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Notes on the Intertidal Ecology of the Freycinet Peninsula

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WITH 3 PLATES AND 4 TEXT FIGURES

SUMMARY

This paper is a continuation of the study of the features of the intertidal region in Tasmania. The areas so far studied were at Blackman's Bay and Pipe Clay Lagoon. The eastern coast at Freycinet Peninsula forms a more rigorous environment than the Blackman's Bay area due to higher and lower extreme temperatures. The eastern coast of the peninsula is exposed to heavy wave action but the western shore is sheltered. Transects on both sides of the peninsula are described and compared. The algae of the Infralittoral fringe are very different on the two sides of the peninsula, the Tasman Sea side being dominated by the large *Sarcophycus* and *Macrocystis* while the sheltered shore is populated by *Cystophora*. There are differences in the animal populations of the two shores but these are not as profound as might be expected. Forms characteristic of the sheltered western coast do not extend to the eastern shore but many forms found on the east coast are found on the sheltered shore. A general poverty of barnacle population is noted and is attributed to the substratum of granite rather than to any climatic factor.

A brief comparison of the features of this coast with those seen at Blackman's Bay is given. Notes on the distribution of several species in Tasmania and New South Wales are added. The possible ecological affinity of the wave exposed coasts of Tasmania with those of western South Africa is mentioned.

INTRODUCTION

This paper is the third of a series on the features of the intertidal region in Tasmania and deals with the ecology of Freycinet Peninsula. The first paper described the conditions on semi-exposed coast in southern Tasmania (Guiler, 1950). Other areas of the coasts of Tasmania will be considered in separate papers.

The peninsula is about 130 miles from Hobart (see fig. 1.). The landward part of the prominence is accessible in places but the distal end is more difficult of approach. Beyond the Quarries and Wineglass (Thouin) Bay the shore is only accessible by poor tracks or by arduous scrambling over rocks. For this reason no detailed work has been carried out on the southern end of the peninsula. A small expedition would be necessary to fully examine the coast hereabouts.

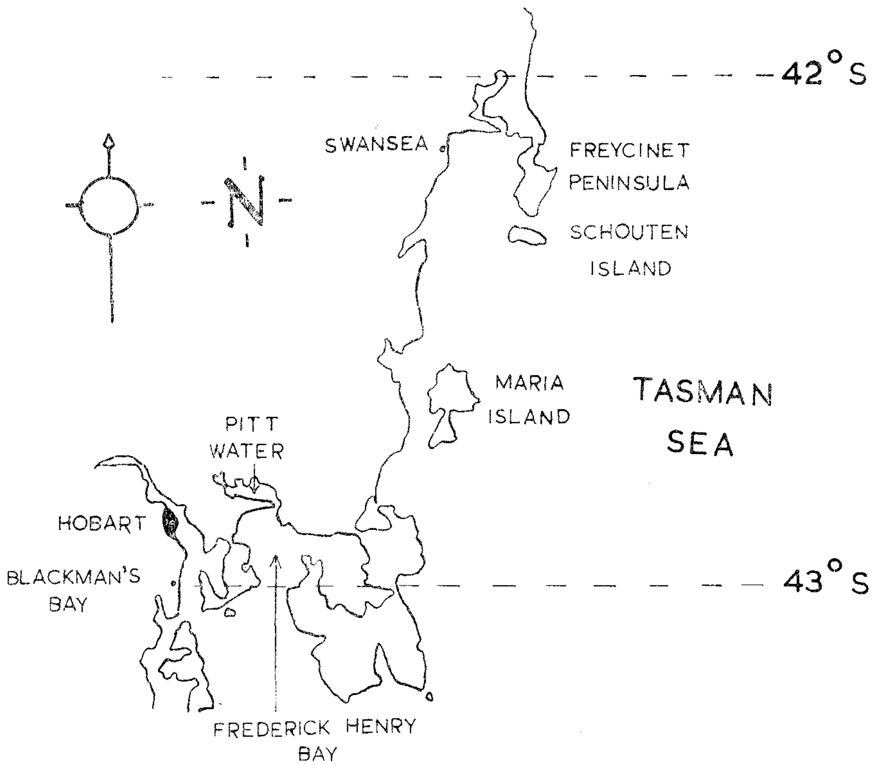

FIG. 1.—Outline of the East Coast of Tasmania showing the position of Freycinet Peninsula.

Transects were examined at Coles Bay, Honeymoon Bay and Sleepy Bay. Examinations for comparison were made at Wineglass Bay, The Fisheries, The Quarries and at several places beyond the Quarries. (See fig. 2).

The terminology used will be the same as that employed in the first paper of this series and follows that of Stephenson and Stephenson (1949). The tidal terminology is that of Chapman (1938).

Freycinet Peninsula lies at approximately the middle of the east coast of Tasmania. The peninsula runs parallel to the general line of the coast. To the west and south the peninsula is separated from the mainland by Oyster Bay and to the east lies the Tasman Sea. There are several lagoons (fig. 2) at the north end of the peninsula where it joins the mainland. It is not proposed to examine the ecological features of these specialized habitats. It is hoped to study the ecology of lagoons at a future date. South of the peninsula are Schouten and Maria Islands. Schouten Island is separated from the peninsula by a narrow strait but Maria Island is 35 miles away. The peninsula shows two major ecological types of coast. The East is exposed to full wave action and the West is sheltered and only experiences the effects of winds and waves blowing across shallow Oyster Bay. On both coasts are varied habitats, ranging from surf beaches and wave exposed coasts to sheltered inlets.

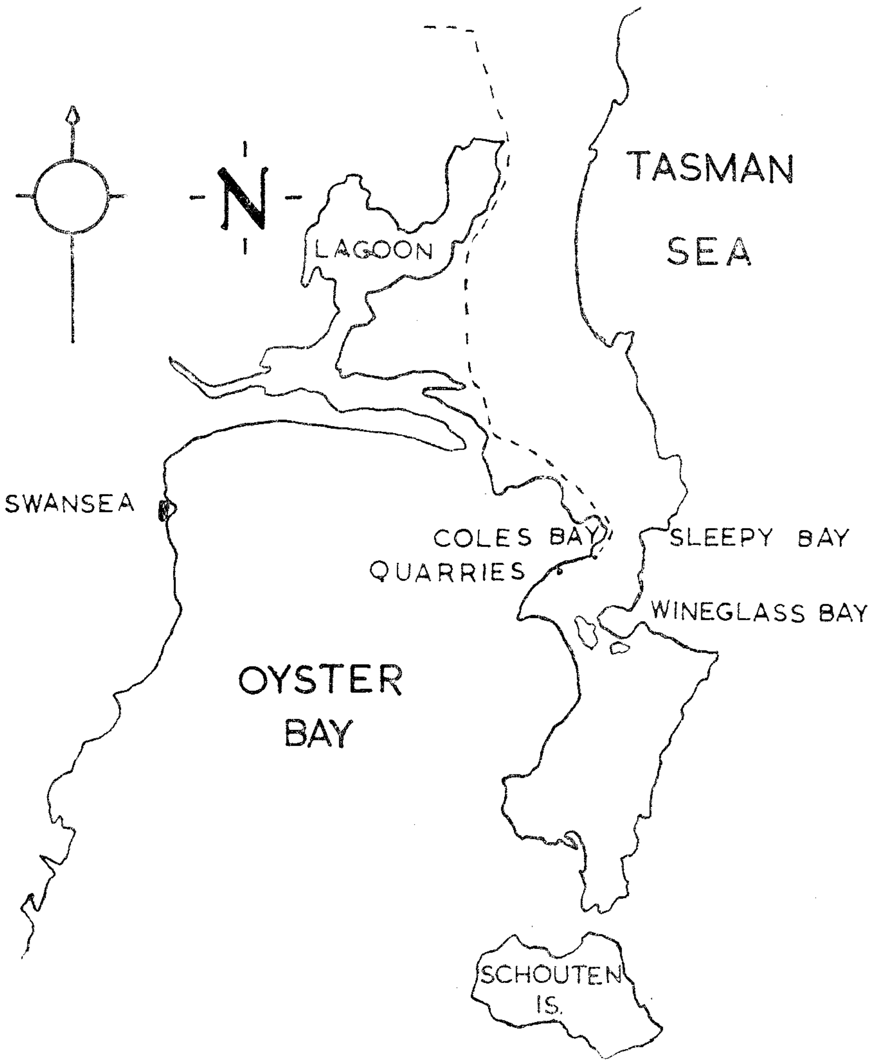

FIG. 2.—Map of Freycinet Peninsula showing most places mentioned in the text. Scale: 8 miles to the inch.

PHYSICAL ENVIRONMENT

(1) *Tides.* There are no tidal data available for the east coast. From observations made on the shore the tides are of approximately the same magnitude and general behaviour as those encountered at Hobart. The exposure figures calculated from the Hobart Recorder may be applied to the east coast but must be considered as very approximate.

(2) *Climatic Factors.* It is generally accepted that the east coast is warmer than Hobart. Examination of the records of the Hobart Weather Bureau reveals that a slightly different state of affairs exists. Swansea is the nearest recording station from which records for a long period are available. Some records are

available from Swanwick at the entrance to the lagoons mentioned above. These latter records are only for a short period and do not give a true picture of the climatic conditions. The climatic data have been taken from the Weather Bureau (1936) and are shown in Figs. 3-4.

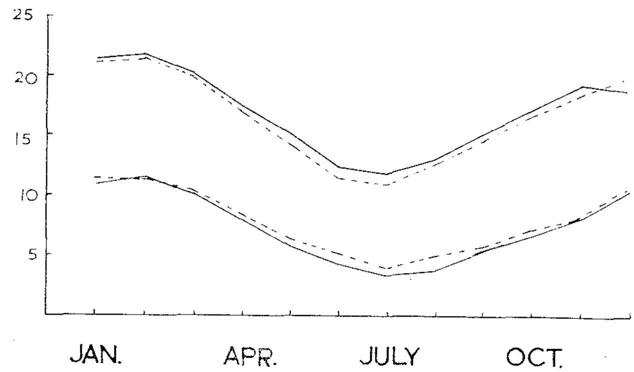

FIG. 3.—Mean monthly maximum and minimum temperatures Swansea (unbroken line) and Hobart (broken line) over 37 and 66 years respectively. The upper pair of curves show the mean monthly maximum temperatures and the lower pair the mean monthly minimum temperatures.

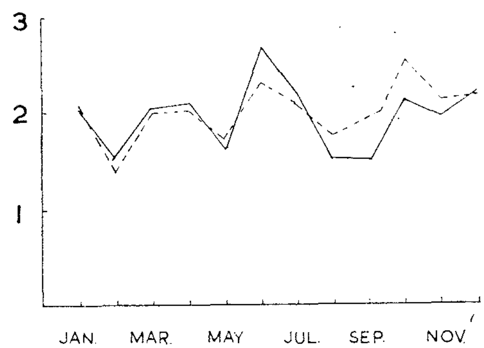

FIG. 4.—Average rainfall at Swansea (unbroken line) and Hobart (broken line) over the last 58 and 68 years respectively.

From the above figures it can be seen that Swansea has a slightly greater temperature range than Hobart but the rainfall is slightly less. Freycinet Peninsula is possibly dryer than the mainland Swansea. The incomplete figures for Swanwick do not support this view but the observations of residents on the peninsula mention that it may be raining in Swansea and quite dry in Coles Bay.

In particular we might note that the east coast experiences warmer temperatures in the summer yet colder in the winter.

(3) *Sea Temperatures.* There are no sea temperatures available. Observations taken over a period of two weeks at Coles Bay in February, 1950, showed an average temperature of 16·8°C. Some records taken at Sleepy Bay in the Tasman Sea were up to 1°C colder than readings taken shortly later at Coles Bay.

Temperatures taken in the sea just off-shore showed the influence of hot rocks and sand. The readings were taken on the afternoon of 6th February, 1950 in the Coles Bay area. The results are shown in Table I.

TABLE I

The influence of warm rocks and sand on sea temperatures at Coles Bay, Freycinet Peninsula. Normal surfaces sea temperature was 15·25°C.

Distance off-shore	*Off Rocks*	*Off Sand*
3 feet	16·75°C.	18·75°C.
10 yards	16·25°C.	17·25°C.
30 yards	15·3°C.	15·25°C.

In spite of the small tidal range the effect of warm sands and rocks on the sea temperature is felt for a distance of nearly 30 yards off-shore. Intertidal organisms are thus bathed during warm days in sea water which may be up to 3° C above normal sea temperatures. It might be stressed that the area considered does not have a closed water circulation. In such a place, e.g. a lagoon, the water temperature may be expected to be greater.

(4) *Currents.* The warm Notonectian Current runs some distance off-shore down the east coast of Tasmania. The full behaviour of this current is not known. In particular, it is not known whether the current actually runs on the coast during the summer months. Certain organisms such as *Physalia* and *Mola,* characteristic of warm seas are found in Tasmania in the summer the former being picked up in numbers on the east coast beaches. Whether they are deposited by the main current or other agencies is not clear. A series of temperature readings taken at Coles Bay when compared with Hobart sea temperatures failed to show any significant difference between the temperatures at these two places.

Fischer (1940a) following Dannevig (1907) notes that the Notonectian current runs along the Tasmanian coast at some distance offshore.

(5) *Geology.* The cliffs and beaches of the peninsula are composed of red granite or its derivatives. On the wave exposed east coast the rock forms steep cliffs but on the west shore the cliffs are either absent or low. At the south end of the peninsula the cliffs are high on both exposed and sheltered coasts. The beaches are formed of either boulders or quartz-felspar shingles or sand. At no place are rock platforms found.

(6) *Wave Action.* During easterly gales the wave action on the east coast of the peninsula is severe. The exposure factor can be expressed as O. (1-10). 4. 2,3. The derivation of this factor has been explained in Guiler (1950, pp. 169-171). At some places the effect of the waves is reduced by the presence of large beds of kelp. It is difficult to evaluate the full effect of these on the intensity of wave action on the shore. The continental shelf does not seem appreciably to diminish or break up the ocean swell.

Discussion

The climate of the east coast, based on Swansea records, is more extreme than that at Hobart. The maximum temperatures throughout the year are higher and the minimum temperatures are lower than in the Derwent area. The annual rainfall is nearly the same as at Hobart, but the distribution throughout the year is different. Swansea has appreciably less rain than Hobart during the period August to November but a heavier rainfall in June and July.

It has been noted previously (Guiler, 1950) that the months of December, January and July are times of great stress for intertidal organisms in southern Tasmania. July is the coldest month of the year on the east coast and is colder than at Hobart. January and February are months of considerable heat, both being warmer than at Hobart. The heaviest rainfall occurs in June and is much greater than any encountered in the Hobart area during that month.

The above climatic factors combined with the tidal factors considered in the first paper of the series (pp. 155-163) gives a more rigorous intertidal habitat for organisms than at Hobart. The lowest temperatures are encountered when the 'low low' water is the early morning tide and the highest temperatures occur when the afternoon tide is the 'low low'. These temperatures are below and above the respective Hobart figures.

ZONATION

(1) On the East Side of the Peninsula

The transects considered here have been numbered consecutively with those of the paper on the ecology of the Blackman's Bay area (Guiler, 1950.).

TRANSECT 9

Station	On the rocks at the head of Sleepy Bay, below the track from the Chateau.
Date	February, 1950.
Type	Wave exposed rocky coast.
Maximum wave exposure	a (1-10) 4, a, 2. The wave exposure is modified by the off-shore kelp beds. This influence is difficult to evaluate.
Description	The transect is on the sloping rocks in the more sheltered part of the bay. In easterly gales the wave action may be severe.
Geology	Red granite.
Tidal data	Approximately similar to those noted for Hobart.
Physical environment	See above.
Zonation	The basic zonation of this transect is as follows:—*Melaraphe unifasciata* (Gray). Balanoid zone. Patelloid zone, *Corallina* zone, infra-littoral fringe with *Sarcophycus*.

(i) The Supralittoral Zone

Most of the Supralittoral is occupied by bare rock. A band of orange lichens commences immediately above the *Melaraphe* zone. A few small *Salicornia* plants are found in clefts in the rock.

(ii) The Supralittoral Fringe

The only common macroscopic organism in this zone is the Littorinid *Melaraphe unifasciata*. This mollusc is fairly evenly distributed over a band zone eight feet in vertical width. The species is found in clefts and hollows in the rocks and also in sun sheltered places.

(iii) The Midlittoral Zone

There are three belts in the Midlittoral. These are a barnacle belt, followed by one of *Patella*-like organisms which in turn is replaced by a *Coralline* belt. The barnacles follow immediately below the Supralittoral fringe. There is the usual narrow mixed belt of barnacles and gastropods at the junction of these two zones. The lower limit of the Midlittoral is marked by a belt of *Corallina*. Between the *Corallina* and the barnacles there is a strip of *Patella*-like organisms. This latter belt is narrow and is separated from the barnacle belt by a narrow band of barnacles, 'patelloids' and a few small tubes of the worm *Galeolaria caespitosa* (Lam.). This latter mixed belt is nine inches in vertical height.

The barnacles inhabiting this zone are all very small, being rarely more than 2·0 mm. in height and 4·0 mm. in breadth. The dominant species are *Elminius simplex* Darwin and *Chthamalus antennatus* Darwin. The density of population in this zone is very low. The barnacles are confined to cracks and other sheltered situations. In several places barnacles occur in closely packed masses but these populations do not occupy large areas and consequently there are not many individuals in each cluster. The reason for the population of barnacles in these few places is not at all clear. Other non-populated areas seem to be just as suitable as many of the chosen areas. There is a slightly greater number of populated areas on sun-sheltered surfaces.

A few small mussels, *Brachyodontes rostratus* (Dunker), are found in cracks in the rock at the same level as the serpulid worm *Galeolaria caespitosa.*

The Patelloid belt is not fully developed in this transect. The species are the same as in the following transect but not as numerous or as large in size. The belt is described more fully in Transect 10.

The few species noted above represent the sum total of the fauna encountered in the upper Midlittoral on the transect. There were no algae. On a quick examination from a few yards away the rock above the worm tubes appears to be devoid of any inhabitants and the few species which occur are all found in semi-cryptic places. (Plate III illustrates to some extent the bareness of the shore.)

Immediately above the kelp is a *Coralline* belt. The algae are the dominant forms found on this part of the shore. *Lithothamnia* (meaning all *Lithothamnion*-type-forms), *Laurencia* sps., *Corallina cuvieri,* some *Ulva lactuca* L. and a few Patelloids, mostly *Siphonaria diemenensis* Quoy and Gaim. are the most common species. The most common barnacle is the large *Catophragmus polymerus* Darwin with a few *Elminius simplex.* Some *Galeolaria* tubes are also found but they are scattered and do not form a continuous incrustation on the rock. The mussel, *Mytilus planulatus* Lam. occurs in the belt but the specimens are small in size and few in numbers. The mussels do not form beds or aggregated masses.

(iv) The Infralittoral Fringe

The Infralittoral fringe furnishes the most striking part of the intertidal region. The large Bull Kelp *Sarcophycus potatorum* (Labill.) Kütz, is very prominent at 'low low' water and forms a sharply defined band running all around the shore. (Plate I).

This alga occupies a considerable amount of the rock space. Its holdfasts do no offer the same habitat for organisms as do the branching holdfasts of *Laminaria* sps. (Plate I.) The illustration in Plate I. is not typical of the traverse. In the area photographed a horizontal ledge below the level of the *Sarcophycus* offers a substratum which has been colonized by a modified *Coralline* population. On the line of the transect there are a few other algae in the Infralittoral fringe, though *Xiphophora* sp. and *Splanchnidium rugosum* (L.) Greville are found. Living near the base of one *Xiphophora* plant were several individuals of the interesting 'patelliform' isopod *Amphoroidea elegans* Baker. All other available *Xiphophora* plants were examined for this species but none of them had specimens of the crustacean dwelling on them.

TRANSECT 10

Station	To the South of the previous transect at Sleepy Bay.
Date	February, 1950.
Type	Exposed rocky coast.
Maximum wave exposure	o. (1-10) 4, a, 3.
Description	From the seaward end of the terrain in Plate III, the transect runs along the rocks to the north of the small island in Sleepy Bay. The island does not shelter the shore from wave action.
Geology	Red granite.
Tidal data	Approximately similar to those noted for Hobart.
Zonation	As in Transect 9.

(i) The Supralittoral Zone

Most of the Supralittoral zone in this transect has a poor lichen population. There are no other species in the zone. At the landward end of the transect are vertical cliffs which carry sparse patches of orange lichens. Most of the Supralittoral which was examined (about 40 feet) lies in a roughly horizontal plane at the foot of these cliffs. The cliffs are in such a position that they do not shelter the zone from the sun.

(ii) The Supralittoral Fringe

As in Transect 9, the Supralittoral fringe is populated by the littorinid *Melaraphe unifasciata*. This gastropod does not reach as high on the shore as in Transect 9. The possible reason for this is discussed later.

(iii) The Midlittoral Zone

The topmost belt of this zone is occupied by barnacles of which the dominant species is *Elminius simplex*. In the lower parts of the barnacle belt there are a few limpets, *Patelloida cantharus* (Reeve). A few small *Brachyodontes rostratus* and *Galeolaria caespitosa* are found in cracks in the rocks. Small specimens of the barnacle *Catophragmus polymerus* inhabit cracks in the lower part of the barnacle belt.

On a sloping face at the same level as the lower barnacle belt, but with a greater degree of wave action the population is composed of the same species as noted above but the *Catophragmus* barnacles are larger and more battered in appearance.

The Patelloid belt is well developed. The dominant forms are *Siphonaria diemenensis* and *Patelloida alticostata*. *Patelloida cantharus* and the large *Cellana limbata* (Philippi) are also common. Living among the limpets are a few *Tetraclita purpurascens* (Wood) and numerous *Catophragmus polymerus*.

The lower Patelloid belt grades off into the *Coralline* belt, which in turn is replaced by the *Sarcophycus* belt. In the latter case the line of demarkation between the belts is very sharp.

The lower parts of the Midlittoral are dominated by various *Coralline* algae. *Corallina cuvieri* Lamouroux is the most numerous of the algae and forms a thick carpet over most of the belt, but is particularly well developed in the lower areas. A large coral alga, not yet identified, forms a very important habitat for small organisms in the *Coralline* belt as a whole (Plate II). This alga occurs in two forms, both of which are to be seen in the plate. The more common and obvious form is regular and dome shaped, being up to three inches in height. The other form is encrusting and of irregular shape. The latter is to be seen to the lower right of the large chiton in the plate. Both forms constitute the habitat for Sphaeromid isopods, amphipods, errant polychaetes and the small mollusc *Lasaea australis* (Lam.). This latter species is very numerous and is to be found in spaces inside the algal mass.

Also found in the *Coralline* belt are some barnacles, mostly *Catophragmus polymerus*, numerous limpets of the species *Cellana limbata* and *Patelloida alticostata* with the pulmonate *Siphonaria diemenensis*. Three species of chiton are common, namely *Plaxiphora albida* (Blainville), *Ischnochiton evanida* (Sowerby) and *I. mayi* Pilsbry. The largest of these is *Plaxiphora* but the other species are more numerous.

(iv) The Infralittoral Fringe

The Infralittoral fringe is dominated by the Bull Kelp, *Sarcophycus potatorum.* Even during calm weather the sweeping action of the fronds of this alga are continuous and strong. In the lower levels of the Infralittoral fringe *Macrocystis pyrifera* (Turn.) Agardh., *Xiphophora* sp. and other smaller species can be seen. Owing to the depth of the water and the strong swell they are very difficult to collect. The small gastropod *Calliotrochus legrandi* (Petterd) has been collected on the various algae.

On other parts of the shore where there are sheltered places with loose boulders a varied fauna is to be found. Many of the species are incrusting and constitute the hypobiose of Gislén (1930). Common species are *Hymeniacidon perlevis* (Montagu), *Sycon gelatinosum* (? var. whiteleggei), two species of Euceratosa, *Haliotis noevosum* Martyn, *Cellana limbata, Patelloida alticostata, Lomis hirta* (Lam.) *Idotea caudacuta* Haswell, isopods and amphipods, a pycnogonid of the genus *Nymphon, Boltenia pachydermatina* Herdman, an ophiuroid, *Chaetomorpha* sp., and encrusting *Codium* and numerous *Lithothamnion* sps.

A few individuals of the ascidian *Pyura praeputialis* (Heller) are found in the more sheltered places. On wave exposed surfaces the species is rare.

The continuous intensity of the heavy swell in the area is shown on a small island just off-shore at Sleepy Bay to the south of the transect. The island is cleft by a fissure which is some seven feet above the level of 'low low' water. On calm days at low tide the swell surges through this cleft. The cleft is populated by numerous plants of *Sarcophycus potatorum* with a modified Infralittoral fringe fauna and flora. (Plate II.)

(2) On the West Side of the Peninsula

TRANSECT 11

Station	On the rocks below the Chateau, Coles Bay.
Date	February, 1950.
Type	Sheltered rocky coast.
Maximum wave exposure	s (0-8) 2. b, 3.
Description	The transect runs at right angles to the shore line, 20 yards to the east of the landing stage below the Chateau.
Geology	Red granite.
Tidal data	Approximately similar to those noted for Hobart.
Zonation	*Melaraphe unifasciata;* barnacle belt; *Galeolaria caespitosa; Hormosira banksii; Corallina* belt; *Cystophora* in Infralittoral fringe.

(i) The Supralittoral Zone

There are no lichens or other macroscopic organisms inhabiting the Supralittoral. The zone is wide and ends abruptly in a sandy soil.

(ii) The Supralittoral Fringe

As in all other transects the Littorinid *Melaraphe unifasciata* is the dominant organism on this part of the shore. The pure *Melaraphe* belt is very restricted, its total vertical height being only four inches. This restriction of the upper limit of the gastropod is to some extent aggravated by the conformation of the granite which is rounded and does not offer any cracks as shelter from the sun.

(iii) The Midlittoral Zone

The zonation of the Midlittoral is very different from that seen at Sleepy Bay. The barnacles, *Elminius simplex* and *Chthamalus antennatus* form a wide mixed belt with *Melaraphe*, ultimately passing into a pure barnacle belt. In sun sheltered places in these belts are found a few very small *Brachyodontes rostratus*. Large numbers of the Trochid *Austrocochlea concamerata* (Wood) are also found in the same places as the mussel. In gulleys at the lower end of the barnacle zone are large numbers of the chiton *Sypharochiton pellis-serpentis* (Quoy and Gaim.), with numbers of tubes of *Galeolaria caespitosa*, a few *Brachyodontes rostratus* and some *Tetraclita purpurascens* (Wood).

The mussel *Brachyodontes rostratus* forms a strip just above the lower limits of the barnacle belt. The *Galeolaria* belt is of considerable width but only seven inches in vertical height. The worm tubes are not as closely packed as in Transect 1 at Blackman's Bay and are also smaller in size.

Hormosira banksii (Turn.) Decaisne follows below the serpulids. There is no mixed *Hormosira-Galeolaria* belt. The alga does not form a dense growth in the nature of a *Hormosiretum*. At the lower end of the *Hormosira* belt there exists a narrow mixed belt of *Hormosira* with *Corallina*. This is followed by a *Coralline* belt.

The fauna of the *Coralline* belt is poor. The alga forms a dense covering to the rock and does not permit the existence of colonial or gregarious animals. Very few animals, mainly isopods, are found in the *Corallina*.

In all of the Midlittoral the fauna is poor both in numbers and species. Other than the index species mentioned above, there are very few forms to be found on the shore.

(iv) The Infralittoral Fringe

The dominant algal forms in the Infralittoral fringe are the two species *Cystophora torulosa* (R. Br.) J. Agardh. and *Caulocystis uvifera* (Ag.) J. Agardh. These algae form a dense ' scrub ' which extends down the rocks to the bay bottom of sand and forms the habitat for a large fauna.

The ' lithothamnia ' are very poorly developed in the Infralittoral fringe. Among other algae present are *Seirococcus axillaris* Greville, *Griffithsia ovalis* Harvey, *Phyllospora ? comosa* (Labill.) C. Agardh. and *Caulerpa sedoides* (R. Brown) C. Agardh. In restricted areas, none of which occur on this transect, are patches of *Zostera nana* Roth. and *Cymodocea antarctica* Endl. The Honeymoon Bay Beaches have several small patches of *Cymodocea* and just to the west of this transect there is a patch of *Zostera*. The *Zostera* does not form a Zosteretum. At the jetty at the opposite side of Coles Bay from the transect there is a large bed of *Zostera*, which, on examination from a boat at low water, seems to have a characteristic fauna. Some *Ulva* and *Enteromorpha* are found in isolated patches on the shore.

Compared with the east side of the peninsula the absence of *Sarcophycus potatorum* is most striking. In deeper water further along the coast past the Quarries, a few small *Sarcophycus* plants are found.

The dominant animal in the *Cystophora* is the gastropod *Cominella lineolata* (Lam.). Other common forms are *Subninella undulata* Solander, *Cantharidus eximius* (Perry), *Phasianella australis* (Gmelin), but only one specimen of the mutton-fish *Haliotis noevosum* (Martyn): *Amblypneustes ovum* Lam. and *Strongylocentrotus erithrogrammus* (Val.) are both numerous in the weed. The cephalopod *Polypus variolatus* (Blainville) is fairly common, one individual being noted with a body length of 18 inches. Crustacea Decapoda are very poorly represented. *Lomis hirta* (Lam.) is the most common species and *Naxia spinosa* (Hess) is also frequent. There must be many more crustaceans but due to the weed being covered by water during the collecting periods many of these must have escaped capture. Only the upper parts of the *Cystophora* belt are uncovered at any 'low low' tide. The only fish captured was the pipefish *Leptonotus semistriatus* (Kaup).

Below stones and boulders there is a large and varied fauna of *Subninella undulata, Euchelus baccatus* (Menke), *Fasciolaria australasia* Perry, *Hipponyx foliacea* Quoy and Gaim, *Pyrene tayloriana* (Reeve), *Marginella pygmaea* Sowerby, *Alliodoris marmorata* Bergh, *Tethya diploderma* Schmidt, *Coscinasterias calamaria* (Gray), *Tosia australis* Gray and *Patiriella calcar* (Lam.). This latter species is very numerous in some places, numbering as many as 10 per square foot. The hermit crab, *Clibanarius strigimanus* (White) is found inhabiting *Fasciolaria* shells.

Also found below stones is the small Symbranchid fish *Alabes rufus* (Macleay). Several species of small fishes swim in the water at the edge of the weed, and seek shelter in the scrub. Most common are small specimens of *Cristiceps australis* Cuv. & Val. and two species of leather-jackets. Other species identified with certainty are *Physiculus barbatus* (Günther), *Pseudolabrus tetricus* (Richardson) and the flathead *Platycephalus bassensis* Cuv. and Val.

TRANSECT 12

Station	At Honeymoon Bay, No. 3.
Date	February, 1950.
Type	Sheltered rocky coast.
Maximum wave exposure	s (1-8) 1. b. 3.
Description	The transect is on the rocks at the south end of Honeymoon Bay, No. 3. It is to seaward of several small isolated rocky outcrops in the sand. The slope is sun exposed.
Geology	Red granite.
Tidal data	Approximately similar to those for Hobart.
Physical environment	As above.
Zonation	As in Transect 10.

It is not intended to describe fully the details of zonation as seen on this transect. The main features of the zonation are the same as those seen at Coles Bay and the fauna of the shore above the barnacle zone is identical to the Coles Bay section.

The mussel *Brachyodontes rostratus* forms a band just above the lower limit of the barnacle belt. It lives in cracks with the chiton *Sypharochiton pellis-serpentis*. At the same level only one individual of the barnacle *Catophragmus polymerus* was noted.

The *Galeolaria* belt is not as fully developed here as at Coles Bay. It is very narrow (about two inches in vertical height) and the tubes are scattered thinly on the rocks. At one place on the shore there is a mass of tubes up to four inches in thickness. From the presence of this mass it is probable that most of the *Galeolaria* belt was covered by thick aggregations of worm tubes, but at some recent time these colonies have been killed or broken. It may be noted here that a similar state of affairs has been observed at Dodge's Ferry, Frederick Henry Bay. Here on December 5th, 1948, there were masses of *Galeolaria* tubes of considerable extent and up to four inches in thickness. These formed the habitat for numerous other species, notably *Lasaea australis* and *Ibla quadrivalvis* (Cuvier). In December, 1950, the rocks were nearly bare with only young worms living on them. In a few places the original masses were still intact. These latter must serve as a breeding stock for the repopulation of the area. The reason for this sudden change in numbers of the serpulids is not known. Returning to Honeymoon Bay, it is obvious therefore, that the *Galeolaria* belt is not in a fully populated state and that some change may be expected over the next few years.

Below the worms is a *Hormosira* belt which in turn is replaced by a *Corallina* belt. The latter extends as far as the Infralittoral fringe which is dominated by a *Cystophora* association similar to that at Coles Bay.

On the same slope of rock slightly to the west of the transect the *Hormosira* belt is replaced by an isolated patch of the mussel *Mytilus planulatus.* (Plate III.) A rock off-shore is populated by mussels alone, but over most of the shore near the transect *Hormosira* is dominant. There is some evidence of competition between the mussels and *Hormosira* on this transect and on the shore at the north of Honeymoon Bay, No. 3. (Plate III.) At two places in the latter area the mussel, also *Mytilus planulatus,* is dominant. Over the rest of the surface at the north end of the bay the two species are in severe competition for space, the alga being dominant. Similarly on this transect, the alga and the mussel are in competition for space.

On this transect one individual of the ascidian *Pyura praeputialis* (Heller) was found. On a rock lying within Honeymoon Bay No. 3 but below the tidal level occupied by *Cystophora,* numerous individuals of this species are crowded together.

On the sun sheltered faces the limpet *Cellana limbata* and the barnacles *Catophragmus polymerus* and *Tetraclita purpurascens* are found. The viviparous anemone *Actinia tenebrosa* (Farqu.) is found locally in cracks and other sun sheltered places. This species is synonymous with the British *A. equina* Linn. (Blackburn, 1937).

In all of the north part of Honeymoon Bay No. 3 the mussel *Brachyodontes rostratus* prefers level or near level surfaces.

Discussion

The salient feature of the intertidal region above the Infralittoral fringe, as at Blackman's Bay, is the poverty both in species and numbers of the fauna and flora. Due to the lack of time no density counts were undertaken, but the fauna of the Midlittoral, especially above the Patelloid belt, is noticeably poor.

As the general poverty of the upper intertidal belts is pronounced on both sides of the peninsula, it may not be attributed to exposure to wave action. It has been shown by Hatton and Fischer-Piette (1932) that barnacles prefer places where there is considerable wave action. At Sleepy Bay there is very strong wave action yet the barnacles are poorly developed both in numbers and size. On rocks with a southerly aspect there is a slight increase in the number of barnacles present but this is not compatible with the increase one might expect if sun exposure were the controlling factor. This latter feature has been noted in all localities visited to date but in all other areas the population of barnacles on sun sheltered faces of rocks is very much greater than on the exposed faces and this suggests that the sun is the controlling factor. The sun exposure on the Freycinet peninsula is more rigorous than at Blackmans Bay but this can hardly be accepted as a valid reason for the scarcity of numbers of some species of the barnacles as these species are also found on the New South Wales coast. On the latter coasts the sun is considerably stronger than any encountered in Tasmania. The percentage exposure to dessication which these barnacles suffer cannot be compared with that for barnacles at similar tidal levels on the Mainland as there are no exposure figures available for Australia. Also, in sun sheltered places there is no luxuriant growth of barnacles.

On the east coast which is exposed to the continual surge of the oceanic swell there is not always spray due to the deadening effect of the kelp on the waves. The wave action, except in gales, is more in the nature of a three feet to six feet rise and fall of sea level without heavy spray. This may be altered by the local topography, but in general on most of the shore there is no spray. Thus, in spite of being a coast exposed to severe wave action, the intertidal levels above the height reached by the waves at 'low low' water in the summer are exposed to the maximum action of dessication. This is, in effect, the explanation offered by Dakin, Bennett and Pope (1948) for the upper 'cut off' of the Infralittoral fringe. In a few places on the Tasman sea coast near Sleepy Bay there is spray all the time, but most of these are inaccessible. At the few places where the effects of this continual spray were examined there was the usual raising of faunistic levels on the shore but no outstanding increase in numbers of the barnacle population.

On the wave sheltered Oyster Bay side of the peninsula there is also a poor barnacle fauna. As on the ocean coast there is no great increase in the numbers of barnacles in sun sheltered places.

It is tentatively suggested that the red granite does not offer a suitable substratum for intertidal organisms in general and, in particular, barnacles. This suggestion may have to be modified as further work is undertaken.

The lichens of the Supralittoral zone show a different vertical distribution from that prevalent in the Blackman's Bay area. In Transect 10 the orange lichens are separated from the *Melaraphe* belt by a broad band of bare rock. This is also characteristic of the more exposed parts of Pierson's Point. In Transect 9, however, the lichens follow directly on the upper limit of the *Melaraphe* zone. In Transect 9 the *Melaraphe* and lichen belts are both closer to the sea than in Transect 10 and previous transects at Blackman's Bay. This may be correlated with a greater amount of spray at Sleepy Bay allowing an upward extension of the upper limit of the *Melaraphe* belt. This wider range results in the elimination of the band of bare rock between the two zones. At the Chateau (Transect 11) the restriction of spray causes the *Melaraphe* belt to be only four inches in vertical height. In this case the smooth rounded surface of the granite does not offer a very suitable habitat for the gastropods. At the Honeymoon Bay transect, where spray is greater during easterly weather than that at Coles Bay, the *Melaraphe* belt is one foot five inches in vertical height.

Table II shows the faunal levels of the different belts at the transects considered in this work.

Bembicium nanum (Lam.) and Trochids are absent from the Sleepy Bay area. Their absence from wave exposed transects has been noted previously (Guiler, 1950, p. 173).

The constitution of the Patelloid belt is the same in both of the major areas described to date. The numbers of the various species are different from at Blackman's Bay. In particular, we may note the *Siphonaria diemenensis* is dominant on the peninsula in place of *Patelloida alticostata* at Blackman's Bay. The population of the Patelloid belt on the east coast is greater than at Hobart.

The absence of *Galeolaria* on wave exposed rocks has already been suggested by the observations made at Transect 5 (on dolerite at Kingston). This result is fully substantiated here where the serpulid does not form a band on the Tasman Sea side of the peninsula. The space thus, theoretically, made available for colonization is largely occupied by an upward extension of the Patelloid belt and partly by a downward extension of the barnacles. Included in the upward movement of the Patelloid belt is a similar movement of other forms inhabiting the belt.

In Transect 10 there is a poor line of demarcation between the Patelloid and barnacle belts. This may be due to the wave action varying considerably over short periods of time. This in turn would allow the larvae of forms from both belts to fix themselves in the mixed belt. If the wave action were constant in intensity a sharper line of demarkation would have been noticed.

In the Coles Bay area, *Brachyodontes rostratus* forms a strip within the barnacle belt. The species is found on wave exposed coasts but it is not plentiful. At Blackman's Bay, the mussel usually occurs in the Patelloid belt. (Table III.)

The mussel *Mytilus planulatus*, which forms extensive beds on semi-exposed coasts in the Blackman's Bay area, is virtually absent from the Sleepy Bay region. There are a few small specimens found in clefts as noted above but neither this species nor any other mussel species forms the dense beds seen at other places in Tasmania. The distribution of this species is also controlled in part by wave exposure as has been discussed in the first paper of this series.

On the wave exposed coast the calcareous algae are more fully developed than seen hitherto. In particular, we might note the large coral-like masses of the alga shown in Plate 5. This alga, which I have not been able to have identified, is a very noticeable feature of the lower shore regions. As noted above, it forms an important habitat in the *Coralline* belt. In the Blackman's Bay area the *Corallines* and *Lithothamnia* are not nearly so well developed.

The ascidian, *Pyura praeputialis*, occurs on the wave exposed coast in no greater numbers than in the Blackman's Bay area. It is found in small numbers in wave sheltered positions on the east side of the peninsula and in larger numbers at Honeymoon Bay. At no place on the peninsula is it as plentiful as at Dodge's Ferry or Pitt Water, both in Frederick Henry Bay, near Hobart.

The Infralittoral fringe shows the greatest difference in dominant types, not only between Sleepy Bay and Coles Bay but also between both these places and Blackman's Bay. At Blackman's Bay the larger algae are not found in quantity at the extreme limit of low water, but below this level plants occur in some numbers. The common species are *Macrocystis pyrifera*, *Xiphophora* and a few *Ecklonia radiata*. The Infralittoral fringe is occupied by a mixture of the larger forms.

At Sleepy Bay the very big alga *Sarcophycus potatorum* dominates the Infralittoral fringe almost to the exclusion of all other species. Also, there is a considerable difference in the density of *Coralline* colonization, with the best development seen on wave exposed coasts and the least at places where the dense *Cystophora* growths permit only a very small colonization by encrusting forms. Kitching (1937) notes that the slow growing *Corallina* at the Infralittoral fringe appears to be able to exclude the much larger *Himanthalia*. This condition, he also states, is probably reversed in deep water. If the *Cystophora* at Coles Bay is in a climax state, and there is little evidence for not making this assumption, there does not appear to be a similar action between the *Corallines* and *Cystophora* in this area. The narrow *Coralline* belt above the *Cystophora* may be the result of inter-specific action but there is no field or experimental evidence available upon which to base any deductions.

In numbers of both species and individuals the Infralittoral fringe at both the localities considered in this paper is less densely populated than at Blackman's Bay. This can be accounted for by the absence of mussel beds. These latter form a most suitable habitat for numerous intertidal species which have been described in the first paper of this series in terms of the epi-, endo- and hypobiose of Gislén (1930).

TABLE II

The relation of the intertidal belts at Transects 9 to 12, Freycinet Peninsula.

TRANSECT 9 Lichens	TRANSECT 10 Lichens Bare Rock	TRANSECT 11 Bare Rock	TRANSECT 12 Bare Rock
Melaraphe	*Melaraphe*	*Melaraphe*	*Melaraphe*
Barnacles	Barnacles with *Brachyodontes* and *Galeolaria* in cracks *Catophragmus*	Barnacles with *Brachyodontes* and *Austrocochlea* in cracks *Brachyodontes* with *Sypharochiton* in cracks	Barnacles with *Austrocochlea* *Brachyodontes*
Few *Galeolaria* with *Brachyodontes* in cracks Patelloid *Corallina*	Patelloid *Corallina*	*Galeolaria* *Hormosira* *Corallina*	*Galeolaria* *Hormosira* and/or *Mytilus* *Corallina*
Sarcophycus	*Sarcophycus*	*Cystophora*	*Cystophora*

TABLE III

The zonation seen on the Freycinet Peninsula compared with that seen at Blackman's Bay. Transects 10-12 as in text, Transect 1 at Pinnacle Point, Blackman's Bay, Transect 2 at the north end of Blackman's Bay and Transect 5 on dolerite at Kingston.

TRANSECT 10 Orange lichens Bare rock	TRANSECT 11 Absent	TRANSECT 12 Absent	TRANSECT 1 Lichens Bare rock	TRANSECT 2 Lichens Bare rock	TRANSECT 5 Lichens Bare rock
Melaraphe	*Melaraphe*	*Melaraphe*	*Melaraphe*	*Melaraphe* with barnacles in cracks	*Melaraphe*
Barnacle with few *Galeolaria* and *Brachyodontes* in cracks	Barnacles with *Brachyodontes* and *Austrocochlea* Barnacles	Barnacles with *Brachyodontes* and *Austrocochlea* Barnacles	*Bembicium* Barnacles	Barnacles with *Brachyodontes* in cracks	Barnacles
Catophragmus	*Galeolaria*	*Galeolaria*	*Galeolaria*	*Brachyodontes* with *Galeolaria*	Variable with wave action
Patelloid	*Hormosira*	*Hormosira* and/or *Mytilus*	Patelloid *Brachyodontes* Patelloid *Catophragmus*	*Catophragmus*	*Catophragmus*
Corallina	*Corallina*	*Corallina*	*Mytilus*	*Mytilus*	*Mytilus*
Sarcophycus	*Cystophora*	*Cystophora*	*Laurencia* *Macrocystis*	*Laurencia*	*Laurencia*

Under rocks, in clefts and other sheltered places both at Blackman's Bay and the Freycinet Peninsula there exists a varied and numerous fauna. Most of this fauna is difficult to identify, being composed mainly of those groups of animals and plants which have never been fully studied in Tasmania. Some of these species have been noted but at present it is intended to name the more obvious and ecologically important of the intertidal species. On exposed coasts the fauna and flora is in the nature of a hypobiose rather than the epibiose of sheltered coasts.

I do not yet propose fully to compare the intertidal region of Tasmania with that of other places in Australia. A few brief notes of comparison between Tasmania and New South Wales will suffice until such time as the work is more complete and other areas in Tasmania have been studied. A general comparison of the Australian intertidal zones as proposed by various authors has been given in the description of the Blackman's Bay area.

The intertidal ecology of New South Wales has been described by Hedley (1915), Fischer (1940b), Pope (1943) and Dakin, Bennett and Pope (1948). Fischer (1940b) gives a few brief notes comparing the zonation in New South Wales with that in Tasmania (p. 307). He based his description on a few brief visits to the shore at Burnie, in the Bass Straits area, and Hobart. A wave exposed coast was not examined. However, the comparative value of the work is not diminished as the sheltered coasts of N.S.W. are also considered.

Fischer states that the *Galeolaria* and *Melaraphe* zones in Tasmania are certainly comparable with the same zones as defined by Hedley at Sydney. The former zone at Sydney forms a belt 18 inches to two feet in width and up to eight inches in thickness (Dakin, et al., 1948). The greater width of the belt at Sydney compared with Hobart is due to the larger tidal range. Both Hedley and Fischer state that the species occurs on wave and surf swept headlands and Dakin and others note that the species extends through all degrees of exposure to the calm waters of Sydney Harbour. Fischer recorded *Galeolaria* as rare in calm waters. Pope (1943) notes that *Galeolaria* does not form a complete covering for the rocks at Long Reef. Comparing this with Tasmania we find that the tubes are rare on coasts which are fully exposed to wave action. This is similar to the New South Wales condition since Dakin, Bennett and Pope note that the species does not flourish where wave action is intense. From the descriptions of *Galeolaria* in New South Wales I think that the species in Tasmania has less toleration for wave action as even the turbulence at Transect 5 is sufficient to cause diminution in numbers. The formation of thick crusts of worm tubes at Sydney seems to reach a higher degree of development than any yet seen in Tasmania where a 4-inch crust is about the maximum thickness observed. In conclusion, this species in Tasmania is not as robust as in New South Wales, requiring less wave action for successful growth. It also flourishes in wave sheltered situations but does not form a thick incrustations on rocks in Tasmania.

The ascidian, *Pyura praeputialis*, is present on wave exposed coasts in New South Wales. Hedley (1915) notes that it demands rough seas, Fischer describes it as living on ' points battus '. Dakin, Bennett and Pope are more specific and have decided that the species requires ocean water with considerable but not excessive wave action. The species is also found in estuaries and land locked bays but is best developed opposite the seawards aperture of the bay (Dakin et al., 1948, p. 205). In Tasmania, the species occurs very infrequently on wave exposed coasts. At Blackman's Bay there is about one individual to every 50 feet of coast. On the east coast at Sleepy Bay individuals of this species are more numerous but do not form clumps. The species at the latter area requires searching for before it can be located. In wave sheltered places in Tasmania the species is frequently very common, occurring in dense sheets on rocks. Some of these localities are to be described in future work. The species does not seem to have a preference for ocean waters. Tentatively, it may be said to prefer estuarine or enclosed waters.

On semi-exposed Tasmanian coasts the mussel *Mytilus planulatus* forms widespread beds. This feature is absent from wave exposed coasts. Similar beds do not form an important part of the shore fauna at Sydney (Hedley, 1915). Fischer (loc. cit.) records *M. planulatus* as occurring in Sydney in calm waters. Dakin, Bennett and Pope record the presence of *Mytilus obscurus* Dunk. but do not mention any formation of mussel beds. We may assume that mussel beds on semi-exposed coasts is a feature of Tasmania which is not shared with New South Wales.

Dakin, Bennett and Pope record the mussel *Brachyodontes rostratus* as forming sheets on parts of the Victorian coast. In the parts of Tasmania examined, the species occurs in clefts in rocks in a similar manner to that noted by the same authors for the same species in New South Wales.

The algae of the Infralittoral fringe are different from those found over most of the coast of New South Wales. *Ecklonia radiata* (Turn.) J. Ag. and *Phyllospora comosa* (Labill.) Ag. are the dominant species over the greater part of the coast of the latter state. *Sarcophycus potatorum*, highly developed on the Tasmanian coasts, appears at the south end of the New South Wales coast. *Ecklonia* has been found at Blackman's Bay but is not common. Very often, *Macrocystis* is a feature of semi-exposed and fully exposed coasts in Tasmania.

I do not propose at this stage to compare the features of the Tasmanian intertidal region with those described in South Africa by the team of workers collaborating with Prof. T. A. Stephenson. A few interesting points are noted below.

There exists a similarity in the zones described on the east coast of Tasmania and the west coast of South Africa (Bright, 1938a & b; Stephenson, Stephenson & Day, 1940). In South Africa the mussels, *Mytilus crenatus*, may replace limpets where the wave action is intense, but in Tasmania the opposite is the case. There are no *Pyura* beds in either locality. The large Infralittoral algae are cold water species in both countries. There is a Patelloid belt in both areas though this may be modified in South Africa.

In conclusion, it is suggested that the intertidal fauna and flora of wave exposed coasts in South and East Tasmania show greater ecological affinities with South Africa than New South Wales.

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References

BLACKBURN, M, 1937.—Lady Julia Percy Island. Part II. The Coelenterata. *Proc. Roy. Soc. Vict.*, 49, 2, 1937, pp. 364-71.

BRIGHT, K. M. F., 1938*a*.—The South African Intertidal zone and its relation to ocean currents. II. An area on the west coast. *Trans. Roy. Soc. S. Afr.*, XXVI, 1, 1938, pp. 49-65.

————————, 1938*b*.—The South African Intertidal zone and its relation to ocean currents. III. An area on the northern part of the west coast. *Trans. Roy. Soc. S. Afr.*, XXVI, 1, 1938, pp. 67-88.

CHAPMAN, R. W., 1938.—The tides of Australia. *Official Year Book of the Commonwealth of Australia*, 31, 1938, pp. 972-984.

DAKIN, W. J., BENNETT, I., and POPE, E. C., 1948.—Some aspects of the ecology of the intertidal zone of the N.S.W. coast. *Austr. J. Sci. Res.*, 1, 2, Ser., B., 1948, pp. 176-231.

DANNEWIG, H. C., 1907.—On some peculiarities in our coastal winds and their influence upon the abundance of fish in in-shore waters. *Proc. Roy. Soc. N.S.W.*, XLI, 1907, pp. 27-45.

FISCHER, P. H., 1940*a*.—Notes sur les peuplements littoraux d'Australie. I. Influence des courants chauds sur la vie littorale en Australie tempérée. *Soc. de Biogeogr.*, Mem. VII, 1940, pp. 279-288.

————————, 1940*b*.—Notes sur les peuplements littoraux d'Australie. II. Sur le peuplement des roches intercotidales en Australie tempérée. *Soc. de Biogeogr.*, Mem., VII, 1940, pp. 289-329.

GISLEN, T., 1930.—The epibioses of Gullmar Fjord. Kristinebergs Zoologiska Sta. 1877-1927. Uppsala, 1930, No. 3, pp. 1-123, No. 4, pp. 1-380.

GUILER, E. R., 1950.—The intertidal ecology of Tasmania. *Pap. Roy. Soc. Tasm.*, 1949 (1950), pp. 135-20.

HATTON, H. and FISCHER-PIETTE, E., 1932.—Observations et expériences sur le peuplement des côtes rocheuses par les cirripedes. *Bull. Inst. Oceanogr. Monaco*, 592, 1932, pp. 1-15.

HEDLEY, C., 1915.—An ecological sketch of the Sydney beaches. *Proc. Roy. Soc. N.S.W.*, 49, 1915, pp. 15-17.

KITCHING, J. A., 1937.—Studies in Sublittoral ecology. II. Recolonization at the upper margin of the Sublittoral region, with a note on the denudation of *Laminaria* forest by storms. *J. Ecol.*, 25, 1937, pp. 482-495.

POPE, E. C., 1943.—Animal and plant communities of the coastal rock platform at Long Reef, N.S.W. *Proc. Linn. Soc. N.S.W.*, 68, 1943, pp. 221-254.

STEPHENSON, T. A. and STEPHENSON, A., 1949.—The universal features of zonation between tide marks on rocky coasts. *J. Ecol.*, 37, 2, 1949, pp. 289-305.

STEPHENSON, T. A., STEPHENSON, A., and DAY, J. H., 1940.—The South African intertidal zone and its relation to ocean currents. VIII. Lamberts Bay and the West coast. *Ann. Natal Mus.*, IX, III, 1940, pp. 345-80.

WEATHER BUREAU, 1936.—Results of Rainfall Observations made in Tasmania. Melbourne.

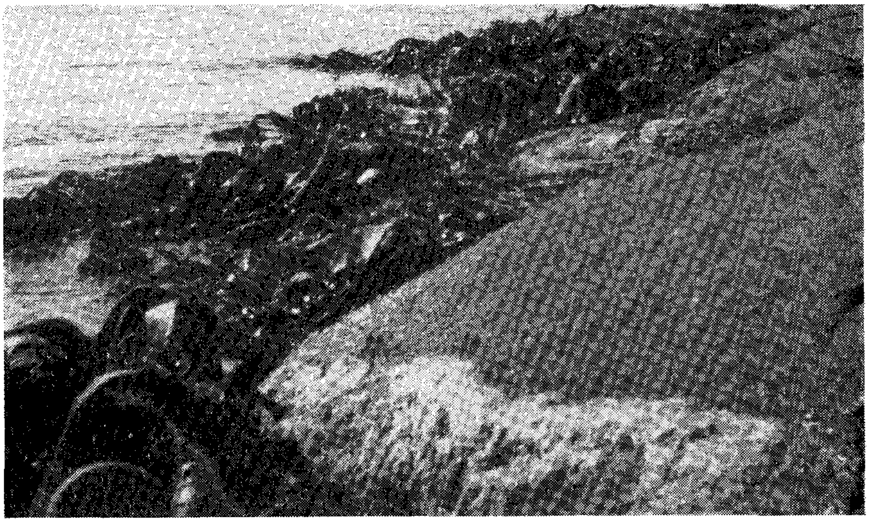

FIG. 1.—The Infralittoral fringe at Sleepy Bay. The photograph also shows the bareness of the Midlittoral.

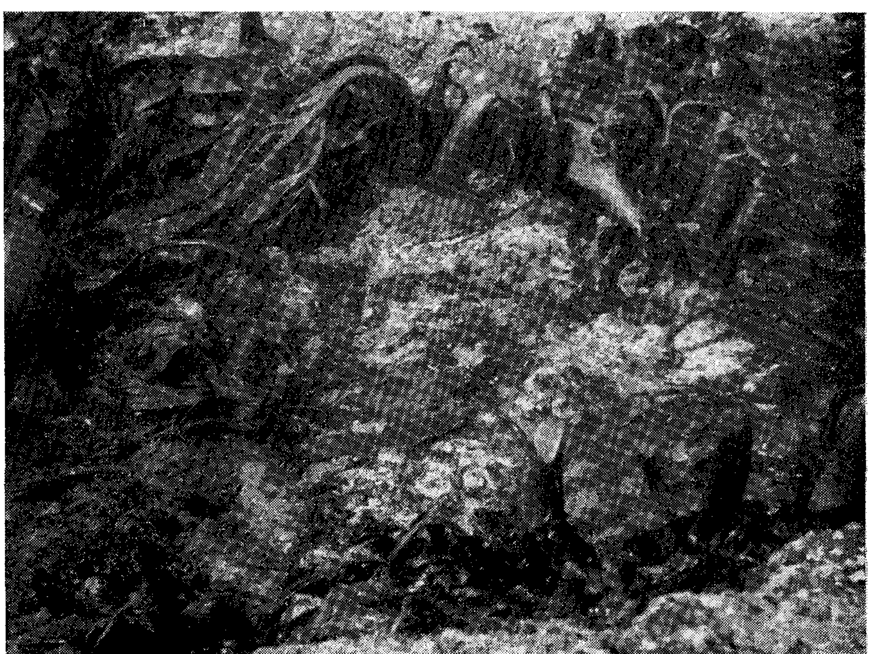

FIG. 2.—Close up view of Infralittoral fringe at Sleepy Bay. The prominent piece of *Sarcophycus* was 2½ inches across.

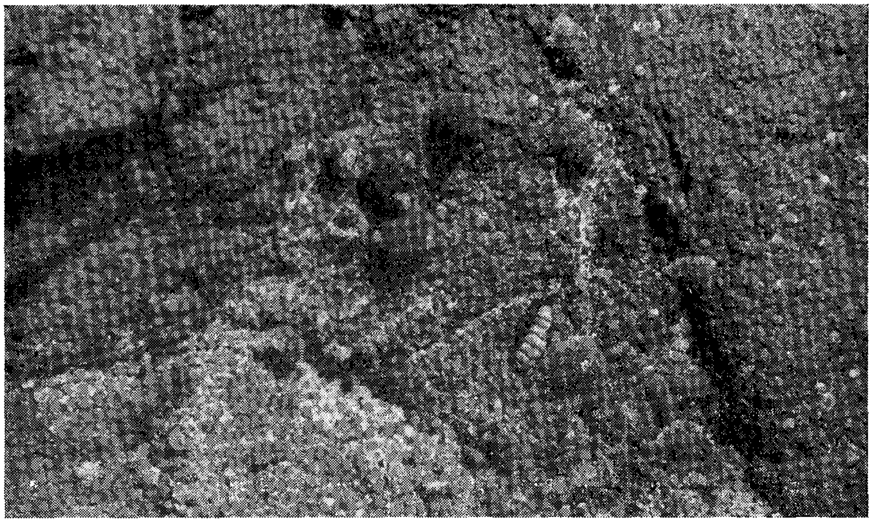

FIG. 1.—The junction of the *Patelloid* and *Corallina* zones at Sleepy Bay. The large chiton is *Plaxiphora albida* and is 4 inches in length. The large domes are encrusting forms of the coral-alga. *Corallina* is out of focus at the bottom right of the figure.

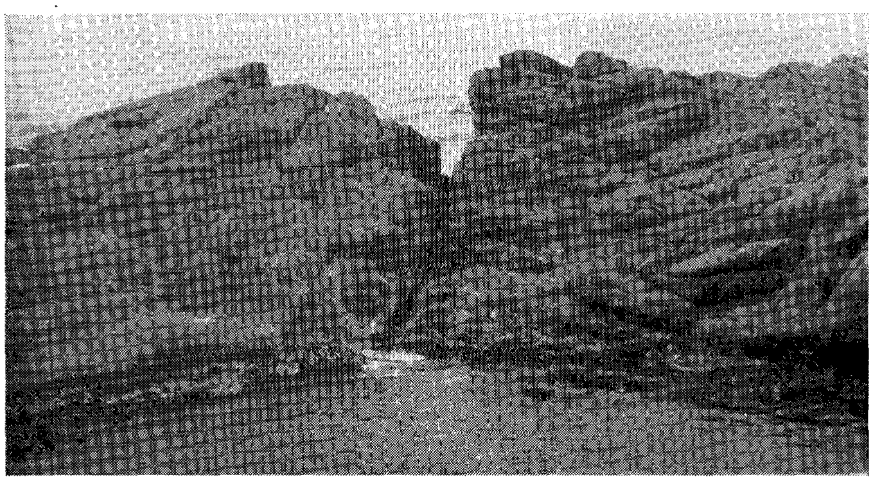

FIG. 2.—Small island off-shore at Sleepy Bay. The cleft is populated by *Sarcophycus*.

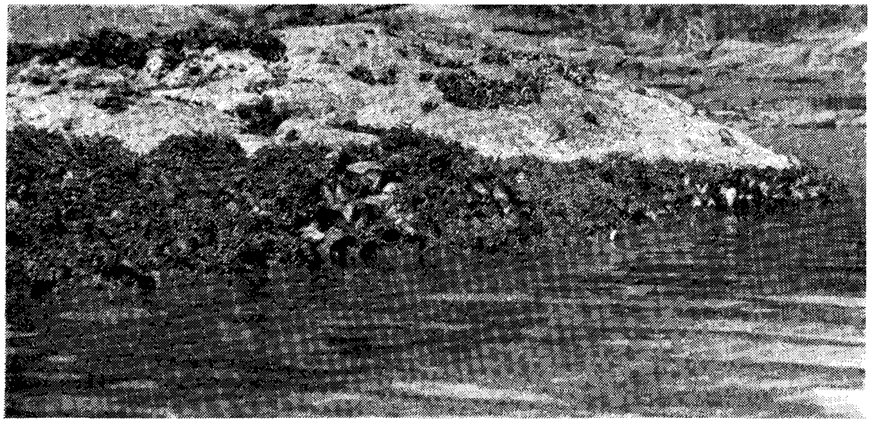

FIG. 1.—Shore at the southern end of Honeymoon Beach No. 3 showing mussels and *Hormosira*.

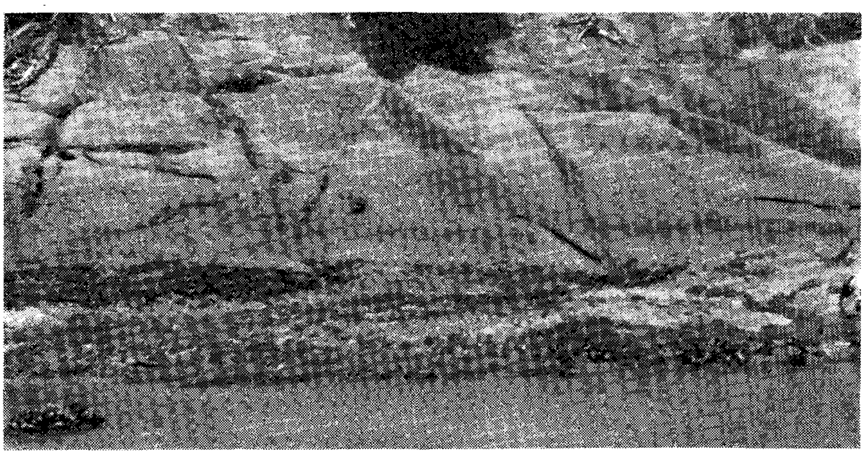

FIG. 2.—Shore at the northern end of Honeymoon Beach No. 2 showing inter-specific competition between *Mytilus* and *Hormosira*.