enteromorpha* and *Ulothrix*, other species extending up to about mid-tide. At Bembridge (South) it may have been the flat slow-draining ledge which enabled many species to extend to 2·2 m above

chart datum, whereas the same species were limited to 1·7 m at St Catherine's Point where the slope was steep and drainage fast. At Bembridge (North) only a few species existed on the ledge at about 2·5 m, the rest being limited to a lower ledge below a belt of sand.

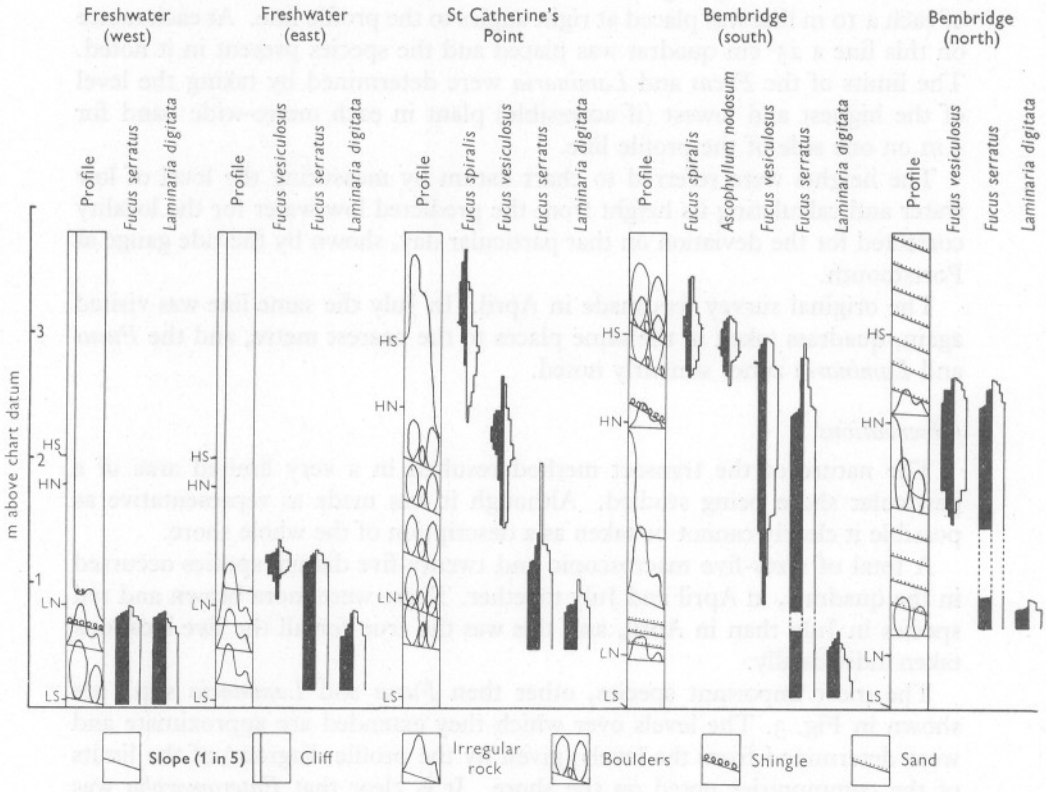

Fig. 4. Diagram of the summarized profiles in the five localities, together with the limits to which the fucoids and *Laminaria* extended, in April and July. HS, HN, mean high water springs and neaps; LN, LS, mean low water neaps and springs. See text for further explanation.

The fucoid and *Laminaria* zones are shown in Fig. 4. Included with them are the diagrams summarizing the profile of each shore. These were constructed from profile drawings in which the horizontal scale was a fifth of the vertical. The slope is thus much steeper than in reality. Each line representing the slope on the diagram refers to the region above the line, and the type of shore in that region is indicated diagrammatically.

The existence of *Fucus spiralis* at Freshwater was probably precluded by the exposed nature of the vertical cliff at the level it would have occupied. It was present on another part of the shore where there were boulders at this level. On the east side *F. vesiculosus* occupied the tops of the rock irregularities,

while the flatter parts were dominated by *F. serratus*. At St Catherine's Point four zones were present, but the shore was apparently too exposed and steep for *Ascophyllum*. The steepness was presumably responsible for preventing *Fucus serratus* from extending higher, as it did on the gentle slopes of the Bembridge shores. At Bembridge (South) *Ascophyllum* was also present on the flat reef, but *Fucus vesiculosus* extended farther down the steeper part, where the surf was probably too strong for *Ascophyllum*. Here the upper limit of *Laminaria* was lower than at the other places, as a belt of sand prevented its extension upwards. Sand also severely limited zone-formation on the northern Bembridge shore, *Fucus vesiculosus* and *F. serratus* occupying the upper ledge.

A complete list of the species encountered is given in Tables 1 and 2 (pp. 779–80). The frequencies in the quadrats of the macroscopic forms are given (Table 1).

Finally it must be said that no definite conclusions can be reached on the factors determining the distribution on these shores without more prolonged observations or experiments. It is possible that similar studies made after several years might reveal important differences in the distribution of many species.

My thanks are due to Mr A. C. Kain for the design and construction of the levelling apparatus and to the Hydrographer (Admiralty) and the Assistant Queen's Harbour Master, Portsmouth, for tidal information. I am also indebted to Dr E. M. Burrows, Dr P. J. Dixon, the late Dr K. M. Drew Baker, Dr N. I. Hendey, Dr and Mrs D. E. G. Irvine and Dr M. W. Parke for the identification of various algae. Dr Hendey was entirely responsible for the identification of the diatoms given in Table 2, and I am extremely grateful to him.

SUMMARY

The southern coast of the Isle of Wight, though mainly sandy, is composed in parts of marl reefs bearing a few algae and in other parts of boulders or hard reefs which bear full algal zonation.

Transect and quadrat studies showed that in 1955 there were more species present in July than April and several species showed a marked increase in cover in July. The vertical distribution of the common species showed little change.

The levels or existence of the fucoid zones are dependent on the slope of the substratum.

A levelling technique suitable for single-handed work is described.

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APPENDIX

TABLE 1. LIST OF ALGAE

The species (other than diatoms) recorded in this work at Freshwater West (F.W.-W.), Freshwater East (F.W.-E), from Compton Bay to Brighstone Bay (S.W.), at St Catherine's Point (St. Cath.), from St Catherine's Point to Ventnor (S.E.), at Bembridge South (Bemb.-S.) and at Bembridge North (Bemb.-N.) in April and July. The occurrence in quadrats is expressed as a percentage of the total number of quadrats taken at that place.

	F.W.-W.		F.W.-E.		S.W.	St Cath.		S.E.	Bemb.-S.		Bemb.-N.	
	Apr.	July	Apr.	July	Apr.	Apr.	July	Apr.	Apr.	July	Apr.	July
Number of quadrats...	30	30	30	30		40	40		35	35	50	50
Zostera nana	–	–	–	–	–	–	–	–	–	–	4	–
Blidingia minima	–	–	–	–	–	–	–	–	–	–	–	2
Chaetomorpha aerea	–	–	–	–	–	23	–	–	–	–	–	–
Cladophora spp.	17	20	50	77	+	13	18	+	54	34	30	44
Codium tomentosum	–	–	–	–	–	–	–	–	3	6	+	2
Enteromorpha spp.	+	67	3	40	+	–	90	+	37	54	10	14
Ulothrix flacca	–	–	–	–	–	35	23	–	–	–	10	–
Ulva lactuca	6	–	–	20	+	–	–	+	9	6	16	18
Ascophyllum nodosum	–	–	–	–	–	–	–	+	+	3	–	–
Asperococcus fistulosus	–	–	–	–	–	–	–	–	6	–	2	10
Chorda filum	–	–	–	–	–	–	–	–	–	–	–	6
Cladostephus spongiosus	3	7	–	3	+	10	3	+	–	6	–	–
Colpomenia peregrina	–	–	–	–	–	–	–	–	–	–	14	–
Dictyota dichotoma	3	27	13	20	–	–	8	–	–	–	–	6
Fucus serratus	13	20	40	40	+	28	28	+	49	43	22	20
F. spiralis	–	–	–	–	–	+	+	+	+	+	+	–
F. vesiculosus	–	–	+	+	+	5	8	+	6	3	4	6
Halidrys siliquosa	–	–	–	–	–	–	–	–	6	3	2	–
Halopteris scoparia	–	–	–	–	–	–	–	–	–	–	–	4
Laminaria digitata	7	10	+	20	–	20	23	+	+	+	4	10
L. saccharina	–	–	–	3	–	–	3	–	–	–	6	4
Leathesia difformis	–	13	–	30	–	–	–	–	–	6	–	–
Petalonia fascia	–	–	–	–	–	–	–	+	3	–	–	12
Pylaiella littoralis	–	–	–	–	–	–	5	–	11	–	8	–
Sphacelaria fusca	–	–	–	–	–	–	–	–	–	6	–	–
S. radicans	–	–	–	–	–	–	–	–	–	6	–	–
Ahnfeltia plicata	–	–	3	3	–	–	3	–	–	–	–	–
Callithamnion hookeri	–	–	–	–	–	5	–	–	–	–	–	–
C. tetricum	–	–	–	–	–	–	3	–	–	–	–	–
Ceramium ciliatum	–	20	–	20	–	–	–	–	–	–	–	–
C. deslongschampsii	–	–	–	–	–	–	–	+	–	–	–	–
C. diaphanum	–	3	–	7	–	–	5	–	–	–	–	–
C. flabelligerum	–	–	–	–	–	3	5	–	–	–	–	–
C. rubrum	–	7	7	30	+	–	20	+	11	23	16	12
Chondrus crispus	17	10	13	17	+	23	38	+	3	3	24	34
Corallina officinalis	47	50	90	87	+	40	35	+	17	17	30	34
Cystoclonium purpureum	–	7	–	–	–	–	5	–	–	–	–	4
Dumontia incrassata	–	–	–	13	–	5	–	–	3	–	12	–
Furcellaria fastigiata	3	–	7	7	+	–	–	–	6	–	7	6
Gastroclonium ovatum	–	7	3	–	–	–	8	–	–	–	–	–
Gelidium coinale	–	–	–	–	–	–	–	–	–	–	–	2
G. latifolium	–	–	–	–	–	–	–	–	–	–	2	4
Gigartina stellata	–	–	–	–	–	–	–	+	3	–	–	–
Griffithsia flosculosa	–	–	–	–	–	–	–	–	–	–	2	4
Halopitys incurvus	–	–	–	–	–	–	–	–	3	–	12	6
Jania rubens	–	–	–	–	–	–	–	–	–	–	2	10
Laurencia hybrida	–	13	3	27	–	8	10	+	9	11	2	–
L. pinnatifida	30	30	33	20	+	35	35	+	20	6	4	4
Lithothamnion spp.	7	17	60	67	–	23	25	+	29	26	36	28
Lomentaria articulata	3	20	10	30	+	15	13	+	–	–	20	24
Membranoptera alata	3	7	7	7	+	20	13	+	–	–	2	10
Phyllophora membranifolia	–	–	13	20	–	–	–	–	6	–	14	10
Plocamium coccineum	–	–	13	7	–	–	3	–	–	–	14	20
Polyides caprinus	–	–	–	–	–	–	–	–	11	11	–	–
Polysiphonia denudata	–	–	–	–	–	–	–	–	–	–	–	4

TABLE 1 (*cont.*)

	F.W.-W.		F.W.-E.		S.W.	St Cath.		S.E.	Bemb.-S.		Bemb.-N.	
	Apr.	July	Apr.	July	Apr.	Apr.	July	Apr.	Apr.	July	Apr.	July
P. fibrata	–	–	3	–	–	–	–	–	–	–	–	–
P. lanosa	–	–	–	–	–	–	–	+	–	3	–	–
P. nigrescens	3	3	–	7	+	13	13	+	29	3	–	4
P. urceolata	–	–	–	–	–	–	–	+	–	3	–	–
Porphyra umbilicalis	–	–	–	–	–	–	–	+	–	–	–	–
Pterosiphonia thuyoides	–	7	+	–	+	–	–	–	–	3	–	2
Ptilota plumosa	–	–	–	–	+	–	5	–	–	–	–	–
Rhodochorton floridulum	–	–	–	–	+	–	–	+	–	–	4	6
Rhodomela confervoides	–	–	–	–	–	–	–	–	–	–	–	2
Rhodymenia palmata	13	30	10	17	+	30	45	+	+	11	14	22
Spermothamnion barbatum	–	–	20	–	–	–	–	–	–	–	–	–
Spyridia filamentosa	–	–	–	–	–	–	–	–	–	–	–	10

TABLE 2. LIST OF DIATOMS

The diatom species recorded in this work at Freshwater West (F.W.-W.), Freshwater East (F.W.-E.), from Compton Bay to Brighstone Bay (S.W.), from St Catherine's Point to Ventnor (S.E.) and at Bembridge South (Bemb.-S.) in April.

	F.W.-W.	F.W.-E.	S.W.	S.E.	Bemb.-S.
Actinoptychus senarius	+	+	–	–	–
Amphipleura rutilans	–	+	–	+	–
Amphora arenicola	–	–	–	+	–
A. exigua	+	–	–	–	–
Biddulphia alternans	+	–	–	–	–
B. aurita	+	+	+	+	–
B. mobiliensis	–	–	–	+	–
Cocconeis costata	+	–	+	–	–
C. dirupta	–	–	+	–	–
C. scutellum	–	–	–	+	–
C. scutellum var. *stauroneiformis*	–	–	–	+	–
Coscinodiscus excentricus	+	–	–	+	–
Diploneis bombus	+	–	–	+	–
Grammatophora oceanica	–	–	+	–	–
Licmophora gracilis	+	–	+	+	–
L. lyngbyei	+	–	–	–	–
Mastogloia binotata	–	–	+	–	–
Navicula cluthensis	–	–	–	+	–
N. cyprinus	–	–	–	+	–
N. distans	+	–	–	+	–
N. grevillei	+	+	–	+	+
N. mollis	+	–	+	+	+
N. ramosissima	+	+	+	+	+
Nitzschia acuminata	–	–	–	+	–
N. angularis	+	–	–	+	–
N. lanceolata	–	–	–	+	–
N. panduriformis	–	–	–	+	–
N. punctata	+	–	–	+	–
N. punctata var. *coarctata*	–	–	–	+	–
N. sigma var. *rigidula*	+	–	–	+	+
Paralia sulcata	+	–	–	+	–
Podosira stelliger	–	–	–	+	–
Rhabdonema arcuatum	–	–	+	–	–
R. minutum	–	–	+	–	–
Rhaphoneis amphiceros	+	–	–	+	–
R. surirella	–	–	–	+	–
Rhoicosphenia curvata	+	–	–	+	–
Rhopalodia musculus	–	–	–	+	–
Synedra affinis	+	–	+	+	–
S. gaillonii	–	–	+	+	–
S. investiens	+	–	+	+	–
S. tabulata	–	–	–	+	–
Thalassiosira decipiens	+	–	–	+	–
Trachyneis aspera	+	–	–	–	–