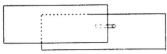
APPENDICES

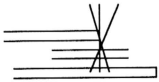
APPENDIX 1 : OBSERVATION ON FERTILITY

Selected receptacles are removed from plants and section cutting is done to prepare slides. The procedures involve :

1. Specimen to be section is placed in water towards one end of a clean slide.
2. Carefully place the second slide (or use the finger) over the first with one end overlapping specimen, as shown below :



3. Position the specimen as required, hold firmly between slides with finger pressure, and use end of upper slide as guide (or using the finger) for the face of razor when cutting. Progressively altering the angle of the razor blade to the vertical. A series of thin, slightly wedge-shape sections can readily be cut. Carefully move the top slide (or finger) to expose more specimen as required.



4. Upper slide and unwanted specimen pieces is removed. Sections are then mounted in water and staining is used.
5. Finally, observe the slides under light microscope.

APPENDIX 2 : PROCEDURE FOR THE ANALYSIS OF AMMONIA

AMMONIA (Phenol-Alcohol Method)

REAGENTS & APPARATUS

Phenol-alcohol solution
Dissolve 10 g reagent grade Phenol (C_6H_5OH) in 100 ml 95% Ethyl Alcohol (C_2H_5OH).

Sodium nitroperusside solution (0.5% w/v)
Dissolve 1 g Sodium Nitroperusside, $NaFe(CN)_5NO.2H_2O$, in 200 ml water.
Store in an amber bottle.
The solution keeps for no >1 month.

Alkaline citrate solution
Dissolve 100 g A.R. Trisodium Citrate, $C_3H_4OH(COONa)_3.2H_2O$, & 5 g NaOH in 500 ml distilled water.

Oxidixing solution
Mix 4 volumes Alkaline Citrate solution & 1 volume Hypochlorite.
This mixture is unstable & should be used on the same day.

Std. ammonia solution
Dissolve 45.8 mg Ammonia Chloride, NH_4Cl, (best grade available) in distilled water & make up to 1 L in a volumetric flask.
A 10X dilution of this stock gives a working solution containing 1.2 µg Ammonia Nitrogen per ml.
It is quite stable.

Reagent bottles or stoppered flasks, 100 - 150 ml capacity.

Dilute HCL (≈ 10% v/v) for washing of glassware.

Spectrophotometer & 10 ml cuvette.

PROCEDURE

Using a graduated cylinder measure 50 ml of each sample into 100 ml reagent bottles/stoppered flasks.
Take 3 additional 50 ml aliquots from 1 of the samples to prepare stds. - preferably from water collected from a zone of minimal biological activity (80 m or deeper).

Spike the std aliquots with the std Ammonia solution :
0.25 ml, 0.50 ml & 1.00 ml (= 6, 12 & 24 µg NH_3-N per L)

Add 2 ml Phenol-Alcohol solution, 2 ml Sodium Nitroperusside solution & 5 ml Oxidizing solution in succession to each 50 ml of sample or std, mixing thoroughly after each addition.

Allow the blue colour of indophenol to develop at room temperature, 22-27°C, for at least 1 hour. Since samples drawn from different depths may have markedly different initial temperatures, it may be preferable to use a water bath, especially for short developing times.

The blue colour is stable for at least 18 hours.

Read the absorbance at 640 nm in a 1o cm cuvette, with distilled water in the reference cell. The absorbance due to the turbidity of each seawater sample should be measured first on duplicate 50 ml samples without reagents.

Treat 50 ml of de-ionized distilled water with the colour-developing reagents to get a reagent blank absorbance.

This value, together with the respective turbidity absorbance, should be subtracted from the final absorbance of each sample or std with the colour developed.

NOTES

The concentration range of ammonia in seawater is normally $\approx 0.1 - 2.0$ μ mole/L
(1 μ mole = 1 μg-atom = 14 μgNH_3-N/L)

Analysis should begin within 2 hours of collecting the samples.
Since filtering usually introduces contamination, unfiltered samples must be used, and hence turbidity blanks must be run, as described above.

All glassware used must be cleaned by washing initially with warm dilute HCl.
Alternatively the HCl may be left standing in the glassware between sets of determination.
Rinse thoroughly with distilled water & then with the sample seawater.
Allow to drain; do not dry.
The HCl may be used repeatedly.

Care must be taken at all times to avoid extraneous contamination by NH_3.

Distilled water used for washing & for making up reagents should be freshly removed from a cation exchange resin column.

Materials containing NH_3 should be kept & used elsewhere.
This includes floor & bench cleaning agents.

Samples should be handled in stoppered bottles or flasks & not be unnecessarily exposed to the atmosphere or to rubber.

No smoking should be allowed in the laboratory.

The reagent blank absorbance should be ≈ 0.060 in a 10 cm cuvette.
The yellow colouration in the blank does not absorb at 640 nm.
This 0.060 absorbance corresponds to ≈ 0.45 μ mole NH_3-N/L.
Samples of zero Ammonia content often occur & may be used as a check of the reagent blank, i.e., if the latter is higher than the lowest sample absorbance, the distilled water supply is probaly contaminated.

Sensitivity varies from day to day.
The extreme range encountered by us has been 0.098 - 0.140 absorbance for 1 μ mole NH_3-N/L.

Turbidity absorbance values range from 0.001 - 0.005 in relatively "clean" waters.

REFERENCE

Solorzano, L. 1969. Determination of ammonia in natural waters by the phenolhypochlorite method. *Limnol. Oceanogr.* **14**:799-801.

APPENDIX 3 : PROCEDURE FOR THE ANALYSIS OF NITRATE

NITRATE

Nitrate can be found in rubber effluent due to the oxidation of ammoniacal nitrogen by microorganisms. The concentration of nitrate in an effluent can be easily measured by the colorimetry. The method is based on the formation of very intense yellow colour of sodium paranitrosalicylate complex after the addition of sodium salicylate solution to the effluent sample.

APPARATUS

I. Spectrophotometer II. Steam-bath

REAGENTS

Sodium salicylate 0.5% (w/v)
Dissolve 5 g in 1 L distilled water.
Must be prepared daily.

Conc. H_2SO_4 (S.G. = 1.84)

NaOH 30% (w/v)
Dissolve 30 g NaOH in 100 ml distilled water.

Std. nitrate solution, 1000 ppm NO_3
Dissolve 1.3710 g $NaNO_3$ in 1 L distilled water.
Keep the solution cool.
Prepare a dilution containing 50 ppm NO_3. (5 ml in 100 ml distilled water)

Std. series
Pipette 0, 1 ,2 ,4 & 6 ml of 50 ppm nitrate solution into beakers of 100 ml.
Continue the procedure as given below.
These solutions contain respectively 0, 50, 100, 200 & 300 μg nitrate.

PROCEDURE

Pipette 5 ml of an effluent sample (filter if necessary) into a beaker of 100 ml.
Make it alkaline by the addition of 0.5 ml of N NaOH.

Add 1 ml sodium salicylate solution & evaporate to dryness on steam-bath.

Take up the residue in 1 ml conc. H_2SO_4.

After 10 min, add 10 ml distilled water & 10 ml 30% NaOH.

Measure the intensity of the yellow coloured complex at 460 nm in a cuvette of 1 cm^2 in a spectrophotometer.

If from the std. curve, the extintion measured is correspondent to a μg of nitrate, then :

a μg NO_3^- / 5 ml effluent
Nitrate (mg/l) = a X 1/5

APPENDIX 4 : PROCEDURE FOR THE ANALYSIS OF PHOSPHATE

DISSOLVED ORTHOPHOSPHATE (SINGLE SOLUTION METHOD : RECOMMENDED)

REAGENTS & APPARATUS

Molybdate solution
Dissolve 15 g A.R. Ammonium Paramolybdate, $(NH_4)6Mo_7O_{24}.4H_2O$, preferably finely crystaline, in 500 ml distilled water.
Keep in a plastic bottle out of direct sunlight.
The solution is stable for a few weeks.

H_2SO_4 solution
Add 140 ml A.R. concentrated H_2SO_4 to 900 ml distilled water & mix, taking the usual precautions.

Ascorbic acid solution
Dissolve 5.4 g of high quality Ascorbic Acid, $C_6H_8O_6$, in 100 ml distilled water.
Prepare this solution on the day it is to be used.

Potassium antimonyl tartarate solution
Dissolve 0.34 g of high quality Potassium Antimonyl Tartarate, $KSbO.C_4H_4O_6$, in 250 ml water, warming if necessary.
Stored in a plastic or glass bottle.
The solution is stable for many months.

Mixed reagent
Mix together 100 ml Ammonium Molybdate, 250 ml H_2SO_4, 100 ml Ascorbic Acid, & 50 ml Potassium Antimonyl Tartarate solutions.
Prepare shortly before use & discard any excess.
Keep for no >6 hr.

Std phosphate solution
Dissolve 0.439 g of desiccated Potassium Dihydrogen Phosphate, KH_2PO_4 (A.R.), in distilled water & make up to 1 L. Add a few drops of Chloroform & store in a dark bottle.
This solution contains 100,000 µg PO_4^{3-}-P/litre.
Prepare 1 litre of PO_4^{3-} solution containing 1000 µg PO_4^{3-}/litre by diluting 10 ml of the above stock. The dilute solution should not be kept for longer than 3 months.

Glassware
Clean thoroughly with conc. H_2SO_4 & rinse well.
It is advisable to retain the same flasks for this determination with occasional H_2SO_4 cleaning.
Apparatus not in use should be kept filled with 0.1% v/v H_2SO_4 in distilled water solution.

Spectrophotometer & 10 ml cuvettes.

PROCEDURE

Carefully make up reference solutions containing 0, 2, 5, & 7 µ PO_4^{3-} by taking), 2, 5, & 7 ml of the 1000 µ PO_4^{3-} -P/litre std solution & diluting to 100 ml with distilled water.

Warm all samples to a temperature between 15 & 30°C in a thermostatically controlled water bath & measure the absorbance of samples to obtain a turbidity correction.

To 100 (or 25) ml of each sample & to the reference solutions, add 10 (or 2.5) + 0.5 ml of mixed reagent from a 25 ml measuring cylinder & mix at once.

After 10 min & within 2 - 3 hr, measure the absorbance of the solutions in a 10 cm cuvette against distilled water at a wavelength of 885 nm.

NOTES

The samples should preferably be analysed within an hr of collection & certainly before 6 hrs has elapsed. Otherwise, they must be either be frozen or kept in iodined-impregnated plastic bottles.[3]

The sample may be frozen by careful immersion in a mixture of solid CO_2 & alcohol &/or stored in a deep-freeze cabinet.

To impregnate plastic bottles with iodine, fill them with a solution containing 8% KI & 5% I_2 & allow to stand for 1 week. Then, wash the bottles with distilled water.
The iodine preservation technique cannot be used if the stannous chloride method is to be used to determine the phosphate.

The effect of temperature on colour development is small, and in many instances, there may be no need to warm the samples first.

Turbidity measurements, if consistent, need not be performed on every sample.

An alternative to preparing a daily requirement of Ascorbic Acid solution is to make up a large quantity (27 g dissolved in 500 ml distilled water) & store, frozen solid in a plastic bottle. Thaw for use & freeze the remainder at once. With this treatment, the reagent is stable for several months.

Orthophosphate-phosphate levels in surface waters are frequently < 10 µg/litre, but at depths > 100 m may range up to 60 µg/litre or more.

"Dissolved orthophosphate" is also variously described as "reactive phosphorus" or "inorganic phosphate". It includes labile organic phosphorus as well as the soluble phosphate ions. Since the particulate matter in seawater is unlikely to contain these forms of phosphorus, it matters little whether the determination is made on unfiltered or filtered water, although for reasons of turbidity & stability the determination on filtered water is becoming favoured.

The unreactive phosphorus (organic or inorganic) level in seawater is found by difference : it equals the total phosphorus determination minus the dissolved orthophosphate determination.

There is no "salt error" in this method.
A given quantity of PO_4^{3-}-P develops the same absorbance in both distilled & seawater.

REFERENCES

Murphy, J. & Riley, J.P. 1962. A modified single solution method for the determination of phosphate in natural waters. *Analytica chim. Acta.* **27**:31-36.

Strickland, J.D.H. & Parsons, T.R. 1968. A practical handbook of seawater analysis. *Bull. Fish. Res. Bd. Can.* **167**: Section II.2.1.

Heron, J. 1962. Determination of phosphate in water after storage in polyethylene. *Limnol. Oceanogr.* 7:316-321.

APPENDIX 5 : GROWTH RATE, DEGENERATIVE RATE, PERCENTAGE OF PLANTS BEARING RECEPTACLES AND MEAN THALLUS LENGTH OF *S. baccularia*

	1995																
Period	20/1-17/2	17/2-17/3	17/3-2/4	2/4-16/4	16/4-14/5	14/5-2/6	2/6-11/6	11/6-28/6	28/6-11/7	11/7-12/8	12/8-26/8	26/8-8/9	8/9-24/9	24/9-8/10	8/10-22/10	22/10-4/11	4/11-25/11	25/11-23/12
No of plants	5	2	4	11	6	24	20	21	6	6	66	68	48	43	30	24	5	2
Growth rate (mm d^{-1})	1.46	1.82	1.50	1.12	2.02	1.64	3.01	2.74	1.83	1.01	1.80	0.72	0.85	0.52	0.68	0.49	0.67	0
Standard deviation	1.30	0.30	1.70	1.03	1.83	1.33	3.36	2.06	1.70	0.73	2.47	0.65	0.89	0.51	0.64	0.51	0.66	0
No of plants	6	12	8	5	2	15	14	13	21	7	45	55	66	50	31	21	8	4
Degenerative rate (mm d^{-1})	-1.73	-3.21	-2.16	-3.31	-0.61	-2.00	-3.13	-2.14	-4.81	-0.60	-2.00	-2.31	-1.70	-1.96	-0.72	-1.41	-0.63	-0.54
Standard deviation	1.15	2.85	2.78	1.66	0.71	2.41	3.84	1.58	4.88	0.40	2.04	3.70	1.81	2.59	0.80	2.28	0.64	0.65
Date	20/1/95	17/2/95	17/3/95	2/4/95	16/4/95	14/5/95	2/6/95	11/6/95	28/6/95	11/7/95	12/8/95	26/8/95	8/9/95	24/9/95	8/10/95	22/10/95	4/11/95	25/11/95
no of plants	28	32	17	18	17	57	39	48	34	30	115	148	148	126	96	65	63	15
% Bearing receptacles	7.14	15.62	0	0	0	0	0	0	2.94	6.67	1.74	1.35	0	0	0	0	0	0
Mean length (mm)	242.96	177.47	108.82	92.11	88.18	90.49	95.46	98.23	92.76	70.40	73.10	71.09	59.82	49.60	42.90	41.23	36.92	33.60
Standard deviation	108.16	83.82	64.49	48.11	45.15	53.19	62.11	66.00	69.34	63.04	47.08	55.13	44.11	37.48	29.57	28.59	19.72	23.15

	1996						
Period	23/12-10/1	10/1-23/1	23/1-8/2	8/2-22/2	22/2-8/3	8/3-24/3	
No of plants	6	16	9	21	13	12	
Growth rate (mm d^{-1})	0.15	0.94	0.56	1.48	1.05	1.15	
Standard deviation	0.11	1.39	0.46	1.40	1.02	1.16	
No of plants	4	7	8	8	15	9	
Degenerative rate (mm d^{-1})	-0.19	-0.76	-0.99	-1.14	-1.29	-1.17	
Standard deviation	0.06	0.69	1.12	0.84	1.03	1.45	
Date	23/12/95	10/1/96	23/1/96	8/2/96	22/2/96	8/3/96	24/3/96
no of plants	20	34	25	32	30	28	22
% Bearing receptacles	0	0	0	0	0	0	0
Mean length (mm)	26.75	30.76	37.56	38.34	49.73	47.61	51.64
Standard deviation	16.85	12.55	23.25	17.56	24.07	31.14	41.40

APPENDIX 6 : GROWTH RATE, DEGENERATIVE RATE, PERCENTAGE PLANTS BEARING RECEPTACLES AND MEAN THALLUS LENGTH OF *S. swartzii*

	1995																
Period	20/1-17/2	17/2-17/3	17/3-2/4	2/4-16/4	16/4-14/5	14/5-2/6	2/6-11/6	11/6-28/6	28/6-11/7	11/7-12/8	12/8-26/8	26/8-8/9	8/9-24/9	24/9-8/10	8/10-5/11	5/11-25/11	25/11-23/12
No of plants	4	5	2	7	2	13	10	8	8	3	13	16	7	8	5	2	2
Growth rate (mm d^{-1})	1.28	1.07	1.76	2.11	0.63	1.6	3.31	1.65	1.08	2.17	1.98	1.62	1.84	1.03	1.54	0.12	0.43
Standard deviation	0.57	0.82	2.22	3.44	0.03	1.22	3.12	1.07	1.31	1.05	1.37	1.13	1.20	0.75	0.81	0.10	0.25
No of plants	7	9	7	2	1	7	7	14	12	1	7	9	13	2	3	3	1
Degenerative rate (mm d^{-1})	-2.76	-1.52	-4.42	-1.86	-0.89	-1.26	-3.43	-2.14	-4.41	-1	-2.62	-3.09	-1.50	-4.88	-2.14	-0.75	-0.25
Standard deviation	2.05	1.94	4.72	2.42	-	1.30	4.88	2.03	2.88	-	3.23	2.03	1.87	4.98	1.48	0.52	-
Date	20/1/95	17/2/95	17/3/95	2/4/95	16/4/95	14/5/95	2/6/95	11/6/95	28/6/95	11/7/95	12/8/95	26/8/95	8/9/95	24/9/95	8/10/95	5/11/95	25/11/95
no of plants	29	31	20	17	10	41	19	34	25	24	22	33	35	20	11	13	5
% Bearing receptacles	31.03	32.26	35.00	0	0	9.76	21.05	5.88	4.00	8.70	18.18	9.09	0.03	15	27.27	15.38	0
Mean length (mm)	236.03	177.10	132.15	58.12	76.00	80.29	93.47	95.35	85.88	69.92	71.95	68.79	61.57	66.90	54.27	46.08	16.40
Standard deviation	91.91	81.64	67.24	47.06	55.16	44.57	57.33	56.97	46.58	50.91	49.98	33.85	38.77	62.86	40.55	36.53	5.41

	1996					
Period	23/12-23/1	23/1-8/2	8/2-22/2	22/2-8/3	8/3-24/3	
no of plants	3	3	5	5	-	
Growth rate (mm d^{-1})	0.81	0.73	2.09	3.52	-	
Standard deviation	0.75	0.48	1.12	3.44	-	
No of plants	5	-	1	-	2	
Degenerative rate (mm d^{-1})	-1.19	-	-0.93	-	-0.41	
Standard deviation	0.52	-	-	-	0.13	
Date	23/12/95	23/1/96	8/2/96	22/2/96	8/3/96	24/3/96
no of plants	4	13	7	7	5	2
% Bearing receptacles	0	0	0	0	60.00	50.00
Mean length (mm)	33.75	29.92	33	75.14	133.60	175
Standard deviation	18.41	14.73	16.02	49.02	106.13	190.92

APPENDIX 7

A. LENGTH CLASSES OF *S. baccularia*

LENGTH CLASSES (mm)	FREQUENCY	% FREQUENCY
0 -49	646	50.19
50 - 99	376	29.22
100 - 149	132	10.26
150 - 199	76	5.91
200 - 249	30	2.33
250 - 299	15	1.17
300 - 349	6	0.47
350 - 399	2	0.16
400 - 449	4	0.31

B. LENGTH CLASSES OF *S. swartzii*

LENGTH CLASSES (mm)	FREQUENCY	% FREQUENCY
0 -49	150	35.13
50 - 99	132	30.91
100 - 149	61	14.29
150 - 199	40	9.37
200 - 249	19	4.45
250 - 299	14	3.28
300 - 349	7	1.64
350 - 399	3	0.70
400 - 449	0	0
450 - 499	1	0.23

APPENDIX 8 : BIOMASS (g m^{-2}), PERCENTAGE OF REPRODUCTIVE PLANTS AND MEAN THALLUS LENGTH (mm) OF *S. baccularia* IN DESTRUCTIVE SAMPLINGS

	Jan-95	*Apr-95	Jul-95	Oct-95	Jan-96	Apr-96
No of quadrats	7	51	57	58	55	55
Wet weight (g m^{-2})	520.23	288.98	501.98	107.93	76.14	147.67
Standard deviation	724.37	198.86	341.05	78.02	37.97	105.20
Dry weight (g m^{-2})	47.88	36.87	64.92	20.31	9.97	28.90
Standard deviation	65.47	21.63	40.99	12.64	4.62	22.75
Ash-free dry weight (g m^{-2})	13.35	6.29	14.00	4.08	1.97	4.39
Standard deviation	16.69	4.54	9.65	2.49	1.00	3.58
No of plants	28	318	373	497	422	454
% reproductive plants	0.00	0.00	0.54	0.00	0.00	0.44
Mean thallus length (mm)	176.89	73.66	127.92	49.30	35.46	49.53
Standard deviation	202.04	39.67	74.00	37.78	23.67	35.68

* The samples were burned; the number of quadrats for dry and ash-free dry weight were 47 and 37, respectively.

APPENDIX 9 : BIOMASS OF *S. baccularia* BETWEEN LINE TRANSECTS FROM APRIL 1995 TO APRIL 1996

Wet weight (g m^{-2})

	Apr 1995	Jul 1995	Oct 1995	Jan 1996	Apr 1996
L1	318.93	770.56	121.28	99.38	123.20
Standard deviation	301.57	368.63	123.22	30.25	107.73
L2	199.84	581.40	91.20	70.58	154.67
Standard deviation	126.29	570.71	52.61	40.06	108.25
L3	473.76	425.60	67.56	57.07	190.60
Standard deviation	256.92	337.90	40.41	54.39	153.81
L4	302.58	539.68	146.72	99.91	175.04
Standard deviation	192.84	292.64	59.67	49.41	116.56
L5	273.14	492.32	116.80	56.48	91.56
Standard deviation	229.49	344.25	88.42	29.60	37.90
L6	165.60	202.31	104.00	73.42	150.93
Standard deviation	86.03	132.14	103.80	24.09	106.95
MEAN TOTAL	288.98	501.98	107.93	76.14	147.67
Standard deviation	198.86	341.05	78.02	37.97	105.20

Dry weight (g m^{-2})

	Apr 1995	Jul 1995	Oct 1995	Jan 1996	Apr 1996
L1	39.46	101.79	18.53	11.83	17.18
Standard deviation	38.73	42.85	18.21	3.31	15.31
L2	32.78	77.92	24.99	8.86	20.08
Standard deviation	11.46	75.99	10.65	4.17	15.87
L3	55.04	55.79	18.20	8.83	25.55
Standard deviation	26.82	42.79	11.63	7.37	21.21
L4	33.40	66.75	25.00	10.75	82.54
Standard deviation	17.54	39.45	8.08	4.81	69.22
L5	37.81	62.35	17.88	9.35	11.35
Standard deviation	23.27	30.08	12.38	4.64	4.77
L6	22.70	24.89	17.27	10.17	16.69
Standard deviation	11.95	14.75	14.88	3.42	10.14
MEAN TOTAL	36.87	64.92	20.31	9.97	28.90
Standard deviation	21.63	40.99	12.64	4.62	22.75

Ash-free dry weight (g m^{-2})

	Apr 1995	Jul 1995	Oct 1995	Jan 1996	Apr 1996
L1	9.00	23.39	3.82	2.36	4.67
Standard deviation	10.82	10.52	3.31	0.92	5.97
L2	6.06	18.96	4.68	1.94	4.38
Standard deviation	2.04	20.29	2.05	1.06	3.30
L3	-	10.83	3.80	1.57	5.60
Standard deviation	-	8.40	2.35	1.08	4.44
L4	6.01	13.45	5.15	2.42	4.76
Standard deviation	3.74	8.89	1.76	1.43	3.52
L5	6.43	12.32	3.52	1.75	2.71
Standard deviation	3.89	6.62	2.25	0.82	1.40
L6	3.97	5.04	3.52	1.76	4.23
Standard deviation	2.23	3.19	3.24	0.68	2.86
MEAN TOTAL	6.29	14.00	4.08	1.97	4.39
Standard deviation	4.54	9.65	2.49	1.00	3.58

APPENDIX 10 : BIOMASS OF *S. baccularia* BETWEEN STATION LEVELS FROM APRIL 1995 TO APRIL 1996

	Apr 1995			Jul 1995			Oct 1995			Jan 1996			Apr 1996		
Biomass (g m^{-2})	WW	DW	AW	WW	DW	AW	WW	DW	AW	WW	DW	AW	WW	DW	AW
Q1	217.92	27.80	5.24	705.60	95.87	21.97	56.00	12.93	2.73	102.93	14.12	2.51	164.53	42.98	4.32
Standard deviation	124.14	11.52	1.98	607.07	79.72	20.74	27.62	6.44	1.33	65.12	7.89	1.26	70.45	50.62	1.89
Q2	172.48	27.23	5.32	508.80	69.86	17.67	117.07	20.83	4.23	79.73	12.26	2.48	176.00	18.77	4.74
Standard deviation	71.66	2.18	0.54	376.44	50.57	14.14	105.91	18.76	3.53	25.04	3.23	0.77	94.98	7.78	2.29
Q3	443.20	49.46	7.82	386.40	54.11	12.98	100.53	19.83	4.01	78.67	8.47	2.31	128.96	40.80	3.66
Standard deviation	303.49	23.41	3.04	337.03	41.96	10.94	39.28	8.83	1.68	50.71	1.87	1.61	45.26	59.02	1.52
Q4	338.93	43.09	6.58	683.73	90.81	19.65	100.80	18.27	3.89	80.27	11.32	2.03	145.33	19.00	3.55
Standard deviation	182.16	22.41	1.91	401.50	51.68	12.05	61.54	7.02	1.47	22.27	3.31	0.56	113.35	15.83	2.29
Q5	337.87	41.18	6.25	586.93	59.46	12.18	92.53	19.31	4.39	80.27	11.12	2.13	165.60	21.10	4.74
Standard deviation	247.91	27.97	4.44	615.07	59.36	11.98	51.91	4.70	1.59	38.23	4.19	1.12	160.79	21.55	4.66
Q6	333.87	42.69	6.16	561.07	69.87	13.91	113.60	22.69	4.27	57.60	7.84	1.51	130.40	16.99	3.84
Standard deviation	296.43	31.97	3.93	303.15	44.41	9.37	68.77	10.73	2.06	34.45	3.79	0.87	45.67	5.30	1.41
Q7	236.40	30.55	4.88	280.53	35.27	6.60	191.68	29.17	5.56	57.07	1.44	1.44	101.60	26.75	2.54
Standard deviation	98.24	13.35	2.20	94.81	12.77	2.43	165.41	23.88	4.17	22.91	0.33	0.33	78.44	37.40	2.07
Q8	527.60	68.62	16.34	529.07	72.06	13.82	95.73	17.54	3.15	80.27	1.98	1.98	118.67	30.77	6.37
Standard deviation	375.64	48.22	18.05	298.58	36.88	7.49	73.75	9.49	1.79	50.82	1.11	1.11	91.63	47.20	7.50
Q9	134.93	20.32	3.17	235.52	29.31	5.35	143.20	27.88	5.67	71.20	1.47	1.47	241.92	59.60	7.03
Standard deviation	91.45	8.92	1.94	170.96	22.17	4.51	105.90	15.99	3.57	60.17	1.15	1.15	209.22	77.49	6.32
Q10	231.47	32.20	4.87	565.76	75.92	15.90	80.80	15.46	3.08	60.80	1.23	1.23	83.52	25.60	2.40
Standard deviation	104.10	9.98	1.87	324.66	43.79	13.28	61.27	13.58	2.64	45.90	0.64	0.64	97.52	42.45	2.40

WW = Wet weight, DW = Dry weight, AW = Ash-free dry weight.

APPENDIX 13 : BIOMASS OF *S. swartzii* BETWEEN STATION LEVELS FROM APRIL 1995 TO APRIL 1996

	Apr 1995			Jul 1995			Oct 1995			Jan 1996			Apr 1996		
Biomass (g m^{-2})	WW	DW	AW	WW	DW	AW	WW	DW	AW	WW	DW	AW	WW	DW	AW
Q1	184.00	-	-	-	-	-	-	-	-	45.60	5.59	1.07	-	-	-
Standard deviation	-									35.07	3.36	0.44			
Q2	622.40	-	-	371.20	49.96	9.81	-	-	-	19.20	2.12	0.29	-	-	-
Standard deviation	-			-	-	-				-	-	-			
Q3	377.60	-	-	80.80	10.56	2.29	-	-	-	11.20	1.89	0.30	97.60	11.81	2.29
Standard deviation	-			12.45	2.32	0.40				-	-	-	-	-	-
Q4	75.20	-	-	1025.60	131.07	25.63	22.40	3.29	0.64	28.00	3.15	0.54	-	-	-
Standard deviation	18.10			-	-	-	-	-	-	10.18	0.43	0.08			
Q5	66.67	3.78	0.69	320.80	38.40	7.97	9.60	3.35	0.63	20.80	2.18	0.36	-	-	-
Standard deviation	74.52	2.62	0.53	339.07	38.94	9.43	4.53	2.13	0.50	-	-	-			
Q6	205.20	23.42	4.29	301.33	35.08	6.77	18.67	3.12	0.52	35.20	4.95	0.92	125.60	15.95	2.82
Standard deviation	230.48	28.54	4.86	339.04	40.30	8.02	9.78	1.38	0.23	11.31	0.25	0.22	125.58	15.86	2.87
Q7	270.40	32.77	5.87	248.53	30.56	5.85	131.60	20.13	3.39	35.20	4.57	0.81	256.40	30.40	5.86
Standard deviation	81.46	11.69	2.32	196.40	24.17	5.12	143.72	18.76	3.00	26.52	3.25	0.61	179.24	21.09	4.10
Q8	212.00	29.88	6.11	382.40	48.24	8.51	206.08	34.00	6.03	37.33	4.69	0.89	198.00	23.37	4.45
Standard deviation	220.19	41.39	9.05	257.77	36.72	6.54	124.50	23.54	4.40	21.84	2.02	0.36	107.75	13.02	2.08
Q9	822.40	95.85	19.63	1020.48	133.55	28.44	373.07	54.75	10.09	88.00	11.00	2.27	418.56	61.82	9.82
Standard deviation	149.03	10.14	5.10	467.19	71.59	19.83	381.85	48.39	8.93	62.54	7.02	1.79	317.03	32.31	6.88
Q10	819.20	123.20	24.98	716.16	95.66	22.21	616.80	84.57	15.29	96.80	11.98	2.52	1418.67	160.32	32.03
Standard deviation	225.83	31.23	7.46	618.70	89.54	23.07	465.51	52.71	9.83	62.80	8.17	1.74	575.52	70.56	13.85

WW = Wet weight, DW = Dry weight, AW = Ash-free dry weight.

APPENDIX 14 : MEAN THALLUS LENGTH (mm) BETWEEN LINE TRANSECTS

A. *S. baccularia*

	Apr 1995	Jul 1995	Oct 1995	Jan 1996	Apr 1996
No of plants	42	85	68	79	60
L1	76.57	149.36	43.00	36.19	51.40
Standard deviation	59.06	68.49	41.60	22.13	30.82
No of plants	51	53	90	78	88
L2	78.82	146.06	46.63	27.60	44.35
Standard deviation	44.63	75.46	31.98	14.69	25.46
No of plants	86	34	57	59	86
L3	73.60	178.06	61.02	35.56	49.00
Standard deviation	34.36	63.80	42.23	29.22	27.69
No of plants	69	64	128	65	73
L4	66.17	126.63	53.67	42.28	76.04
Standard deviation	28.53	77.44	34.40	25.59	52.18
No of plants	38	81	84	83	55
L5	81.47	111.90	42.99	30.53	40.33
Standard deviation	41.87	66.91	39.78	19.58	21.56
No of plants	32	56	70	58	92
L6	68.59	72.41	48.91	44.38	38.23
Standard deviation	29.45	50.69	38.55	27.72	34.39

B. *S. swartzii*

	Apr 1995	Jul 1995	Oct 1995	Jan 1996	Apr 1996
No of plants	21	3	24	9	14
L1	94.95	98.67	94.63	32.89	157.64
Standard deviation	38.08	30.55	74.80	16.08	70.01
No of plants	12	38	15	37	16
L2	106.17	148.79	104.47	41.78	125.69
Standard deviation	71.26	70.26	47.86	15.49	74.25
No of plants	29	22	18	10	12
L3	83.45	158.55	93.83	41.50	183.92
Standard deviation	45.80	67.98	73.68	26.15	92.12
No of plants	25	11	7	5	10
L4	61.96	168.27	49.43	31.20	120.30
Standard deviation	38.29	60.98	42.29	8.70	90.47
No of plants	24	14	22	10	9
L5	134.17	110.21	98.82	39.30	216.44
Standard deviation	37.76	46.39	67.34	23.38	114.08
No of plants	17	17	15	1	6
L6	122.41	150.82	73.73	106.00	200.83
Standard deviation	65.59	108.91	49.32	-	100.51

APPENDIX 15 : DESTRUCTIVE SAMPLINGS

A. LENGTH CLASSES OF *S. baccularia*

LENGTH CLASSES (mm)	FREQUENCY	% FREQUENCY
0 -49	1126	53.82
50 - 99	549	26.24
100 - 149	224	10.71
150 - 199	107	5.11
200 - 249	63	3.01
250 - 299	14	0.67
300 - 349	2	0.10
350 - 399	1	0.05
400 - 449	2	0.10
450 - 499	1	0.05
500 - 549	0	0
550 - 599	0	0
600 - 649	2	0.10
650 - 699	0	0
700 - 749	0	0
750 - 799	0	0
800 - 849	0	0
850 - 899	1	0.05

B. LENGTH CLASSES OF *S. swartzii*

LENGTH CLASSES (mm)	FREQUENCY	% FREQUENCY
0 -49	125	25.51
50 - 99	141	28.78
100 - 149	97	19.80
150 - 199	71	14.49
200 - 249	28	5.71
250 - 299	15	3.06
300 - 349	10	2.04
350 - 399	2	0.41
400 - 449	1	0.20

APPENDIX 16 : PERCENTAGE FREQUENCY FOR EVERY DESTRUCTIVE SAMPLINGS

A. *S. baccularia*

LENGTH CLASSES (mm)	JAN 1995	APR 1995	JUL 1995	OCT 1995	JAN 1996	APR 1996
0 -49	7.14	29.25	17.16	66.20	79.38	66.74
50 - 99	53.57	49.37	21.98	21.73	18.48	24.01
100 - 149	3.57	16.67	23.86	9.05	1.66	6.39
150 - 199	14.29	3.46	18.5	2.21	0.47	2.20
200 - 249	7.14	0.63	14.21	0.80	0	0.44
250 - 299	0	0.63	2.95	0	0	0.22
300 - 349	3.57	0	0.27	0	0	0
350 - 399	0	0	0.27	0	0	0
400 - 449	0	0	0.54	0	0	0
450 - 499	0	0	0.27	0	0	0
500 - 549	0	0	0	0	0	0
550 - 599	0	0	0	0	0	0
600 - 649	7.14	0	0	0	0	0
650 - 699	0	0	0	0	0	0
700 - 749	0	0	0	0	0	0
750 - 799	0	0	0	0	0	0
800 - 849	0	0	0	0	0	0
850 - 899	3.57	0	0	0	0	0

B. *S. swartzii*

LENGTH CLASSES (mm)	JAN 1995	APR 1995	JUL 1995	OCT 1995	JAN 1996	APR 1996
0 -49	11.76	15.62	9.52	34.65	70.83	10.45
50 - 99	47.06	42.97	19.05	25.74	27.78	17.91
100 - 149	5.88	23.44	27.62	18.81	1.39	25.37
150 - 199	29.41	14.06	22.86	14.85	0	13.43
200 - 249	5.88	0.78	11.43	2.97	0	16.42
250 - 299	0	3.12	5.71	0.99	0	5.97
300 - 349	0	0	2.86	1.98	0	7.46
350 - 399	0	0	0.95	0	0	1.49
400 - 449	0	0	0	0	0	1.49

APPENDIX 17 : ENVIRONMENTAL PARAMETERS

Date	Jan-95	Feb-95	Mar-95	Apr-95	May-95	Jun-95	Jul-95	Aug-95	Sep-95	Oct-95	Nov-95	Dec-95	Jan-96	Feb-96	Mar-96	Apr-96
Salinity (%)	30.0	31.0	31.0	31.5	31.0	32.0	31.0	26.0	30.0	28.0	31.0	27.0	30.0	31.5	31.0	31.0
Temperature (°C)	29.0	30.0	31.0	35.0	36.0	32.0	33.0	33.0	30.5	33.4	31.4	31.0	29.5	28.7	31.5	34.5
D.O. (mg l^{-1})	7.4	7.6	9.8	11.8	14.3	9.3	12.5	13.5	8.4	13.4	10.6	8.2	10.2	8.0	11.7	7.3
pH	7.30	7.87	8.24	8.52	8.83	8.34	7.13	8.30	7.70	8.35	7.70	8.04	7.76	8.34	8.71	8.05
Ammonia (µg L^{-1})	4.52	4.08	0.33	1.15	0.26	1.23	1.40	4.14	6.50	5.35	7.19	7.53	3.82	1.70	1.59	1.21
Nitrate (µg L^{-1})	3.50	2.17	1.94	0.08	2.35	50.68	27.99	13.07	32.12	34.65	8.82	45.17	62.08	31.73	3.47	2.12
Phosphate (µg L^{-1})	17.01	5.42	8.03	3.80	0.92	9.20	0.20	2.24	0.56	2.61	1.11	85.84	0.67	0.40	0.69	1.10
*Mean Temperature (°C)	26.6	26.5	27.6	NA	27.8	27.9	27.0	26.6	26.7	27.2	26.4	25.8	26.2	26.6	27.7	27.5
*Maximum Temperature (°C)	31.6	31.8	33.0	32.7	32.8	32.4	31.6	31.0	31.3	31.9	31.1	30.2	31.2	32.1	33.8	32.4
*Minimum Temperature (°C)	23.3	23.2	23.8	24.1	24.3	24.3	23.4	23.5	23.1	23.8	23.5	23.1	22.8	23.1	23.9	23.7
*Daily Sunshine hours (Hr)	5.9	5.5	7.2	6.8	7.1	6.5	5.5	4.5	4.4	6.1	3.8	3.4	5.7	7.0	7.8	7.1
*Daily Solar Radiation (MJm^{-2})	16.37	16.66	19.65	17.53	18.07	16.82	15.80	14.93	NA	NA	NA	NA	NA	9.04	NA	17.95
*Daily Rainfall Amount (mm)	132.4	70.0	149.0	175.7	212.5	136.3	305.7	294.1	407.0	136.3	318.7	214.4	22.8	80.4	117.5	218.8

* Data from Malaysia Meterological Department (Malacca Airport)
NA : Not available