STUDIES OF HYPNEA SPICIFERA

Part I Morphology Anatomy and Reproduction of H.spicifera.

Part II Seasonal Reproductive Cycle and Ecology of H.spicifera.

Thesis submitted by Florence E. Hewitt for the degree of Master of Science of Rhodes University.

Investigation of Seasonal Reproductive Cycle of Hypnea spicifera.

The object was to investigate the seasonal life history of Hypnea spicifera, i.e. the absolute occurence of the various components (vegetative, tetrasporic, male and cystocarp fronds). As it was not possible to make regular examinations of the same plants growing in their natural environment, the evidence was obtained by an examination of the erect parts of the thallus to determine the frequency of vegetative, tetrasporic, male and cystocarpic fronds. This investigation was carried out by sampling over a period of a year from March 1950 to February 1951.

The locality from which the samples were taken is situated to the west of the rocky outcrop which forms the eastern boundary of Salt Vlei Bay (Kowie). This locality is a little over a mile along the shore to the west of the Kowie River. The area from which the samples were collected is roughly ½ acre. In this locality there is a sloping sandy beach, the seaward side of which is broken up by low rocky ridges of uptilted Witteberg quartzite (fig. 7s) These run out to sea roughly parallel to one another with sandy patches in between. The sandy inlets are much broken up by smaller ridges and isolated rocks making the sea floor very uneven. During the period under investigation H. spicifera grew in quantity in dense patches on the furthest parts of the rocky ridges and at the lower levels of the rocky outcrop in the inlets. At low water of spring tides

the Hypnea zone lay within the splash zone, i.e. was never truly emersed (except at unusually low spring tides 5/2/50 and 3/5/50) and the greater part of the zone was awash with every wave. Shore collecting in this part of the zone was thus possible at each month of the year. Further out the beds of Hypnea were washed by heavy surf and material could be obtained only at considerable risk. In calm weather material could be collected in places from the lower zones at intervals between the waves. The sampling material was taken as far as possible from all these parts of the zone (excluding pools). At times e.g. 23/2/51 when there was a strong wind and heavy sea the collecting of sufficient material became extremely difficult. H.spicifera also grows in dense patches on isolated rocks further out to sea and at inaccessible ends of rocky ridges. This part of the zone was visible at low water of spring tides, but always inaccessible on account of heavy surf and very uneven sea floor. Special apparatus would be required for the purpose of collecting from this level. During the second half of the year the area of rock surface from which material could be collected was greatly reduced owing to deposition of sand which entirely covered some of the rock surfaces from which plants had been collected during the first six months.

METHOD USED IN OBTAINING SAMPLE. (The comments and criticisms incorporated in this account are offered by F.J.Hewitt).

In determining the absolute occurrence of the various components the real difficulty is in establishing for counting purposes a unit group which is consistent from month to month.

To do this by sampling necessitates the establishment of a standard group the absolute size of which is unaffected by the condition of the seaweed. For this reason the volume of seaweed, or weight of seaweed is unsuitable. The only fundamental way of determining the size of the group is in area of earth surface. This cannot be simplified to area of rock surface on a small scale because of the jagged nature of the rock, and because much of the material from the lower levels grows in places subjected to heavy pounding by the sea, making complete extraction difficult. Furthermore the actual surface area may not be as important in determining the quantity, as the volume of seaweed within a given distance of the surface - the extreme cases being a cylinder of seaweed about a thin spike of rock of very small surface area, and a flat rock surface. To collect samples over an area large enough to eliminate the shapes of rocks would be en enormous task. In practice there may be a way of simplifying the problem.

This investigation was carried out by the analysis of a number of samples taken at random from a given area of rocky shore. The samples were collected at the lowest tide on the day following the full moon (with one exception December 1950 when the material was collected on December 22nd, full moon December 24th). Thirteen samples were thus collected during the period March 1950 to February 1951. Owing to the very dense growth, and intricate branching of the rhizomatous portions an attempt to isolate individual plants would have been wholly impracticable. The individual erect frond was therefore adopted as the unit. Tufts i.e. handfuls of H.spicifera were

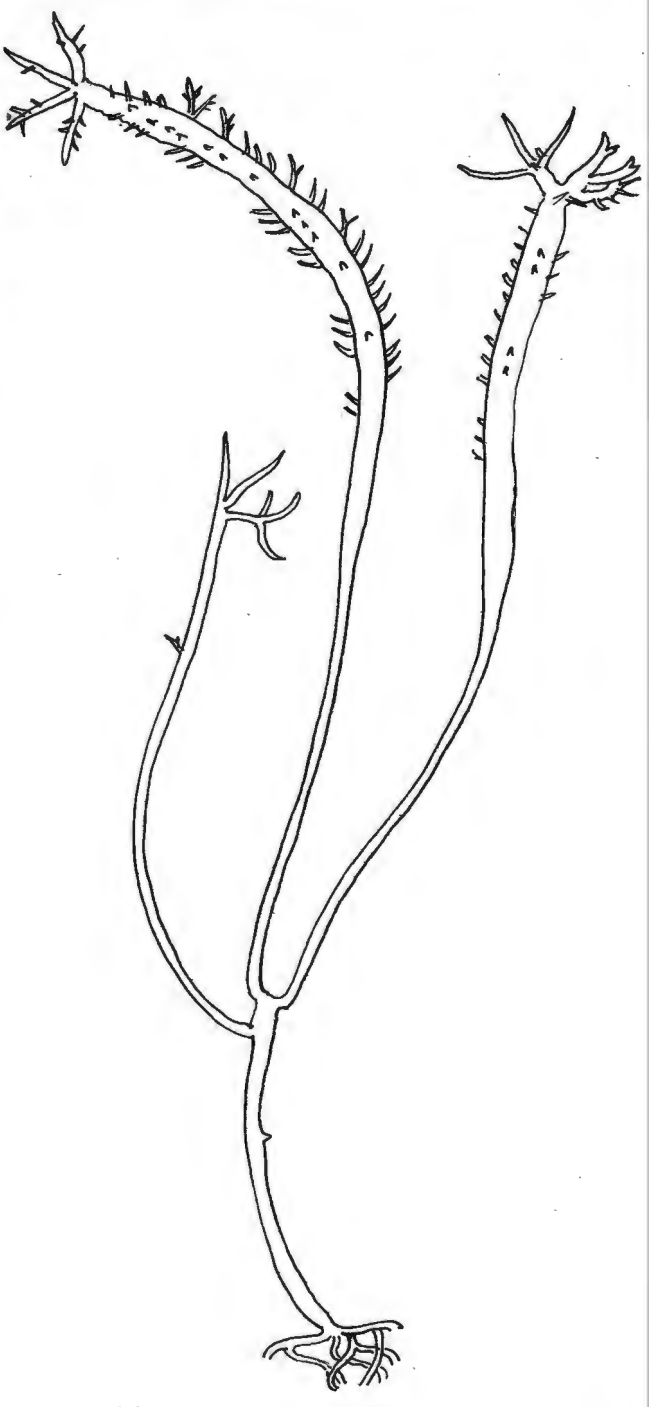
taken at random from the rocks at different levels over the sampling area. Drift was entirely ignored. The collecting of sufficient material by 2 people took generally 1 hour - 1½ hours. The tufts were placed in a pile on the beach (Fig. 76) and were then broken up by hand into much smaller tufts. These were thoroughly mixed up and the heap was then divided into 4 roughly equal parts. One of these was taken at random and this sample was taken back to the laboratory. The tufts were then taken in turn, the living healthy erect fronds detached from the rhizomatous portion and classified as vegetative, tetrasporic, male, cystocarpic or young fertile. Microspopic examination of the fertile branchlets was necessary for all but the vegetative and mature cystocarpic fronds. A total of 2000 fronds was thus classified each time. With the exception of the first sample 3/3/50 records were kept in groups of 100 (i.e. in the order in which the fronds were detached and examined) as shown in the tables in the appendix. It was thus possible to construct the probability zones shown in Graphs D, E, F, G At the beginning of the investigation samples of more than 2000 were counted. Thus the calculations for 3/3/50 are based on a total of 3028 fronds, for 3/4/50 on 2200 fronds and for 3/5/50 on 3000 fronds. From June 1950 - February 1951 all calculations were based on a total of 2000 fronds.

Any single erect axis arising from the rhizomatous portion was regarded as an erect frond. This therefore included short simple unbranched axes as well as axes bearing large numbers of branches.

AMPLING AREA, SALT VLEI, AT L.W. S.T.

SHOWING PART OF HYPNEA ZONE EMERSED

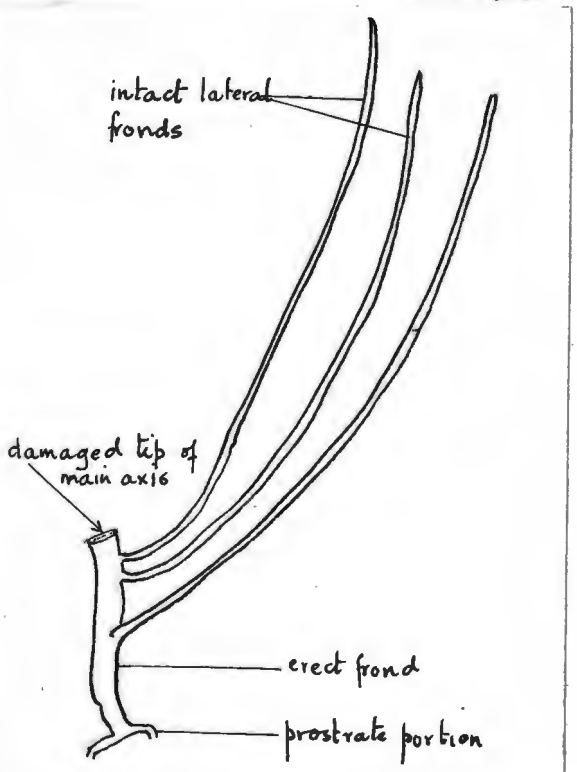
FIG. 78 YOUNG FERTILE FROND



DAMAGED FROND SHOWING NO REGENERATION

G77

DISCARDED



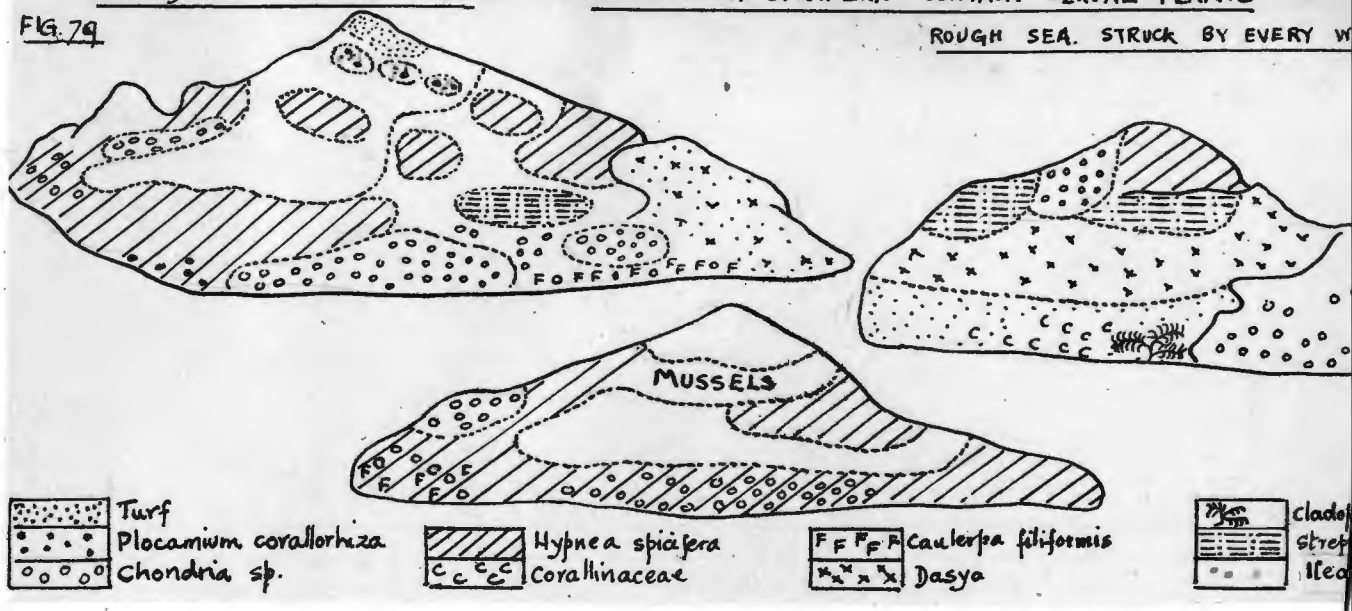
IPLE, BEFORE DIVISION INTO 4 PARTS

ISOLATED ROCKS AT SALT VLEI.

PATCHES OF H. SPICIFERA CONTAIN SEXUAL PLANTS

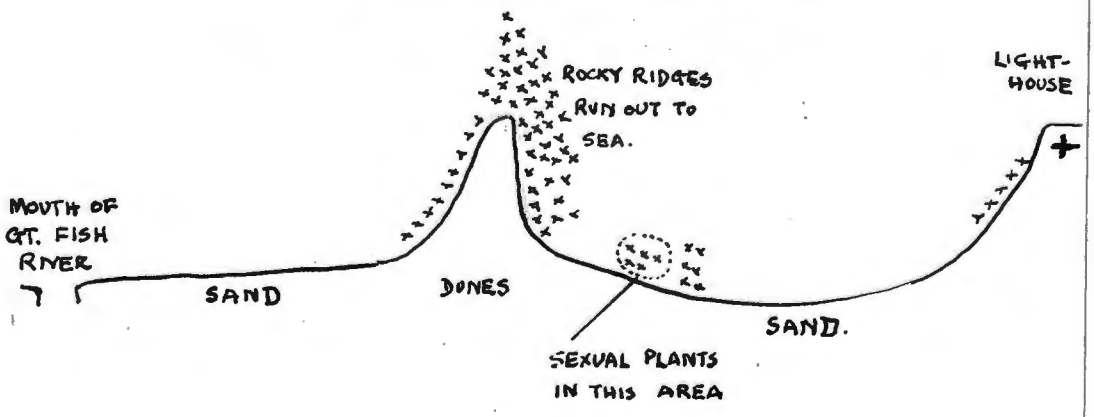
FIG. 79

ROUGH SEA. STRUCK BY EVERY W



? Strebloclad

FIG. 80 ROCKS ON WESTERN SIDE OF FISH RIVER



In classifying the erect fronds the following were neglected and are not shown in the count:

i. Very young erect fronds less than about 1 cm. in length.

ii. Detached fronds which in collecting or in transit had broken off from the rhizomatous portion. These were omitted since there was no way of ascertaining whether they were whole fronds or branches broken off from the attached fronds.

iii. Fronds so badly damaged that the remaining portions could not be identified as either fertile or sterile.

iv. Stumps of fronds showing no regeneration. (Fig. 77)

Stumps 1 cm. long or more regenerating from near the tip were classified as vegetative fronds.

The fronds classified as young fertile (yf) (Fig. 76) were for the most part short fronds about 5 cms. in length (sometimes longer) bearing young fertile branchlets which when examined microscopically showed no signs of either tetraspores or sexual cells, i.e. they were undetermined. Fronds classified as fertile sometimes bore only 2 or 3 isolated fertile branchlets (Figs. 17, 84)

The percentages of vegetative, tetrasporic, male, cystocarpic and young fertile fronds throughout the year are shown in the accompanying table. (Graph A)

During the early part of the year the unidentifiable damaged fronds and stumps were discarded because they constituted a relatively small proportion of the whole and since certain Molluscs are always found feeding on H.spicifera it was assumed

that they were largely responsible for the injured fronds and stumps. Unfortunately the importance of the stumps was not recognised until it was too late to use them for purposes of a month to month comparison. On 28/8/50 the whole of the upper Hypnea zone which had formerly consisted of relatively short erect green fronds resembled a newly mown lawn, the erect fronds being reduced to short unidentifiable stumps a few cms. long. Since these could not be included in any of the categories of the accounts they were ignored. Thus by the exclusion of the uppermost zone the sample ceased to be random. A fortnight later (12/9/50) i.e. half-way between the September and October counts, the whole of the Hypnea zone was strikingly divided into 3 belts in varying degrees of disintegration. See Section on "Dying off and regeneration of fronds". By September 24th a considerable amount of regeneration had already taken place in the upper part of the zone and these regenerating fronds (13% of the total no. of vegetative fronds) are shown in the sample of that day. Although this zone does not form a large part of the whole count a month to month comparison of the components becomes impossible since the regenerating stumps classified in September as vegetative are derived from stumps totally ignored in the August sample (see discussion later).

Therefore although the H.spicifera in the middle and upper parts of the zone presented such a changed appearance in August and September this is not reflected in the graphs. Graph A shows the vegetative fronds at their maximum in September, whereas much of the Hypnea was really dead. This figure

represents the proportion of healthy vegetative to fertile fronds.

On September 24th 1754 out of 2000 fronds were classified as vegetative (see Appendix). Of these 233 had produced new branches from immediately behind the tips, i.e. 13% of the vegetative fronds were regenerating stumps. Regenerating fronds and relatively short young vegetative fronds formed a conspicuous part of the samples during the next few months. Regenerating fronds were still a conspicuous feature of the sample taken on December 22nd, and here although the vegetative were (as in all months) the most numerous in the tufts, they were relatively inconspicuous on account of the more profuse branching and greater length of the fertile fronds.

The method employed was therefore satisfactory for determining the relative occurrence of various constituents for any month, but is unsuitable when a month to month comparison is required, since the size of the group is determined by the number of identifyable fronds i.e. the effective area which has been expanded or contracted until 2000 identifyable fronds have been sampled. The defect of this method is that the size of the group is a function of the prolificness of identifyable fronds. Therefore using this method no real comparison on a month to month basis can be made as to the occurrence of the various components per unit area of the coast. The inclusion of stumps would have helped to reduce the error, but even then a similar effect would have been introduced by the appearance of new shoots. In October and November the change in the relative

proportions of the components may have been due either to dying off of fronds or to the appearance of certain components in greater quantity. Lacking an absolute size of sample inter-comparison of months is not reliable. As representative samples could not be continuously observed it was impossible to ensure that the group of one particular month could be compared with that of another month. Though the error would have been reduced by counting the stumps throughout the year the possibility still remains that some portions may have disappeared altogether leaving no trace. This was in effect the case where deposition of sand in the sampling area completely obliterated large patches of H.spicifera.

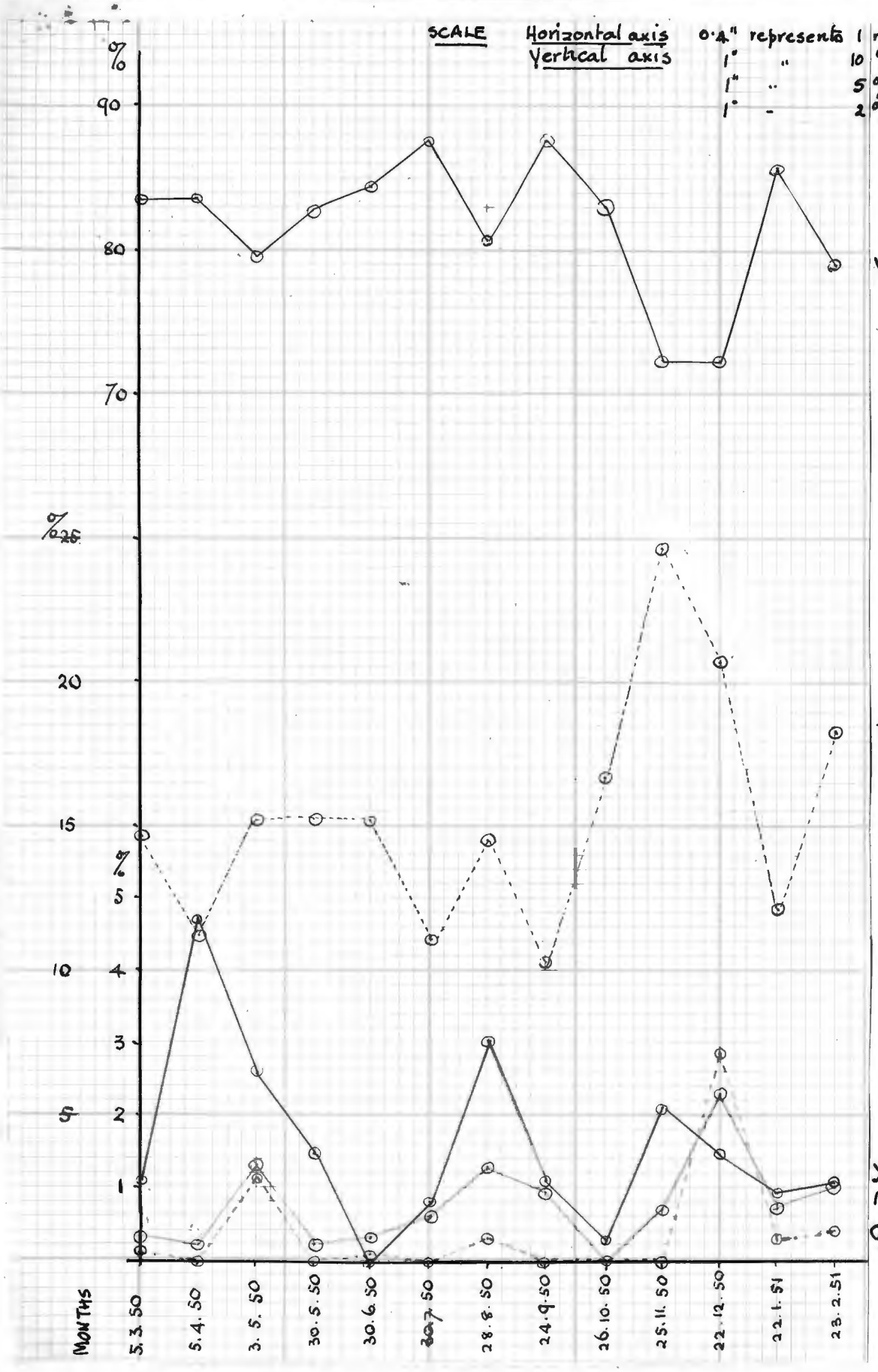
Results and Comments

The %s of the various components are shown in the accompanying tables App. A+B and illustrated graphically in graphs A, B, C. Graphs D, E, F, G represent probability zones for the vegetative, tetrasporic, male and cystocarpic fronds. The construction of these is explained in Appendix C (Probable errors). In the graphs showing probability zones it will be observed that the scatter is not large and in spite of the manner in which the groups were collected it can therefore be assumed that these were representative samples.

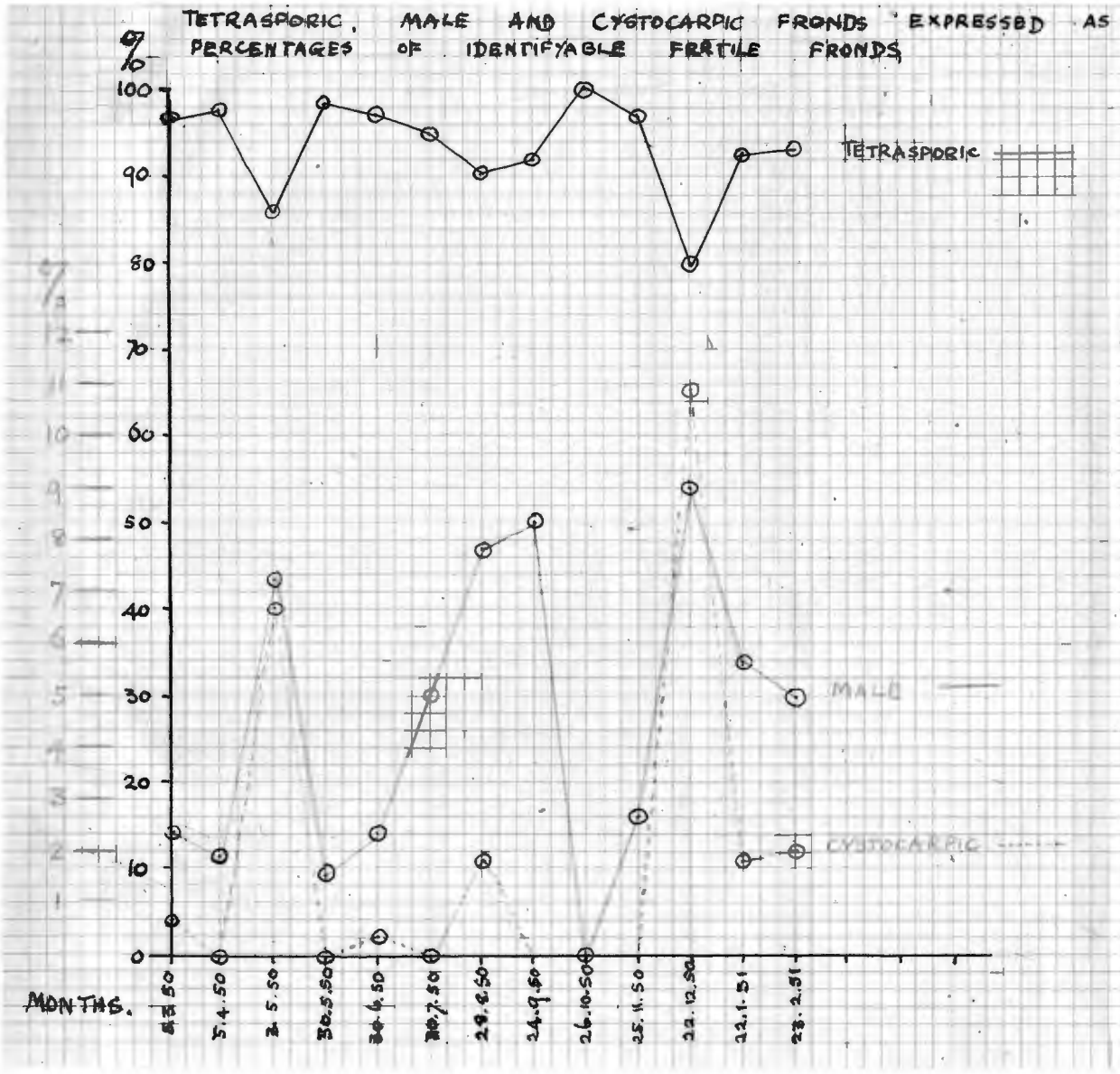
Comments

1. The data show no marked seasonal variations as regards reproduction for that region. The variations seem more likely to be due to the method of collection rather than to the season

PERCENTAGES OF VEGETATIVE, TETRASPORIC, MALE, CYSTOCARPIC AND YOUNG FERTILE FRONDS IN TOTAL NO. OF FRONDS COUNTED.



GRAPH B



SCALE

Vertical axis

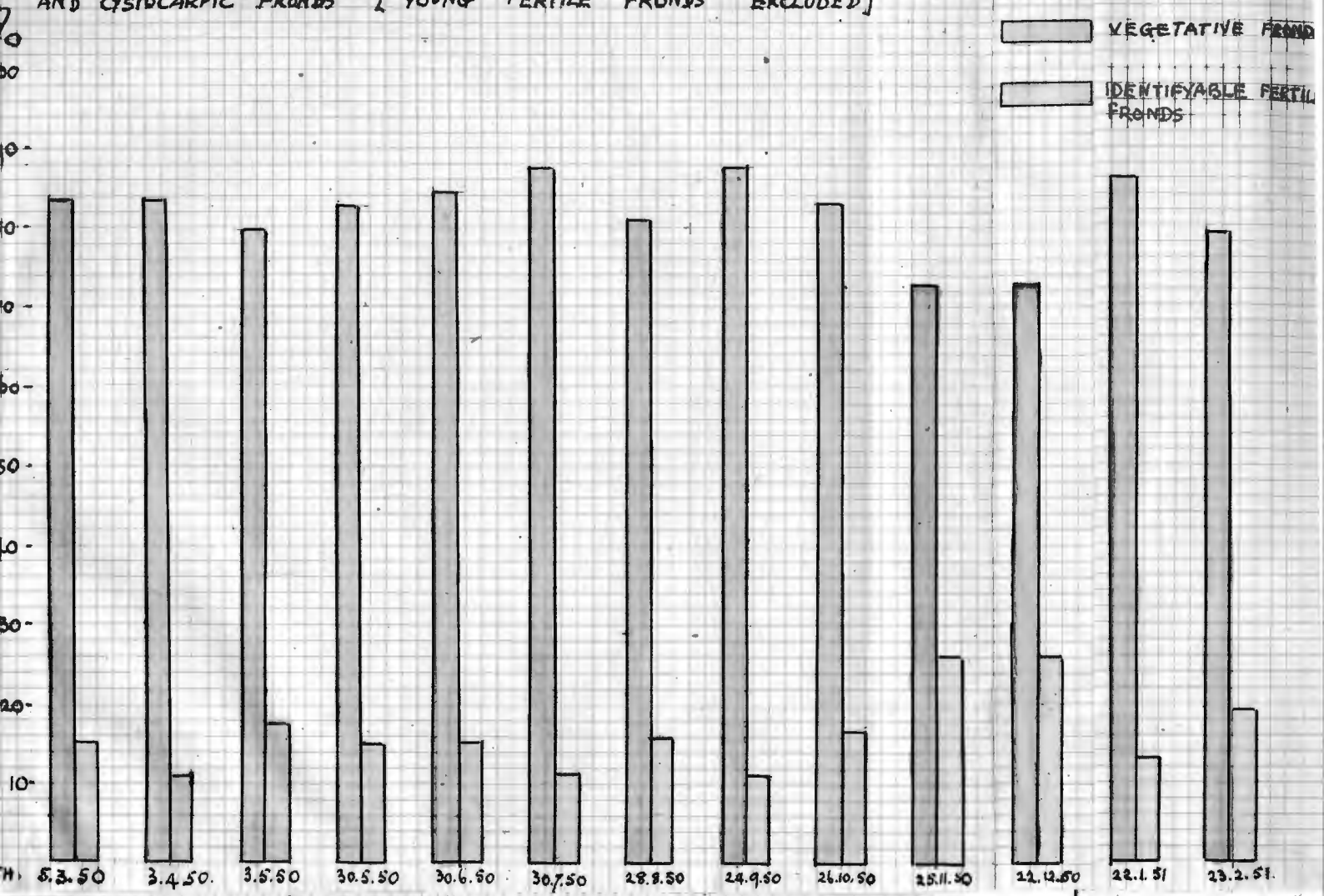
1" represents 20% tetrasporic

0·3" represents 1% Male and cystocarpic

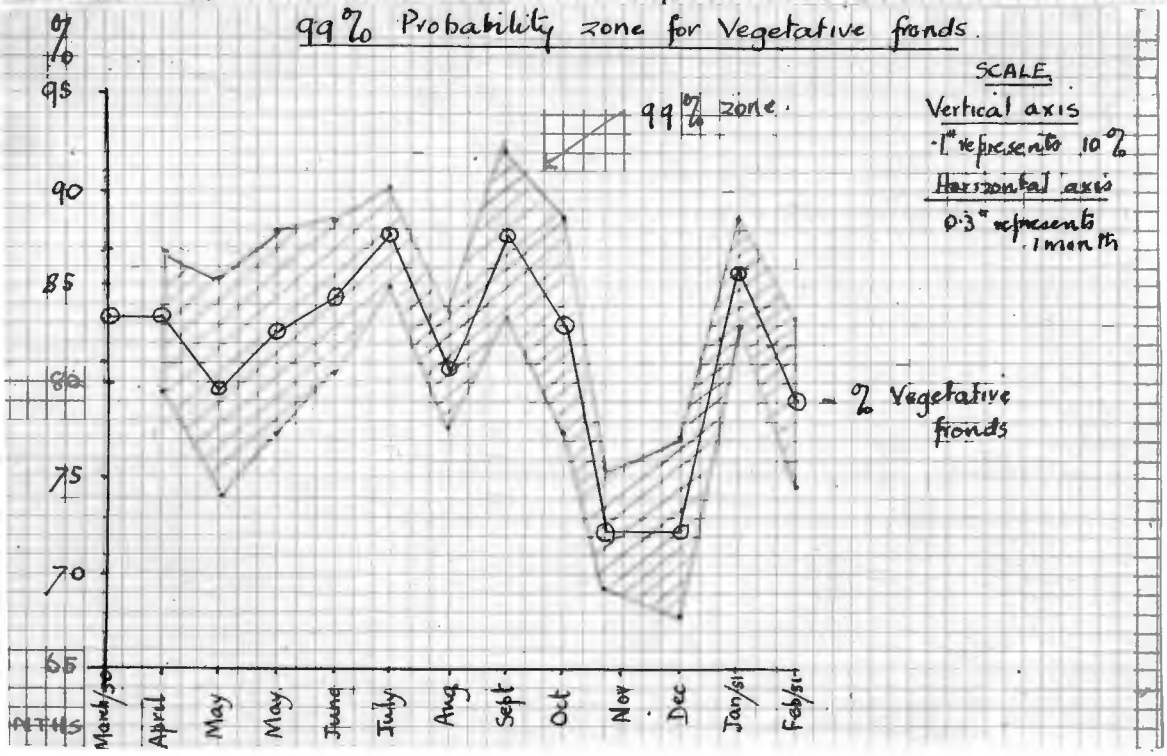
Horizontal axis

0·3" represents 1 month.

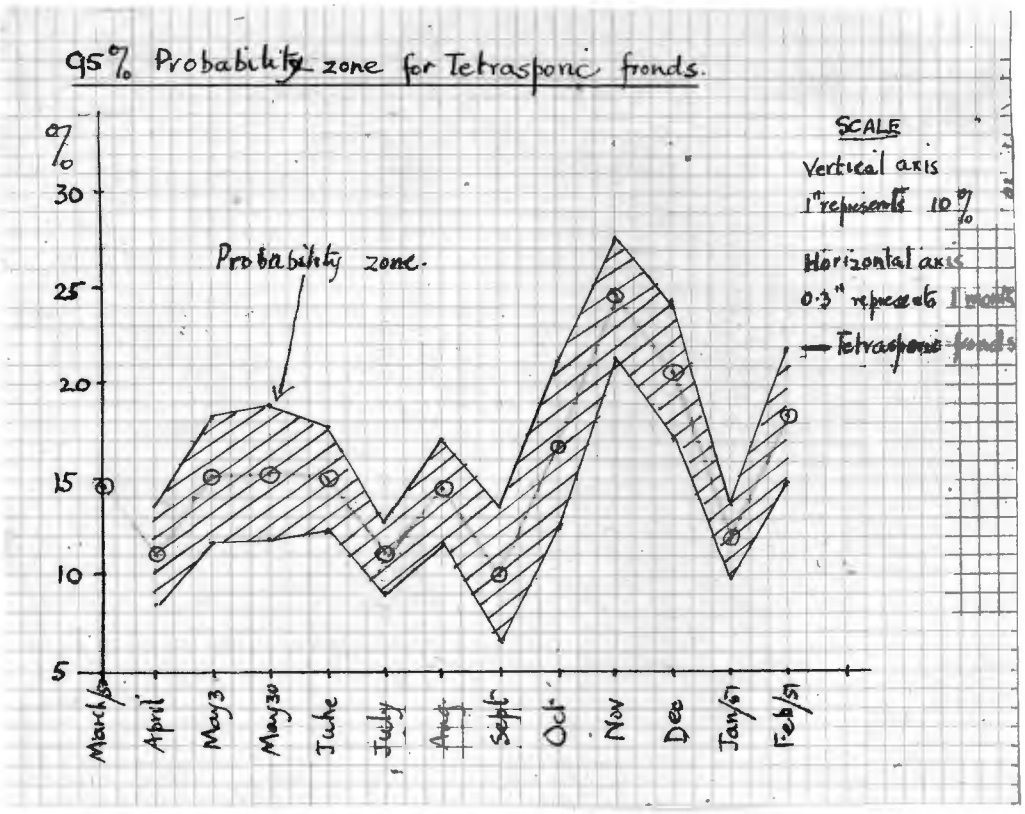
CHART SHOWING VEGETATIVE AND FERTILE FRONDS AS PERCETAGES OF TOTAL NUMBER COUNTED EACH MONTH. FERTILE FRONDS INCLUDE ONLY IDENTIFYABLE TETRASPORIC, MALE AND CYSTOCARPIC FRONDS [YOUNG FERTILE FRONDS EXCLUDED]



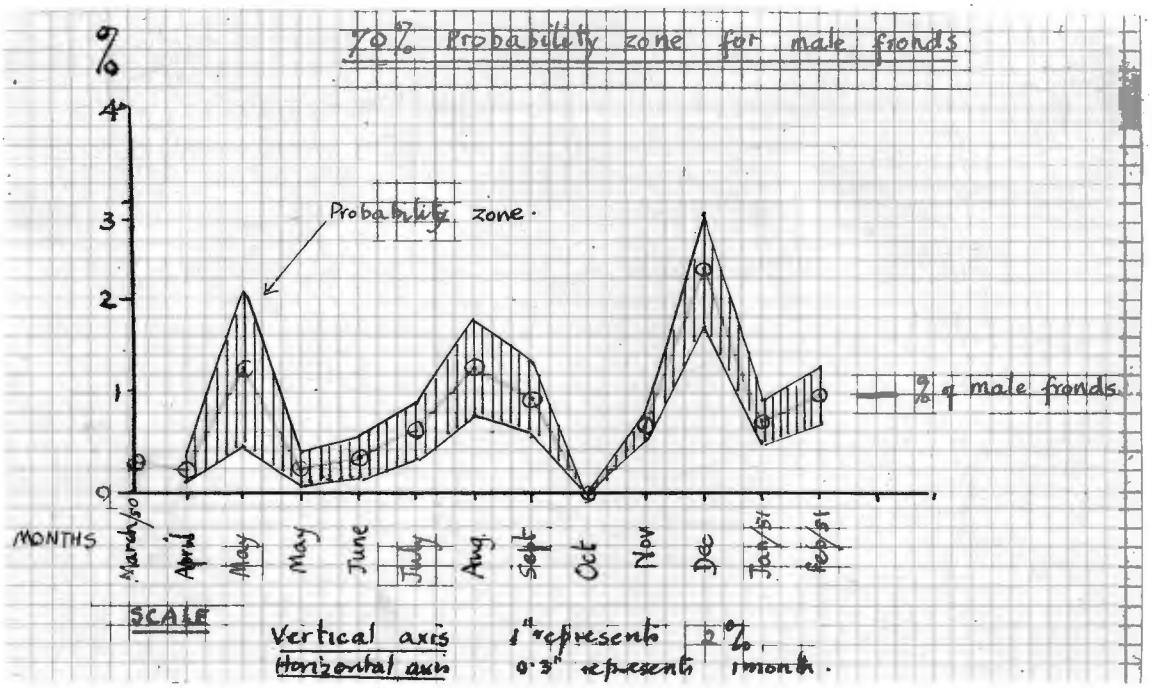
99% Probability zone for Vegetative fronds.



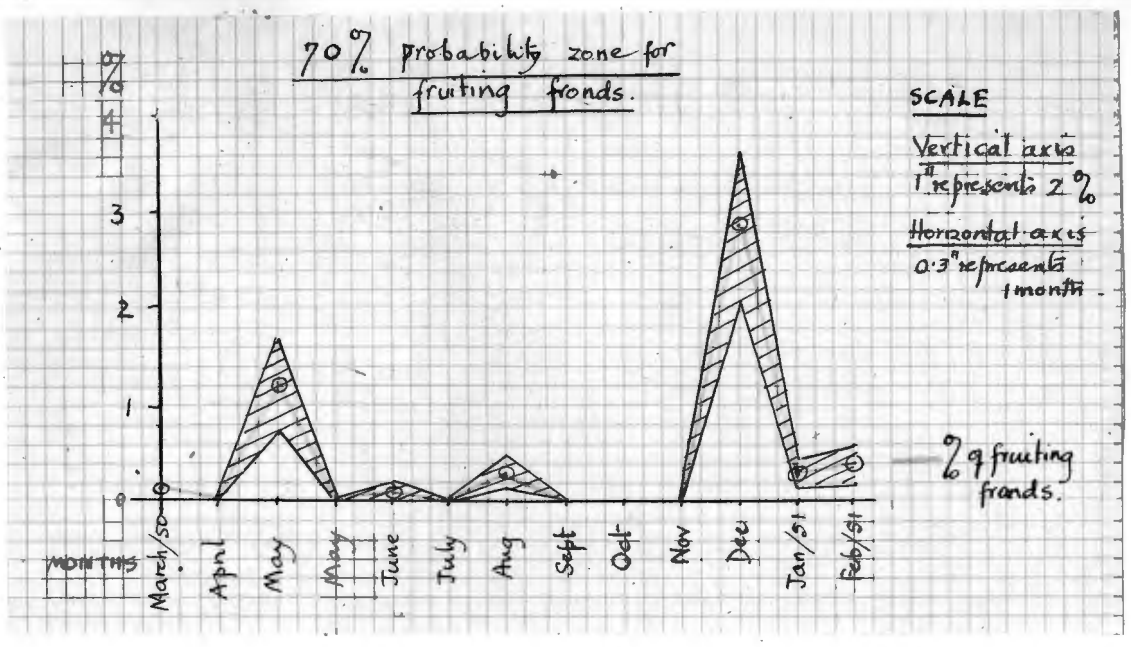
GRAPH E



GRAPH F



GRAPH G


70% probability zone for fruiting fronds.
SCALE
Vertical axis
1" represents 2%
Horizontal axis
0·3" represents 1 month.
% of fruiting fronds.
3
2
1
0
MONTHS
March/Sept
April
May
May
June
July
Aug
Sept
Oct
Nov
Dec
Jan/51
Feb/51

of the year. Since the area studied was small there can be no generalising for the species over the whole range of distribution.

2. At all seasons of the year during which the investigation was carried out both vegetative and fertile fronds occurred, the vegetative constituting from 87.7% (Sept. 24th) to 72.25% (Dec. 22nd) of the sample. The vegetative fronds always out-numbered the fertile. It does not necessarily follow that the majority of plants are vegetative (sterile), merely the majority of fronds. (It seems probable that vegetative reproduction to a large part accounts for the dense growth in communities).

3. Tetrasporic fronds occur throughout the year constituting 24.85% (Nov.) to 10.25% (Sept.) of the sample. Numerically they always greatly exceeded the sexual fronds.

4. At all times male fronds were in excess of cystocarpic fronds. Since the numbers of male fronds present in any one sample was always small the absence of male in October cannot be regarded as significant. For the same reason it is very doubtful whether any importance can be attached to the absence of cystocarpic fronds in certain months.

5. Following the dying off of fronds during September there was a marked increase in December of the proportion of male and cystocarpic fronds to tetrasporic fronds.

Thus, in spite of the fact that no direct comparison in terms of counts is permissible from month to month, in actual fact an indication that the effective area sampled could not have varied very widely may be gathered from the fact that the time spent collecting the desired quantity of material was not

conspicuously different at various seasons of the year except on occasions when rough seas made the work difficult. Therefore no conclusion can be drawn as to month to month variations unless the apparent variations are several times larger than the possible variation in the effective area sampled as discussed above. Thus to be significant, month to month changes by a factor of at least 10N or more will be necessary, and any smaller changes may be attributed to changes in the effective area sampled. This investigation has established relative trends thoroughly during the period of one year. If month to month relations of one particular constitutent were to be established on an absolute basis i.e. per unit area in some future investigation, then factors could be applied to the monthly counts which could bring them all into an absolute relationship.

The cause of the dying off of fronds at Salt Vlei during August and September was unknown. In order to establish whether this is a seasonal occurrence it would be necessary to carry on the investigation over a longer period. It is possible that the dying off of fronds followed emersion of an unusually long period at low water of spring tides and consequent exposure to sun and wind. There were however no signs of dying off and regeneration following the very low spring tides of 5/2/50 and 3/5/50 when banks of H.spicifera normally awash at every wave at low water of spring tides lay dry and limp on the rocks for an hour or more exposed to a hot sun. At intervals during the year the presence of small patches of pinkish or white tipped fronds in the upper zone was not uncommon among the plants growing on the horizontal

platforms (see note on Dying off and Regeneration) .

(A year later in January 1952 the relatively small amount of H.spicifera found growing along the Salt Vlei coast was almost all a sickly yellowish green colour. The fertile fronds examined were found to be young tetrasporic fronds. Much more sand had been deposited and the Porphyra community which during 1950 had been very scantily represented then extended over a much greater intertidal range. It is probable that the very stormy weather of November 1951 and the deposition of sand was in part responsible for the reduction in quantity of H.spicifera. On this occasion all the H.spicifera in the drift was of a similar pale colour with very few fertile branchlets i.e. apparently young plants.)

SAMPLES TAKEN FROM OTHER LOCALITIES

On three occasions during the year samples were taken in the same way from two other localities for comparison with the regular sampling area, as shown in table (c) App. A. These localities were specially selected because sexual plants (ordinarily rare) commonly occurred there.

On June 30th 1950 and September 12th 1950 samples were taken from a small chain of isolated rocks on the eastern side of Salt Vlei bay. These rocks then stood about 4 ft. high out of the sand and lay a short distance to the west of the sampling area (Fig. 79) They were accessible only at the lowest spring tide in between the waves. H.spicifera grew on the tops and sides. On September 12th as in the sampling area the upper

Hypnea zone on top of the rock was worn down to short stumps 1" - 2" long. Much of the lower zone was decomposing, i.e. the fronds were discoloured. In addition there was a heavy deposition of sand round the base and much less rock surface was exposed. On this occasion to avoid the removal of too much material the whole of the sample was used for counting purposes, i.e. it was not divided into 4 as in all other cases. About of the sample taken was disragarded since it was unidentifyable. This sample was therefore highly artificial.

On August 13th 1950 a sample was taken from rocks to the east of Fish River Lighthouse. (Fig. 80) In this locality most of the H.spicifera grew on horizontal beds on the sea floor, some buried in sand, and washed by every wave.

The results were shown in table C (Appendix A) together with the corresponding figures for the usual Salt Vlei sampling area. It will be seen that

i) in all cases the proportion of vegetative to fertile fronds remain high.

ii) the differences relate mainly to the proportions of tetrasporic to sexual fronds.

On September 12th at the chain of rocks in Salt Vlei Bay the drop in the % of cystocarpic fronds was to be expected, since the cystocarpic plants were known to have formed an important part of the uppermost zone - then reduced to stumps.

Dying Down and Regeneration of Erect Fronds

During most of the time that H.spicifera was under observation in on one or other locality at every spring tide from January 1950 to the end of September 1950 there were signs of its dying off locally in patches (see record below). This was not observed in any locality on a large scale until September 1950.

As the erect fronds, both vegetative and fertile, die they turn purplish or mauve, then fade to pink, and turn white or (Fig. 81) yellowish before becoming soft and pulpy. They then rot away leaving at the base short healthy stumps a few cms. long and unchanged in colour. In the case of fertile fronds the mauve discolouration usually begins with the stichidia, from there spreading over the rest of the frond. Usually the tip turns pink (or mauve) first (Fig. 82) giving the affected part of the sward a very characteristic appearance. Sometimes the tips remain green while the middle region is pink or whitish.

The prostrate portion appears to remain intact. After the dead portions of the fronds have disintegrated the presence of large numbers of worn down stumps all more or less the same length gives the sward the appearance of having been closely cropped, or mown. The disappearance of the dead parts of the fronds is soon followed by the development of new erect fronds and by the regeneration of the stumps, new branches arising from immediately below the injured tissue (as shown in fig.43 - Pl1). The young shoots on the regenerating branches may have translucent pinkish blue tips, the blueish colour being especially noticeable if the tips are held up to the light. These blueish parts are

FIG.82 PINK TIPPED FRONDS X1½ NAT. SIZE

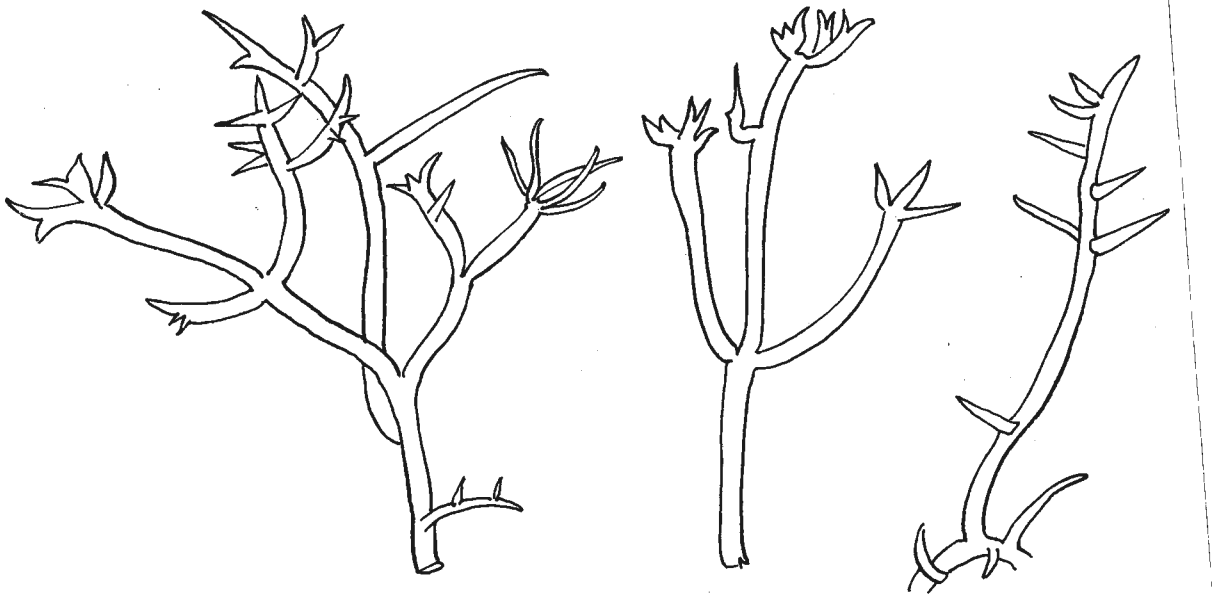


Fig. 83 Position of Stumps in Hypnea zone.

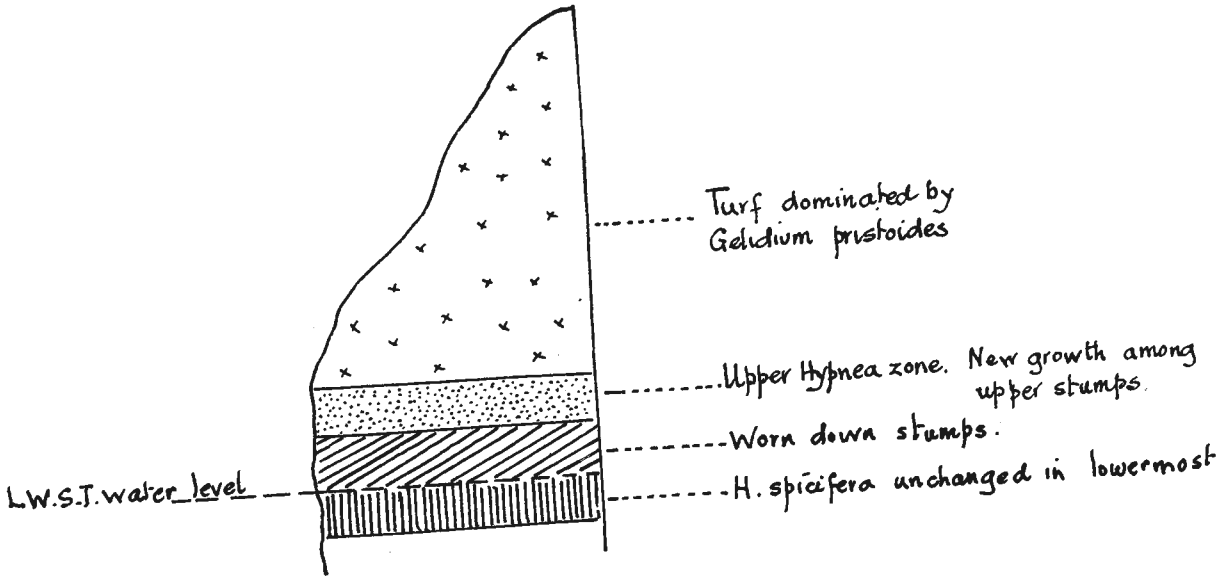


FIG. 81 DYING FROND

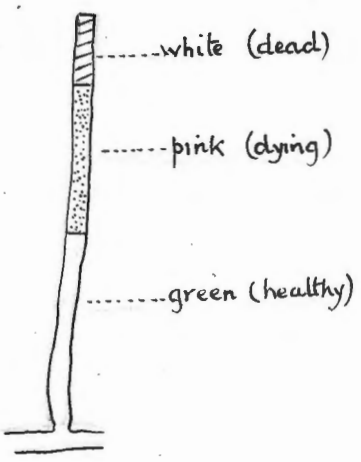
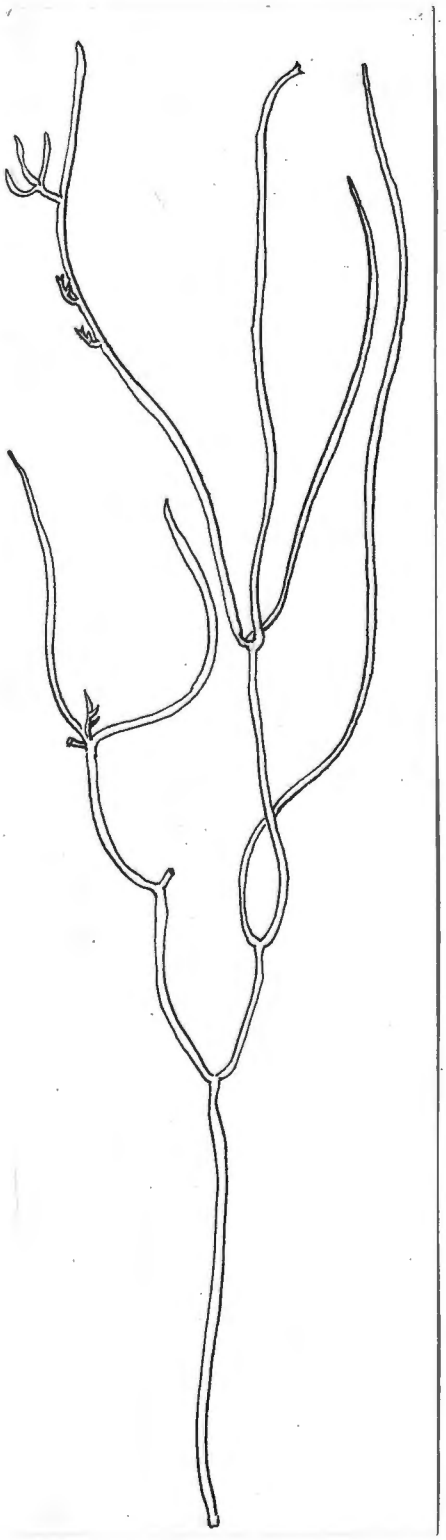


Fig. 84

Tetrasporic frond with few stichidia, from attenuated plant.



softer to the touch than the rest of the frond.

At Salt Vlei, September 12th 1950, the dying off of erect fronds was so extensive as to alter the whole appearance of the Hypnea zone. Three more or less clearly defined regions could be distinguished in the zone, viz:

i. The uppermost region (ordinarily consisting of plants with short erect fronds remaining upright when emersed).

The whole of this region consisted of worn down stumps of erect fronds, presenting the appearance of having been closely cropped. Many of these stumps measured approximately 2" in length, some with about 1 cm. of decaying whitish tissue remaining at the top. In others the whitish tissue had rotted away leaving the bare green stumps. There were at this stage no signs of regeneration.

ii. The middle region (ordinarily consisting of plants with dark olive green fronds up to a foot or more in length.)

In this region some of the longer fronds remained intact. This part of the zone contained an admixture of short green stumps, short stumps with dead whitish or yellowish tips, long purple fronds, long mauve or pink fronds together with some healthy long green fronds. Single tufts contained fronds in all these stages of decomposition. Thus this whole region instead of being dark green presented a brindled appearance, predominantly mauve.

iii. The lowermost region.

Where H.spicifera was submerged on this occasion at

low water of spring tides it remained for the most part unaltered, viz. a dark greenish colour. In places, however, there was an admixture of mauve fronds. At lower levels out to sea on inaccessible rocks where H.spicifera is succeeded by kelp and lashed by every wave it appeared to be intact i.e. blackish in colour.

Besides H.spicifera certain other species also showed signs of fairly extensive dying off of parts of the erect fronds. At the same level as H.spicifera the terminal segments of many of the fronds of Halimeda cuneata were bleached white likewise at the same level at which the purplish fronds of H.spicifera were so abundant the tips of Caulerpa filiformis were white and decomposing. The upright fronds of Gelidium amansii were whitish and sickly looking, and patches of Caulerpa racemosa var. zeyheri were yellowish and apparently dying.

Five days later (17/9/50) at Ship Rock, Kasouga, the erect fronds of H.spicifera were found to be dying off on a large scale (as at Salt Vlei) from Ship Rock along the stretch of rocks towards Kariega River Mouth. The effect was lass obvious than at Salt Vlei since this was not a spring tide. Roughly the same three regions were visible as at Salt Vlei - the whole sward presenting a similar brindled appearance. Much of the longer H.spicifera was still intact, and fronds a foot or more in length remained green and healthy looking. Inaccessible rocks, out at sea, were covered with long black H.spicifera showing no signs of discolouration. At Ship Rock as at Salt

Vlei other species showed signs of dying off. Extending above and below the Hypnea zone, great numbers of the green fronds of Caulerpa filiformis ended in 1" - 2" of whitish tissue, with damaged tips. Since in this locality Caulerpa filiformis grows in fairly extensive sheets the whitish dying fronds were a conspicuous feature. In the open sea Gelidium amansii growing at the same level as H.spicifera was turning white. That in pools showed no discolouration. Some Hypnea musciformis appeared to be dying. At H.spicifera level some Gracilaria denticulata was a sickly green or pinkish colour. These fronds were crisp and gave the impression of being new growth.

By 24/9/50 at Salt Vlei the areas of the Hypnea zone still roughly corresponded to those of 12 days previously, though marked changes had taken place. In the upper part of the sward very little of the close cropped Hypnea was in evidence, owing to much new growth and the regeneration of the worn down stumps. Some of these regenerated fronds were now 6 cms. - 7 cms. long (the majority less than 6 cms.). This part of the Hypnea zone appeared fresh and healthy. (Fig. 83)

In the main the old dead fronds had almost entirely disappeared from the whole of the Hypnea zone. There was a total absence of the long purplish fronds and very few of the mauve. In the middle region the short clean stumps were visible, though in places decomposing and pink tissue still adhered to the bases of the fronds. The lowermost submerged region remained unaltered.

Where H.spicifera was fresh and green Chondria sp.was in

the main also fresh and green, though in places the dead fronds of Chondria remained. Very little Caulerpa filiformis was in evidence on 24/9/50, specimens seen had erect fronds approximately 6" long. As this beach changes considerably owing to the deposition of sand the existing C.filiformis may have been buried.

Signs of dying off of erect fronds of H.spicifera were noted as follows:-

1. 6/1/50 Kasouga. Ship Rock Platform.

Some of the short stiff H.spicifera on the horizontal platform with bright mauve tips. Plants hanging from ledges and those at lower levels show no discolouration.

2. 21/1/50 Rocks between Fish River Mouth and Fish River Lighthouse.

Patches of H.spicifera in upper levels worn down to stumps.

3. 5/2/50 Salt Vlei.

A small amount of H.spicifera in the upper part of the zone in situations exposed to air for some time at low water of spring tides with pink tips and pink branchlets.

Some of the long H.spicifera lying dry and limp upon the rocks - very low spring tide.

4. 17/2/50 Three Sisters (Kleinemonde).

Patches of worn down stumps in pools.

5. 18/2/50 Kowie Point.

Quantities of pink tipped H.spicifera in mixed Hypnea zone (i.e. in upper portion of zone).

6. 20/2/50 Rocky Platform between 2nd and 3rd Kwaai Hoek.

Some white tipped on horizontal platform (i.e. in upper

part of zone). Most of the white tipped fronds in situations exposed to air for some time at low water of spring tides. Not all exposed parts of the zone show discolouration.

7. 30/4/50 Kenton.

Some of H.spicifera in gullies with Ecklonia exasperata (subject to swell) with white tips, giving a flecked appearance to the Hypnea zone.

8. 3/5/50 Salt Vlei.

Very low tide. H.spicifera obtainable in places normally inaccessible. Both long and short H.spicifera lying dry and shrivelled on the rocks at low water of spring tides.

9. 5/6/50 Salt Vlei.

Regenerating plants with light green tips.

10. 7/7/50 Kasouga. Ship Rock.

Upper part of the zone dying off in patches. Tips white and pink.

11. 23/7/50 1st Kwaai Hoek.

Some white tipped fronds in upper part of zone on horizontal platform.

12. 10/9/50 Kenton.

Some H.spicifera in gullies worn down to short green stumps.

13. 12/9/50 Salt Vlei.

Large scale discolouration of fronds as described above.

14. 17/9/50 Ship Rock. Kasouga.

Large numbers of fronds discoloured as described above.

15. 24/9/50 Salt Vlei.

Very little discolouration. Regeneration taking place

in upper part of zone as described.

Since the part of the Hypnea zone which was submerged at low water of spring tides remained to a large extent intact, and since at all times during the period when Hypnea was under observation it was the uppermost part of the zone which showed discolouration it seems probable that the dying off was due to local conditions. This explanation is supported by the simultaneous discolouration of other species in September at Salt Vlei and Kasouga. It is also significant that on 10/9/50 at Kenton (two days before the banks of Hypnea at Salt Vlei presented a brindled appearance) no large scale changes were observed in the Hypnea zone.

Since the dying off and regeneration of new fronds at Salt Vlei took place in less than a month it is possible that this may have occurred on a large scale at other times between the random counts e.g. between 3/5/50 when a large part of the belt lay dry and semi shrivelled, and 5/6/50 when some regeneration was noted. Similarly from the records this may have occurred earlier in the year as well. However, it seems improbable that large scale dying off could have occurred anywhere except locally, since Hypnea spicifera was regularly under observation at one or other of the localities along the Bathurst and Alexandria coasts at low spring tide.

COLOUR AND LENGTH OF FRONDS.

Colour

The colour of H.spicifera was described by De Toni as "saepe corallino - ruber, nunc purpureus, aut in amethystium tendens". Variations in colour and length of the mature erect fronds are related to intertidal position and to the heaviness of the sea. Plants growing in the upper part of the zone which is usually wholly emersed for an hour or more at low water of spring tides, or subjected to spray, are usually bright green in colour. The erect fronds of these plants are short and stand upright when emersed. The bases of the mature fronds are a dark bottle green, the middle regions of the fronds lighter in colour ending in translucent green tips. On the horizontal platforms these green plants constitute a conspicuous part of the zone. Those plants on the tops of rocks are usually a lighter green than those below.

In rough water plants from the middle part of the zone have olive green fronds, darker (often brownish) towards the base and lacking the translucent tips. Towards the tip the brownish green changes to a medium green lacking the brownish tinge. Plants from the lower levels in rough water have dark brownish green, or brownish black fronds more or less uniformly dark throughout the whole length of the frond. At low levels in the roughest places erect fronds are almost black, attenuated and wiry, sparsely branched with scattered fertile branchlets. The bases of fronds are sometimes stone coloured.

Plants in moderately calm water e.g. in the calmer inlets between rocky ridges and in pools, are olive green in colour,

sometimes a sickly looking yellowish green. Plants from quiet water e.g. inlets at Salt Vlei may have the lower parts of the fronds reddish brown (or a rich dark red under water) with the upper parts dark green. Submerged plants in quiet places e.g. Shark's Bay, may have dull coloured brownish green fronds with reddish tips. These fronds are not as flexible as those of plants at lower levels.

Very young erect fronds (approximately 1 cm. long) are usually fawn coloured below and pinkish towards the tips. The young branches which sprout from regenerating fronds are often a yellowish green colour. At lowest levels the young fronds are often a translucent stone colour.

The youngest parts of the prostrate system are very pale in colour, usually a pale translucent pink. The older portions from which mature fronds arise are similar in colour to the bases of the fronds which spring from them.

Occasionally plants were found with yellowish green fronds, bearing yellowish green fertile branchlets.

The green colour of the fronds is situated in the two peripheral layers of small cells, and is most dense in the outer layer. The green colour and fresh appearance of fronds was retained on two occasions for five days by plants kept in a closed tin. Plants collected from Fish River in January 1950 retained their green colour for three days, though exposed to air.

Colour of Fertile Regions

In general young fertile branchlets are more or less similar in colour to the rest of the frond.

Tetrasporic Fronds.

The stichidia of fronds containing ripe tetraspores are often dark owing to the presence of pigmented tetraspores within e.g. a greenish frond may bear purplish, dark green, dark purple or blackish fertile branchlets. Immature tetraspores are generally green. When ripe they become in most cases reddish, or reddish brown in colour, but may be various shades of olive green or brown (i.e. may lack the reddish tinge).

Cystocarpic Fronds.

Ripe cystocarps are visible to the naked eye as minute red globules among the fertile branchlets. They generally have colourless or faintly greenish glassy walls through which the mass of carpospores is visible. Young cystocarps are a translucent greenish colour, with yellowish spores within. When ripe the spores turn red. At Fish River some plants with brownish fronds had conspicuous mustard yellow, golden, or brownish cystocarps.

Male Fronds.

To the naked eye the fertile regions of the male fronds are very similar in colour to the sterile parts. Under a lens the fertile areas appear pale and glassy.

Length of Fronds.

In general the shortest plants grow in the uppermost part of the zone. Lengths of fronds were measured to compare the differences in length in relation to position in the intertidal belt and to compare sizes of male, female and tetrasporic fronds.

Altogether 532 tetrasporic tufts were measured. The longest erect fronds were taken as follows:-

60 cms. Rocky Ridges at Salt Vlei 3/4/50. Very dark spindly fronds with scattered stichidia.

55.5 cms. Rocky Ridges Salt Vlei 5/2/50. Very thin spindly fronds, medium green in colour, with few olive green stichidia.

55 cms. Sea floor on eastern side of Shelly Bay 5/5/50. 55 cms. a common length for plants in lower parts of gullies.

53 cms. Sea floor. Diaz Cross.

These long fronds all came from plants growing at low levels and exposed to heavy seas, or to heavy swell.

Altogether 34 male tufts were measured. The longest of these (36 cms.) came from near Fish River Mouth. Altogether 40 cystocarpic tufts were measured, of which the longest (34 cms) came from Salt Vlei.

At Fish River Mouth where an admixture of sexual and tetrasporic plants was found in the same intertidal position the lengths were as follows:-

No. and type of Tuft	Range in length of longest fertile frond	Average length of longest fertile frond	Range in length of shortest fertile frond	Average length of shortest fertile frond
16 male tufts	8 cms -36cms	24 cms	7 cms - 21.5cms	17 cms
12 female tufts	9 cms-31.5cms	20 cms	6.5cms-25 cms	15 cms
9 tetrasporis tufts	18 cms-37 cms	25 cms	9 cms - 21 cms	15 cms

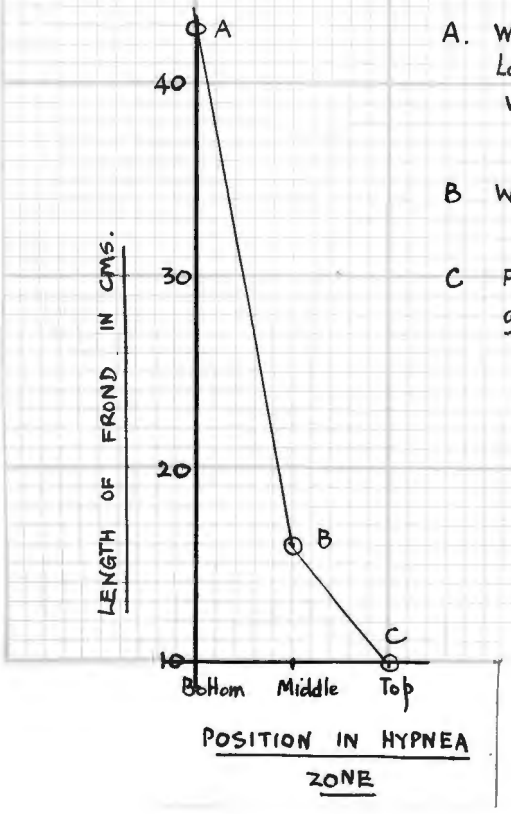
Although these are very small numbers on which to base generalisations it would appear that there is little difference between the average lengths of the tetrasporic and sexual plants growing in the same intertidal position. The general impression gained throughout the whole investigation was that the sexual plants were on the whole smaller than the tetrasporic. This impression was probably largely due to the fact that when sexual plants (always rare) were required for investigation they were taken from known localities in the middle or upper part of the intertidal zone: in such places the long spindly plants were altogether absent.

The shortest plants were always found growing at the upper levels. In the upper part of the Hypnea sward on the horizontal platform at Kenton, where the erect fronds are short, green and stiff, the longest fronds (all tetrasporic) in eight tufts collected at random on 5/3/50 ranged from 15 cms - 22 cms from base to tip. Most of the longer fronds were covered with short, densely crowded stichidia. On the same platform, but lower in the intertidal zone, where the fronds were still green, but darker in colour and thinner, the longest fronds were 27 cms - 34 cms from base to tip.

It was usually difficult to obtain plants from the lowest levels owing to heavy surf, but at low water of spring tides they could sometimes be gathered from the sea floor of bays and inlets in the vicinity of rocky platforms. These plants were usually very thin and wiry, very dark in colour, sparsely branched and with few stichidia. (FIG. 84) In such situations, except at low water of

GRAPH H

KENTON: VERTICAL ROCKS FACING SEA 1.5.50.



A. With C. filiformis Long. attenuated, very dark

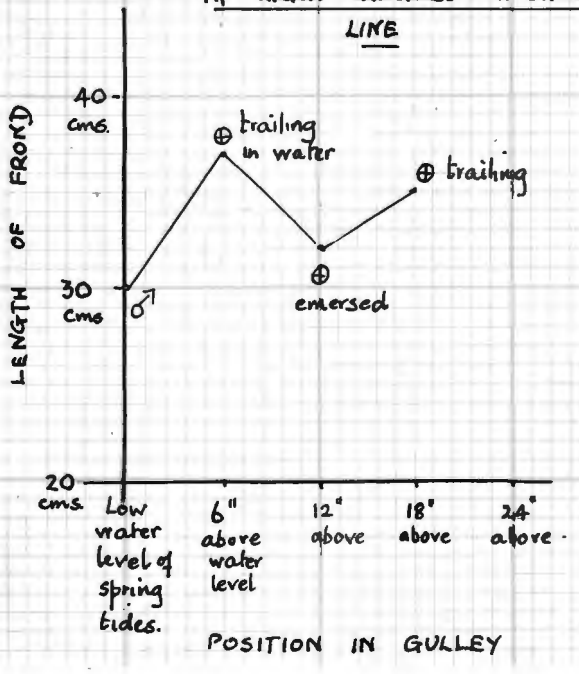
B With G. cartilagineum

C Fronds thicker, with green tips

GRAPH J.

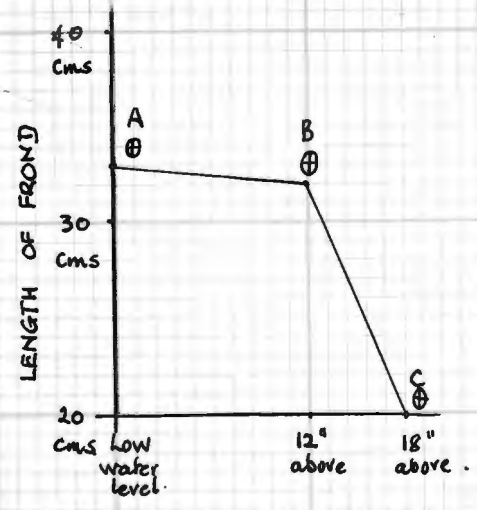
KENTON. 5.3.50.

SIDE OF SHELTERED GULLEY (a AT RIGHT ANGLES TO SHORE LINE



GRAPH K

KENTON 5. 3. 50. GULLEY



A. Fronds very thin dark, wiry. Few stichidia.

B. Fronds thin + wiry. Brownish Few stichidia

C. Fronds fairly thick. Dark green at base, light green above

spring tides H.spicifera is subjected to very heavy seas. Of sixteen tufts (all tetrasporic) collected at random (together with Gelidium cartilagineum) from the rocks covering the sea floor of Shelly Bay (a relatively sheltered bay) the longest fronds ranged from 32 cms - 55 cms in length, averaging 43 cms. Plants taken from the sea floor where there was heavy swell measured 26 cms - 40 cms in length. Most of the long fronds had scattered sparse stichidia in which there were few, isolated tetraspores.

Plants on the sea floor are not necessarily longer than those on the vertical ledges above them. This is sometimes the case also in gullies where plants which trail in the water at low water of spring tides may be longer than those which are submerged. At Kenton 5/3/50 and 17/6/50 measurements were taken of plants growing in gullies and on vertical sides of platforms. Tufts were taken in a vertical line from different levels of the Hypnea zone as shown in figs H,J,K and the measurements of the longest erect fronds were recorded. These are shown in graphs H, J, K.

From these it can be seen that whereas the shortest fronds are always in the uppermost part of the zone, the longest are usually, but not always, at the lowest level.

Note on the Composition of a Tuft.

A large tuft may be composed of 400 or more erect fronds, of which the vegetative fronds are by far the most numerous, but the less conspicuous, since the reproductive fronds are longer, and more profusely branched, bearing fertile branchlets.

The composition of 2 large tufts (Salt Vlei 5/7/51) was as follows:-

Tuft A — 4½" diameter across base — Total 442 fronds.

No. of fronds	Length	Description
25	8½" - 16"	All fertile
30	6" - 8½"	10 fertile - remainder vegetative
54	4" - 5½"	5 fertile - remainder vegetative
187	1½" - 4"	3 fertile - remainder vegatative Many unbranched.
103	" - 1½"	All vegetative. Almost all unbranched. ~~Broken fronds.~~
43		Broken fronds.

442 Total

i.e. roughly 90% vegetative

Tuft B — 4" x 3" across base — Total 463 fronds

No. of fronds	Length	Description
55	8½" - 14"	All fertile
61	6" - 8½"	29 fertile - remainder vegetative
65	4" - 6"	6 fertile - remainder vegetative
156	1½" - 4"	All vegetative. Mainly unbranched
108	" - 1½"	All vegetative. All unbranched.
18		Broken fronds.

463 Total

i.e. roughly 80% vegetative

Owing to the very intricate nature of the rhizomatous portion it is very difficult to determine the number of separate plants constituting a single tuft. That a tuft may consist of at least 2 plants is shown by the fact that tufts often contain mixtures of sexual and tetrasporic plants.

FIG. 85.

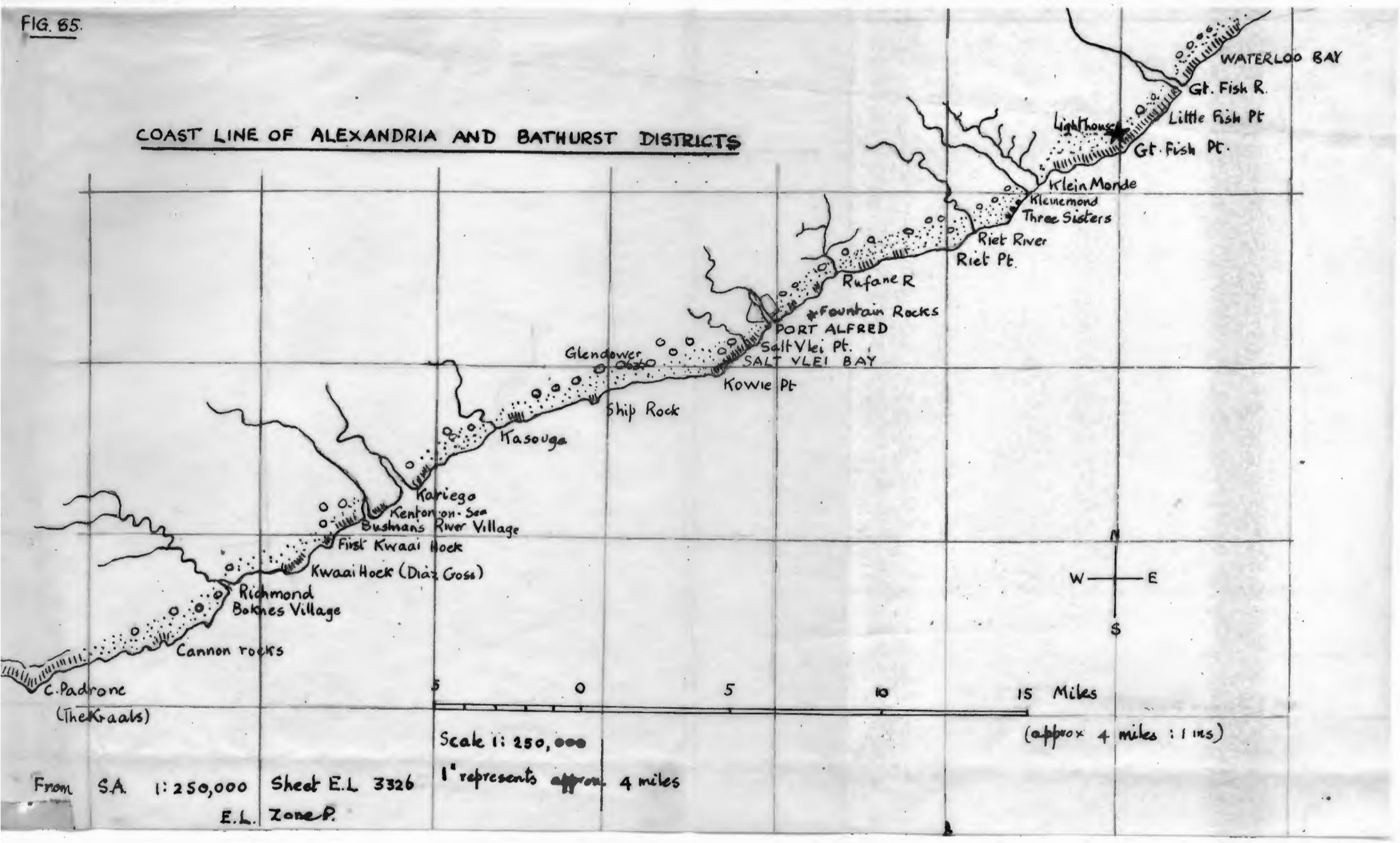

COAST LINE OF ALEXANDRIA AND BATHURST DISTRICTS
WATERLOO BAY
Gt. Fish R.
Little Fish Pt
Lighthouse
Gt. Fish Pt.
Klein Monde
Kleinemond
Three Sisters
Riet River
Riet Pt.
Rufane R
Fountain Rocks
PORT ALFRED
Salt Vlei Pt.
SALT VLEI BAY
Glendower
Kowie Pt
Ship Rock
Kasouga
Kariega
Kenton-on-Sea
Bushmans River Village
First Kwaai Hock
Kwaai Hock (Diaz Goss)
Richmond
Bokmes Village
Cannon rocks
C. Padrone
(The Kraals)
N
W
E
S
5 0 5 10 15 Miles
(approx 4 miles : 1 ins)
Scale 1: 250,000
1" represents approx. 4 miles
From S.A. 1:250,000 Sheet E.L. 3326
E.L. Zone P.

FIG. 86 PART OF ROCK PLATFORM AT SHIP ROCK, KASOUGA.

GENERAL ECOLOGY OF H.SPICIFERA

H.spicifera tends to grow in dense communities in the lower part of the intertidal zone. It is usually attached to rock, or to some other firm substratum, e.g. to worm tubes (Gunnaraea capensis), in the upper part of the zone is often fixed to mussel shells. The greater part of the Hypnea zone is emersed for some time at low water of spring tides. Except at unusually low tides it is washed by waves, or in the upper part of the zone is splashed or covered with spray, sufficiently frequently to remain wet and glistening throughout the whole of the period of emersion. In the lowest part of the zone it is constantly subjected even at low water of spring tide to very severe wave action.

Along the Bathurst, Alexandria coasts H.spicifera is found in abundance, dominating a zone on rocky ridges, and on dune rock platforms where it is attached to vertical walls forming the sides of the platform, to roofs of overhanging ledges, and to the walls of gullies. It grows also at corresponding levels on isolated rocks beyond the intertidal zone where it is constantly pounded by very heavy breakers. Only rarely does it appear to extend into the sublittoral zone. It is not uncommonly a constituent of rock pools, where it is always submerged, usually fringing the pool just below the water level.

Along the open shore deposition of sand may cause the fronds to be buried to a depth of some inches.

H.spicifera will now be considered in its relation to other species on rocky platforms, in gullies, on rocky ridges, in quiet

water and in pools as it occurs in places along the Alexandria and Bathurst coasts (Fig 65) One or more of these localities was visited every spring tide during the period January 1950 to the end of September 1950.

ROCKY PLATFORMS.

Relatively small dune-rock platforms are found at Riet River (Three Sisters), Kasouga (Ship Rock), Kareiga River Mouth, Kenton, and at First, Second and Third Kwaai Hoek (Diaz Cross) on the western side of the Bushman's River Mouth (Fig 66) The surfaces of the platforms, which are broken up by gullies, are much pitted and contain shallow depressions and some pools. The platforms end abruptly, dropping vertically into the sea. At many places the greater part of the platform is exposed to the air at low water of spring tide, but the lower levels are awash, or covered by spray at every wave, and are in many cases subjected to splash as the vertical seaward side of the platform is struck by the waves.

In general the sequence on the platforms is as follows:-

i. An upper relatively bare zone sparsely covered with a fine dingy brown turf. This is often rich in Bostrychia e.g.First Kwaai Hoek, Ship Rock. This zone is devoid of larger species with the exception of occasional isolated Ulva sp.

ii. This is followed by a zone in which the turf (brown in colour) is much thicker and more compact, forming a close carpet. In general this part of the platform is also devoid of larger forms with the exception of isolated individuals e.g. Ulva sp,

Splachnidium rugosum, Ilea fascia. · Zones (i) and (ii) are exposed to the air for some hours at low water of spring tides.

iii. A turf-covered zone dominated by the dark brown Gelidium pristoides. Gelidium reptans is usually an important constituent of this turf. The zone contains the larger forms mentioned in (ii), present in the same way as scattered individuals. It is often, but not always, subjected to splash at low water of spring tides and in wet places Callithamnion stuposum is an important constituent of the turf, e.g. Ship Rock, First Kwaai Hoek, Kenton. In the lower part of the zone Laurencia natalensis is a very common feature.

iv. A zone dominated by H.spicifera occupying the lower part of the platform and extending to the sublittoral. The upper part of the zone is mixed with Gelidium pristoides. The most important part of the Hypnea zone is on the overhanging ledges of the platform and on the vertical sides down which it extends to the sublittoral. On most of the Kenton platforms and at other places e.g. Third Kwaai Hoek, the upper part of the Hypnea girdle overlapping the mussel zone is situated on the lower part of the horizontal surface of the platform. Here the Hypnea does not form a continuous carpet, but forms isolated bright green islands among the dark brown turf. The erect fronds here are short (a few cms long) and succulent looking with glassy green tips, remaining upright when emersed. These bright green plants usually constitute a relatively small part of the whole zone. This part of the platform is subjected to splash and spray at low water of spring tides and is sometimes the only part of the Hypnea zone

which is easily accessible at low water of spring tide.

The plants at lower levels, i.e. those at the edge of the platform and those hanging from ledges and from the vertical sides facing the open sea are constantly washed by heavy surf. These plants are dark in colour, almost black, with long erect fronds which collapse when immersed. The erect fronds of plants from the lowest zones are usually very dark, thin, attenuated and sparsely branched. The longest fronds are not always those from the lowest part of the zone. In some cases those which hang from ledges and trail in the water at low water of spring tides are longer than those anchored at low water level (Kasouga Ship Rock, Kenton).

At Kasouga (Ship Rock) there is very little short green Hypnea on the horizontal platform, the Hypnea girdle being in the main confined to the vertical walls where it is stringy and very dark in colour. Here on the main part of the platform only the uppermost zone is readily accessible at low water of spring tide.

Below the patches of short green Hypnea which invade the Gelidium pristoides zone on the horizontal surfaces of the platforms e.g. at Kenton, is a mixed zone in which Hypnea spicifera is found together with a variety of forms. The most common of these are:-

Laurencia - several species including L.natalensis.

Halimeda cuneata (Kenton, Diaz Cross).

Gelidium - several species including Gelidium amansii.

Caulerpa racemosa var. zeyheri (Kenton, Ship Rock, Three Sisters).

Ilea fascia.

In the lower part of the zone on the vertical sides of the platform H.spicifera dominates almost to the exclusion of all else. In places subjected to very rough seas e.g. on vertical rock surfaces buffetted by the full force of the waves Gelidium cartilagineum and the wiry Gelidium amansii are the two larger forms which most commonly occur in the Hypnea zone. Gelidium cartilagineum often invades from the zone below Hypnea and may become established in small patches among the dark coloured fronds of the lower and middle parts of the Hypnea zone. In such situations, especially if it grows from overhanging ledges Gelidium cartilagineum is often very conspicuous among the Hypnea on account of the greater length of its fronds and its deep red colour, e.g. at Kenton tufts of G.cartilagineum with fronds approximately 32 cms long were found growing among dark coloured Hypnea with thin fronds about 18 cms long. Below this, on the same rock face the almost black, attenuated fronds of H.spicifera measured 43 cms long.

Along the Kenton coast in inaccessible places subjected to heavy pounding by waves at low water of spring tides occasional Anatheca dentata, Gracilaria denticubata and much more commonly Geledium amansii are mixed with dark attenuated Hypnea spicifera. (fig 87) +88 In rough places the leathery Anatheca dentata, Gracilaria denticulata and Gracilaria beckeri may occur below the Hypnea girdle. This is commonly the case at Kasouga (Snip Rock) and along the Kenton coast from Shelly Bay to Fisherman's Cave. On vertical rocks facing the shore (i.e. in relative shelter) Dictyota dichotoma is sometimes a constitutent of the Hypnea zone (Kenton).

FIG. 87 VEGETATION ON ROCK FACING SEA BETWEEN KENTON + KARIEGA RIVER MOUTH

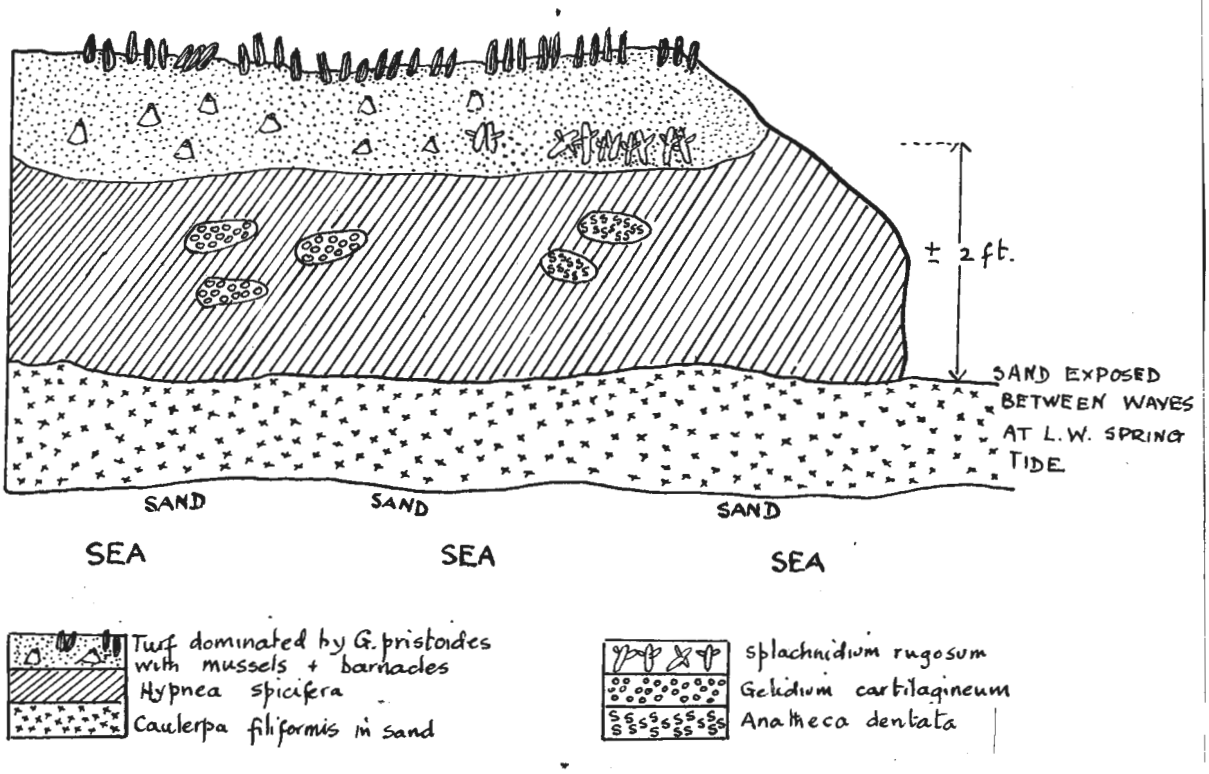


FIG. 88 ZONES OF VEGETAT

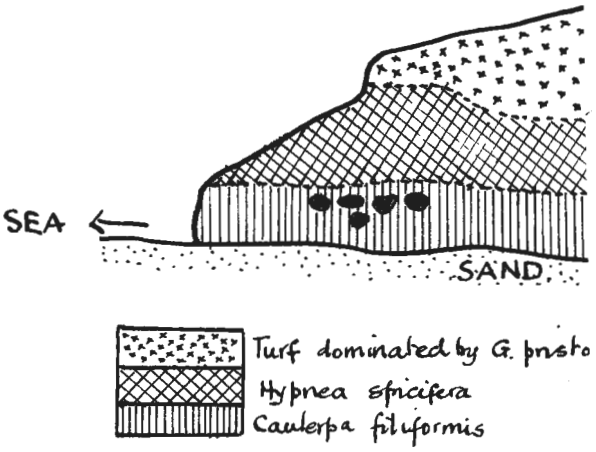


Fig. 89 Isolated rock near Ship Rock, Kenton.

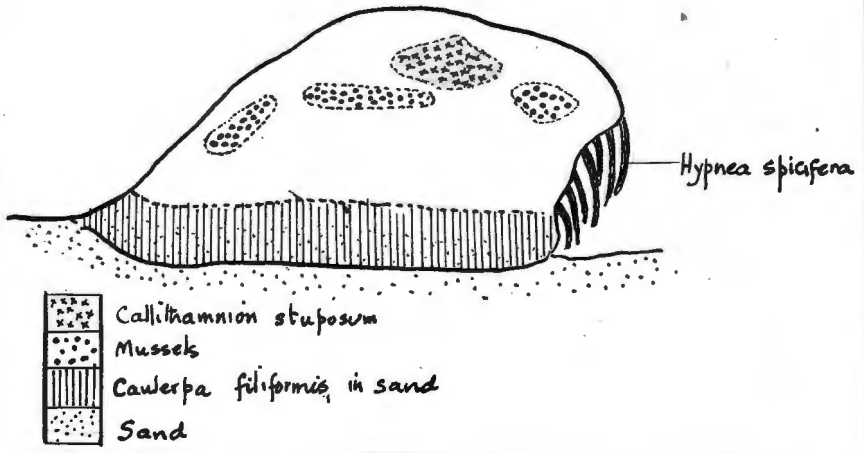
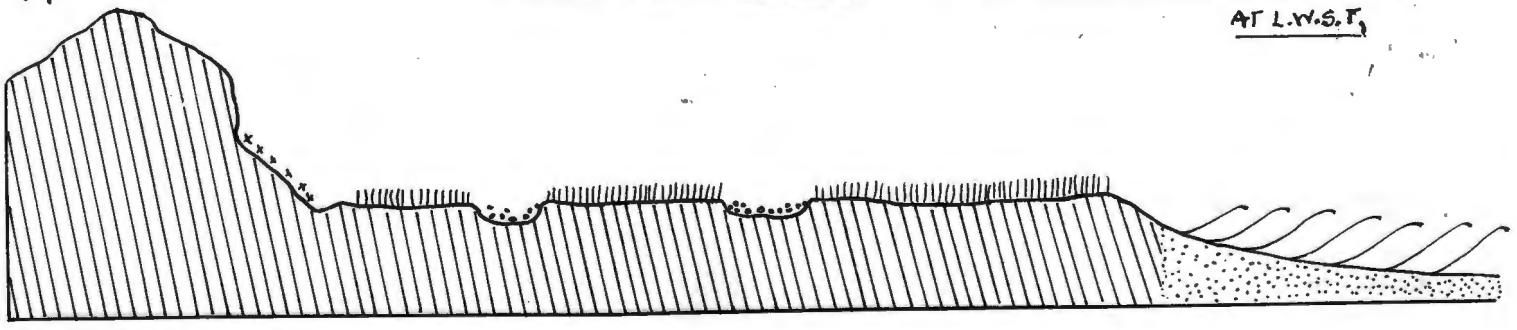
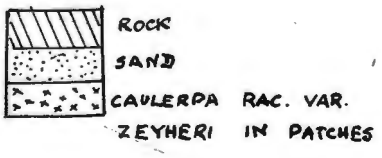


Fig. 90 KENTON

A

BEDS OF H.SPICIFERA + C.FILIFORMIS ON LOW FLAT ROCKS SLOPING GRADUALLY INTO THE SEA. CONTINUOUSLY WASHED BY WAVES AT L.W.S.T.





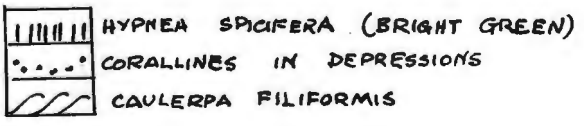


FIG 90 B HYPNEA SPICIFERA BORDERING SHELLY BAY

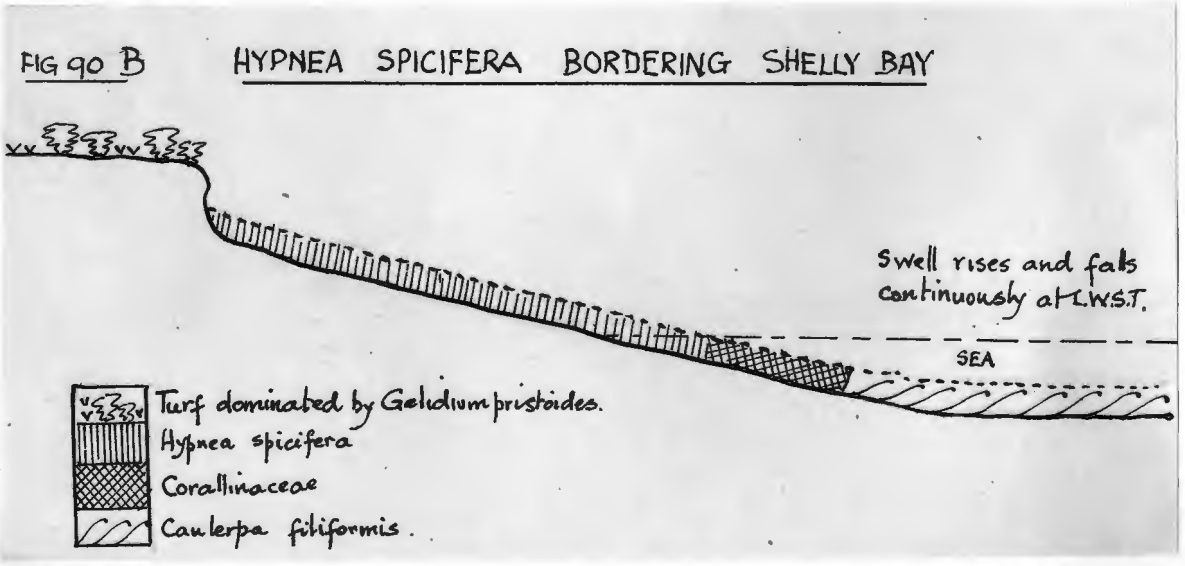


Fig. 91 H. spicifera on rock in background. C. filiformis in sand in foreground.

At its lowest levels on the vertical sides of the platform the erect fronds of H.spicifera generally trail or float in the water. Where there is severe pounding by the waves as along the Kenton coast Gelidium cartilagineum often occupies the vertical rock surface immediately below H.spicifera. Since in most cases in this part of the coast the seaward walls of the platform drop vertically to a sandy sea bed conditions are not favourable for the development of Ecklonia biruncinata which is not common along the Kenton coast. At Shelly Bay small patches of it occur below the Hypnea zone. Similarly small patches occur mixed with the lower part of the Hypnea zone on the eastern (rougher) side of the Ship Rock platform and more uncommonly there on the western (calmer and sandier) side. In places at Kariega rocks some Ecklonia biruncinata is mixed with Hypnea spicifera.

In less fierce situations where the horizontal rocks do not drop vertically into the sea, but slope gradually to the sandy sea floor extensive and conspicuous bright green sheets of Caulerpa filiformis partially buried in sand usually succeed Hypnea spicifera (Figs. 89, 90) This is the case in parts of the Kenton coast (Fig. 91) between Ship Rock and Kasouga River, at Kariega Rocks, First Kwaai Hoek, Second and Third Kwaai Hoeks. In the last named of these localities Caulerpa filiformis is visible on the rocks out at sea. Caulerpa filiformis often occurs in the lower part of the Hypnea zone of the gradually sloping platform in which case the rock surfaces are usually dominated by H.spicifera, the sandy patches by Caulerpa filiformis. (Fig. 93) In places, e.g. Ship Rock Caulerpa filiformis may occur in the sand above the Hypnea zone.

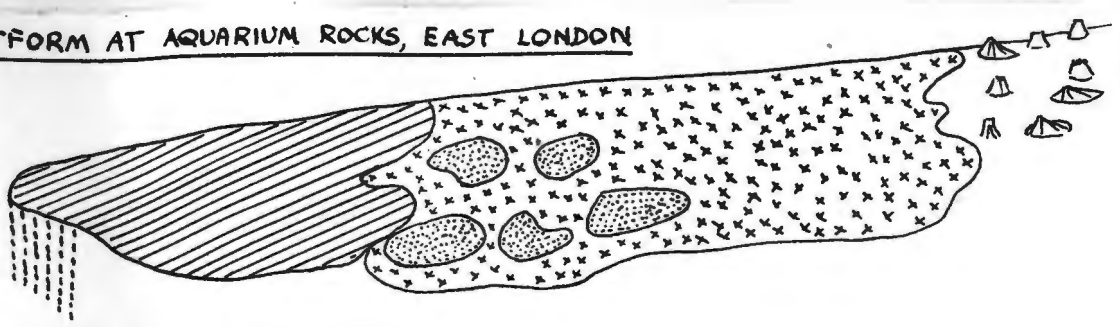
Though Caulerpa filiformis favours sandy situations it is not confined to them, e.g. in a number of places as at Kenton, it grows together with Hypnea spicifera on rock, the prostrate parts of each interlacing with the other, while the erect fronds of both trail in the water at low water of spring tides.

East London platforms.

Further eastwards along the coast, at East London, the flat rocks at the Aquarium form a platform which slopes gradually towards the sea. Here the lower part of the platform is broken by channels which open to the sea. The upper part of the beach is boulder strewn and barren, except for Littorina. (fig. 92)

Gelidium pristoides (not very plentiful) dominates a zone on this platform and is succeeded by a Coralline turf containing Ulva sp., Laurencia sp. and large patches of Caulerpa racemosa var. zeyheri. Beyond this zone, on the lower sloping part of the platform bright green swards of short Hypnea spicifera extend as far as the edge and are succeeded by Ecklonia which dominates the vertical sides of the platform and colonises the sublittoral In places where the rocks slope gently into the sea Hypnea is mixed with Ecklonia. In this locality very little H.spicifera is to be found on the vertical walls and the long dark fronds so characteristic of the Kenton, Kariega and Kasouga platforms appear to be absent. Similarly, inaccessible isolated rocks out at sea are capped with short green Hypnea spicifera, succeeded by Ecklonia. In places Caulerpa filiformis, a lighter and more bluish green than Hypnea spicifera occupies the ledges above the Hypnea zone. In

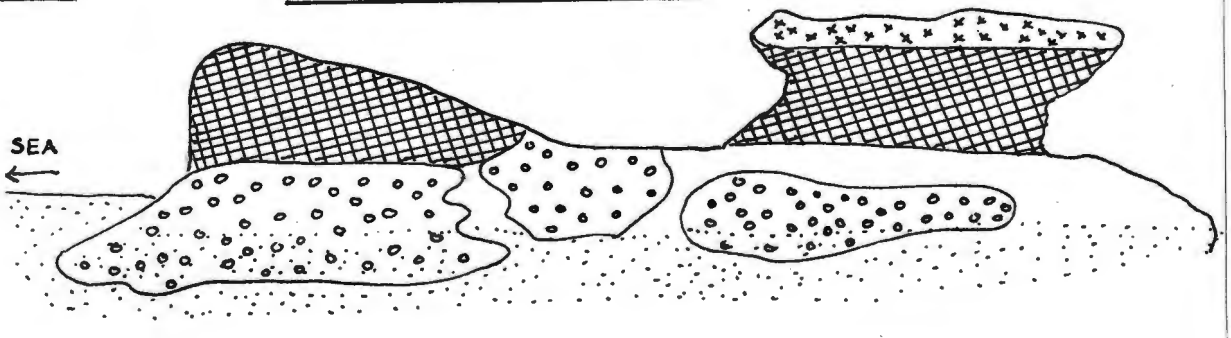
FIG. 92 PLATFORM AT AQUARIUM ROCKS, EAST LONDON



HYPNEA SPICIFERA
ECKLONIA ON EDGE OF PLATFORM
CAULERPA RACEMOSA VAR. ZEYHERI IN DEPRESSIONS IN ROCKS

CORALLINE TURF
GELIDIUM PRISTOIDES TURF WITH BARNACLES + LIMPETS

FIG. 93 NEAR SHIP ROCK, KASOUGA



CAULERPA FILIFORMIS
HYPNEA SPICIFERA

TURF WITH MUSSELS
SAND

FIG. 94 EDGE OF PLATFORM AT BATS CAVE, EAST LONDON

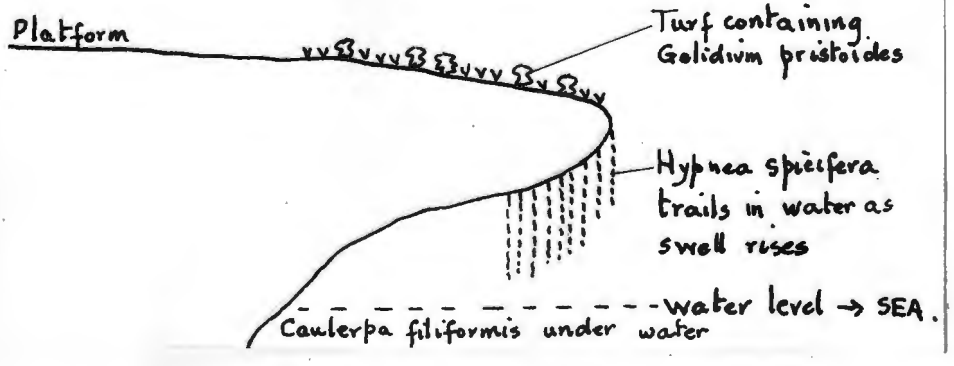


Fig. 95 Gullies in rock platforms at low water of spring tides showing extent of Hypnea zone

where?

general where there is little sand Caulerpa filiformis is sparse. In the whole of the East London area the Hypnea swards are an exceptionally vivid green colour. This is possibly due to the fact that the observer on the shore at low water of spring tides is directly facing the morning sun.

At Eastern Beach (Bat's Cave) East London there is an upper and a lower platform, the lower being broken up by pools and gullies. On the lower turf covered platform there is relatively little Gelidium pristoides. Here Hypnea spicifera succeeds carpets of Caulerpa racemosa var. zeyheri which covers not only horizontal surfaces but also vertical and sloping walls especially in the neighbourhood of pools. Except where the platform is level the Hypnea zone is not very extensive and on vertical walls quickly gives way to Ecklonia which constitutes a very prominent feature, tossing in the waves below the Hypnea zone. The plants constituting the Hypnea zone on the platform have short bright green upright fronds a few inches long. The upper parts of the zone are mixed with a turf containing a number of small forms including Gelidium reptans, Griffithsia secunda and Acrosorium sp. (cf. Bat's Cave). In places where the water is roughGelidium cartilagineum and Gelidium amansii are mixed with Hypnea, Gelidium amansii being often in quieter water. Inaccessible rocks out at sea appear to be capped with long black Hypnea, together with quantities of Gelidium cartilagineum succeeded by kelp. In calm water where there is sand at low levels Hypnea is succeeded by Caulerpa filiformis as shown in fig. 94.

Cannon Rocks.

Horizontal rock surfaces of a rather different nature and of a very much smaller area are found to the west of Cannon Rocks and between Fish River Mouth and Fish River lighthouse. Here the flat rock surfaces exposed at low water of spring tides are flush with the sandy beach. These support beds of Hypnea spicifera, most of which lies below the mussel zone, showing the usual sequence of bright green - olive green - dark fronds from higher to lower levels. Throughout the whole of the zone at Cannon Rocks is an admixture of short Caulerpa filiformis, also scattered Halimeda cuneata, Gelidium amansii, Ulva sp. and small amounts of Ilea fascia. In a similar situation at Fish River the beds of Hypnea contain a high proportion of sexual plants.

GULLIES

These are clefts ranging from about 2 ft. to 5 ft. wide in the lower parts of the rocky platforms at Kenton, Kareiga, First and Second Kwaai Hoek, Kasouga (Ship Rock), Aquarium Rocks (East London) and elsewhere. In the main the gullies run at right angles to the shore line. Their landward ends and sides have vertical rock walls which at the shallow landward ends may only be one or two feet deep. The vertical walls of the lower ends of the gullies which are open to the sea may be four or five feet deep or more. At low water of spring tides the greater part of each gully empties and refills rapidly with every wave, the incoming water surging over the edges. Since the sudden inrush of water often

strikes the vertical walls of the closed landward ends with some violence, the vegetation on the walls of the gully is subjected to much swirl as well as swell. Most of the gullies have sandy floors which are for the most part devoid of vegetation, the plant life being mainly confined to the vertical walls.

Hypnea spicifera does not attain its maximum development in gullies - its maximum development appears to be in inaccessible places in the open sea, but it is almost always present in gullies, and dominates a zone. In the gullies at Kenton which are typical of most localities the landward ends of the gullies are bordered by a turf dominated by Gelidium pristoides, and a mussel zone, giving way to the Hypnea belt below (Fig. 95) The zone dominated by Hypnea spicifera which usually extends the greater part of the length of the gully is seldom much more than three feet in vertical depth, and in many cases less. The lower part of the zone is anchored not much below the water level of low water of spring tides (usually not much more than a few inches below). At the upper levels of the Hypnea belt is a narrow zone (usually about one-third of the total depth of the zone) with characteristic short green fronds, and below these the longer, darker olive green fronds constitute the greater part of the Hypnea belt on the vertical walls. In the lowest part of the zone the Hypnea is almost black, and attenuated, trailing in the water. In many cases the Hypnea on the side of the gully which is in the shade at low water of spring tides appears to be denser, darker, more attenuated and more luxuriant than on the sunny side.

In most of the Kenton gullies conditions are very rough and

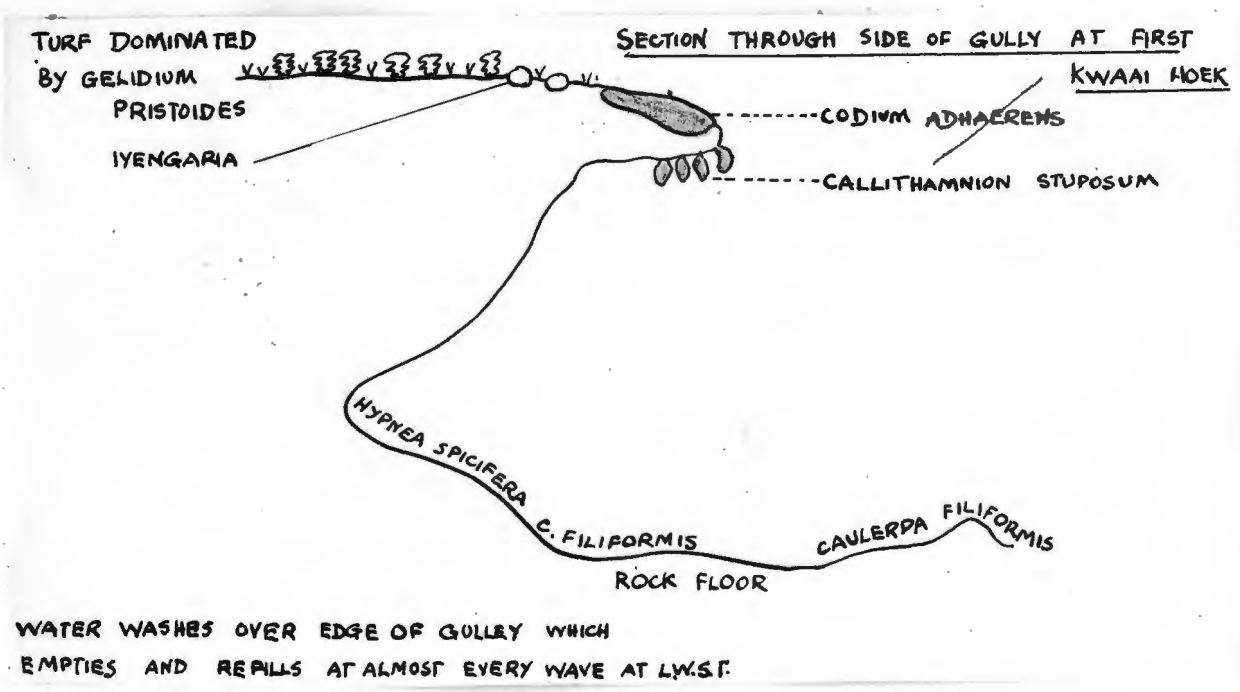


FIG. 97 GULLY AT AQUARIUM ROCKS, EAST LONDON

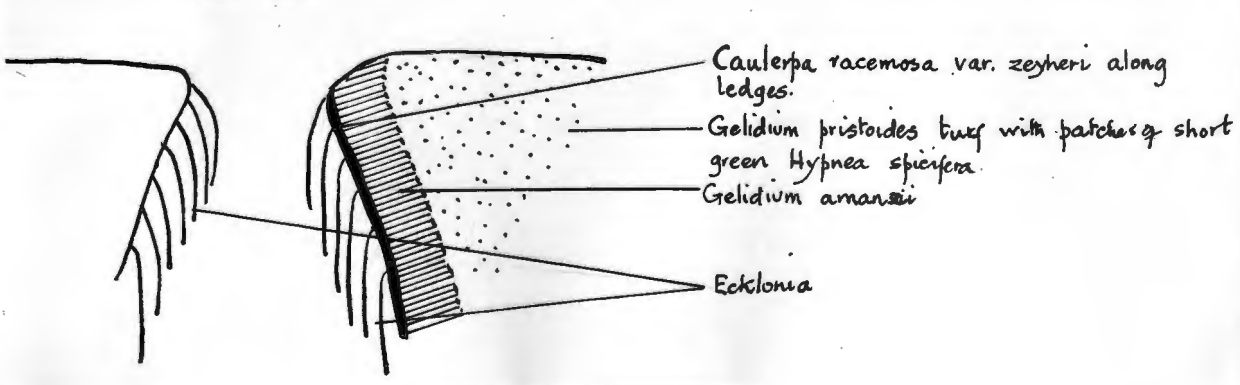


FIG. 98 SHARK'S BAY (KOWIE WEST) QUIET WATER.

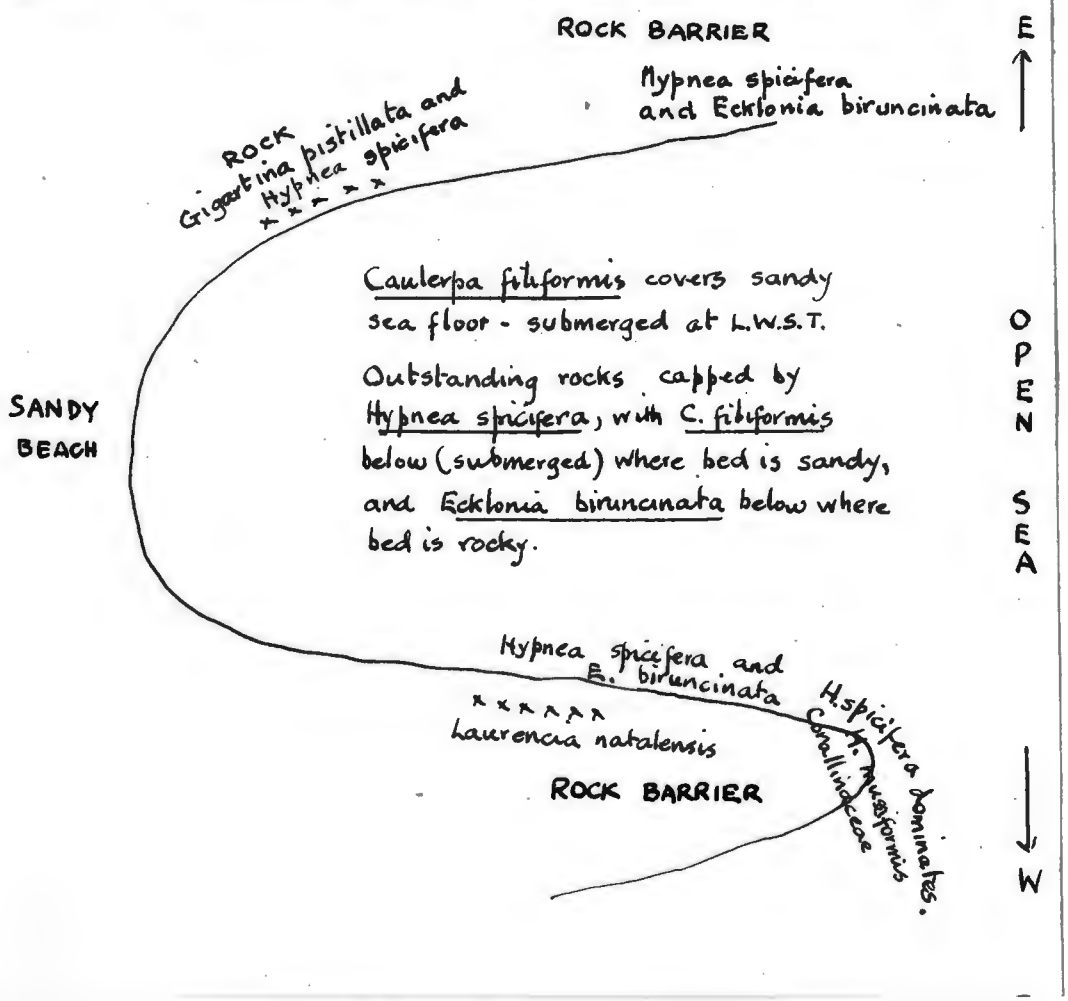


Fig.99a. H. spicifera and G. pistillata together on low reefs

Kleinemonde

Fig.99b Mixed Hypnea belt on low reefs.

Kleinemonde.

there is a general absence of shelter loving forms. On the vertical sides of the seaward ends of the gullies Hypnea spicifera is often succeeded by dense growths of Gelidium cartilagineum attached just below water level of low water of spring tides, or by a mixed zone containing Gelidium amansii, Gracilaria denticulata, Sarcodia ~~capensis~~ Anatheca dentata; the latter being usually at the bottom of the gully partly buried in sand. In places Gracilaria beckeri and Gracilaria denticulata are present in the mixed zone. At lower levels where there is a rocky floor and much swell as in certain of the Kenton and Ship Rock gullies Ecklonia biruncinata often succeeds Hypnea spicifera. At the upper ends of the shallower gullies where the movement of water is less violent and only the short green part of the Hypnea zone is represented Caulerpa filiformis with short green fronds only a few inches (approximately 3") long may succeed Hypnea spicifera, in which case Caulerpa filiformis is often partly buried in the sandy floor. In many of the Kenton gullies Plocamium corallorhiza succeeds H.spicifera.

The Hypnea zone of gullies often contains an admixture of other forms. In rough places the most common of these is Gelidium amansii, Gelidium cartilagineum may invade from the zone below, and in situations where there is much swirl Spyridia cupressina is not uncommonly mixed with Hypnea spicifera. Where the movement of water is less violent as in certain of the Kenton gullies Sargassum sp., Caulerpa filiformis, Codium sp. and Plocamium corallorhiza are mixed with Hypnea, and sometimes Halimeda cuneata (Ship Rock). Under these conditions H.spicifera and C.filiformis are both usually clogged with sand.

Under the roofs of overhanging ledges where there is both shade and shelter Peyssonelia capensis and Botryocladia madagascariensis are both to be found in the Hypnea zone (Kenton, Diaz Cross, Three Sisters) though neither is common.

In sheltered gullies which are to some extent protected from the open sea (as at First Kwaai Hoek) Hypnea may appear only in small quantities, mixed with Hypnea musciformis above the Caulerpa filiformis zone.(fig 96)In some of the quieter gullies it is absent altogether, its place being taken by Caulerpa filiformis. For the most part conditions in gullies are too strenuous for the growth of Caulerpa racemosa var. zeyheri - though this does occasionally occur together with H.spicifera and C.filiformis even in swiftly moving water as at Third Kwaai Hoek.

In the gullies at Aquarium Rocks East London H.spicifera does not colonise to any extent: its place being taken by Ecklonia. Very little Hypnea is present on the vertical walls as in fig.97

QUIET WATER

In sheltered parts of bays where the water is quiet Hypnea spicifera does not dominate in the same way, and other species form a greater part of the population than in any other situation. Apart from its failure to reach its maximum density in quiet water, the long dark attenuated Hypnea spicifera characteristic of situations in which it flourishes best is absent. In quiet water the fronds are usually not much more than 1 - 1½ ft. long, olive green in colour.

Stretches of relatively quiet water occur in bays at Kleinemonde, Kenton (Shelly Bay) and at the Kowie (Shark's Bay near Salt Vlei). At Kleinemonde the sea floor is broken into small relatively calm sandy inlets about 20 yds. wide separated by low rocky reefs running out to sea more or less at right angles to the shore. At low water of spring tides the water in the inlets is shallow (about 18 ins. deep) and disturbed only by gentle swells. The tops of the low reefs which are exposed to the air at low water of spring tides are covered by a thick, dark green turf consisting of a mixture of Gigartina species including G.pistillata and short Hypnea spicifera, (Fig. 99) superficially resembling each other in colour (dark green) and size. At lower levels H.spicifera is mixed with Caulerpa filiformis, H.spicifera tending to dominate the upper part of the mixed zone and C.filiformis the lower. In many places Caulerpa Holmesiana occupies the zone below H.spicifera. An iridescent Chondria species is a common constituent of the mixed Hypnea zone. Further out to sea H.spicifera is replaced by Ecklonia biruncinata, the rocks beyond the sheltered inlets are covered with beds of kelp, occupying positions which in other parts of the Bathurst and Alexandria coasts one would expect to find occupied by H.spicifera.

The inlets between the ridges have an uneven floor of sand and stones, and here there is a mixture of forms. Tufts consisting of mixtures of Gracilaria denticulata, Caulerpa filiformis, Hypnea spicifera and Chondria are present. In the shallow parts where the floor is sandy very extensive beds of Caulerpa filiformis occur.

At Shark's Bay (Kowie) a small inlet of relatively quiet water is protected on both sides by low lying ridges (Fig.96) Here as at Kleinemonde H.spicifera does not dominate to the same extent as it does in rough situations. A mixed Hypnea zone including also Gigartina radula, Gigartina pistillata, Laurencia natalensis, Ulva sp. and Hypnea musciformis borders the bay. In this zone H.spicifera occurs in tufts on rocks at low water of spring tides level, but the tufts are more isolated than in rough water and are mixed with other species e.g. Gigartine pistillata (dark green in colour and roughly similar in size to H.spicifera). Except where the bay borders the open sea there is no extensive zone dominated by H.spicifera, its place being taken by dense beds of Caulerpa filiformis (Fig. 98). Further out to sea this is replaced by Ecklonia biruncinata. The seaward ends of the rocky ridges which shelter the eastern side of the inlet are capped by a mussel zone dominated by Gelidium pristoides, succeeded in turn by Hypnea spicifera and Ecklonia biruncinata. (Fig. 100)

In places at Salt Vlei there are small, relatively quiet inlets between rocky ridges where H.spicifera seldom dominates completely. The floors of these inlets are usually covered by a mixture of forms. In such places Caulerpa filiformis, Caulerpa holmesiana, Caulerpa racemosa var.zeyheri and various Corallines are common and important constitutents of the Hypnea zone. Further out to sea, in rougher water this zone is succeeded by Ecklonia biruncinata.

At Kenton, Shelly Bay is protected by two rocky headlands

and in the quiet water of the eastern side H.spicifera together with Hypnea musciformis, Caulerpa filiformis and Plocamium corallorhiza cover the rocks forming the sea floor. These are emersed at low water of spring tides.

In the quieter water on the eastern side of the rocky point at Fish River Mouth Coralline turf and Ulva sp. are more abundant than on the western rougher side. Here banks of short bright green H.spicifera succeed the Gelidium pristoides zone.

In the quiet water of Eastern Beach East London Hypnea is anchored in the sand together with short Caulerpa filiformis (3" - 4" long), Halimeda cuneata and Dictyopteris sp.

In the relatively calm water of Humewood Beach (Port Elizabeth) where there is a flat platform sloping gradually into the sea H.spicifera appeared to be altogether absent in March 1950, though its presence on Humewood beach and at Beacon Pt. has been recorded by Stephenson (S.A.Intertidal Zone iv. P.E.district).

SAND

Although Hypnea spicifera is typically a species of vertical and sloping rocks it may sometimes be found in horizontal beds partly buried in sand which varies in depth from a few inches to a foot or more. Erect fronds removed from sand at Kei River Mouth measured up to 41.5 cms. Small localised patches of this sort are usually found where there is comparative shelter e.g. at Kasouga Ship Rock and at Kenton patches of Hypnea spicifera occur among the more extensive beds of Caulerpa filiformis. (Fig. 103)

Under similar conditions at Eastern Beach East London, Bat's Cave East London, Kei River Mouth, and west of Cannon Rocks Hypnea spicifera grows out of sand in relatively quiet water among Caulerpa filiformis. Sometimes, as at East London, there is an admixture of Halimeda cuneata. Between Fish River Lighthouse and Fish River Mouth horizontal beds of H.spicifera containing a large proportion of sexual plants grow out of sand in the shelter of outlying rocks.

POOLS

H.spicifera grows on the vertical walls and floors of pools cut off from the sea at low water of spring tides, but it is not the most common inhabitant. Pools ranging in depth from one to several feet deep were examined in the following localities:-

Salt Vlei (Kowie)
Shark's Bay (pools at side)
Shelly Bay (Kenton)
Kareiga Rocks
First Kwaai Hoek
Three Sisters
Fish River
Aquarium Rocks, East London
Bat's Cave, East London
Eastern Beach, East London
Humewood, Port Elizabeth - Beacon Point
Ship Rock, Kasouga

H.spicifera is an inhabitant of pools in all the above localities with the exception of Humewood, Port Elizabeth. In most cases it is olive green in colour, seldom exceeding 15 cms. in length e.g. :-

At various times:

Salt Vlei - under 25 cms.

Bat's Cave, East London - 5 cms.

Shark's Bay - under 15 cms, mainly 5cms.- 10 cms.

Eastern Beach, East London - 5 cms.-10 cms.

(See note on length)

In pools it is commonly associated with a mixture of species of which the chief are Corallinaceae e.g. Amphiroa ephedraea, Plocamium corallorhiza, Caulerpa filiformis, Dictyota sp., Laurencia natalensis, ~~Phyllitis~~ Ilea fascia, Cladophora rugulosa, Ulva, Codium duthiae, Halimeda cuneata, Caulerpa holmesiana, Caulerpa racemosa var.zeyheri. In the Kariega pools it is associated with Gymnogongrus polycladus, Gracilaria beckeri, and Zanardinula nodifera. In stagnant murky pools on the eastern side of the rocky point at Fish River Mouth a rich Colpomenia community flourishes, in which H.spicifera is absent. In pools along the Humewood coast the usual associates of H.spicifera (Corallines, H.cuneata, G.amansii) are there.

ROCKY RIDGES

Whereas the dune rock platforms such as those at Kenton and Kariega occur only at intervals of some miles along the Alexandria and Bathurst coasts, the greater part of the rocky area of this

FIG. 100 ROCKY HEADLAND ON EASTERN SIDE OF SHARK'S BAY

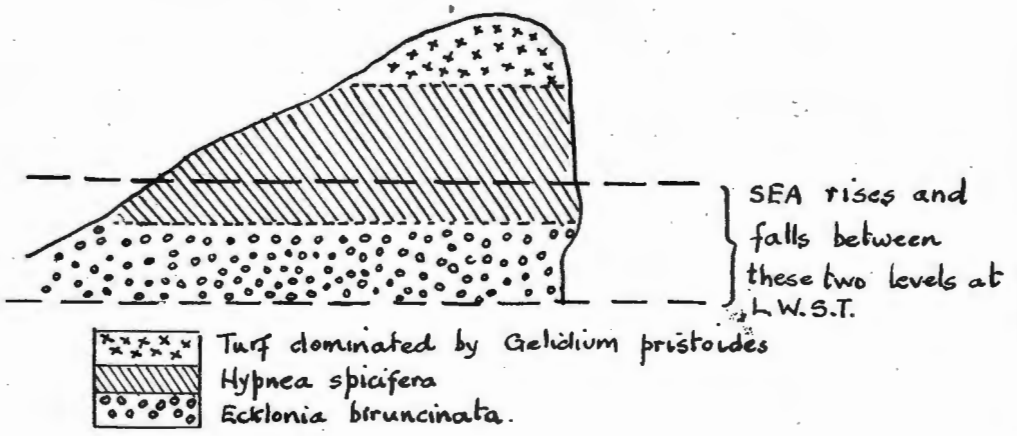


Fig. 101 Wall of shallow inlet on eastern side of Shark's Bay, (Kowie)

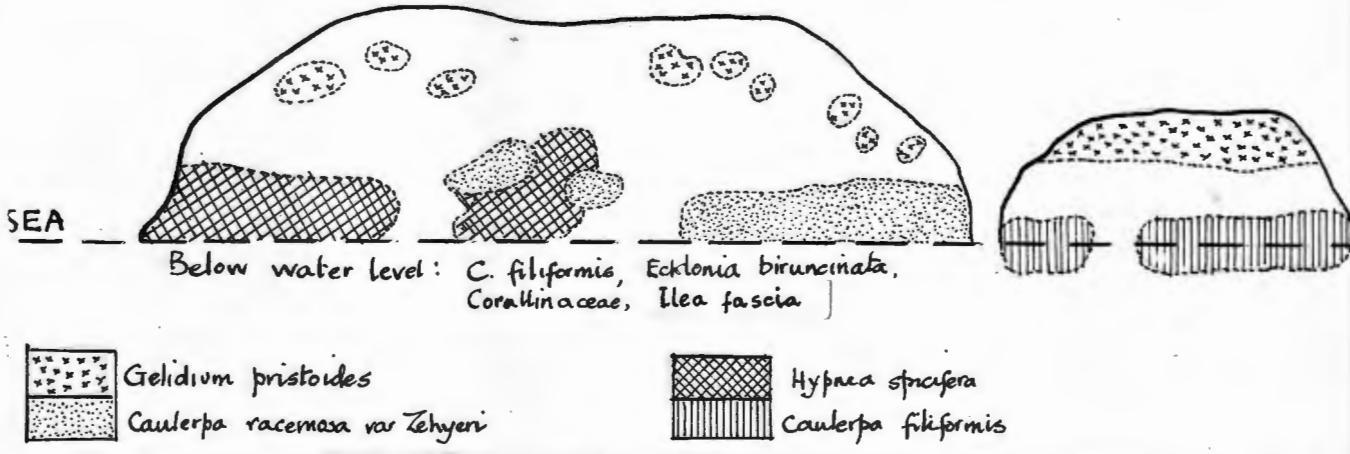


FIG. 102 LOW ROCKY RIDGES NEAR FISH RIVER MOUTH

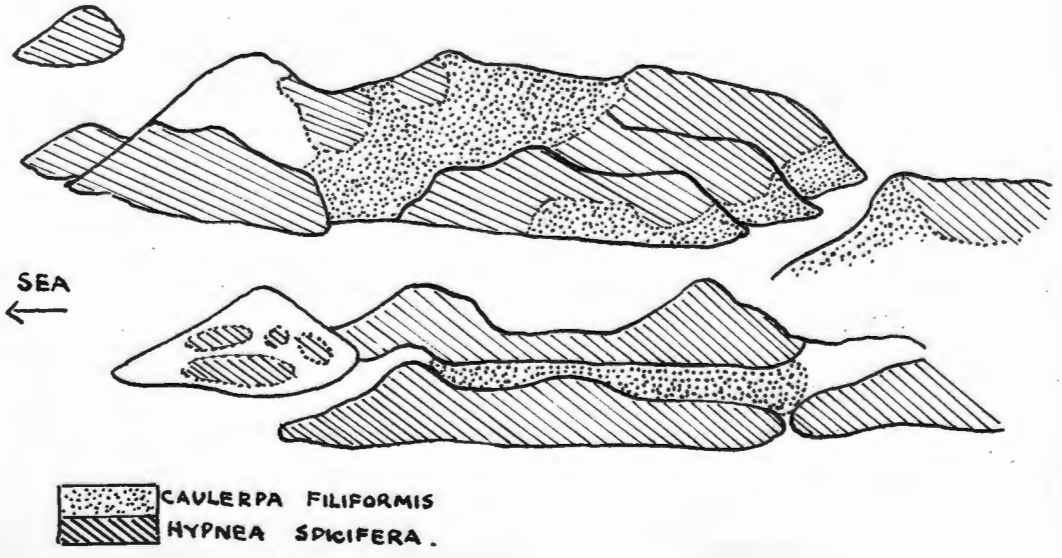


Fig. 103 H. spiaifera growing in sand.

Fig. 104 H. spiaifera below barnacles at Salt Vlei.

Fig. 105 H. spicifera on outlying rocks off Shelly Bay headland. (Kenton)

coastline consists of relatively low ridges running out to sea, often more or less at right angles to the shore line. In some places these rocky areas extend for a mile or more along the beach. The ridges run into the sea roughly parallel to one another, with pools and inlets between. Such rocky outcrops occur at Salt Vlei, Kowie Point, Cannon Rocks, between Fish River Mouth and Fish River Lighthouse, at Kleinemonde, and outside this area near Cove Rock, 10 miles west of East London (mud and dolerite ridges at Cove Rock). Kleinemonde is excluded from this discussion as there the situation is sheltered and the chief features of that locality are referred to under the section "Quiet Water".

At Salt Vlei, Kowie Point, Fish River, the rocky ridges form the boundaries of wide bays, and are subjected to very severe pounding by the surf.

In such situations H.spicifera grows on the further parts of the ridges, dominating a zone below Gelidium pristoides (Figs. 100, 101) Where the sea is rough, e.g. at Salt Vlei, Kowie Point, the growth of H.spicifera is very luxuriant. The greater part of the H.spicifera belt e.g. at Salt Vlei forms dense coverings on the vertical and steeply sloping walls of the ridges, and on the tops of the furthermost ridges, on the tops and sides of rocks on the sea floor below the ridges. (Fig. 104) It also covers isolated rocks further out to sea, visible at low water of spring tides, but not accessible on account of heavy surf and very uneven sea floor. In general H.spicifera tends to grow more densely and luxuriantly in inaccessible places and on the sides of ridges subjected to rougher

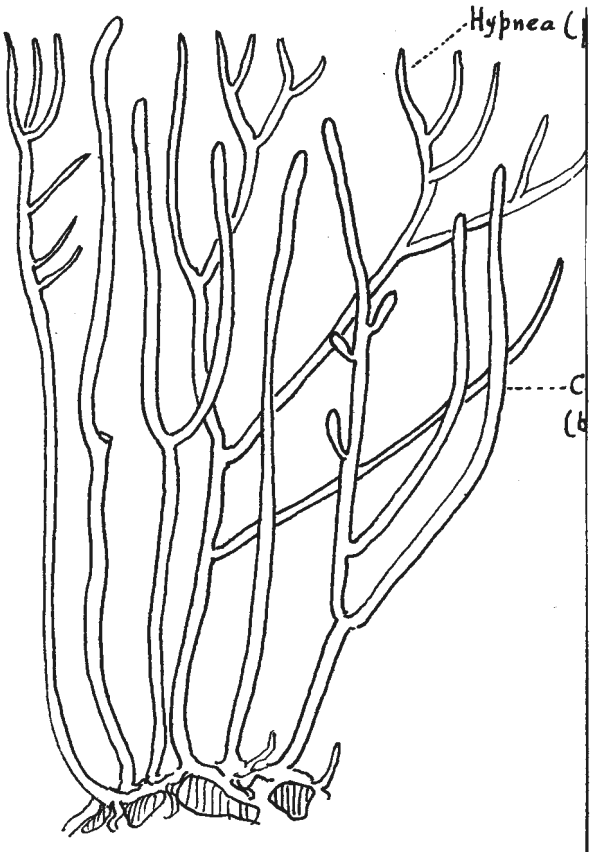


Fig 106 Hypnea + Chondria growing toge

water. This is conspicuously so on the rocky ridges between Cannon Rocks and the small isolated platforms to the west.

In the absence of extensive horizontal rock surfaces the swards of short bright green H.spicifera are absent, except during periods of new growth as at Salt Vlei. Under ordinary conditions there is relatively little of the short green H.spicifera. The greater part of the zone consists of plants with fairly long olive green fronds (middle levels) and plants with black attenuated fronds (lower levels).

In the upper part of the zone there may be an admixture of forms, including Laurencia natalensis, Streptocladia sp. and even in rough situations (e.g. Salt Vlei) small forms e.g. Tayloriella tenebrosa, Pollexfenia sp. are to be found growing among the prostrate parts of H.spicifera. On the more sheltered sides of the ridges e.g. at Kowie Point, Salt Vlei, H.spicifera may be mixed with Caulerpa racemosa var. zehyeri, Ulva sp., Halimeda cuneata, Codium sp.

In situations where the sea is rough especially at Salt Vlei, Kowie Point and in the neighbourhood of Cannon Rocks, Chondria sp. is often found in quantity mixed with H.spicifera in the middle and lower parts of the zone (Fig. 79) This is especially so on the seaward side of rocky outcrops which meet the full force of the waves. Superficially this species of Chondria resembles H.spicifera (Fig. 106), being roughly similar to it in growth form, with a creeping prostrate part often intertwined with that of H.spicifera, and long cylindrical fronds roughly similar in size

and colour to those of H.spicifera. The erect fronds of Chondria are distinguishable by their rounded tips, more reddish colour, often iridescent surface, and a characteristic odour. In places this species of Chondria forms dense tufts among the Hypnea, but does not dominate except in isolated patches over small areas.

Of lesser importance are Anatheca dentata and Gracilaria denticulata both of which occur in small isolated tufts below H.spicifera and sometimes mixed with the lower part of the zone. Both are characteristic of very rough water e.g. at Salt Vlei, and are commonly buried deep in sand.

In the areas of rocky ridges the lowest part of the H.spicifera zone and the sublittoral are inaccessible even at low water of spring tides owing to the heavy surf and the uneven nature of the sea floor. Occasionally when there is an exceptionally low spring tide e.g. at Salt Vlei, this zone becomes accessible. At the Salt Vlei rocks in places where the sea is less rough the Hypnea zone is succeeded by Caulerpa filiformis growing on rock and in sand. In places the Caulerpa filiformis invaded the Hypnea zone, and dense patches of bright green C.filiformis are found among the dark banks of H.spicifera. Where the rocky ridges extend to the sublittoral Hypnea is generally succeeded by Ecklonia biruncinata. This seldom appears to be a wide zone and is subjected to very heavy seas. In places it invades the lower part of the Hypnea zone. Quantities of Carpophyllum scalare are often mixed with Ecklonia biruncinata and where there are patches of sand below the rocky ridges a

mixture of C.filiformis and E.exasperata succeeds the Hypnea zone. Locally a narrow belt of Carpophyllum scalare, Ecklonia biruncinata and Zonaria cuneata may constitute a zone along the wall of a rocky ridge immediately below H.spicifera. On the more sheltered sides of the ridges bordering calm water at low water of spring tides a narrow but dense belt of Caulerpa holmesiana sometimes succeeds H.spicifera, the C.holmesiana trailing in the water, hidden under the long fronds of H.spicifera

At Kowie Point as in parts of Salt Vlei the zone dominated by Chaetangium erinaceum is succeeded by a zone dominated by Gelidium pristoides below which is the mixed Hypnea zone. The constitution of the Hypnea zone is similar to that at Salt Vlei and the short bright green Hypnea of the upper levels is quickly succeeded by the longer dark erect fronds. Caulerpa filiformis and Ecklonia biruncinata succeed the Hypnea zone as at Salt Vlei.

Cannon Rocks

Cannon Rocks consists of a boulder strewn beach the greater part of which is devoid of algal vegetation except where there are pools. Mussels and barnacles are abundant in this area, possibly providing attachment for Gelidium pristoides. In the smooth bare parts devoid of mussels and barnacles there is no extensive turf and little Gelidium pristoides. Below the G.pristoides zone, and in inaccessible places on the rougher sides of the ridges is a belt of H.spicifera. At low water of spring tides this is exposed between the waves, and patches of Ecklonia biruncinata are visible below it. The bays between the ridges are boulder strewn

and difficult to move about in freely. Here H.spicifera is absent. Caulerpa filiformis occurs in patches, without appearing to have any direct relation to the Hypnea zone. In relative shelter H.spicifera is mixed with Halimeda cuneata, Dictyota sp., Laurencia natalensis and Hypnea musciformis.

On the rocky ridges to the west of Cannon Rocks below the wide Gelidium pristoides zone, and mixed with patches of lilac Lithothamnion is the mussel belt, with H.spicifera growing in inaccessible places on the sides of the ridges exposed to rough surf and in inaccessible places in the inlets between the ridges where there is a very heavy sea. It is succeeded by Ecklonia biruncinata which in places extends into the gullies between the ridges. In places the inlets are boulder strewn and there Hypnea spicifera is absent.

Fish River Mouth.

On the western side of the rocky point between Fish River Mouth and Fish River Lighthouse a series of rocky ridges run out to sea with deep gullies and channels between. These ridges are much higher than those near the Kowie and the sandy floors of the gullies which in places are covered with loose stones are relatively barren. The tops of the ridges are for the most part bare. Below is a zone dominated by Chaetangium erinaceum, dried out in places at low water of spring tides. This is succeeded by a turf containing at its upper levels scattered Gelidium pristoides, and at its lower levels Corallines, though neither of these is abundant. The lower part of this turf is mixed with

Hypnea spicifera, and in this mixed zone Acrosorium sp., Laurencia sp., Callithamnion stuposum and Gigartina spp. occur.

To the west of these rocky ridges several isolated rocky outcrops emersed at low water of spring tides are covered for the most part with almost pure communities of H.spicifera and Caulerpa filiformis as shown in fig. 102. At lower levels some of these outcrops serve as rock barriers giving some protection from the full force of the waves to the rocky outcrops on the landward side. The tops of these outlying rock barriers are covered with long dark H.spicifera succeeded by C.filiformis. Of those rocky outcrops which are accessible at low water of spring tides both landward and seaward sides are covered with H.spicifera and C.filiformis, the banks of C.filiformis (fronds 1 - 2 ft.long) tending to be more extensive on the sheltered landward sides. The greater part of the C.filiformis patches is partially buried in sand.

Cove Rock.

On the rocky ridges near Cove Rock (East London) the Hypnea zone is a mixed one and relatively insignificant compared with the very conspicuous belt of Ecklonia (fronds 2 - 4 ft.) which succeeds it. In shelter H.spicifera is often mixed with Laurencia natalensis, Dasya and sometimes Caulerpa filiformis.

RIVER MOUTHS

H.spicifera extends for some distance along the river side of the eastern pier bounding the mouth of the Kowie River. Here it grows on the vertical wall at level of low water of spring tides below a zone containing Gigartina radula and Gigartina pistillata. A sample taken at low neap tide on 26/2/50 was found to contain some Caulerpa filiformis mixed with greenish fairly short H.spicifera. Below the olive green H.spicifera is a narrow continuous belt of Ecklonia biruncinata. This part of the river wall is subjected to heavy swell.

H.spicifera also occurs on isolated rocks in the mouth of the Bushman's River.

ISOLATED ROCKS IN OPEN SEA

at various points along the coast.

These were inaccessible without special equipment. Except at East London and Port Elizabeth they appeared to be densely clothed with long dark H.spicifera. (Fig. 105)

EPIPHYTES ON H.SPICIFERA

Epiphytes are common on H.spicifera especially on the fertile branchlets which may be thickly invested. The number of epiphytic species is however small. Along the Bathurst and Alexandria coasts the most common epiphytes on H.spicifera are Hypnea musciformis, Polyzonia elegans and species of Callithamnion and Ceramium. Polysiphonia and Tayloriella less frequently occur.

Species of Callithamnion, Tayloriella and Acrosorium have been found attached to wound tissue. An incrustation of Polyzoa commonly covers the lower portions of the erect fronds, extending a distance of some centimetres from the base.

Through most of the region investigated Hypnea spicifera is dominant at lowest intertidal level, and there is relatively little admixture of other species. Where other species occur, Gelidium amansii, and species of Chondria and Caulerpa are among the more common constituents of the zone. In quiet water H.spicifera is replaced to a greater extent than anywhere else; in general the rougher the sea the more striking is its dominance.

PERCENTAGES OF IDENTIFIABLE FERTILE AND VEGETATIVE FRONDS

Date	Total counted	No of Vegetative fronds	No. of fertile fronds (tetrasporic male and cystocarpic)	% Vegetative fronds	% Identifiable fertile fronds
March 3rd/50	3028	2533	459	83.6	15.1
April	2200	1841	255	83.6	11.5
May 3rd	3000	2392	529	79.7	17.6
May 30th	2100	1741	327	82.8	15.5
June 30th	2000	1688	312	84.4	15.6
July 30th	2000	1750	234	87.5	11.7
Aug. 28th	2000	1618	321	80.9	16.05
Sept. 24th	2000	Veg. and Regenerating 1754	224	87.7	11.2
Oct. 26th	2000	1661	334	83.05	16.7
Nov. 25th	2000	1447	511	72.35	25.5
Dec. 22nd	2000	1451	521	72.25	26.05
Jan. 21st /51	2000	1718	264	85.9	13.2
Feb. 23rd /51	2000	1583	396	79.15	19.8

Male, fruiting and tetrasporic fronds expressed as % of identifiable fertile fronds.

	% tetrasporic fronds	% male fronds	% fruiting fronds
March 5/50	96.9	2.4	0.6
April 3/50	97.6	1.9	0
May 3/50	86.2	7.2	6.6
May 30/50	98.4	1.5	0
June 30/50	97.4	2.3	0.3
July 30/50	94.8	5.13	0
Aug. 28/50	90.4	7.78	1.8
Sept. 24/50	91.7	8.4	0.0
Oct. 26/50	100	0	0
Nov. 25/50	97.2	2.7	0
Dec. 22/50	80	9.02	10.9
Jan. 22/51	92.4	5.6	1.8
Feb. 23/51	92.9	5.05	2.02

PERCENTAGES OF VEGETATIVE AND FERTILE FRONDS IN PLACES OUTSIDE AREA UNDER INVESTIGATION AT SALT VLEI

Place and Date	% Vegetative	% Tetrasporic	% Male	% Cystocarpic	% Young fertile
Isolated rocks in Salt Vlei Bay 30/6/50	85	4.95	2.9	5.3	1.8
Salt Vlei sampling area 3/6/50	84.4	15.2	0.35	0.05	-
Isolated rocks in Salt Vlei Bay 12/9/50	78.2	17.1	2.55	2	0.15
Salt Vlei sampling area 24/9/50	87.7	10.5	0.93	-	-
28/8/50	80.9	10.5	1.25	0.3	3.05
Rocks between Fish River Mouth and Fish River Lighthouse 13/8/50	76.3	5.8	7.5	6.8	3.5
Salt Vlei sampling area 30/7/50	87.5	11.1	0.6	-	0.8

RANDOM COUNT

SALT VLEI 3/4/50

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	78	16	-	-	6	78	16	-	-	6
200	161	33	-	-	6	80.5	16.5	-	-	3
300	251	41	-	-	8	83.6	13.6	-	-	2.6
400	342	49	-	-	9	85.5	12.5	-	-	2.25
500	415	68	-	-	17	83	13.6	-	-	3.4
600	494	79	-	-	27	82.3	13.2	-	-	4.5
700	566	104	-	-	30	80.85	14.85	-	-	4.3
800	661	106	3	-	30	82.6	13.25	0.37	-	3.75
900	748	118	3	-	31	83.1	13.1	0.3	-	3.43
1000	821	141	3	-	35	82.1	14.1	0.3	-	3.5
1100	899	149	3	-	49	81.6	13.5	0.3	-	4.09
1200	990	158	3	-	49	82.5	13.2	0.25	-	4.08
1300	1076	168	3	-	53	82.7	12.8	0.2	-	4.07
1400	1167	176	3	-	54	83.3	12.6	0.2	-	3.8
1500	1239	197	3	-	61	82.6	13.1	0.2	-	4.06
1600	1323	206	3	-	68	82.7	12.8	0.2	-	4.25
1700	1408	212	4	-	76	82.8	12.5	0.2	-	4.5
1800	1486	221	4	-	89	82.55	12.4	0.2	-	4.9
1900	1578	222	4	-	96	83.3	11.7	0.21	-	5
2000	1668	230	5	-	97	83.4	11.5	0.25	-	4.85
2100	1756	241	5	-	98	83.6	11.5	0.2	-	4.6
2200	1841	250	5	-	104	83.68	11.36	0.22	-	4.72

RANDOM COUNT

SALT VLEI 3/5/50

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	84	10	4	1	1	84	10	4	1	1
200	162	29	4	1	4	81	13.5	2	0.5	2
300	244	44	4	2	6	81.3	14.6	1.3	0.6	2
400	330	58	4	2	6	82.5	14.5	1	0.5	1.5
500	410	67	4	2	17	82	13.4	0.8	0.4	3.4
600	491	82	4	2	21	81.8	13.6	0.6	0.3	3.5
700	567	96	4	2	31	80.9	13.7	0.5	0.3	4.4
800	660	101	4	2	33	82.5	12.6	0.5	0.25	4.1
900	754	107	4	2	33	83.7	11.8	0.4	0.2	3.6
1000	840	108	4	12	36	84	10.8	0.4	1.2	3.6
1100	895	152	4	12	37	81.3	13.8	0.4	1.09	3.3
1200	948	187	4	12	49	79	15.5	0.3	1.0	4.1
1300	1031	200	4	12	53	79.3	15.3	0.3	0.9	4.1
1400	1116	214	4	12	54	79	15.2	0.3	0.85	3.8
1500	1195	234	4	12	55	79.6	15.6	0.3	0.8	3.6

continued overleaf.

RANDOM COUNT

SALT VLEI 3/5/50 (continued)

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cyctocarpic Fronds	% Young Fertile Fronds
1600	1272	256	4	12	56	79.5	16	0.25	0.75	3.8
1700	1358	264	5	14	59	79.8	15.5	0.3	0.8	3.4
1800	1439	277	7	14	63	79.8	15.3	0.4	0.7	3.5
1900	1524	285	9	19	63	80.2	15.0	0.5	1.0	3.3
2000	1613	287	12	22	66	80.65	14.35	0.6	1.1	3.3
2100	1700	289	13	30	68	80.9	13.7	0.6	1.4	3.2
2200	1780	303	13	30	74	80.9	13.7	0.6	1.4	3.3
2300	1857	323	13	32	75	80.9	14	0.6	1.4	3.2
2400	1919	338	36	32	75	79.9	14	1.5	1.3	3.1
2500	1996	361	36	32	75	79.8	14.4	1.4	1.3	3
2600	2073	383	36	33	75	79.7	14.7	1.4	1.3	2.9
2700	2147	405	38	35	75	79.5	15	1.4	1.3	2.7
2800	2229	422	38	35	76	79.6	15	1.3	1.2	2.7
2900	2306	443	38	35	78	79.5	15.3	1.3	1.2	2.7
3000	2392	456	38	35	79	79.7	15.2	1.26	1.16	2.6

RANDOM COUNT

SALT VLEI 30/5/50

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	87	6	4	-	3	87	6	4	-	3
200	168	25	4	-	3	84	12.5	2	-	1.5
300	251	40	4	-	5	83.4	11.6	1.3	-	1.6
400	349	42	4	-	5	87.25	10.5	1	-	1.25
500	444	46	4	-	6	88.8	9.2	0.8	-	1.2
600	527	63	4	-	6	87.8	10.5	0.66	-	1
700	616	74	4	-	6	88	10.5	0.6	-	0.85
800	698	92	4	-	6	87.2	11.4	0.4	-	0.5
900	766	124	4	-	6	85.1	13.8	0.4	-	0.6
1000	857	130	4	-	9	85.7	13	0.4	-	0.9
1100	934	150	4	-	12	84.9	13.6	0.4	-	1.09
1200	1019	163	4	-	14	84.8	13.6	0.3	-	1.16
1300	1104	177	4	-	15	84.9	13.6	0.3	-	1.1
1400	1193	188	4	-	15	85.2	13.5	0.3	-	1.07
1500	1282	194	5	-	19	85.4	12.9	0.3	-	1.2
1600	1346	224	5	-	25	84.1	14	0.3	-	1.6
1700	1413	253	5	-	29	83.1	14.8	0.3	-	1.7
1800	1494	271	5	-	30	83	15	0.3	-	1.6
1900	1581	284	5	-	30	83.2	14.9	0.2	-	1.5
2000	1667	297	5	-	31	83.4	14.8	0.25	-	1.5
2100	1741	322	5	-	32	82.8	15.3	0.2	-	1.5

RANDOM COUNT

SALT VLEI 30/6/50

Total No. of Erect Fronds	Vegatative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	94	6	-	-	-	94	6	-	-	-
200	178	22	-	-	-	89	11	-	-	-
300	258	42	-	-	-	86	14	-	-	-
400	345	55	-	-	-	86.25	13.75	-	-	-
500	430	69	1	-	-	86	13.8	0.2	-	-
600	528	71	1	-	-	88	11.9	0.2	-	-
700	612	87	1	-	-	87.4	12.4	0.1	-	-
800	701	97	2	-	-	87.6	12.1	0.25	-	-
900	778	118	4	-	-	86.4	13.1	0.4	-	-
1000	861	135	4	-	-	86.1	13.5	0.4	-	-
1100	933	160	6	1	-	84.8	14.5	0.5	0.09	-
1200	1025	168	6	1	-	85.4	14	0.5	0.08	-
1300	1109	184	6	1	-	85.3	14.1	0.5	0.07	-
1400	1195	198	6	1	-	85.35	14.1	0.4	0.07	-
1500	1274	218	7	1	-	84.9	14.5	0.5	0.06	-
1600	1362	230	7	1	-	85.1	14.3	0.4	0.06	-
1700	1437	255	7	1	-	84.5	15	0.4	0.05	-
1800	1509	283	7	1	-	83.8	15.5	0.4	0.05	-
1900	1596	296	7	1	-	84	15.5	0.4	0.05	-
2000	1688	304	7	1	-	84.4	15.2	0.35	0.05	-

RANDOM COUNT

SALT VLEI 28/8/50

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	77	13	6	-	4	77	13	6	-	4
200	152	33	9	-	6	76	16.5	4.5	-	3
300	226	47	14	-	13	75.3	15.66	4.6	-	4.3
400	314	58	14	-	14	78.5	14.5	3.5	-	3.5
500	392	79	14	-	15	78.4	15.8	2.8	-	3
600	478	90	14	-	18	79.55	15	2.3	-	3
700	568	98	15	-	19	81.1	14	2.1	-	2.7
800	655	105	19	-	21	81.8	13.1	2.4	-	2.6
900	742	113	19	-	26	82.5	12.5	2.1	-	2.8
1000	818	131	19	3	29	81.8	13.1	1.9	0.3	2.9
1100	899	147	19	4	31	81.7	13.3	1.7	0.4	2.8
1200	980	161	23	4	32	81.6	13.4	1.7	0.3	2.6
1300	1046	192	23	4	35	80.4	14.7	1.7	0.3	2.7
1400	1129	202	24	5	40	80.6	14.4	1.7	0.35	2.85
1500	1212	214	25	5	44	80.8	14.2	1.6	0.3	2.8
1600	1294	227	25	5	49	80.9	14.2	1.5	0.3	3.06
1700	1377	243	25	5	50	81	14.3	1.5	0.3	2.9
1800	1456	261	25	5	52	80.9	14.5	1.4	0.3	2.8
1900	1540	275	25	5	55	81.05	14.5	1.3	0.3	2.9
2000	1618	290	25	6	61	80.9	14.5	1.25	0.3	3.05

RANDOM COUNT

SALT VLEI 30/7/50

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	95	5	-	-	-	95	5	-	-	-
200	183	17	-	-	-	91.5	8.5	-	-	-
300	272	27	-	-	1	90.6	9	-	-	0.3
400	362	32	5	-	1	90.5	8	1.25	-	0.25
500	450	44	5	-	1	90	8.8	1	-	0.2
600	530	62	5	-	3	88.3	10.3	0.8	-	0.4
700	618	72	6	-	4	88.3	10.3	0.8	-	0.6
800	704	86	6	-	4	87.55	10.75	0.75	-	0.5
900	797	93	6	-	4	88.55	10.3	0.6	-	0.4
1000	882	107	6	-	5	88.2	10.7	0.6	-	0.5
1100	967	121	6	-	6	87.9	11	0.5	-	0.5
1200	1059	129	6	-	6	88.3	10.8	0.5	-	0.5
1300	1146	140	7	-	7	88.15	10.8	0.5	-	0.5
1400	1232	151	8	-	9	88	10.8	0.6	-	0.6
1500	1324	158	9	-	9	88.2	10.6	0.6	-	0.6
1600	1405	175	11	-	9	87.8	10.9	0.7	-	0.6
1700	1490	183	12	-	15	87.6	10.8	0.7	-	0.9
1800	1576	197	12	-	15	87.5	10.8	0.7	-	0.8
1900	1665	207	12	-	16	87.6	10.9	0.6	-	0.85
2000	1750	222	12	-	16	87.5	11.1	0.6	-	0.8

RANDOM COUNT

SALT VLEI 24/9/50

Total No. of Erect Fronds	Vegetative Fronds not showing regeneration	Vegetative Fronds showing regeneration	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds not showing regeneration	% Vegetative Fronds showing regeneration	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	86	11	2	1	-	-	86	11	2	1	-	-
200	171	23	4	2	-	-	85.5	11.5	2	1	-	-
300	232	58	7	2	-	1	77.3	19.3	2.3	0.6	-	0.3
400	294	86	15	2	-	3	73.5	21.5	3.75	0.5	-	0.75
500	365	105	23	3	-	4	73	21	4.6	0.6	-	0.8
600	451	109	32	4	-	4	75.2	18.2	5.3	0.6	-	0.6
700	534	112	44	4	-	6	76.3	16	6.3	0.57	-	0.85
800	620	116	50	4	-	10	77.5	14	6.25	0.5	-	1.25
900	699	127	57	4	-	13	77.6	14.1	6.3	0.4	-	1.4
1000	767	138	73	7	-	15	76.7	13.8	7.3	0.7	-	1.5
1100	823	144	109	7	-	17	74.8	13.1	9.9	0.6	-	1.5
1200	899	156	113	14	-	18	74.9	13	9.41	1.2	-	1.5
1300	994	159	114	14	-	19	76.4	12.2	8.7	1.1	-	1.4
1400	1067	172	128	14	-	19	76.2	12.3	9.1	1	-	1.3
1500	1145	182	139	14	-	20	76.3	12.1	9.2	0.9	-	1.3
1600	1217	197	152	14	-	20	76.1	12.3	8.7	0.8	-	1.2
1700	1296	203	167	14	-	20	76.2	11.9	9.8	0.7	-	1.2
1800	1384	204	175	15	-	22	76.8	11.3	9.2	0.8	-	1.2
1900	1451	227	184	16	-	22	76.3	11.9	9.7	0.8	-	1.15
2000	1521	233	205	19	-	22	76.05	11.65	10.25	0.95	-	1.1

87.7

RANDOM COUNT

SALT VLEI 26/10/50

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	98	2	-	-	-	98	2	-	-	-
200	179	19	-	-	2	89.5	9.5	-	-	1
300	271	26	-	-	3	90.3	8.6	-	-	1
400	333	63	-	-	4	83.25	15.75	-	-	1
500	415	81	-	-	4	83	16.2	-	-	0.8
600	500	96	-	-	4	83.3	16	-	-	0.6
700	582	114	-	-	4	83.1	16.3	-	-	0.6
800	667	129	-	-	4	83.4	16.1	-	-	0.5
900	752	144	-	-	4	83.5	16	-	-	0.4
1000	825	171	-	-	4	82.5	17.1	-	-	0.4
1100	909	187	-	-	4	82.6	17	-	-	0.4
1200	996	199	-	-	5	83	16.6	-	-	0.4
1300	1067	228	-	-	5	82	17.5	-	-	0.4
1400	1145	250	-	-	5	81.8	17.8	-	-	0.35
1500	1220	275	-	-	5	81.3	18.3	-	-	0.3
1600	1294	301	-	-	5	80.8	18.8	-	-	0.3
1700	1386	309	-	-	5	81.5	18.2	-	-	0.3
1800	1461	334	-	-	5	81.1	18.5	-	-	0.3
1900	1561	334	-	-	5	82.1	17.6	-	-	0.3
2000	1661	334	-	-	5	83.05	16.7	-	-	0.25

RANDOM COUNT

SALT VLEI 25/11/50

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	63	36	-	-	1	63	36	-	-	1
200	142	56	1	-	1	71	28	0.5	-	0.5
300	219	77	1	-	3	73	25.6	0.3	-	1.0
400	298	91	1	-	10	74.5	22.75	0.25	-	2.5
500	367	120	1	-	12	73.4	24	0.2	-	2.4
600	447	140	1	-	12	74.5	23.3	0.2	-	2.0
700	529	158	1	-	12	75.6	22.6	0.1	-	1.7
800	598	185	2	-	15	74.7	23.1	0.25	-	1.9
900	671	210	3	-	16	74.5	23.3	0.3	-	1.7
1000	741	239	3	-	17	74.1	23.9	0.3	-	1.7
1100	811	268	4	-	17	73.7	24.4	0.4	-	1.5
1200	886	288	9	-	17	73.8	24.0	0.75	-	1.4
1300	956	315	10	-	19	73.5	24.2	0.8	-	1.5
1400	1019	348	10	-	23	72.8	24.8	0.7	-	1.6
1500	1086	378	12	-	24	72.4	25.2	0.8	-	1.1
1600	1162	400	13	-	25	72.7	25	0.8	-	1.6
1700	1224	434	13	-	29	72	26.1	0.8	-	1.7
1800	1296	455	14	-	35	72	25.3	0.8	-	1.9
1900	1362	483	14	-	41	71.7	25.4	0.7	-	2.15
2000	1447	497	14	-	42	72.35	24.85	0.7	-	2.1

RANDOM COUNT

SALT VLEI 22/12/50

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	79	17	-	-	4	79	17	-	-	4
200	129	55	1	9	6	64.5	27.5	0.5	4.5	3
300	204	74	5	10	7	68	24.6	1.6	3.3	2.3
400	284	93	5	11	7	71	23.2	1.2	2.7	1.7
500	345	125	10	12	8	69	25	2	2.4	1.6
600	421	145	11	13	10	70.2	24.2	1.8	2.2	1.6
700	494	170	11	13	12	70.6	24.1	1.6	1.9	1.7
800	571	193	11	13	12	71.4	24.1	1.4	1.6	1.5
900	648	210	11	17	14	72	23.3	1.2	1.9	1.5
1000	723	228	11	23	15	72.3	22.8	1.1	2.3	1.5
1100	784	256	18	26	16	71.3	23.3	1.6	2.3	1.4
1200	875	264	19	26	16	72.9	22	1.4	2.2	1.3
1300	952	283	19	27	17	73.2	21.7	1.4	2.1	1.3
1400	1033	297	23	27	18	74.5	21.2	1.8	1.9	1.3
1500	1091	326	29	31	21	72.7	21.7	1.9	2.1	1.4
1600	1157	350	36	35	22	72.3	21.9	2.2	2.2	1.4
1700	1225	373	36	43	23	72	21.9	2.1	2.5	1.3
1800	1297	394	41	43	25	72	21.9	2.3	2.4	1.4
1900	1371	402	46	54	27	72.1	21.1	2.4	2.8	1.4
2000	1451	417	47	57	29	72.25	20.85	2.35	2.85	1.45

RANDOM COUNT

SALT VLEI 22/1/51

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	87	13	-	-	-	87	13	-	-	-
200	170	26	1	-	3	85	13	0.5	-	1.5
300	248	47	1	-	4	82.6	15.6	0.3	-	1.3
400	330	64	2	-	4	82.5	16	0.5	-	1
500	413	79	2	-	6	82.6	15.8	0.4	-	1.2
600	497	93	3	-	7	82.8	15.5	0.4	-	1.2
700	583	100	9	1	7	83.3	14.3	1.3	0.1	1
800	671	109	11	1	8	83.9	13.6	1.4	0.1	1
900	758	120	13	1	8	84.2	13.3	1.4	0.1	0.8
1000	840	136	13	1	10	84	13.6	1.3	0.1	1
1100	918	157	13	1	11	83.45	14.3	1.2	0.1	1
1200	1009	166	13	1	11	84.4	13.8	1.1	0.1	0.9
1300	1103	171	13	1	12	84.8	13.15	1	0.1	0.9
1400	1192	182	13	1	12	85.1	13	0.9	0.1	0.85
1500	1275	198	13	1	13	85	13.2	0.9	0.1	0.9
1600	1366	205	13	3	13	85.4	12.8	0.8	0.2	0.8
1700	1452	218	13	3	14	85.4	12.8	0.8	0.2	0.8
1800	1548	222	13	3	14	86	12.3	0.7	0.2	0.8
1900	1626	239	15	3	17	85.6	12.6	0.8	0.15	0.9
2000	1718	244	15	5	18	85.9	12.2	0.75	0.25	0.9

RANDOM COUNT

SALT VLEI 23/2/51

Total No. of Erect Fronds	Vegetative Fronds	Tetrasporic Fronds	Male Fronds	Cystocarpic Fronds	Young Fertile Fronds	% Vegetative Fronds	% Tetrasporic Fronds	% Male Fronds	% Cystocarpic Fronds	% Young Fertile Fronds
100	77	19	-	-	4	77	19	-	-	4
200	147	41	4	3	5	73.5	20.5	2	1.5	2.5
300	227	61	4	3	5	75.6	20.3	1.3	1	1.6
400	306	82	4	3	5	76.5	20.5	1	0.7	1.25
500	394	93	4	4	5	78.8	18.6	0.8	0.8	1
600	482	104	4	5	5	80.3	17.3	0.7	0.8	0.8
700	555	129	5	5	6	79.3	18.4	0.7	0.7	0.8
800	639	144	5	5	7	79.9	18	0.6	0.6	0.9
900	731	152	5	5	7	81.2	16.7	0.55	0.5	0.8
1000	815	164	7	5	9	81.5	16.4	0.7	0.5	0.9
1100	882	192	11	5	10	80.2	17.45	1.0	0.4	0.9
1200	962	211	11	5	11	80.2	17.6	0.9	0.4	0.9
1300	1042	228	13	5	12	80.15	17.5	1.0	0.4	0.9
1400	1103	262	15	5	15	78.8	18.7	1.1	0.4	1.1
1500	1189	276	15	5	15	79.3	18.4	1.0	0.3	1.0
1600	1259	304	15	5	17	78.7	19	0.9	0.3	1.1
1700	1338	321	17	7	17	78.7	18.9	1	0.4	1
1800	1412	341	19	8	20	77.4	18.9	1	0.4	1.1
1900	1497	355	19	8	21	78.8	18.7	1	0.4	1.1
2000	1583	368	20	8	21	79.15	18.4	1	0.4	1.05

RANDOM COUNT

SALT VLEI 3/4/50

Types of fronds in successive hundreds as counted.

Hundreds of Fronds	Vegetative Fronds per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
1st. 100	78	16	-	-	6
2nd. "	83	17	-	-	-
3rd. "	90	8	-	-	2
4th. "	91	8	-	-	1
5th. "	73	19	-	-	8
6th. "	79	11	-	-	10
7th. "	72	25	-	-	3
8th. "	95	2	3	-	-
9th. "	87	12	-	-	1
10th. "	73	23	-	-	4
11th. "	78	8	-	-	14
12th. "	91	9	-	-	-
13th. "	86	10	-	-	4
14th. "	91	8	-	-	1
15th. "	72	21	-	-	7
16th. "	84	9	-	-	7
17th. "	85	6	1	-	8
18th. "	78	9	-	-	13
19th. "	92	1	-	-	7
20th. "	90	8	1	-	1
21st. "	88	11	-	-	1
22nd. "	85	9	-	-	6

RANDOM COUNT

SALT VLEI 3/5/50

Types of fronds in successive hundreds as counted.

Hundreds of Fronds	Vegetative Fronds per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
1st. 100	84	10	4	1	1
2nd. "	78	19	-	-	3
3rd. "	82	15	-	1	2
4th. "	86	14	-	-	-
5th. "	80	9	-	-	11
6th. "	81	15	-	-	4
7th. "	76	14	-	-	10
8th. "	93	5	-	-	2
9th. "	94	6	-	-	-
10th. "	86	1	-	10	3
11th. "	55	44	-	-	1
12th. "	53	35	-	-	12
13th. "	83	13	-	-	4
14th. "	85	14	-	-	1
15th. "	79	20	-	-	1

(continued overleaf)

RANDOM COUNT

SALT VLEI 3/5/50 (continued)

Types of fronds in successive hundreds as counted.

Hundreds of Fronds	Vegetative Fronds per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
16th. 100	77	22	-	-	1
17th. "	86	8	1	2	3
18th. "	81	13	2	-	4
19th. "	85	8	3	5	-
20th. "	89	2	1	3	3
21st. "	87	2	-	8	2
22nd. "	80	14	-	-	6
23rd. "	77	20	-	2	1
24th. "	62	15	23	-	-
25th. "	77	23	-	-	-
26th. "	77	22	-	1	-
27th. "	74	22	2	2	-
28th. "	82	17	-	-	1
29th. "	77	21	-	-	2
30th. "	86	13	-	-	1

RANDOM COUNT

SALT VLEI 30/6/50

Types of fronds in successive hundreds as counted.

Hundreds of Fronds	Vegetative Fronds per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
1st. 100	94	6	-	-	-
2nd. "	84	16	-	-	-
3rd. "	80	20	-	-	-
4th. "	87	13	-	-	-
5th. "	85	14	1	-	-
6th. "	98	2	-	-	-
7th. "	84	16	-	-	-
8th. "	89	10	1	-	-
9th. "	77	21	2	-	-
10th. "	83	17	-	-	-
11th. "	72	25	2	1	-
12th. "	92	8	-	-	-
13th. "	84	16	-	-	-
14th. "	86	14	-	-	-
15th. "	79	20	1	-	-
16th. "	88	12	-	-	-
17th. "	75	25	-	-	-
18th. "	72	28	-	-	-
19th. "	87	13	-	-	-
20th. "	92	8	-	-	-

RANDOM COUNT.

SALT VLEI 30/7/50

Types of fronds in successive hundreds as counted.

Hundreds of Fronds	Vegetative Fronds per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
1st. 100	95	5	-	-	-
2nd. "	88	12	-	-	-
3rd. "	89	10	-	-	1
4th. "	90	5	5	-	-
5th. "	88	12	-	-	-
6th. "	80	18	-	-	2
7th. "	88	10	1	-	1
8th. "	86	14	-	-	-
9th. "	93	7	-	-	-
10th. "	85	14	-	-	1
11th. "	85	14	-	-	1
12th. "	92	8	-	-	-
13th. "	87	11	1	-	1
14th. "	86	11	1	-	2
15th. "	92	7	1	-	-
16th. "	81	17	2	-	-
17th. "	85	8	1	-	6
18th. "	86	14	-	-	-
19th. "	89	10	-	-	1
20th. "	85	15	-	-	-

RANDOM COUNT

SALT VLEI 28/8/50

Types of fronds in successive hundreds as counted.

Hundreds of Fronds	Vegetative Fronds per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
1st. 100	77	13	6	-	4
2nd. "	75	20	3	-	2
3rd. "	74	14	5	-	7
4th. "	88	11	-	-	1
5th. "	78	21	-	-	1
6th. "	86	11	-	-	3
7th. "	90	8	1	-	1
8th. "	87	7	4	-	2
9th. "	87	8	-	-	5
10th. "	76	18	-	3	3
11th. "	81	16	-	1	2
12th. "	81	14	4	-	1
13th. "	66	31	-	-	3
14th. "	83	10	1	1	5
15th. "	83	12	1	-	4
16th. "	82	13	-	-	5
17th. "	83	16	-	-	1
18th. "	80	18	-	-	2
19th. "	83	14	-	-	3
20th. "	78	15	-	1	6

RANDOM COUNT

SALT VLEI 24/9/50

Types of fronds in successive hundreds as counted.

Hundreds of Fronds	Vegetative Fronds not showing regeneration per 100	Vegetative Fronds showing regeneration per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
1st. 100	86	11	2	1	-	-
2nd. "	85	12	2	1	-	-
3rd. "	61	35	3	-	-	1
4th. "	62	28	8	-	-	2
5th. "	71	19	8	1	-	1
6th. "	86	4	9	1	-	-
7th. "	83	3	12	-	-	2
8th. "	86	4	6	-	-	4
9th. "	79	11	7	-	-	3
10th. "	68	11	16	3	-	2
11th. "	56	6	36	-	-	2
12th. "	76	12	4	7	-	1
13th. "	95	3	1	-	-	1
14th. "	73	13	14	-	-	-
15th. "	78	10	11	-	-	1
16th. "	72	15	13	-	-	-
17th. "	79	6	15	-	-	-
18th. "	88	1	8	1	-	2
19th. "	67	23	9	1	-	-
20th. "	70	6	21	3	-	-

RANDOM COUNT

SALT VLEI 26/10/50

Types of fronds in successive hundreds as counted.

Hundreds of Fronds	Vegetative Fronds per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
1st. 100	98	2	-	-	2
2nd. "	81	17	-	-	1
3rd. "	92	7	-	-	1
4th. "	62	37	-	-	-
5th. "	82	18	-	-	-
6th. "	85	15	-	-	-
7th. "	82	18	-	-	-
8th. "	85	15	-	-	-
9th. "	85	15	-	-	-
10th. "	73	27	-	-	-
11th. "	84	16	-	-	-
12th. "	87	12	-	-	1
13th. "	71	29	-	-	-
14th. "	78	22	-	-	-
15th. "	75	25	-	-	-
16th. "	74	26	-	-	-
17th. "	92	8	-	-	-
18th. "	75	25	-	-	-
19th. "	100	-	-	-	-
20th. "	100	-	-	-	-

RANDOM COUNT

SALT VLEI 25/11/50

Types of fronds in successive hundreds as counted.

Hundreds of Fronds	Vegetative Fronds per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
1st. 100	63	36	-	-	1
2nd. "	79	20	1	-	-
3rd. "	77	21	-	-	2
4th. "	79	14	-	-	7
5th. "	69	29	-	-	2
6th. "	80	20	-	-	-
7th. "	82	18	-	-	-
8th. "	69	27	1	-	3
9th. "	73	25	1	-	1
10th. "	70	29	-	-	1
11th. "	70	29	1	-	-
12th. "	75	20	5	-	-
13th. "	70	27	1	-	2
14th. "	63	33	-	-	4
15th. "	67	30	2	-	1
16th. "	76	22	1	-	1
17th. "	62	34	-	-	4
18th. "	72	21	1	-	6
19th. "	66	28	-	-	6
20th. "	85	14	-	-	1

RANDOM COUNT

SALT VLEI 22/1/51

Types of fronds in successive hundreds as counted.

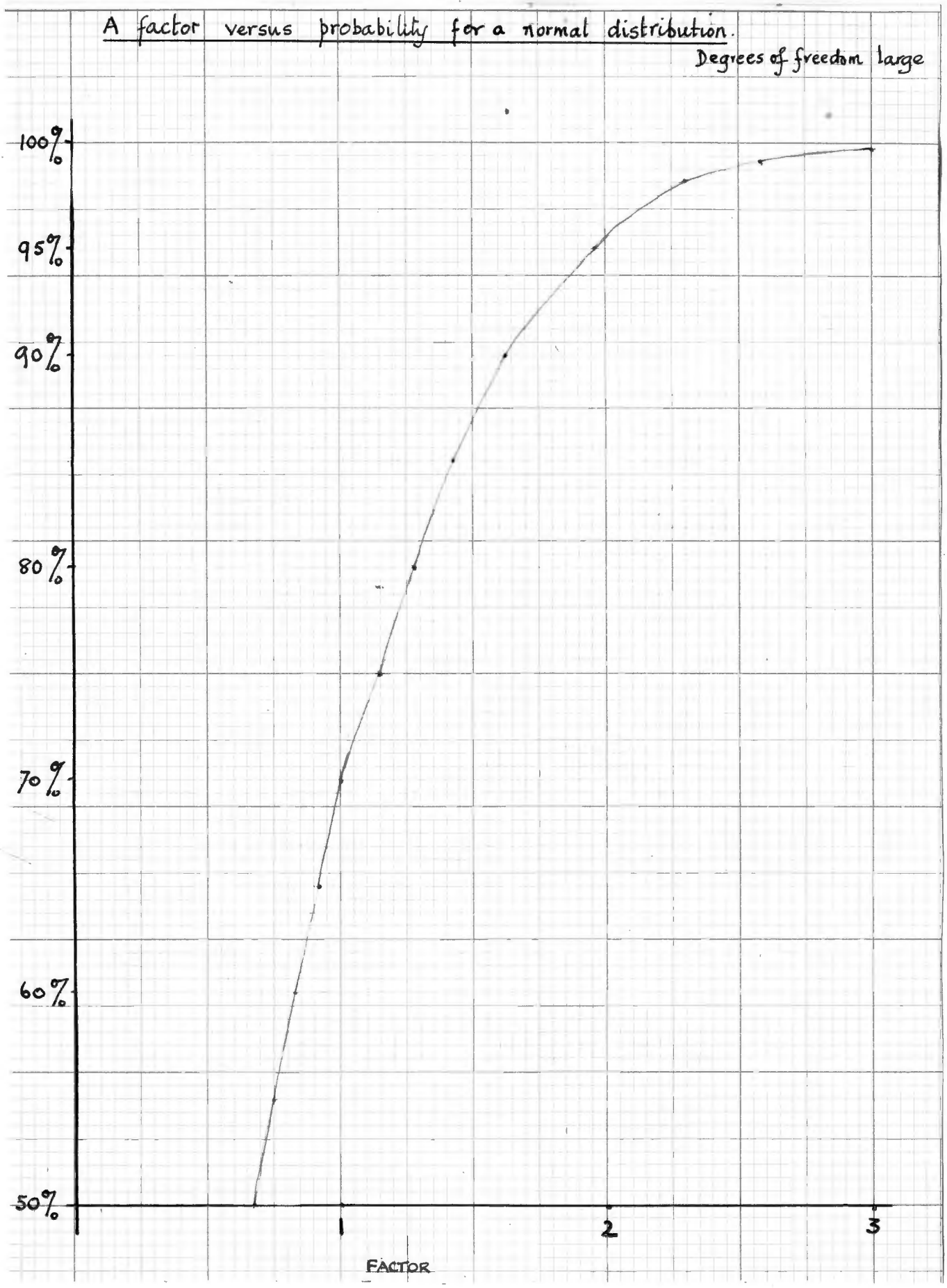
Hundreds of Fronds	Vegetative Fronds per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
1st. 100	87	13	-	-	-
2nd. "	83	13	1	-	3
3rd. "	78	21	-	-	1
4th. "	82	17	1	-	-
5th. "	83	15	-	-	2
6th. "	84	14	1	-	1
7th. "	86	7	6	1	-
8th. "	88	9	2	-	1
9th. "	87	11	2	-	-
10th. "	82	16	-	-	2
11th. "	78	21	-	-	1
12th. "	91	9	-	-	-
13th. "	94	5	-	-	1
14th. "	89	11	-	-	-
15th. "	83	16	-	-	1
16th. "	91	7	-	2	-
17th. "	86	13	-	-	1
18th. "	96	4	-	-	-
19th. "	78	17	2	-	3
20th. "	92	5	-	2	1

RANDOM COUNT.

SALT VLEI 23/2/51

Types of fronds in successive hundreds as counted.

Hundreds of Fronds	Vegetative Fronds per 100	Tetrasporic Fronds per 100	Male Fronds per 100	Cystocarpic Fronds per 100	Young Fertile Fronds per 100
1st. 100	77	19	-	-	4
2nd. "	70	22	4	3	1
3rd. "	80	20	-	-	-
4th. "	79	21	-	-	-
5th. "	88	11	-	1	-
6th. "	88	11	-	1	-
7th. "	73	25	1	-	1
8th. "	84	15	-	-	1
9th. "	92	8	-	-	-
10th. "	84	12	2	-	2
11th. "	67	28	4	-	1
12th. "	80	19	-	-	1
13th. "	80	17	2	-	1
14th. "	61	34	2	-	3
15th. "	86	14	-	-	-
16th. "	70	28	-	-	2
17th. "	79	17	2	2	-
18th. "	74	20	2	1	3
19th. "	85	14	-	-	1
20th. "	86	13	1	-	-


A factor versus probability for a normal distribution.
Degrees of freedom large
100%
95%
90%
80%
70%
60%
50%
1
2
3
FACTOR

SUMMARY OF METHOD OF DETERMINING PROBABILITY RANGE

Properties of Matter Champion and Davy Page 262 and seq.

Applied General Statistics Croxton and Crowden Page 307 and seq.

Probability zones were constructed to find out to what extent the individual counts for each month were likely to be valid. The numbers of the constitutent fronds (tetrasporic, vegetative etc.) in each successive 100 fronds in the total of 2000 were recorded for every month (except March 1950) and from these the range was calculated.

To find the range R for a given probability P i.e. a number such that there is the probability P of the true value differing from the arithmetic mean by less than this number, the procedure is as follows:-

The factor F is determined for the value P decided upon by reference to the Graph opposite (see Appendix E Croxton and Cowden).

Then $R = \frac{F}{\sqrt{n}} \sqrt{\frac{\Sigma d^2}{n}}$ where n is the number of values used in determining the arithmetic mean, and

$\sqrt{\frac{\Sigma d^2}{n}}$ is the standard deviation.

When the actual figures used are less than 30 (and in this case using 100 fronds numbers less than 30 often occur) the values used for the factor-versus-probability are in accordance with table F in Applied General Statistics : Croxton and Cowden.

A sample calculation (tetrasporic fronds for June 1950) is shown as follows:-

TETRASPORIC FRONDS JUNE 1950

Hundreds of fronds	Number of tetrasporic fronds	Deviation from Arithmetic Mean	Square of Deviation
1st 100	6	-9.2	84.64
2nd "	16	0.8	.64
3rd "	20	4.8	23.04
4th "	13	-2.2	4.84
5th "	14	-1.2	1.21
6th "	2	-13.2	174.2
7th "	16	0.8	.64
8th "	10	-5.2	27.04
9th "	21	5.8	33.64
10th "	17	1.8	3.24
11th "	25	9.8	96.04
12th "	8	-7.2	51.84
13th "	16	0.8	.64
14th "	14	-1.2	1.44
15th "	20	4.8	23.04
16th "	12	-3.2	10.24
17th "	25	9.8	96.04
18th "	28	12.8	163.8
19th "	13	-2.2	4.84
20th "	8	-7.2	51.84

TOTAL 304 Sum of Squares of Deviation = 852.89

Arithmetic Mean = 15.2

R for 95% $= \frac{F}{\sqrt{n}}\sqrt{\frac{\Sigma d^2}{n}}$

$= \frac{1.96}{4.47}\sqrt{42.64}$

$= 2.9\%$ (2.86%)

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