THE EFFECTS OF ENVIRONMENTAL STRESS ON THE
COMMUNITY STRUCTURE AND PRODUCTIVITY OF SALT MARSH
EPIPHYTIC COMMUNITIES

Progress Report

John J. Lee

City College of the City University
New York, New York

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ABSTRACT

In the past year we have made significant progress toward our goals of understanding the principles underlying the structural/functional relationships of the microbial and meiofaunal assemblages at the base of the food webs in detritus dominated near-shore communities. The work supported by this contract has resulted in the publication, or acceptance for publication, of substantial contributions to the field of experimental marine ecology. These theoretical and experimental contributions coupled with several major technological and procedural advances should eventually help to establish realistic guidelines for effective use and management of shallow embayments, salt marsh bordered estuaries and near-shore coastal marine environments.

Among the theoretical and experimental advances is the actual demonstration and quantitative measurement of information processing in food web transformations. Although ecosystem cybernetics has received some theoretical attention in the past, no practical methods had been developed to assess its importance. Assessment of the informational content and transfer requirements for the "normal" functioning of productive food webs has significant theoretical and practical implications which are discussed in context with the data obtained in this subproject on niches and resource partitioning.

The new series of differential media and keys to algal colony types published this year have proven to be effective tools for the isolation and culture of a wide spectrum of organisms heretofore not studied in continuous laboratory culture.

Our first field experiments on transplanted and local natural communities aimed at testing the changes in community structure at a particular location due to local water quality, heavy metals and water insoluble fractions of crude oil are nearing completion. The aufwuchs communities were incubated and manipulated in situ in a newly developed apparatus which shows great promise to routine use in water quality assessments.

The results of quantitative and qualitative studies on mineral cycling, trophic efficiency, special growth factors, estimations of biotic potential, competition and microbial community succession are also presented in this detailed progress report.

The work supported by this contract has resulted in the publication of 5 technical papers this year. Two additional papers have been accepted for publication and 3 papers have just been completed and are under review.

I.

COMPLETED PROJECTS

A brief synopsis of each of the full papers, all appended as part of this report, follows:

1. Norman M. Saks, John J. Lee, William A. Muller and John H. Tietjen. 1974. The growth of salt marsh microcosms subjected to thermal stress. Presented at the Thermal Ecology symposium held at Augusta, Georgia, 3-5 May 1972. In: Thermal Ecology, AEC Symposium Series, pp 391-398.

In this paper we discussed some of our preliminary experiments on the effects of temperature and interspecific competition between pairs of organisms, a marine benthic feeding ciliate, Euplotes vannus, and either Allogromia laticollaris, a foraminifera, or Chromodorina germanica, a benthic nematode. At 15° C, neither Allogromia nor Chromodorina reproduce in the presence of Euplotes but the small numbers in the inoculum reduce Euplotes populations to $\leq 1/2$ that of controls. At 25° C each of the species was affected by the presence of another species. This was reflected by changes in both amplitude and phase of populations. The effect of temperature on the growth and survival of their food was also studied.

2. John J. Lee. 1974. Towards understanding the niche of foraminifera. In: Foraminifera; (E. H. Hedley & G. Adams, eds.) pp. 207-260. Academic Press, London & New York.

In this chapter, many facets of the niches of salt marsh foraminifera are discussed. The point of the review is to give a microbiologist's microscale perspective of the functional roles of a few littoral benthic foraminifera in their communities and the methods which can be used to gain insight into this aspect of their biology. Both field and laboratory approaches are stressed in the review. Patchiness, substrate preferences, seasonality, culture

methods, nutrition and growth factors, interspecific and intra-specific competition, ecological efficiency and symbiosis in foraminifera are discussed in detail.

3. John J. Lee, Lawrence J. Crockett, Johnny Hagen and Robert J. Stone. 1974. The taxonomic identity and physiological ecology of Chlamydomonas hedleyi (the algal flagellate symbiont from the foraminifer Archaias angulatus). Br. Phycol. J. 9:407-422.

Symbiosis between algae and invertebrates is a significant phenomenon in the marine environments in which it occurs. Although symbiotic associations between foraminifera and various species of algae have been known for over 65 years, the taxonomic identity of any of the symbionts or their metabolic contributions to their hosts has never been clarified. In this paper we discuss the fine structure, taxonomic identity, and physiological ecology of a symbiotic alga from a foraminifera which we recently isolated into axenic culture. The symbiont has no vitamin or organic requirements but growth is 3 x in the presence of thiamin, and 2 x in the presence of 1 μ M glutamic acid, histidine and methionine. Urea was the best nitrogen source. The symbiont fixed $\sim 7 \times 10^{-7}$ M carbon $\text{hr}^{-1} \text{gm}^{-1}$, 57% of which was released into the medium as a chromatographically homogeneous organic molecule provisionally identified as mannitol.

4. John J. Lee and William A. Muller. 1975. Culture of salt marsh microorganisms and micrometazoa. Presented at the Conference on Culture of Invertebrate Animals held at the Greenport Aquaseum, Greenport, N. Y., Oct. 5-7, 1972. Plenum Press, N. Y.

The purpose of the conference was to bring together experts on the culture of microorganisms and micrometazoa of northeastern

U. S. estuarine and coastal waters. In our paper we discuss the rationale and the techniques for collecting and setting up agnotobiotic and gnotobiotic cultures of salt marsh microorganisms and micrometazoa. The paper is sufficiently detailed so that a beginning graduate student could use it as a laboratory manual for the study of near shore bacteria, algae, protozoa and micrometazoa. We also elaborate on our experience in this field and give helpful hints on pitfalls to be avoided.

5. John J. Lee, Marie E. McEnery, Eileen M. Kennedy and Howard Rubin. 1975. A nutritional analysis of a sublittoral epiphytic diatom assemblage from a Long Island salt marsh. J. Phycol. 11: 14-49.

This paper is the product of one of the most time consuming and difficult projects we have ever attacked in the laboratory. At the onset we hoped that a study of the auxotrophic profile of the microbial assemblage would give us insight into some of the subtle variables which regulate population succession and information within the assemblage. Several important technological gaps were bridged on the way to reaching our goals. We designed a series of differential media which are effective as tools for the isolation and nutritional characterization of the algae and bacteria from the community. Many diatom species can be recognized by their colony type or growth pattern on solidified differential media. A dichotomous key and illustrated plates have been developed as an aid to their identification. The changes in population structure of the community were also reflected by changes in the nutritional patterns in the community as judged by qualitative and quantitative differences in the growth of diatoms and bacteria on the differential media tested. The comparative abilities of individual species isolated from the community to grow on the wide range of test media was evaluated. A measure, the Colony Band-Width Index (CBI) was developed as a comparative aid. A high CBI indicates that a species

has a wide range of organic tolerance, possibly no macro- or micro-nutrient requirements, or is nutritionally quite versatile. The nutritional requirements and selectivity of media for individual species is also discussed. A rank order listing of media for the growth of individual species is given.

The distribution of many species in the community was seasonal. Distribution patterns were tested statistically. Many species showed high correlation with others in abundance or in their appearance in the community indicating possible common abiotic and biotic dependencies. These correlations are tabulated.

Perhaps the most significant advance is the development of new tools which we can use to isolate and study ecologically significant organisms in the laboratory. The new media and methods give promise that the functional interrelationships between diatoms from the same community assemblage may someday be accessible for detailed analysis. They may also be useful for the culture of many new species of protozoa and micrometazoan herbivores. The auxotrophic profile of the diatom assemblage suggests that some measure of stability within this important component of the community is achieved through heterotrophic diversity. The same might be suggested as a key factor in community succession.

6. William A. Muller. 1975. Competition for food and other niche-related studies of 3 species of salt marsh foraminifera. Mar. Biol. (in press)

Several hundred species of foraminifera grow in various salt marshes throughout the world. Very little is known of the differences in their niches which allow some species to grow while others in the same marsh do not. Tracer feeding and microcosm experiments provided some of the data used for testing a graphic representation of the Hutchinsonian niche. A polygon was constructed using 6 factors: temperature, salinity, pH, feeding rate, interspecific competition, and intraspecific competition as niche determinants. The

effects of these biotic and abiotic factors on the generation time of 4 species of foraminifera were tested. Biotic factors were more difficult to evaluate than the abiotic ones. An equation, based on competitive feeding experiments, was developed to reduce data to a single coefficient. One species, Spiroloculina hyalina, did not compete with the other species for food, but Allogromia laticollaris and Rosalina leei were competitive. Intraspecific competition (crowding) seems to be an important factor limiting the exploitation of available community space by Allogromia laticollaris but it was not a limiting factor for the other 2 species. A. laticollaris was characterized as a rare species which may become locally abundant when dominant species are missing. S. hyalina is also a rare species with a high biotic potential but with very specialized niche requirements. It will bloom in physically unstressed environments provided that moderate numbers of appropriate species of bacteria are present. R. leei is stable, a conspicuous species whose moderate numbers are relatively unaffected by physical stress and competition.

7. John J. Lee, John H. Tietjen, Norman M. Saks, George G. Ross, Howard Rubin, William A. Muller. Educing and modeling the functional relationships within sublittoral salt marsh aufwuchs communities - inside one of the black boxes. Presented at a symposium on Modeling Esutaries during the 2nd International Conference on Estuaries, Myrtle Beach, S. C. , Nov. 1973. To be published in the Proceedings.

The gist of our paper is that at the present time information on the population structure of at least one community, and by inference other communities, is too fragmentary to be used in modeling and predicting community structure and function. Studies of salt marsh aufwuchs community foraminifera, nematodes and micro-

algae grown in gnotobiotic culture suggest it is unreasonable to assume that measurements made on one species will be good estimators for similar parameters of other species or the assemblage as a whole. Nutritional experiments suggest many meiofauna are selective feeders and gain different nutritional values from the food they assimilate. Many problems relating to the population structure and dynamics of aufwuchs microbial and meiofaunal food webs were illustrated and discussed.

8. Howard A. Rubin and John J. Lee. Informational energy flow as an aspect of the ecological efficiency of marine ciliates. Submitted to American Naturalist.

The role of information processing in food web energetic transformations was experimentally tested using 2 marine ciliates, Euplotes vannus and Uronema marinum, as experimental animals. In these experiments, caloric value of food was normalized so that information transfer could be measured. The informational quality of food was experimentally demonstrated by 3 independent means: 1) decay of synchrony in optimally reproducing cultures; 2) switching time lags; 3) comparison of generating times on calorically normalized diets. Information utilization was measured in terms of cell cycle advancement. Reproduction of the ciliates was often delayed when they were transferred from a diet of one algal species to a diet of another species. These switching time lags (≤ 2.5 hr) were interpreted as a consequence of adaptive enzyme formation, an information recognition response. Simple food web experiments tested whether or not the ciliates selected food to maximize their biotic potential. The information transfer system was modeled within the conceptual framework of automata theory. The model was successful in predicting the outcome of 80% of the mixed diet experiments. It also predicted, because of switching time lags, that a patchy environment should be more productive than a homogeneous one. Food

quality and spatial distribution of predators and their prey are therefore important factors in population dynamics. A measure of informational gain in food web transformations was developed.

"Cyberons", a new unit of information utilization related to the energy saved per food organism processed, are defined and can be converted into moles ATP or caloric equivalents.

The research for 2 papers on closely related subjects has been completed and the manuscripts by the same authors are in early stages of preparation.

9. M. E. McEnery and John J. Lee. Allogromia laticollaris - a foraminiferan with an unusual apogamic metagenic life cycle.

Submitted to the Journal of Protozoology.

Allogromia laticollaris is an unusual meiofaunal species because it has a life cycle which is extremely plastic and seemingly responsive to environmental changes. Before we began this study it was known that the species was capable of reproducing by at least six different means (sexual, endogenous budding, exogenous budding, binary fission, cytotomy and schizogony). Under particular environmental or dietary conditions, some types of reproduction are favored over others.

In this baseline study we described the life cycle of 3 strains of the species raised under defined conditions on a uniform diet. Almost bizarrely, each of the 3 strains had a different, nonclassical, and basically apogamic life cycle. The strain isolated at the lab in Cold Spring Harbor has a regular 26 day life cycle that alternated between 2 cytologically different schizonts. By comparison, the life cycles of the strains isolated from Towd Point, Southampton, L. I. and Sippewissett Marsh near Woods Hole, Mass. were abbreviated. The details of the life cycles are quite fascinating and present some challenging problems for the cell biologist.

WORK IN PROGRESS

In addition to completing the aforementioned studies, we are pleased to report substantial progress on other subprojects.

- A. Comparative quantitative and qualitative studies
- on the role of diverse meiofaunal species in the detritus food chain of marine marshes including:
- a) mineral cycling, energy flow, biological half-life, trophic efficiency estimations;
 - b) food web complexion studies and "special growth factors";
 - c) estimations of biotic potential and realized productivity.

The aim of the subproject is to gain comparative insight into the functional complexities of micro- and meiofaunal food webs and thereby obtain some reasonable bases for interpreting some of the changes which take place, or could take place, in stressed communities. During the past year a number of separate, but related, studies were directed toward these goals.

Recently we have isolated two species of harpacticoid copepods, Nitocra typica and Leptocaris brevicornis, in culture, and have begun to study their physiological ecology and the effect of food quality of their fecundity. Nitocra typica survived over a fairly large range of temperature (10°-30° C) and pH (4.5-10) but reproduction and survival of nauplii and copepodites occurred over a narrower range. Life cycles were shortest, 22 days, at temperatures between 20°-25° C and pH 6-7; at 15° C and at other pH, life cycles are extended (50-60 days or longer). With respect to parts of the life cycle, the naupliar stage is lengthened at 15° C to 13-24 days in contrast to 7-12 days at 25° C. Copepodites take from 4-7 days to mature (lower number represents 25° C) at which time, seizure begins (males attach to females and remain from a few hours to a few days) and subsequently copulation occurs. In life cycle experiments

involving isolated gravid females we observed that up to 3 successive egg sacs could be laid by each gravid female without additional copulation. Experiments are now in progress to determine the viability of the nauplii from successive egg sacs which are fertilized by stored sperm. Katona (1975) observed that the mean number of egg sacs produced by isolated females of Eurytemora affinis, a planktonic copepod, is significantly less than the number produced when in the presence of males. He also found that hatching success of the eggs in the second sacs produced by isolated fertilized females is reduced (after a period of time the stored sperm are no longer viable).

In our initial experiments to study the effect of diet on the growth and reproduction of N. typica we inoculated 15 copepods onto petri dishes (15 x 100 mm) containing a solidified medium (erdschreiber) with a liquid overlay. We felt the agar substrate would be helpful since the naupliar stages do not have swimming legs and must crawl. The results of the first experiments were erratic, however, because the bacteria sometimes grew in patches on the substrate. Aseptic washing of the inocula by serially washing the copepods in 9-hole spot plates and using an antibiotic mixture in the overlay improved the reproducibility of the experiments. The washing procedure was very time consuming because the copepods are very fragile and easily damaged.

As an alternative we reduced inoculum size to 2 gravid females and used smaller experimental vessels (60 x 15 mm). This method reduces the carry-over of food organisms from stock cultures and also gives the opportunity to observe the effects of individual species or mixtures of food species on the entire life cycle of the animal. The gravid females were picked with large pipettes and then were allowed to swim out into the petri plate. Stock cultures used in experiments were placed at 5° C for 1 hr prior to use in order to slow the activities of the copepods and also diminish the chances of mechanical damage during the set-up of the experiments.

Of the 12 species of algae which have been tested so far,

only 5 species, Dunaliella parva (14) Chlamydomonas spp (B1-1), Cylindrotheca closterium (9, 709, B1-35), C. fusiformis (B1-27) and Amphora acutiuscula var. coffeaformis (B1-16) provide complete diets. Surprisingly, only one of the four species of Dunaliella tested sustained all developmental stages of the life cycle and the adults. Even among those algal species which supported the complete life cycles of the copepods there were considerable differences in fecundity and viability on different diets (Table 1 and Figs. 1-12). Although the work is still in progress, the conclusions about this species niche seem quite obvious at this point. It is a nutritional specialist which is highly adapted to partition the resources available.

Some experiments on the mineral cycling abilities of nematodes were continued this year. In these experiments 5 $\mu\text{Ci/ml}$ of label (^{14}C , ^{35}S , ^{32}P) were inoculated into a solidified nematode growth medium with a shallow liquid overlay. Large populations of each of the various stages of the nematodes were transferred onto the labeled media and were allowed to grow 1-2 weeks depending on the life cycle of the worm. After growing in the labeled medium, the worms were transferred onto "cold" (unlabeled) media and 10 adults, intermediate stages and juveniles were picked, washed 3 X and placed in scintillation vials. An aliquot of the final wash also was placed in a vial as a control, reflecting relative carry-over as a check on procedure. The three stages of worms were picked successively every 1-2 weeks and at the end of the 2 week period all vials were counted on a Beckman liquid scintillation counter. The results were then plotted in CPM/ μgm nematode to determine biological half-life.

The results of these experiments are summarized in the accompanying figures (13-16). The biological half-life of ^{14}C in Monhystera differs in each age class. The C T_b for adults was ~ 2 d; intermediate stages ~ 5 d; and newly hatched juveniles 2.3 d. The T_b for S was: 2 d for adults; 1 d for intermediate stages; and 3 d for juveniles. The T_b for P was: 9.6 d for adults; 5 d for intermediates; and 1 d for juveniles. The T_b for S in Rhabditis marina adults was ~ 1.5 d while for intermediate stages it was

TABLE 1

Effect of temperature and diet on the reproduction of *Nitocra typica**

FOOD	Average #**		Average #***		Gravid ♀ of**		First appearance of copepodites		First appearance gravid ♀ of second generation	
	15° C	25° C	15° C	25° C	15° C	25° C	15° C	25° C	15° C	25° C
<i>Dunaliella quartoelecta</i> (50)	16	30	38	13	5	1	day 13	day 8	day 30	day 21
<i>Dunaliella parva</i> (14)	25	35	44	49	11	11	day 13	day 13	day 30	day 16
<i>Dunaliella</i> spp (55)	40	12	8	3	3	2	day 21	day 9	day 41	day 22
<i>Dunaliella</i> spp (98)	22	12	4	1	1	0	day 13	day 11	day 41	0
<i>Chlamydomonas</i> spp (B1-1)	32	42	57	58	13	13	day 13	day 13	day 30	day 18
unidentified chlorophyte (105)	11	30	0	0	0	0	0	0	0	0
<i>Cylindrotheca closterium</i> (BL-35)	30	44	38	35	8	12	day 24	day 11	day 34	day 22
<i>Cylindrotheca closterium</i> (9)	25	48	36	50	6	30	day 22	day 15	day 30	day 17
<i>Cylindrotheca closterium</i> (709)	35	38	64	24	33	2	day 22	day 11	day 27	day 13
<i>Cylindrotheca fusiformis</i> (B1-27)	28	39	62	54	18	16	day 20	day 13	day 30	day 15
<i>Amphora acutiuscula</i> var <i>coffeaformis</i> (B1-16)	22	16	45	25	11	10	day 24	day 13	day 35	day 15
<i>Phaeodactylum tricornutum</i> (39)	10	18	8	30	4	8	day 15	day 11	day 27	day 15
B1-27 + B1-1 ***	16	P	41	P	12	P	day 13	P	day 25	P
BL-1 + 709 ***	20	P	60	P	14	P	day 13	P	day 24	P
BL-27 + 55 ***	22	P	18	P	4	P	day 19	P	day 26	P
BL-35 + 50 ***	20	P	27	P	8	P	day 13	P	day 19	P

* all experiments at day 0 contain 2 gravid females

** average number of stage present throughout experiment

*** # copepodite-adults present at termination of experiment At 15° C day 41;
at 25° C day 22; for mixtures of food day 26

P experiment in progress

DAYS

Fig. 1 a. *Dunaliella* spp (strain 98) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, *Nitocra typica*.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, *Nitocira typica*.

Fig. 1 b. *Dunaliella* spp (strain 98) at 25° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 2 a. Dunaliella parva (strain 14) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, *Nitocra typica*.

Fig. 2 b. *Dunaliella parva* (strain 14) at 25° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, *Nitocra typica*.

Fig. 3 a. *Dunaliella guartolecta* (strain 50) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 3 b. Dunaliella quartolecta (strain 50) at 25° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocira typica.

Fig. 4 a. Dunaliella spp (strain 55) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocira typica.

Fig. 4 b. Dunaliella spp (strain 55) at 25° C.

DAYS

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 5 a. Chlamydomonas spp (strain B1-1) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 5 b. Chlamydomonas spp (strain B1-1) at 25° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 6 a. unidentified chlorophyte (strain 105) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocira typica.

Fig. 6 b. unidentified chlorophyte (strain 105) at 25° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, *Nitocera typica*.

Fig. 7 a. *Cylindrotheca closterium* (strain BL-35) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 7 b. Cylindrotheca closterium (strain Bl-35) at 25° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 8 a. Cylindrotheca closterium (strain 9) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 8 b. Cylindrotheca closterium (strain 9) at 25° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 9 a. Cylindrotheca closterium (strain 709) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 9 b. Cylindrotheca closterium (strain 709) at 25° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 10 a. Phaeodactylum tricornutum (strain 39) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocera typica.

Fig. 10 b. Phaeodactylum tricornutum (strain 39) at 25° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, *Nitocra typica*.

Fig. 11 a. *Amphora acutiuscula* var *coffeaformis* (strain BI-16) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, *Nitocira typica*.

Fig. 11 b. *Amphora acutiuscula* var *coffeaeformis* (strain BI-16) at 25° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocra typica.

Fig. 12 a. Cylindrotheca fusiformis (strain B1-27) at 15° C.

The effect of microalgae on the developmental cycle of a marine harpacticoid copepod, Nitocira typica.

Fig. 12 b. Gylindrotheca fusiformis (strain B1-27) at 25° C.

~ 7 d; for juveniles ~ 10 d.

The tracer feeding experiments were done in 3 stages. Bacteria or algae were inoculated with $10 \mu\text{Ci/ml } ^{32}\text{P}$; bacteria grew for 24 hrs and algae 48-72 hrs. The bacteria were spun down $3 \times 10,000 \text{ rpm}$ at 5°C in a Sorvall refrigerated centrifuge; the algae washed $3 \times$ at $5,000 \text{ rpm}$ for 10 min. in a Sorvall GLC-1 centrifuge. The remaining pellets were resuspended in 0.3 ml of sea water; 0.1 ml was placed in a scintillation vial; 0.1 ml was counted using a hemocytometer or a B & L spectronic 20 spectrophotometer; the final 0.1 aliquot was added to tubes of 50 nematodes.

The nematodes were allowed to feed for 24 hrs, after which time they were picked, washed, and placed on unlabeled media for 2-8 hrs in order to allow any indigested foods remaining in their gut to be voided. The worms were then washed and counted on a Beckman liquid scintillation counter.

In tracer feeding experiments with Monhystera denticulata, Chromodorina germanica and Rhabditis marina, we found a wide range in rates of consumption of different species of algae and bacteria. Data was presented at the Estuarine Conference. Not all the potential food ingested was digested. Rates of assimilation ranged from a low of 22% to 100%. There was, for instance, 4 orders of magnitude difference in rates of consumption of 2 different but closely related species of algae by one worm. Rhabditis marina digested $1 \times 10^{-4} \text{ mg}$ of Dunaliella parva/day/worm and digested 88% of what it ate, while it digested 31% or $6 \times 10^{-8} \text{ mg/worm/day}$ of Chlamydomonas hedleyi, a symbiotic alga isolated from a foraminifera. Rhabditis also ate fairly large amounts (2×10^{-5}) of two other species of algae, Nitzschia acicularis and Phaeodactylum tricorutum, and 5 species of bacteria, A 5-3, A 1-1, A 5-6, D 1-1 and D 5-2. Chromodorina consumed very low numbers of bacteria and generally consumed large quantities of most species of algae tested. The feeding patterns of Monhystera on algae were similar to those of Rhabditis. One hundred per cent of one species of bacterium (B1-1)

Fig. 14

 ^{14}C vs. ^{35}S vs. ^{32}P Intermediate
Monhystera

^{35}S Rhabditis
marina

NUMBER OF ORGANISMS EATEN / FORAM

fed to the worm was eaten while only 0.4% of another species (C1-4) was eaten.

We have also begun to test trophic efficiency and mineral cycling in another series of experiments. Into the vessels of a Gilson respirometer, worms and bacteria or bacteria alone were inoculated into media containing various ^{14}C labeled substrates. $^{14}\text{CO}_2$ was trapped in 40% KOH moistened filter paper placed in the center well of the flask. At the end of each experiment (3 hrs) the substrate turnover was measured. Overall respiration was measured by means of the Gilson apparatus. Initial results with Rhabditis marina and Monhystera sp indicate that substrate turnover is ~ 125-150% of the rate of the flasks with bacteria alone. Preliminary estimates of nematode ecological efficiencies and associated trophic dynamic measurements are tabulated (Table 2).

We have also studied the ecological efficiency ($E_e\%$) of populations of one worm, Rhabditis marina, as a function of time. For these experiments the worms were inoculated into large numbers of flasks with 4 species of bacteria in a medium which would promote the slow steady growth of the bacteria. Bacteria alone were inoculated into control flasks. Measurements were made weekly. At the beginning of each experiment a known quantity of labeled bacteria were added to each flask. Each week a census of the worm population was made and their rates of growth, respiration and ingestion were measured. The data (Table 3; Fig. 17) suggest that Rhabditis, at least grown this way, has a very low ecological efficiency. Additional experiments are in progress.

Several interesting labeled experiments were done using axenic Rhabditis marina. The worms were exposed to mM amounts of labeled low MW substrates, glycine, glucose, sucrose, aspartic acid, Na acetate, and Na bicarbonate. The worms were incubated for 2 hrs in labeled substrate and then transferred to unlabeled medium for an additional 2 hrs. They were then harvested into vials. Dead worms and aliquots from the washing medium served as controls. No uptake of substrate was measured. The experiment was repeated with

TABLE 2

Preliminary estimates of marine nematode efficiencies

	Ingestion $\mu\text{gC/pop/gen}$	Respiration $\mu\text{gC/pop/gen}$	Assimilation $\mu\text{gC/pop/gen}$	Production	% $E_a=A/I$	% $E_t=P/A$	% $E_e=P/I$
<u>Monhystera</u> sp	980 μg	C^{14} 1082 μg	-102	50 μg	-	-	5.10
		$\text{N}_2\text{O}+\text{G}$ 321 μg	-121		-	-	
<hr/>							
<u>Rhabditis marina</u>	12~grams	C^{14} 23.35 μg	~12	1584 μg	~100	0.013	0.013
		$\text{N}_2\text{O}+\text{G}$ 11.26 μg	~12		~100	0.013	

TABLE 3

Energetic consideration of the growth of Rhabditis marina fed a mixture of 4 species of bacteria (un-identified species of Pseudomonas strains R 1, R 2, R 4 and R 6) at 25 C.

Week	Population	Ingestion $\mu\text{gC}/\text{worm}/\text{hr}$	Respiration $\mu\text{l O}_2/\text{hr}/\text{g}$	Production $\mu\text{g C}/\text{worm}$	$E_e = P/I$
1(10/31)	38	4×10^{-8}	1452	1.6×10^{-4}	0.0%
2(11/ 6)	1477	0.88×10^{-8}	375	1×10^{-5}	0.31%
3(11/10)	2886	1.02×10^{-8}	474	3.6×10^{-5}	-0.099%
4(11/13)	2713	12.3×10^{-8}	758	3.7×10^{-6}	-0.0002%
5(11/16)	2602	6.21×10^{-8}	142	4.6×10^{-6}	+0.004%

FIG. 17

3 M $\pm$ 15 μ M microspheres added to the experimental medium. No appreciable uptake of labeled substrate was measured. When 0.5-10 μ M microspheres were used, some uptake of most substrates was measured. These results suggest to us that the cuticle of the worms does not permit absorption of even low MW compounds and that dissolved nutrients probably do not play much of a role in the nutrition of Rhabditis.

Some progress was also made in the study of the special growth factors required by Rhabditis marina. We found that this organism is capable of digesting only a small number of species of bacteria and that it will grow in continuous monoxenic culture with very few. Growth stimulating factors were found in milk, brewers yeast, autoclaved bacteria, malt extract, gelysate peptone which led us to suspect that in addition to hemoglobin the worm requires either additional vitamins and/or some lipid growth factors.

R. marina was maintained axenically on Base B plus 25% (v/v) Graces Insect media (Grand Island Biological Company, L. I., N. Y.). Graces Insect Media is a highly enriched nutritive media containing amino acids, vitamins, fatty acids and sugars. The pre-sterilized Graces Insect media was added aseptically to solidified Base B and slanted. The nematodes were transferred once a week with the weekly addition of antibiotics, and thus maintained for more than 75 generations. Before finding Graces Insect media best for maintenance, we tested two other prepared organic media, M 199 and C. briggsae medium (G.I.B. Co). In ease case yeast extract, hemoglobin, case amino acids, trypticase and autoclaved bacteria were used as nutrient additives. Continuous growth and reproduction did not take place in either medium supplements.

The addition of various peptones, carbohydrates or yeast extract to Graces medium did not stimulate further growth. Crude natural materials rich in lipids (i.e. egg yolk, milk, whole egg, lactalbumin and brewers yeast) were stimulatory. Hexane and aqueous extracts of whole egg powder were more stimulatory than undefined supplements tested. Additional experiments with other

TABLE 4

Assay for the nutritional requirements of Rhabditis marina. * I.

		A			B			C			D		
		no add			hexane extract whole egg powder 2.5 mg%			aqueous extract whole egg powder 1 mg%			aqueous extract whole egg powder 1 mg%		
		Init.	3 da	6 da	Init.	3 da	6 da	Init.	3 da	6 da	Init.	3 da	6 da
I.	No add	40	200	100	40	72	50	40	53	60	25	34	36
II.	TEM 1 mg%	40	71	20	42	12	14	55	77	25	30	64	75
III.	TWEEN 80												
	0.5 mg%	65	198	250	54	68	130	100	35	70	115	200	150
IV.	Soy lecithin												
	0.5 mg%	105	142	170	100	50	35	45	- -	- -	75	300	306
V.	Menadione	30											
	0.1 mg%	30	25	- -	15	- -	- -	20	15	20	25	26	75
VI.	Animal lecithin												
	0.5 mg%	95	45	31	43	150	300	150	100	200	100	300	350
VII.	Cephalin												
	0.1 mg%	35	5	10	50	30	55	120	90	350	130	160	120
VII.	Egg lecithin												
	a) 0.1 mg%	130	80	100	100	25	15	65	120	200	60	180	200
	b) 0.5 mg%	30	70	80	50	70	90	100	200	100	110	50	50

* Medium was solidified Base B (Lee et al., in press) and Graces Insect medium 15% (v/v); incubation 25° C; results of second serial transfer.

TABLE 5

Assay for the nutritional requirements of *Rhabditis marina*.* II.

		A		B		C		D	
		no add		whole egg powder 50 mg%		B+ hemoglobin 0.01%		hexane extract whole egg powder 2.5 mg%	
		Initial	6 day	Initial	6 day	Initial	6 day	Initial	6 day
1.	Oleic acid								
	a) 0.1 mg%	4	14	8	3	5	20	9	8
	b) 0.5 mg%	7	5	3	16	4	18	6	21
	c) 1 mg%	4	10	4	8	2	5	2	6
2.	Palmitic								
	a) 0.1 mg%	3	16	3	13	4	12	3	--
	b) 0.5 mg%	15	20	5	3	6	14	3	6
	c) 1 mg%	6	8	6	11	14	28	13	20
3.	Oleic and palmitic								
	a) 0.1 mg%	10	8	5	9	12	16	3	10
	b) 1 mg%	10	20	11	50	9	30	6	10
4.	Linolenic, linoleic, stearic								
	a) 0.1 mg%	8	42	5	52	13	67	12	63
	b) 0.5 mg%	18	85	6	90	4	56	11	20
5.	Linolenic, linoleic, stearic, oleic, palmitic								
	a) 0.1 mg%	10	80	16	35	5	42	13	33
	b) 1 mg%	8	100	8	25	10	48	12	52

* Medium was solidified Base B (Lee et al., in press) and Graces Insect medium 15% (v/v); incubation 25° C; results of 7th serial transfer.

lipid rich materials showed that a growth factor was also found in Tween 80, soy lecithin, cephalin and TEM 4T (Table 4). Only 1 mg% (w/v) TEM 4T and 0.5 mg% (w/v) Tween 80 stimulated growth after 7 serial point to point transfers. Experiments showed combinations of oleic, stearic, linolenic, linoleic and palmitic acids plus 0.01% (w/v) hemoglobin might satisfy the nutritional requirements of the worm (Table 5). Additional experiments are planned.

A number of experiments this year were directed toward broadening our understanding of the niches of 2 meiofaunal species, Euplotes vannus (a hypotrichous ciliate) and Chromadorina germanica (a nematode). Euplotes vannus grows and reproduces over a fairly wide abiotic range: temperature 12-25° C, salinity 14-60 ‰, pH 5.0-9.8. Chromadorina germanica has a wider temperature tolerance (14-34° C) but narrower salinity (19-41 ‰) and pH (6-9.8) ranges (Table 6). Euplotes does not seem to be inhibited by crowding although Chromadorina is affected. Muller's methods were used to calculate an interspecific competition coefficient and to graphically represent aspects of the niches of both species. (See Muller 1975, which is appended to this report; COO 3254-5). The fecundity of Chromadorina germanica is greatly reduced in the presence of other species and in many respects this animal has a very narrow niche compared to other meiofaunal species (Figs. 18-23). Except for its fairly wide intraspecific crowding tolerance, it has the second narrowed niche of any species yet studied. (Spiroloculina hyalina, a foraminiferan, has the narrowest niche.) Euplotes vannus, on the other hand, has the widest niche of any of the species tested, largely because it is unaffected by crowding or by the presence of other microherbivorous species.

One of the key issues in defining the biotic variables which regulate community structure is whether many of the meiofauna are so highly specialized for resource partitioning that they are stenotrophic (restricted to only a few species in their diet). If many species are so specialized, then food webs and community structure must be evaluated in very complex ways here-to-fore only theoretically

TABLE 6

Summary of niche parameters for Euplotes vannus and Chromadorina germanica.

	<u>Euplotes vannus</u>		<u>Chromadorina germanica</u>	
	range	optimum	range	optimum
Temperature (° C)	12-25	22	14-34	20
Salinity (‰)	14-60	26	19-41	26
pH	5.0-9.8	6-8	6-9.8	
feeding rate (# cells/f/day)	10^2 - 10^8	10^6	10^2 - 10^8	10^7
Intraspecific crowding	1->3000 (no effect)	1->3000	75-300+	
Interspecific competition*		0.65		0.33

*After Muller, 1975. (See paper in press in appendix of this progress report.)

Fig. 18 Graphic representation of the niche of *Euplotes vannus*.

Fig. 19 Graphic representation of the niche of *Chromadorina Germanica*.

Fig. 20 Graphic representation of the niche of *Allogromia laticollaris*.

Fig. 21 Graphic representation of the niche of Ammonia beccarii.

Fig. 22 Graphic representation of the niche of *Rosalina leei*.

Fig. 23 Graphic representation of the niche of *Spiroloculina hyalina*.

considered by ecosystem cybernetics. (For extensive discussion see COO 3254-16 and COO 3254-22 appended to this report.) This year we began experiments on the effect of food density on the diet and stability of meiofaunal populations. A priori one might expect that if Lotka-Volterra kinetics dominate feeding relationships that the animals will feed upon the most abundant prey species. When a particular prey species declines numerically, the consumer would be expected to switch to another, more abundant prey. If this is not true and switching does not occur, then any large deviations from a strictly abundance relationship may be taken as evidence of dietary specialization and used as a measure of food web stability and informational complexion.

Allogromia laticollaris was chosen as the initial experimental animal for this subproject because its diet has received some prior attention in our laboratory and because it is very hardy and easily manipulated in dietary experiments. Allogromia used in these experiments were uniform in size and at a mid life cycle, a very actively feeding life cycle stage. Except for controls, the total concentration of both species of algae was kept at a constant level, 1×10^6 or 10^7 /ml. This concentration is at a level fairly close to the saturation limits for feeding by Allogromia. The concentration of each of the food species was varied in proportion to each other from 1:4-4:1 of the reference species. Controls contained only a single species and were varied only in concentration at levels which paralleled those in experimental vessels. The results of our initial experiments are presented graphically (Figs. 24-28). As can be seen the presence of a second potential food species variously effected the predator's feeding patterns. Phaeodactylum tricornutum was not eaten in as great a quantity in the presence of Dunaliella parva as it was alone (Fig. 24). On the other hand, when Phaeodactylum was present in small concentrations ($< 2:1$) feeding on Dunaliella was enhanced (Fig. 24); switching occurred after 1:1 prey concentration.

Fig. 24 The effect of varying concentration of 2 species of prey on consumption by Allogromia laticollaris.

1. Phaeodactylum tricornutum (39) control.
2. Dunaliella parva (14) in the presence of Phaeodactylum tricornutum.
3. Phaeodactylum tricornutum in the presence of Dunaliella parva.
4. Dunaliella parva control.

Fig. 25 The effect of varying concentration of 3 species of prey on consumption by Allogromia laticollaris.

1. Nan ochloris spp (41) in the presence of Dunaliella parva (14).
2. Chlamydomonas subehrenberghii (93) in the presence of Nan.ochloris spp (41).
3. Dunaliella parva (14) in the presence of Nan.ochloris spp (41).
4. Nan.ochloris sp (41) in the presence of Chlamydomonas subehrenberghii (93).

Fig. 26 The effect of varying concentration of 2 species of prey on consumption by Allogromia laticollaris.

1. Nitzschia acicularis (8) in the presence of Cylindrotheca closterium (9).
2. Nitzschia acicularis (8) control.
3. Cylindrotheca closterium (9) control.
4. Cylindrotheca closterium (9) in the presence of Nitzschia acicularis (8).

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Feeding of Allogromia on mixed diets of Nan ochloris sp (strain 41), Chlamydomonas subehrenberghii (strain 93) and Dunaliella parva seemed to follow Lotka-Volterra kinetics even though there was at least an order of magnitude difference in the consumption of Nan ochloris in the presence of Dunaliella parva and the closely related Chlamydomonas subehrenberghii (Fig. 25). In the presence of large amounts of each other, neither Nitzschia acicularis nor Cylindrotheca closterium were eaten at control levels (Fig. 26). Switching was not evident. Nan ochloris were eaten in relatively constant quantities in the presence of Dunaliella salina, but in the presence of Cylindrotheca closterium switching was evident at a ratio of 2:1 or greater (Fig. 27). The reverse (Cylindrotheca eaten in the presence of Nan. ochloris) was also true. Switching was also seen in mixtures of Dunaliella parva and Cylindrotheca closterium (Fig. 28); feeding on Dunaliella was negligible below the 2:1 ratio of D. parva:C. closterium.

Fig. 27 The effect of varying concentration of 3 species of prey on consumption by Allogromia laticollaris.

1. Cylindrotheca closterium (9) in the presence of Nan. ochloris sp (41).
2. Dunaliella salina (13) in the presence of Nan. ochloris sp (41).
3. Nan. ochloris sp (41) in the presence of Dunaliella salina (13).
4. Nan. ochloris sp (41) in the presence of Cylindrotheca closterium (9).

Fig. 28 The effect of varying concentration of 2 species of prey on consumption by Allogromia laticollaris.

1. Cylindrotheca closterium in the presence of Dunaliella parva (14).
2. Cylindrotheca closterium control.
3. Dunaliella parva control.
4. Dunaliella parva in the presence of Cylindrotheca closterium.

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- B. Stress and field experiments on transplanted and local natural communities to test the changes in community structure due to local water quality, heavy metals, etc.

Experiments on the effects of heavy metal ions on the growth of epiphytic communities begun last year were continued. Choice of concentrations to be tested was based on Dr. Grant Gross' analyses of the levels of metallic ions present in the N.Y.C. Ambrose light tower sludge dumping area. Thus far we have measured LD₅₀ and MLD for 3 species of worms and their food when grown under optimal conditions. For both the algae and the worms the toxicity of the various ions was generally: Ag>Hg>Cu>Pb (Tables 7, 8). Tolerance was generally lower for exposure to metals for long periods. The data for 30 days exposure are also tabulated (Table 9). In general, metallic ions were more lethal to the foraminifera and nematodes than they were to the algae. With few exception they and 2 species of algae were killed by the lowest levels of metallic ions tested in the experiment (Table 7). The MLD for most algae was $\sim 5 \times 10^{-4}$ g/L (0.5 ‰) of lead, chromium and mercury. Chlorophyte B1-1 was a bit more resistant to lead. All the organisms were more sensitive to silver; MLD for this ion was $\leq 1 \times 10^{-6}$ g/L (0.005 ‰).

For the past 3 years we have been attempting to develop an apparatus which would permit us to do some critical field experiments under ambient, or as close to ambient conditions as possible. The device we were seeking to develop had to have a reasonably free exchange of sea water and metabolites with the surrounding sea water, retain all the algae and meiofauna, and be able to withstand the stresses imposed by natural environmental perturbations. Our initial studies in the summer of 1971 used dialyzing membranes to retain the organisms and allow exchange of soluble materials with the environment. The membranes were tied at both ends and suspended in racks above the marsh surface. Every design we tried

TABLE 7

The toxicity of selected heavy metals to various salt
marsh aufwuchs algae. *

Alga Tested	Ag		Cr		Cu		Hg		Pb	
	LD ₅₀	MLD	LD ₅₀	MLD	LD ₅₀	MLD	LD ₅₀	MLD	LD ₅₀	MLD
BL-1	7	10 (1)**	40	80 (4)	22	60 (2)	40	60 (3)	90	>100 (5)
SH-1	5	9 (1)	40	60 (4)	30	60 (3)	40-50	50 (2)	80	>100 (5)
8	3	5 (1)	70	80 (4)	9	60 (3)	20	30 (2)	100	>100 (5)
RF-8	2	5 (1)	--	--	--	50 (4)	1	6 (2)	20	30 (3)
9	3	5 (1)	70	80 (4)	9	-- (2)	10-20	40 (3)	100	>100 (5)
BL-15a	3	5 (1)	--	--	20	50 (3)	3	5 (1)	10	30 (2)
BL-17	4	6 (2)	--	--	20	40 (4)	2	5 (1)	20	30 (3)
38	7	10 (1)	20	90 (4)	40	60 (2)	40-60	60 (3)	>100	>100 (5)
50	10-20	-- (2)	40	80 (4)	30	80 (3)	4	8 (1)	>100	>100 (5)
55	0.8	1-10 (1)	80	80 (4)	69	100 (3)	4	10 (2)	>100	>100 (5)

* all values in ppm
 ** values in parenthesis represent relative toxicity on a
 scale of 1-5, where 1 = most toxic, 5 = least toxic.

TABLE 8

The acute toxicity of selected heavy metals to 3 species of salt marsh aufwuchs nematodes.*

Metal	<u>Chromadorina</u>			<u>Monhystera</u> **		<u>Rhabditis</u> **	
	LD ₅₀	MLD		LD ₅₀	MLD	LD ₅₀	MLD
Ag	0.25	0.5	24 hr	0.5-1	> 1	1	> 1
		0.4	3 d				
		0.3	6 d				
Hg	0.25	~ 1	24 hr	0.1	> 1	> 1	> 1
		0.8	3 d				
		0.75	6 d				
Pb	~5-10	> 100		> 100	> 100	> 1	> 1
Fe	>100	>100	24 hr	> 40	> 40	> 1	> 1
Cr	>100	>100	24 hr	~ 75	≈ 100	> 1	> 1
Cu	2-3	> 75	24 hr	3	> 74	> 1	> 1
		75	3 d				

* all values in PPM

** data for 24 hr

TABLE 9.

Preliminary study of the effects of heavy metal ions on the growth of selected salt marsh microorganisms and micrometazoa. *

Organism	Lead		Chromium		Mercury		Silver	
	LD 50/30	MLD	LD 50/30	MLD	LD 50/30	MLD	LD 50/30	MLD
<u>Algae</u>								
BL-1	6×10^{-4}	1×10^{-3}	1×10^{-4}	3×10^{-4}	2×10^{-4}	5×10^{-4}	1.5×10^{-6}	7×10^{-6}
RF-1	4×10^{-4}	5.5×10^{-4}	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
SH-1	5×10^{-4}	9×10^{-4}	1×10^{-4}	3×10^{-4}	1×10^{-4}	4×10^{-4}	2.5×10^{-6}	5×10^{-6}
RF-8	2×10^{-4}	6×10^{-4}	2×10^{-4}	3×10^{-4}	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
BL-15A	2×10^{-4}	5×10^{-4}	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
8	5.5×10^{-4}	9×10^{-4}	4×10^{-4}	5×10^{-4}	3×10^{-4}	4×10^{-4}	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
9	6×10^{-4}	6×10^{-4}	2×10^{-4}	3×10^{-4}	4×10^{-4}	5×10^{-4}	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
38	4×10^{-4}	7×10^{-4}	2×10^{-4}	3×10^{-4}	2×10^{-4}	3×10^{-4}	2×10^{-6}	3×10^{-6}
39	8×10^{-4}	1×10^{-3}	2×10^{-4}	4×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-6}	4×10^{-6}
50	5×10^{-4}	7×10^{-4}	2×10^{-4}	3×10^{-4}	2×10^{-4}	3×10^{-4}	2×10^{-6}	3×10^{-6}
55	5×10^{-4}	9×10^{-4}	3×10^{-4}	4×10^{-4}	1×10^{-4}	2×10^{-4}	2×10^{-6}	$< 1 \times 10^{-6}$
<u>Nematodes</u>								
<u>Chromadorina</u>	$< 1 \times 10^{-4}$	2×10^{-4}	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
<u>Rhabditis</u>	2.5×10^{-4}	4×10^{-4}	1.5×10^{-4}	3×10^{-4}	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	2×10^{-6}	4×10^{-6}
<u>Monhystrera</u>	2.5×10^{-4}	7×10^{-4}	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	1.5×10^{-6}	6×10^{-6}
<u>Foraminifera</u>								
<u>Spiroloculina hyalina</u>	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
<u>Rosalina leei</u>	5×10^{-4}	9×10^{-4}	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
<u>Allogromia laticollaris</u>	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-4}$	1.5×10^{-6}	3×10^{-6}

* MLD and LD 50/30 given in g/l.

during the summer had poor performance characteristics. It seemed to make little difference if the membranes were tightly suspended or loosely suspended, wind and wave action tore them in less than a week. Membranes of different manufacture were almost equally as fragile in the environment. In the summer of 1972, experimental vessels were made from 60 ml serum bottles with their bottoms cut off. The edges of the bottom were coated with paraffin and the bottoms were covered by a dialyzing membrane bound on nylon fishing line. The vessels were then secured in wooden racks which held 3 replicates of 10 different experimental situations. At each station the natural community from all 3 experimental stations, Sandy Hook, N. J., North Sea Harbor, L. I. and Jamaica Bay, N. Y., were incubated inside the experimental vessels as was the mixed inocula from all 3 areas. Other variables included inocula from the same station incubated with chunks of metallic Ag, Cu, Cr, Fe, Pb and crude oil. The dialysis membranes were obtained from the food products division of Union Carbide, and have, according to the manufacturer, an average pore radius of 24 μm . The initial inocula and each of the 1 ml weekly samples were individually preserved in the field in small vials containing 95% alcohol. In the laboratory each sample was transferred to centrifuge tubes and washed 3 times with distilled water to remove the salt. The diatoms were then treated with H_2O_2 , dehydrated in ethanol, and placed on microscope slides. They were mounted using Zeiss phase contrast mounting medium (Einschlubmittel L 15).

On June 27, 1972, hurricane Agnes destroyed our experimental apparatus. The results of the initial experiment are tabulated (Tables 10, 12). The experiment was begun again on July 12, 1972. By the time 3 weeks had passed, it became obvious that the dialysis membranes were weakening and breaking. After the membranes were examined by phase microscopy, it became obvious that they were being attacked by cellulose digesting bacteria and were unsuitable for this type of long-term experiment. Consultation with many manufacturers led to the conclusion that none of the dialyzing membranes

currently on the market would be suitable for this kind of experiment. After a careful survey of the materials commercially available, we chose nylon filters with a $1\text{ }\mu\text{m}$ radius pore (Millipore NRWP 142 50) for additional experiments which were begun on August 15, 1972 and ran until September 19, 1972. The membranes proved durable and gave promise for utility in the experiments we did in the summer of 1973. The diatom population structure of one set of experimental flasks, those containing iron, was examined. In addition to a reduction in population size in the experimental flasks we also found considerable changes in the structure of the community (Table 13).

In the summer of 1973 we finally tested a device which meets performance criteria. The experimental vessels are made from falcon tissue culture flasks which are perforated by 12 1.25 cm holes, and to which $1\text{ }\mu\text{m}$ pore size nylon membranes (Millipore, Duralon NRWP 142 50) have been bonded. These are held in a rugged apparatus constructed of lucite designed to hold each flask horizontally 3 cm from the substrate. The bottom of the flasks are not in direct contact with the holding apparatus. Below each flask is a 1 cm high chamber, the floor of which is perforated with many 0.6 cm holes (see attached photograph). The apparatus was then suspended between poles driven into the marsh substrate.

Two experiments were done using the experimental apparatus at Sippewisset Marsh, at Jamaica Bay, and at Towd Point in Southampton, New York. In the first experiment, populations of organisms from each of the field locations were transplanted to each of the other locations. A mixture of the inoculum from all 3 locations was incubated with reagent grade chunks of Fe, Cu, Zn, Cr, Pb and crude oil.

Each week, 5 ml samples were removed from each of the experimental vessels. Diatom community size estimates were made by hemocytometer. Peroxide cleaned frustules are being used for the study of the diatom population structure. Inocula for the experiments was

TABLE 10.

76.

Comparison of the inocula from the 3 field stations used in the study. * **

Species	Jamaica Bay		Sandy Hook		Southampton	
	#	%	#	%	#	%
<u>Cyclotella striata</u>	884	87.6	648	64.41	100	9.73
<u>Achnanthes hauckiana</u>	23	2.28			65	6.32
<u>Navicula cryptocephala</u>	26	2.58				
<u>Synedra gallioni</u>			75	7.46	152	14.79
<u>Achnanthes longipes</u>			94	9.34		
<u>Opephora martyi</u>					85	8.27
<u>Fragilaria construens</u>					42	4.09
<u>Skeletonema costatum</u>					32	3.11
<u>Achnanthes wellisiae</u>					33	3.21
<u>Nitzschia sigma</u>					36	3.50
<u>Navicula salinarum</u>					34	3.31
<u>Navicula mensicoides-like</u>					34	3.31
<u>Nitzschia apiculata</u>					25	2.43
<u>Navicula halophila</u>					27	2.62
<u>Cocconeis scutellum</u>					25	2.43
Total specimens counted	1009		1006		1028	
Σ %	89.88		81.21		67.1	
# of species identified	33		50		87	

* If species represented < 2%, it was not included in the results.

** Samples taken in the field June 9, 1972.

TABLE 11

Seasonal succession in the diatom assemblage
of Enteromorpha growing in Jamaica Bay.

Date	6-9-72		6-15-72		6-23-72		6-27-72	
Count (species)	1009(33)		1026(67)		1009(49)		1002(54)	
Species	#	%	#	%	#	%	#	%
<u>Cyclotella striata</u>	884	87.6	479	46.69	530	52.53	624	62.28
<u>Cyclotella</u> sp			28	2.73	44	4.36	21	2.01
<u>Achnanthes hauckiana</u>	23	2.28	65	6.64	103	10.21	53	5.29
<u>Achnanthes wellisiae</u>			106	10.33	65	6.44	77	7.68
<u>Navicula cryptocephala</u>	26	2.58	34	3.31	30	2.97		
<u>Navicula incomposita</u> var.			35	3.41				
<u>Fragil aria construens</u>			23	2.24	21	2.08		
<u>Coscinodiscus</u> sp					36	3.57		
<u>Nitzschia proxima</u>					21	2.08		
Σ %		89.88		75.35		76.51		77.26

TABLE 12

Comparison of samples from the control flasks
and the inoculum after 1 week incubation. *

Species	Inoculum		Control flask	
	#	%	#	%
<u>Cyclotella striata</u>	884	87.6	181	41.9
<u>Achnanthes hauckiana</u>	23	2.28	12	2.78
<u>Navicula cryptocephala</u>	26	2.58		
<u>Melosira nummuloides</u>			48	11.11
<u>Synedra gallioni</u>			26	6.02
<u>Cocconeis scutellum</u>			19	4.40
<u>Melosira sulcata</u>			16	3.70
<u>Cyclotella sp</u>			16	3.70
<u>Opephora martyi</u>			14	3.24
<u>Coscinodiscus sp</u>			10	2.31
<u>Striatella unipunctata</u>			9	2.08
<u>Achnanthes longipes</u>			9	2.08
<u>Navicula incomposita</u> like			9	2.08
Total number of specimens counted		1009		432
Σ %		92.5		86.4
# of species identified		33		44

* If species represented < 2%, it was not included in the results.

TABLE 13

The effect of iron on the growth and community structure of natural populations of diatoms.

Species	Control 1014 (79)		Iron Treatment * 188 (41)	
	#	%	#	% **
<u>Rhopalodia musculus</u> (+ " <u>gibberula</u> ")	299	29.48	11	5.85
<u>Navicula digitoradiata</u>	90	8.87	30	15.95
<u>Nitzschia sigma</u>	77	7.59	14	7.45
<u>Achnanthes hauckiana</u>	54	5.32	9	4.78
<u>Opephora martyi</u>	52	5.12	9	4.78
<u>Bacillaria paradoxa</u>	42	4.14	6	3.19
<u>Cyclotella</u> sp	35	3.45		
<u>Achnanthes longipes</u>	31	3.06		
<u>Synedra gallioni</u>	27	2.66	10	5.31
<u>Melosira nummuloides</u>	22	2.16	7	3.72
<u>Pleurosigma angulatus</u>			10	5.31
<u>Melosira sulcata</u>			8	4.25
<u>Nitzschia panduriformis</u>			6	3.19
<u>Caloneis westii</u>			5	2.65
<u>Pleurosigma affini</u>			4	2.12

* Fewer individual diatoms were present in these vessels (3 replicates).

** If species represented < 2%, it was not included in the results.

1×10^4 cells/ml. In the transplantation experiments all the communities seemed to thrive fairly well in Sippewisset. The community from Southampton grew best, in terms of total numbers of organisms/ml in Sippewisset marsh; Jamaica Bay was the worst initially, but eventually it came up to the Sippewisset level.

About 300 species have been collectively found in the 3 marshes. The greatest diversity in any individual sample analyzed so far was 96 species. The analysis of the effects of individual ions on the community structure is very complex and very time consuming as any one who has studied diatom communities will tell you. Microscopic analysis of the Woods Hole diatom communities were completed this past month and are presented in tabular form (Tables 14, 15). We are currently in the process of putting the data into the memory of the University computer from the remote terminal in our laboratory so that we can analyze it by means of several recurrent group programs. The data are obviously too extensive to analyze by superficial scanning but some preliminary impressions have been gleaned from the data.

In the first week of incubation, crude oil completely inhibited the growth of Melosira nummuloides, whereas the growth of M. sulcata was selectively enhanced. The growth of Synedra fasciculata was relatively enhanced in the presence of Fe, Cu, Zn and Cr. Cu depressed the growth of Opephora martyi. Zn more than doubled the proportion of A. hauckiana. Most ions depressed the growth of N. microcephala.

At Sippewisset, Fe did not effect the overall growth of the diatom community initially, but eventually growth was < 30-50% of controls. Cu and Pb strongly inhibited growth. Population size in the presence of these ions was generally from 5-45% of controls. The effect of crude oil was similar. Except for an initial lag, Zn and Cr were less inhibitory. Zn was the least inhibitory of all those tested; populations fluctuated from 15-100% of controls. Cr populations varied from about 15-80% of controls.

Table 14. Percent abundance of taxa identified from diatom communities transplanted to Woods Hole, Mass. (WH) from Southampton, N. Y. (SH), Jamaica Bay, N. Y. (JB), and mixed inocula (MIX) of each community.

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Achnanthes chilensis</u>	--	--	--	0.1	0.5	--	--	--	--	--	1.4	--
<u>A. conspicua</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>A. haukiana</u>	12.9	1.7	2.2	14.2	18.2	1.7	3.3	6.1	11.2	1.4	8.5	5.3
<u>A. haukiana</u> var. <u>rostrata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. hustedii</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. lanceolata</u>	--	0.2	--	--	--	--	--	--	0.2	--	--	--
<u>A. pinnata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. lemmermanni</u>	--	--	--	--	--	--	--	--	--	0.4	--	--
<u>A. linearis</u>	--	--	--	--	--	--	--	--	--	--	1.3	--
<u>A. longipes</u>	2.3	0.5	0.4	1.4	1.7	--	0.1	1.1	2.3	--	--	1.5
<u>A. lorenziana</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. mintuissima</u>	--	--	--	0.5	--	--	--	--	--	--	--	--
<u>A. wellsiae</u>	0.4	--	--	0.3	--	0.4	--	0.5	0.1	--	--	--
<u>A. pseudosolea</u>	2.5	0.2	0.6	2.3	0.7	2.7	0.7	3.0	1.0	0.3	0.3	--
<u>Actinopterychus undulatus</u>	--	--	--	--	--	--	--	--	0.1	0.2	--	0.1
<u>Amphiprora alata</u>	--	0.2	0.1	0.2	--	--	0.3	0.4	0.2	0.4	--	--

-- Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Amphiprora decipiens</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Amphora acutiuscula</u>	2.4	0.4	--	4.7	6.0	0.8	0.6	1.7	1.6	1.3	1.3	0.6
<u>A. angusta</u> var. <u>ventricosa</u>	--	0.2	--	--	--	--	--	--	--	0.1	--	--
<u>A. beaufortiana</u>	0.1	--	--	--	--	0.2	0.2	0.1	--	0.1	--	--
<u>A. coffeaeformis</u>	0.1	0.1	0.5	0.4	--	--	--	--	0.1	0.1	--	0.2
<u>A. costata</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>A. cymbifera</u>	0.1	--	--	--	--	0.5	--	0.4	0.1	0.2	0.3	0.2
<u>A. exigua</u>	--	--	--	--	--	0.1	--	--	--	--	--	--
<u>A. hyalina</u>	--	--	--	0.3	--	--	--	--	--	0.4	--	--
<u>A. macilenta</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. osterearia</u> var.	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>A. ovalis</u> var. <u>affinis</u>	0.2	--	--	0.2	--	0.3	0.3	0.3	--	0.1	0.4	--
<u>A. ovalis</u> var. <u>pediculus</u>	--	--	--	--	--	--	--	0.1	--	--	--	--
<u>A. quadrata</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>A. rhombica</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sublaevis</u>	0.3	0.3	0.1	0.3	0.3	--	0.2	0.4	--	0.4	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Amphora tenuissima</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. tumida</u>	0.1	--	--	--	--	--	0.5	--	--	--	0.1	--
<u>A. turgida</u>	0.7	0.2	0.2	0.1	--	--	0.8	0.1	--	0.2	0.1	--
<u>A. veneta</u>	0.3	--	--	--	--	--	--	--	--	0.1	0.2	--
<u>A. sp. 139</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 140</u>	--	0.5	--	--	--	0.1	--	--	--	0.4	--	--
<u>A. sp. 140.4</u>	0.5	0.1	--	0.3	--	0.1	--	--	0.1	--	--	--
<u>A. obtusa</u>	0.1	--	--	0.2	--	--	--	--	--	--	--	0.1
<u>A. sp. 140.8</u>	--	--	--	--	0.3	0.2	--	0.3	--	0.1	--	0.2
<u>A. sp. 146</u>	--	--	--	--	0.3	--	--	--	--	--	--	--
<u>A. sp. 150</u>	0.1	--	--	--	--	--	--	0.2	--	--	--	--
<u>A. sp. 150.2</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 152</u>	0.5	--	0.3	0.1	--	--	--	--	--	--	--	--
<u>A. sp. 162</u>	--	--	--	--	--	--	0.1	--	--	--	--	--
<u>A. sp. 140.1</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. proteus</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Amphora pusio</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Amphipleura rutilans</u>	0.1	--	0.2	--	--	--	--	--	--	--	--	--
<u>A. micans</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Anorthoneis hummii</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Auliscus punctatus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Auricula insecta</u>	--	0.2	0.1	--	--	--	--	0.2	--	--	--	--
<u>Biddulphia pulchella</u>	--	--	--	--	--	--	--	--	--	0.1	--	--
<u>Caloneis westii</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>Campylodiscus sp.</u>	--	14.8	0.4	0.3	--	5.2	--	0.2	--	--	--	--
<u>Chaetoceros affine</u>	0.3	--	--	--	--	--	--	--	--	--	--	--
<u>Cocconeis dirupta</u>	--	1.3	--	--	--	--	--	0.1	--	--	--	--
<u>C. disculoides</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. disculus</u>	--	--	--	--	--	--	--	0.2	0.1	--	--	--
<u>C. fluminensis</u>	--	--	--	0.8	1.3	--	0.3	0.1	0.5	0.1	0.4	--
<u>C. pediculus</u>	0.3	--	--	--	--	--	--	--	--	--	--	--
<u>C. placentula</u>	0.1	--	1.2	--	0.4	--	0.1	--	--	--	--	0.2

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Cocconeis placentula</u> var. <u>euglypta</u>	--	--	--	0.2	--	--	--	--	--	--	--	--
<u>C. scutellum</u>	0.8	0.5	1.0	0.5	0.7	0.1	0.5	0.4	0.4	0.1	0.8	0.5
<u>C. scutellum</u> var.	--	--	0.3	--	--	--	--	--	--	--	--	--
<u>C. sp. 84</u>	--	--	--	0.5	--	--	--	--	--	--	--	--
<u>Coscinodiscus lineatus</u>	0.3	--	--	--	--	--	--	0.1	--	--	--	--
<u>C. marginatus</u>	0.6	--	--	0.6	--	0.2	--	--	0.2	--	--	--
<u>C. micans</u>	--	--	--	--	--	--	--	--	--	--	--	0.4
<u>C. nitidus</u>	--	0.1	--	--	--	--	--	--	--	0.4	--	--
<u>C. oculus iridis</u>	0.3	--	--	--	--	--	--	--	0.1	--	--	0.1
<u>C. pygmae</u> var. <u>micropunctata</u>	--	0.7	0.4	0.2	0.2	0.2	--	0.1	0.4	0.2	--	0.1
<u>C. radiatus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. sp.</u>	--	45.2	0.8	2.2	--	48.9	0.6	1.2	--	30.2	1.7	--
<u>Cyclotella caspia</u>	0.5	--	--	--	--	--	--	--	2.0	0.2	--	2.5
<u>C. meneghiniana</u>	--	--	0.9	0.5	0.4	0.3	0.5	1.0	4.2	0.4	0.4	1.1
<u>C. striata</u>	1.8	1.4	--	0.3	--	0.4	--	0.1	0.3	--	0.4	0.1
<u>Cylindrotheca closterium</u>	0.1	--	--	--	--	0.1	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Cymbella affinis</u>	--	--	--	--	0.1	--	--	--	--	--	--	--
<u>C. pusilla</u>	0.3	0.3	--	--	0.2	--	--	--	0.8	--	--	0.7
<u>Denticula subtilis</u>	3.3	0.2	1.9	2.1	0.7	0.1	1.4	0.2	2.7	0.1	0.7	1.5
<u>Diatoma sp.</u>	--	--	1.5	--	--	--	--	--	--	--	--	--
<u>Dimmerogramma dubium</u>	--	--	--	--	--	--	--	--	--	0.3	0.3	--
<u>D. minor</u>	--	--	--	1.4	0.1	0.1	0.8	0.3	0.1	0.7	0.5	--
<u>D. sp.</u>	--	--	--	--	--	--	--	--	--	--	0.2	--
<u>Diploneis crabro</u>	0.8	0.1	--	0.2	0.6	--	0.1	0.1	0.2	0.2	0.2	0.2
<u>D. smithii</u>	--	--	--	0.1	--	--	--	--	--	--	--	0.1
<u>D. pseudovalles</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Endictya oceanica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Fragilaria lapponica</u>	0.1	0.5	--	--	--	--	--	--	--	--	--	--
<u>F. construens</u> var. <u>subsalina</u>	2.0	--	--	--	--	--	--	--	1.4	--	--	--
<u>F. construens</u> var. <u>venter</u>	4.5	0.7	2.7	6.0	5.3	1.5	8.2	4.0	2.4	13.0	21.5	10.0
<u>Gomphonema olivaceum</u> var.	--	--	--	--	--	0.1	--	--	--	--	--	--
<u>G. parvulum</u>	0.2	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Grammatophora angulosa</u>	--	--	--	0.1	--	--	--	--	--	--	--	--
<u>G. marina</u>	0.6	--	0.2	0.3	--	--	0.1	--	--	--	0.3	0.2
<u>G. oceanica</u> var. <u>minuscule</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. serpentina</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Gyrosigma accumatum</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>G. balticum</u>	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>G. fascicola</u> var. <u>arcuata</u>	--	--	--	--	--	--	--	0.1	--	--	--	--
<u>G. febigenii</u>	--	--	--	--	--	--	--	0.1	--	--	--	--
<u>G. peisonis</u>	--	--	0.5	--	--	--	0.1	--	--	--	--	--
<u>G. sp.</u>	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>Hantzschia amphioxys</u>	--	--	--	--	--	--	--	0.2	--	--	--	--
<u>H. virgata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Licmophora abbreviata</u>	0.7	--	--	0.3	--	--	--	0.2	--	--	--	--
<u>L. dalmatica</u>	0.7	--	--	--	--	--	--	--	--	--	--	--
<u>L. ehrenbergerii</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>L. lynebyei</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Licmophora</u> sp. 22	--	0.2	--	--	--	--	--	--	--	--	--	--
<u>L.</u> sp. 20	0.3	--	--	--	--	--	--	--	--	--	--	--
<u>Mastogloia</u> <u>augulata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M.</u> <u>braunii</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>M.</u> <u>danseii</u> var. <u>elliptica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M.</u> <u>exigua</u>	1.4	--	--	0.6	8.8	0.2	0.1	2.6	9.7	0.6	0.6	8.5
<u>M.</u> <u>pumila</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M.</u> <u>pusilla</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M.</u> <u>smithii</u>	--	--	--	--	--	--	--	--	0.9	--	--	8.3
<u>M.</u> <u>smithii</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>Melosira</u> <u>distans</u>	--	--	--	--	--	--	0.5	--	--	--	--	--
<u>M.</u> <u>jurgensii</u>	--	--	12.5	0.5	--	--	0.5	--	--	0.2	--	--
<u>M.</u> <u>nummuloides</u>	14.6	--	49.5	14.8	3.6	2.9	31.8	29.1	0.7	1.3	3.7	4.9
<u>M.</u> <u>subflexilis</u>	--	--	--	--	--	0.9	--	--	--	--	--	--
<u>M.</u> <u>sulcata</u>	2.5	3.0	3.3	1.9	1.9	1.1	1.3	1.2	0.1	0.7	1.8	0.6
<u>M.</u> <u>sulcata</u> var. <u>coronata</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/3
<u>Navicula abunda</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. approximata</u> fo. <u>elongata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. arenaria</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. biconica</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. cancellata</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>N. cincta</u>	1.0	0.6	0.2	0.2	0.2	--	--	0.5	1.4	0.1	0.2	1.
<u>N. confervacea</u> var. <u>peregrina</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. cryptocephala</u>	2.0	--	0.3	1.9	1.2	0.3	0.3	1.0	8.5	0.6	1.5	6.
<u>N. cryptocephala</u> var. <u>veneta</u>	1.3	--	0.4	--	--	--	--	--	--	--	--	--
<u>N. digito-radiata</u>	0.8	--	1.7	1.3	0.3	0.7	1.1	0.9	0.2	0.3	0.2	0.
<u>N. diserta</u>	0.7	1.1	--	--	--	0.8	0.3	0.5	0.5	1.9	1.8	0.
<u>N. diverstriata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. elegans</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. forcipita</u>	0.2	--	--	0.2	0.1	--	0.2	--	--	0.1	--	--
<u>N. gottlandica</u>	--	--	--	--	--	--	--	--	0.2	0.2	--	0.
<u>N. granulata</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Navicula gregaria</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. halophila</u>	--	0.7	--	--	--	--	--	--	--	--	--	--
<u>N. hennedyi</u>	0.2	--	0.1	--	--	--	--	0.1	--	--	0.1	--
<u>N. integra</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. litoricola</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. lyra</u>	--	0.3	--	--	0.2	--	--	--	0.1	--	--	0.
<u>N. maculata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. marina</u>	--	--	--	--	--	--	--	--	0.2	--	--	0.
<u>N. menisculus</u>	2.2	0.3	1.1	0.7	1.9	0.5	1.0	0.6	0.8	2.6	2.9	2.
<u>N. menisculus</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. monilifera</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. misella</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. muralis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. mutica</u>	0.2	--	--	--	--	--	--	--	--	--	--	--
<u>N. mutica</u> var. <u>cohnii</u>	0.3	--	--	--	--	--	0.1	--	--	--	--	--
<u>N. opima</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Navicula patrickae</u>	6.4	1.3	--	2.4	4.6	1.2	0.6	1.0	1.4	1.7	1.6	2.0
<u>N. palepebralis</u> var. <u>angulosa</u>	--	--	--	--	--	--	--	0.1	--	--	--	--
<u>N. pavillardii</u>	--	--	--	--	--	--	--	--	--	0.3	--	--
<u>N. peregrina</u>	--	--	--	--	--	--	--	--	--	0.1	--	--
<u>N. plagiostoma</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. platyventris</u>	0.5	2.5	0.9	0.2	--	0.3	0.7	0.3	--	0.8	0.3	0.2
<u>N. pullus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. placentula</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. pygmae</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. radiosa</u> var. <u>cuneata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. regularis</u>	0.1	0.2	--	--	--	--	--	--	--	--	--	--
<u>N. rhynchocephala</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. salinarum</u>	1.8	--	--	1.0	0.2	--	0.7	0.1	0.1	--	0.4	0.5
<u>N. simplex</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. spectabilis</u>	--	--	--	--	--	--	--	0.1	--	--	--	--
<u>N. subapiculata</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Navicula subdiffusa</u>	0.5	0.3	0.3	0.1	0.7	0.3	0.5	0.3	0.2	0.2	--	0.1
<u>N. tripunctata</u> var. <u>schizonemoides</u>	0.2	--	0.1	0.1	0.2	0.1	--	0.1	--	0.1	0.1	0.2
<u>N. vara</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. viridula</u>	--	0.2	--	--	--	--	--	--	--	--	--	--
<u>N. yarrensis</u>	--	--	--	0.4	0.1	--	0.2	0.1	0.1	--	--	0.2
<u>N. sp. 89</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 95</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 100.10</u>	0.1	--	--	--	--	--	--	--	0.1	--	--	--
<u>N. sp. 100.12</u>	--	--	--	--	--	--	--	--	--	0.1	--	--
<u>N. sp. 100.60</u>	0.2	--	--	--	--	--	--	--	--	0.1	--	--
<u>N. sp. 104</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 104.1</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 105</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. accomoda</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 108</u>	--	--	--	--	--	--	--	--	--	--	0.4	--
<u>N. sp. 109</u>	0.2	--	--	0.4	0.9	--	--	0.5	--	0.2	--	0.1

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Navicula</u> sp. 114	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp. 117	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp. 120.1	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp. 120.2	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp. 120.4	--	--	--	--	--	--	--	--	0.1	--	--	--
<u>N.</u> sp. 120.5	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp. 130.2	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp. 130.5	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp. 140	--	--	--	0.2	--	--	--	--	--	--	--	--
<u>N.</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--
<u>Nitzschia acuminata</u>	--	--	0.2	--	--	--	--	--	--	--	0.2	--
<u>N.</u> <u>acicularis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> <u>amphibia</u>	--	0.2	--	--	--	--	--	--	--	--	--	0.4
<u>N.</u> <u>apiculata</u>	--	0.3	--	--	--	--	0.5	--	--	0.1	--	0.1
<u>N.</u> <u>australis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> <u>capitellata</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Nitzschia clausii</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. communis</u>	0.2	0.2	--	--	--	--	--	--	--	--	--	--
<u>N. duboides</u>	--	--	--	--	--	--	0.2	--	--	--	--	--
<u>N. epithemioides</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. filiformis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. fonticola</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. frustulum</u>	0.2	0.1	0.6	--	--	0.1	0.3	--	0.1	0.5	0.4	--
<u>N. frustulum</u> var. <u>perminuta</u>	0.2	0.4	--	--	--	--	--	--	--	--	--	--
<u>N. frustulum</u> var. <u>perpusilla</u>	1.0	1.7	1.1	1.1	--	0.6	0.7	0.1	--	1.0	--	--
<u>N. frustulum</u> var. <u>subsalina</u>	--	--	--	--	--	0.9	0.9	0.2	0.1	3.0	3.2	1.2
<u>N. grossistriata</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>N. hungarica</u>	--	--	3.1	--	0.1	--	11.6	3.5	--	0.3	1.9	0.9
<u>N. hybrida</u>	--	--	0.2	--	--	--	--	--	--	--	--	--
<u>N. incurva</u>	--	--	--	--	--	--	--	0.1	--	--	--	--
<u>N. kutzinghiana</u>	0.2	--	--	--	--	--	--	--	--	--	--	--
<u>N. laevis</u>	--	--	--	--	--	--	--	0.2	0.1	0.2	0.2	0.1

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Nitzschia lanceolata</u> var. <u>minima</u>	--	--	--	0.5	13.3	--	--	12.3	2.1	6.7	3.8	3.0
<u>N. longa</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. longissima</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. lorenziana</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. lorenziana</u> var. <u>subtilis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. microcephala</u>	0.1	--	--	0.1	0.3	0.2	0.5	--	1.1	1.9	--	1.6
<u>N. microcephala</u> var.	--	--	--	--	--	--	--	--	3.3	--	1.6	2.1
<u>N. obtusa</u>	--	--	--	--	--	--	0.1	0.1	0.1	--	0.4	0.1
<u>N. obtusa</u> var. <u>scapelliformis</u>	--	--	--	0.1	--	--	--	--	--	--	--	--
<u>N. palea</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. panduriformis</u>	--	--	0.2	--	--	--	0.2	--	--	--	--	--
<u>N. paradoxa</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. proxima</u>	0.3	--	0.1	--	--	--	0.6	--	--	--	0.4	--
<u>N. punctata</u> var. <u>coaracta</u>	--	--	0.2	--	--	--	0.3	0.1	--	--	0.1	--
<u>N. recta</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. rhombica</u>	--	--	--	--	--	--	0.4	--	0.3	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Nitzschia rigida</u> var. <u>rigidula</u>	--	--	--	--	--	--	0.3	0.2	0.1	--	--	--
<u>N. sigma</u>	0.4	0.1	1.1	0.1	0.4	--	--	0.4	0.4	0.2	0.2	--
<u>N. sigma</u> var. <u>intercedens</u>	--	--	--	--	--	--	0.2	--	--	0.1	--	--
<u>N. socialis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. spathulata</u>	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>N. sublinearis</u>	--	--	--	--	--	--	0.1	--	--	--	--	--
<u>N. subtilis</u>	--	--	--	--	--	--	--	--	0.1	--	--	--
<u>N. thermalis</u> var. <u>minor</u>	0.1	--	--	0.3	0.3	0.1	0.3	0.2	--	0.1	0.2	--
<u>N. tryblionella</u>	--	--	0.5	0.7	--	--	--	--	--	--	--	--
<u>N. tryblionella</u> var. <u>salinarum</u>	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>N. sp. 165</u>	--	--	--	--	--	--	0.1	--	--	--	--	--
<u>N. sp. 167</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 168</u>	--	--	--	--	--	--	0.1	--	--	--	--	--
<u>N. angularis</u> var. <u>affinis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 170.1</u>	--	--	--	0.1	--	--	--	--	--	--	--	--
<u>N. sp. 171</u>	0.2	0.2	--	--	1.0	--	0.1	--	0.2	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Nitzschia</u> sp. 190.1	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp.	0.2	--	--	--	--	--	--	1.0	--	--	--	--
<u>Oestrupia powelli</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Opephora martyi</u>	1.9	1.0	--	7.1	2.1	22.2	13.6	5.5	10.8	18.0	23.2	16.1
<u>O. pacifica</u>	0.4	0.2	0.4	0.8	0.1	--	0.5	--	--	0.2	--	--
<u>O. martyi</u> var.	--	--	--	--	--	--	4.1	--	0.6	--	2.3	0.9
<u>Pinnularia</u> sp. 100.8	--	--	--	--	--	--	--	--	--	0.2	--	--
<u>Plagiogramma staurophorum</u>	--	--	--	--	--	--	0.1	--	--	--	0.1	--
<u>Pleurosigma angulatum</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>P. salinarum</u>	--	--	0.1	0.1	--	--	0.1	0.1	--	0.2	--	--
<u>P.</u> sp.	--	--	--	--	--	--	0.1	--	--	--	--	--
<u>Rhopolodia gibberula</u>	1.5	--	0.5	0.7	4.3	--	--	3.0	2.9	0.3	1.0	4.6
<u>R. musculus</u>	--	--	--	--	--	--	0.3	--	--	--	2.0	5.0
<u>Rhaponeis amphiceros</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>R.</u> sp.	--	--	0.1	--	--	--	--	--	0.1	--	--	0.1
<u>Rhizosolenia</u> sp.	0.1	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Rhoicosphenia curvata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Skeletonema costatum</u>	0.3	--	--	--	--	--	--	--	--	--	--	--
<u>Synedra affinis</u>	0.6	--	1.0	0.4	1.2	--	0.2	1.3	2.2	0.3	--	0.3
<u>S. affinis</u> var. <u>tabulata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. fasciculata</u>	--	--	--	0.1	--	--	--	--	--	--	--	--
<u>S. fasciculata</u> var. <u>tabulata</u>	1.2	0.3	1.0	1.2	0.6	--	0.1	0.9	--	--	--	--
<u>S. fasciculata</u> var. <u>truncata</u>	--	--	--	--	--	--	--	--	--	0.3	--	--
<u>S. fulgens</u>	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>S. gaillonii</u>	--	--	--	--	--	--	--	--	1.3	--	--	0.6
<u>S. radians</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. undulata</u>	--	--	--	--	--	--	--	--	--	--	--	0.1
<u>S. sp.</u>	0.1	--	--	--	0.1	--	--	--	--	--	--	--
<u>Stauroneis salina</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. spicula</u>	--	--	--	--	--	--	0.1	0.1	--	--	--	--
<u>Surirella litoris</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. ovata</u>	0.2	--	--	--	0.1	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	7/3	7/3	7/3	7/3	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31
<u>Striatella interrupta</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>S. unipunctata</u>	0.1	--	0.1	0.2	0.2	0.3	--	--	--	--	0.1	--
<u>Tabellaria fenestrata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>T. flocculosa</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Thalassionema nitzschioides</u>	2.6	0.5	0.2	1.9	1.4	0.1	0.1	0.7	1.7	0.3	--	0.5
<u>T. nitzschioides</u> var. <u>lanceolata</u>	--	0.2	0.1	--	--	--	--	--	--	--	--	--
<u>Tropidoneis lepidoptera</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>T. maxima</u> var. <u>adriatica</u>	0.2	--	--	--	--	--	--	--	--	--	--	--
<u>T. sp.</u>	--	--	0.3	--	--	0.2	--	--	--	--	--	--
<u>Thalassiosira eccentricus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>T. pseudonana</u>	8.0	10.8	1.3	16.0	12.2	1.6	3.4	9.0	5.2	1.2	2.6	1.1
<u>T. sp. 5</u>	0.8	--	--	--	--	--	0.3	0.1	--	--	--	--
<u>Terpsinae americana</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Trachyeis aspera</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Achnanthes chilensis</u>	0.8	--	5.0	1.9	--	0.8	4.0	0.7
<u>A. conspicua</u>	--	--	--	--	--	--	--	--
<u>A. haukiana</u>	4.5	1.3	10.1	4.0	1.1	3.1	4.3	1.6
<u>A. haukiana</u> var. <u>rostrata</u>	--	--	--	--	--	--	--	--
<u>A. hustedii</u>	--	--	--	--	--	--	--	--
<u>A. lanceolata</u>	--	--	--	--	--	--	--	--
<u>A. pinnata</u>	--	--	--	--	--	--	--	--
<u>A. lemmermanni</u>	--	--	--	--	--	--	--	--
<u>A. linearis</u>	--	0.1	0.7	--	--	--	--	--
<u>A. longipes</u>	0.7	0.4	--	0.7	0.6	0.2	0.1	0.8
<u>A. lorenziana</u>	--	--	--	--	--	--	--	--
<u>A. mintuissima</u>	--	--	--	--	--	--	--	--
<u>A. wellsiae</u>	1.1	0.3	0.2	2.4	2.9	1.2	0.9	1.2
<u>A. pseudosolea</u>	6.8	2.1	1.5	13.8	16.7	6.9	5.2	7.2
<u>Actinoptychus undulatus</u>	--	0.2	0.1	--	--	--	--	0.3
<u>Amphiprora alata</u>	--	0.9	--	--	--	--	0.6	--

-- Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Amphiprora decipiens</u>	--	--	--	--	--	--	--	--
<u>Amphora acutiuscula</u>	2.1	0.9	0.2	1.2	1.2	0.3	--	0.4
<u>A. angusta</u> var. <u>ventricosa</u>	--	--	0.1	0.2	--	--	1.0	--
<u>A. beaufortiana</u>	--	0.4	0.1	--	--	0.2	--	--
<u>A. coffeaeformis</u>	0.2	--	0.8	--	0.1	0.5	0.5	0.2
<u>A. costata</u>	--	--	--	--	--	--	--	--
<u>A. cymbifera</u>	--	0.5	0.5	--	--	--	--	--
<u>A. exigua</u>	--	--	--	--	--	--	--	--
<u>A. hyalina</u>	0.1	1.4	--	0.2	--	--	--	2.3
<u>A. macilenta</u>	--	--	--	--	--	--	0.3	--
<u>A. osterearia</u> var.	--	--	--	--	--	--	--	--
<u>A. ovalis</u> var. <u>affinis</u>	0.2	0.3	0.1	0.1	0.5	0.6	--	0.3
<u>A. ovalis</u> var. <u>pediculus</u>	--	--	--	--	--	0.1	--	--
<u>A. quadrata</u>	--	--	--	--	--	--	--	--
<u>A. rhombica</u> var.	--	--	--	--	--	--	--	--
<u>A. sublaevis</u>	0.9	2.8	0.2	0.5	0.8	2.3	1.5	0.5

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Amphora tenuissima</u>	--	--	--	0.6	--	0.5	--	--
<u>A. tumida</u>	--	--	--	0.2	--	--	--	--
<u>A. turgida</u>	--	0.2	--	--	--	--	--	0.2
<u>A. veneta</u>	0.1	--	0.2	--	0.5	--	2.3	--
<u>A. sp. 139</u>	--	--	--	--	--	--	--	--
<u>A. sp. 140</u>	0.2	0.2	--	--	--	--	--	--
<u>A. sp. 140.4</u>	--	--	--	--	--	--	--	--
<u>A. obtusa</u>	--	--	--	--	--	--	--	--
<u>A. sp. 140.8</u>	--	0.1	--	--	--	0.1	--	0.2
<u>A. sp. 146</u>	--	--	--	--	--	--	--	--
<u>A. sp. 150</u>	--	--	--	--	--	--	--	--
<u>A. sp. 150.2</u>	--	--	--	--	--	1.0	--	0.2
<u>A. sp. 152</u>	--	--	--	--	--	--	--	--
<u>A. sp. 162</u>	--	--	--	--	--	--	--	--
<u>A. sp. 140.1</u>	--	--	--	--	--	--	--	--
<u>A. proteus</u>	--	--	--	--	--	--	--	0.2

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Amphora pusio</u>	--	--	--	--	--	--	--	--
<u>Amphipleura rutilans</u>	--	0.1	--	0.1	--	--	0.6	1.4
<u>A. micans</u>	--	--	--	--	--	--	--	--
<u>Anorthoneis hummii</u>	0.1	--	--	--	--	--	--	--
<u>Auliscus punctatus</u>	--	--	0.1	--	--	--	--	--
<u>Auricula insecta</u>	--	1.0	--	0.1	--	--	--	0.3
<u>Biddulphia pulchella</u>	--	--	--	--	--	--	--	0.1
<u>Caloneis westii</u>	--	--	--	--	--	--	--	--
<u>Campylodiscus sp.</u>	--	--	--	--	--	--	--	--
<u>Chaetoceros affine</u>	--	--	--	--	--	0.3	--	--
<u>Cocconeis dirupta</u>	--	--	--	--	--	--	--	--
<u>C. discoloides</u>	0.1	--	--	--	--	--	--	--
<u>C. disculus</u>	--	--	--	--	--	--	--	0.2
<u>C. fluminensis</u>	0.4	--	--	--	0.1	0.2	0.1	--
<u>C. pediculus</u>	--	--	--	0.4	0.7	--	0.3	--
<u>C. placentula</u>	0.3	--	0.6	--	0.2	0.4	4.9	0.3

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Cocconeis placentula</u> var. <u>euglypta</u>	--	--	--	--	--	--	--	--
<u>C. scutellum</u>	0.1	0.3	0.6	--	--	0.7	0.5	0.2
<u>C. scutellum</u> var.	--	--	0.2	--	--	--	--	--
<u>C. sp. 84</u>	--	--	--	--	--	--	--	--
<u>Coscinodiscus lineatus</u>	--	--	--	--	--	--	--	--
<u>C. marginatus</u>	--	--	--	--	--	--	--	--
<u>C. micans</u>	--	--	--	--	--	--	--	--
<u>C. nitidus</u>	--	--	--	--	--	--	--	--
<u>C. oculus iridis</u>	--	--	--	--	--	--	--	--
<u>C. pygmae</u> var. <u>micropunctata</u>	0.7	0.6	--	0.3	--	--	--	--
<u>C. radiatus</u>	--	--	--	0.1	--	0.3	--	--
<u>C. sp.</u>	--	6.1	1.2	--	--	--	--	--
<u>Cyclotella caspia</u>	1.0	2.0	0.5	--	--	--	--	--
<u>C. meneghiniana</u>	0.4	0.9	0.4	0.2	0.3	1.0	0.2	0.1
<u>C. striata</u>	0.1	0.2	--	--	0.5	0.1	0.3	0.2
<u>Cylindrotheca closterium</u>	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Cymbella affinis</u>	--	--	--	--	--	--	--	--
<u>C. pusilla</u>	0.2	0.3	--	1.6	0.3	0.6	0.3	6.5
<u>Denticula subtilis</u>	0.8	--	0.2	0.3	0.4	--	0.1	--
<u>Diatoma</u> sp.	--	--	0.6	--	--	--	--	--
<u>Dimmerogramma dubium</u>	--	--	--	--	--	--	--	--
<u>D. minor</u>	0.3	0.2	0.5	0.2	0.2	--	0.1	0.2
<u>D. sp.</u>	--	--	--	--	--	0.1	--	--
<u>Diploneis crabro</u>	0.4	--	--	0.2	--	0.1	0.1	0.1
<u>D. smithii</u>	0.2	0.1	--	0.2	0.1	0.1	--	0.2
<u>D. pseudovaldes</u>	--	--	--	--	--	--	--	--
<u>Endictya oceanica</u>	--	--	--	--	--	--	--	--
<u>Fragilaria lapponica</u>	--	--	--	--	--	--	--	--
<u>F. construens</u> var. <u>subsalina</u>	0.6	8.6	1.3	--	--	1.0	1.1	--
<u>F. construens</u> var. <u>venter</u>	7.7	12.5	23.0	17.1	1.8	8.1	5.9	4.3
<u>Gomphonema olivaceum</u> var.	--	--	--	--	--	--	--	--
<u>G. parvulum</u>	--	--	--	--	0.1	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Grammatophora angulosa</u>	--	--	--	--	--	--	--	--
<u>G. marina</u>	--	0.6	0.2	--	--	0.1	0.4	0.2
<u>G. oceanica</u> var. <u>minuscula</u>	--	1.6	--	--	--	--	--	--
<u>G. serpentina</u>	--	--	--	--	--	--	--	--
<u>Gyrosigma accumatum</u>	--	--	--	--	--	--	--	--
<u>G. balticum</u>	--	0.1	--	--	--	--	--	--
<u>G. fascicola</u> var. <u>arcuata</u>	--	--	--	--	--	--	--	--
<u>G. febigenii</u>	--	--	--	--	--	--	--	--
<u>G. peisonis</u>	--	--	--	--	--	0.1	--	--
<u>G. sp.</u>	--	--	--	--	--	--	--	--
<u>Hantzschia amphioxys</u>	--	--	0.1	--	--	0.1	0.1	--
<u>H. virgata</u>	--	--	--	--	--	--	--	--
<u>Licmophora abbreviata</u>	--	--	--	--	--	--	--	--
<u>L. dalmatica</u>	--	--	--	--	--	--	--	--
<u>L. ehrenbergerii</u>	--	--	--	--	--	--	--	--
<u>L. lynebyei</u>	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX.	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Licmophora</u> sp. 22	--	--	--	--	--	--	--	--
<u>L.</u> sp. 20	--	--	--	--	--	--	--	--
<u>Mastogloia</u> <u>augulata</u>	--	--	--	--	--	--	--	0.2
<u>M. braunii</u> var.	--	--	--	--	--	--	--	--
<u>M. danseii</u> var. <u>elliptica</u>	--	--	--	--	--	--	--	--
<u>M. exigua</u>	26.3	9.1	1.6	12.8	36.6	24.6	2.7	9.6
<u>M. pumila</u>	--	--	--	--	--	--	--	4.0
<u>M. pusilla</u>	--	--	--	--	5.1	--	--	2.0
<u>M. smithii</u>	7.4	--	--	4.4	4.7	2.1	1.5	7.4
<u>M. smithii</u> var.	--	--	--	--	--	--	--	--
<u>Melosira</u> <u>distans</u>	--	--	--	--	--	--	--	--
<u>M. jurgensii</u>	--	--	--	--	--	--	--	--
<u>M. nummuloides</u>	0.8	1.6	1.9	0.1	--	0.2	--	0.1
<u>M. subflexilis</u>	--	--	--	--	--	--	--	--
<u>M. sulcata</u>	0.5	2.9	2.4	0.5	0.3	0.8	0.7	0.2
<u>M. sulcata</u> var. <u>coronata</u>	--	--	--	--	0.1	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Navicula abunda</u>	--	--	--	--	--	--	--	--
<u>N. approximata</u> fo. <u>elongata</u>	--	--	--	0.4	--	--	--	--
<u>N. arenaria</u>	--	0.1	0.1	--	--	--	--	--
<u>N. biconica</u> var.	--	--	--	--	--	--	--	--
<u>N. cancellata</u>	--	0.4	1.0	--	0.3	--	--	0.1
<u>N. cincta</u>	0.7	0.3	0.4	0.3	--	0.4	--	0.1
<u>N. confervacea</u> var. <u>peregrina</u>	--	--	--	--	--	--	--	--
<u>N. cryptocephala</u>	2.2	1.0	1.6	0.4	0.9	0.8	0.1	0.2
<u>N. cryptocephala</u> var. <u>veneta</u>	--	--	--	--	--	--	--	--
<u>N. digito-radiata</u>	0.3	0.3	0.1	0.2	--	0.5	0.2	0.5
<u>N. diserta</u>	0.7	0.7	1.1	0.8	0.3	0.7	0.3	0.4
<u>N. diverstriata</u>	0.1	--	--	--	--	--	--	--
<u>N. elegans</u>	--	--	--	--	--	--	--	--
<u>N. forcipita</u>	0.1	--	--	--	--	--	--	0.1
<u>N. gottlandica</u>	--	--	--	--	--	--	--	--
<u>N. granulata</u>	--	--	--	--	--	--	--	0.1

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Navicula gregaria</u>	--	--	--	--	--	0.1	--	--
<u>N. halophila</u>	--	--	--	--	--	--	--	--
<u>N. hennedyi</u>	--	--	--	0.2	0.3	0.1	--	0.3
<u>N. integra</u>	--	0.1	--	--	--	--	--	--
<u>N. litoricola</u>	--	--	--	--	--	--	--	--
<u>N. lyra</u>	0.3	--	--	--	--	0.2	0.2	0.1
<u>N. maculata</u>	--	--	--	--	--	--	--	--
<u>N. marina</u>	--	--	--	--	--	--	--	--
<u>N. menisculus</u>	3.4	0.9	0.9	0.9	--	0.1	--	0.2
<u>N. menisculus</u> var.	--	--	--	--	--	--	--	--
<u>N. monilifera</u>	--	--	--	--	--	--	--	--
<u>N. misella</u>	--	--	0.9	0.3	--	--	--	--
<u>N. muralis</u>	--	0.2	--	--	--	--	--	--
<u>N. mutica</u>	--	--	--	--	--	--	--	--
<u>N. mutica</u> var. <u>cohnii</u>	--	--	--	--	--	--	--	--
<u>N. opima</u>	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES.	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Navicula patrickae</u>	0.4	0.2	0.7	0.1	--	0.3	--	0.8
<u>N. palepebralis</u> var. <u>angulosa</u>	--	--	--	--	--	--	--	--
<u>N. pavillardi</u>	0.1	0.3	--	0.8	0.3	2.0	0.4	1.7
<u>N. peregrina</u>	--	--	--	--	--	--	--	--
<u>N. plagiostoma</u>	--	--	--	--	--	0.1	--	--
<u>N. platyventris</u>	--	0.7	0.3	--	--	0.9	--	--
<u>N. pullus</u>	--	--	--	--	--	--	--	0.1
<u>N. placentula</u>	--	--	--	--	--	--	--	--
<u>N. pygmae</u>	--	--	--	--	--	0.1	--	--
<u>N. radiosa</u> var. <u>cuneata</u>	--	--	--	--	--	--	--	--
<u>N. regularis</u>	--	0.2	--	--	--	--	--	--
<u>N. rhynchocephala</u>	--	--	--	--	--	--	--	--
<u>N. salinarum</u>	0.2	--	1.3	0.7	--	0.1	0.4	--
<u>N. simplex</u>	--	--	--	--	--	--	--	--
<u>N. spectabilis</u>	--	--	--	--	--	--	--	--
<u>N. subapiculata</u>	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Navicula subdiffusa</u>	0.4	0.9	0.1	--	--	0.1	--	0.2
<u>N. tripunctata</u> var. <u>schizonemoides</u>	--	--	--	0.1	--	--	--	--
<u>N. vara</u>	--	--	--	--	--	--	--	--
<u>N. viridula</u>	--	--	--	--	--	--	--	0.1
<u>N. yarrensis</u>	0.2	--	--	--	--	--	0.3	0.2
<u>N. sp. 89</u>	--	--	--	--	--	--	--	--
<u>N. sp. 95</u>	--	--	0.4	--	--	--	--	--
<u>N. sp. 100.10</u>	--	--	--	--	--	--	--	--
<u>N. sp. 100.12</u>	--	--	--	--	--	--	--	--
<u>N. sp. 100.60</u>	--	--	--	--	--	--	--	--
<u>N. sp. 104</u>	--	--	--	--	--	--	--	--
<u>N. sp. 104.1</u>	--	--	--	--	0.4	--	--	--
<u>N. sp. 105</u>	--	--	--	--	--	--	--	--
<u>N. accomoda</u>	--	--	--	--	--	--	--	--
<u>N. sp. 108</u>	--	--	--	--	--	--	--	--
<u>N. sp. 109</u>	0.2	--	--	--	--	0.2	0.4	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Navicula</u> sp. 114	--	--	--	--	--	0.1	--	--
<u>N.</u> sp. 117	--	0.1	--	--	--	0.7	--	--
<u>N.</u> sp. 120.1	--	--	--	--	--	--	--	--
<u>N.</u> sp. 120.2	--	--	--	--	--	--	--	--
<u>N.</u> sp. 120.4	--	--	--	--	--	--	--	--
<u>N.</u> sp. 120.5	--	0.1	--	--	--	--	--	--
<u>N.</u> sp. 130.2	--	--	--	--	--	--	--	--
<u>N.</u> sp. 130.5	--	--	--	--	--	--	--	--
<u>N.</u> sp. 140	--	--	--	--	--	--	--	--
<u>N.</u> sp.	--	--	--	1.6	--	--	--	--
<u>Nitzschia acuminata</u>	--	--	--	--	--	--	--	--
<u>N.</u> <u>acicularis</u>	--	--	--	--	--	0.1	--	--
<u>N.</u> <u>amphibia</u>	--	--	--	--	--	0.9	--	0.5
<u>N.</u> <u>apiculata</u>	--	--	--	0.1	--	--	--	0.4
<u>N.</u> <u>australis</u>	--	--	--	--	--	--	--	--
<u>N.</u> <u>capitellata</u>	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Nitzschia clausii</u>	--	--	--	--	--	--	--	--
<u>N. communis</u>	--	--	--	--	--	0.1	--	--
<u>N. duboides</u>	--	--	--	--	--	--	--	0.1
<u>N. epithemioides</u>	--	--	--	--	--	--	--	--
<u>N. filiformis</u>	--	--	--	--	--	--	0.2	--
<u>N. fonticola</u>	--	--	--	--	--	--	--	--
<u>N. frustulum</u>	--	--	--	--	--	0.2	--	0.1
<u>N. frustulum</u> var. <u>perminuta</u>	--	--	--	--	--	--	--	0.2
<u>N. frustulum</u> var. <u>perpusilla</u>	0.2	--	0.1	0.6	0.6	3.3	0.5	1.2
<u>N. frustulum</u> var. <u>subsalina</u>	--	1.9	1.6	0.6	--	--	0.4	--
<u>N. grossistriata</u>	--	--	--	--	--	--	--	--
<u>N. hungarica</u>	--	0.1	0.7	0.1	0.1	--	--	0.1
<u>N. hybrida</u>	--	--	--	--	--	--	--	--
<u>N. incurva</u>	--	--	--	--	--	--	--	--
<u>N. kutzinghiana</u>	--	--	--	--	--	--	--	--
<u>N. laevis</u>	0.1	0.1	--	0.3	--	0.2	--	0.2

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Nitzschia lanceolata</u> var. <u>minima</u>	2.5	1.3	0.5	3.8	3.9	0.8	--	8.7
<u>N. longa</u>	--	--	--	--	--	--	--	--
<u>N. longissima</u>	--	--	--	--	--	--	--	--
<u>N. lorenziana</u>	--	--	--	--	--	--	--	0.1
<u>N. lorenziana</u> var. <u>subtilis</u>	--	--	--	--	--	--	--	--
<u>N. microcephala</u>	3.4	0.5	--	8.3	0.6	5.3	1.2	0.8
<u>N. microcephala</u> var.	--	0.9	1.0	--	--	--	--	--
<u>N. obtusa</u>	--	--	--	--	--	0.1	--	--
<u>N. obtusa</u> var. <u>scapelliformis</u>	--	--	--	--	--	--	--	--
<u>N. palea</u>	--	--	--	--	--	0.1	--	--
<u>N. panduriformis</u>	--	--	--	--	--	--	--	--
<u>N. paradoxa</u>	--	--	--	--	--	--	--	--
<u>N. proxima</u>	--	--	0.1	--	--	0.1	0.4	0.1
<u>N. punctata</u> var. <u>coaracta</u>	--	--	0.1	--	--	0.1	--	--
<u>N. recta</u>	--	--	--	--	--	--	--	2.0
<u>N. rhombica</u>	--	1.8	0.2	--	--	--	--	0.1

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Nitzschia rigida</u> var. <u>rigidula</u>	--	--	--	0.1	0.2	--	--	--
<u>N. sigma</u>	0.3	0.1	0.2	--	0.4	--	0.3	--
<u>N. sigma</u> var. <u>intercedens</u>	--	--	--	--	--	--	--	--
<u>N. socialis</u>	--	--	--	--	--	--	--	--
<u>N. spathulata</u>	--	--	--	--	--	--	--	--
<u>N. sublinearis</u>	--	--	--	--	--	--	--	--
<u>N. subtilis</u>	--	--	--	0.1	--	--	0.1	--
<u>N. thermalis</u> var. <u>minor</u>	--	--	--	--	--	--	--	--
<u>N. tryblionella</u>	--	--	--	--	--	--	--	--
<u>N. tryblionella</u> var. <u>salinarum</u>	--	--	--	--	--	--	--	--
<u>N. sp. 165</u>	--	--	--	--	--	--	--	--
<u>N. sp. 167</u>	--	--	--	--	--	--	--	--
<u>N. sp. 168</u>	--	--	--	--	--	--	--	--
<u>N. angularis</u> var. <u>affinis</u>	--	--	--	--	--	--	0.2	0.2
<u>N. sp. 170.1</u>	--	--	--	--	--	--	--	--
<u>N. sp. 171</u>	0.2	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Nitzschia</u> sp. 190.1	--	--	--	--	--	--	--	--
<u>N.</u> sp.	--	--	--	--	--	--	--	--
<u>Oestrupia powelli</u>	--	--	--	--	--	--	--	0.2
<u>Opephora martyi</u>	10.4	22.0	12.0	15.3	2.6	11.9	3.2	11.3
<u>O. pacifica</u>	--	0.2	0.6	0.3	--	--	--	--
<u>O. martyi</u> var.	--	0.4	1.6	--	--	0.3	--	--
<u>Pinnularia</u> sp. 100.8	--	--	--	--	--	--	--	--
<u>Plagiogramma staurophorum</u>	--	--	--	--	--	--	--	--
<u>Pleurosigma angulatum</u>	--	--	--	--	--	--	--	--
<u>P. salinarum</u>	--	--	--	--	--	--	--	--
<u>P.</u> sp.	--	--	--	--	--	--	--	--
<u>Rhopolodia gibberula</u>	4.3	0.4	1.6	7.8	0.8	1.5	2.8	7.0
<u>R. musculus</u>	--	--	13.0	3.8	--	0.3	7.8	5.4
<u>Rhaponeis ampiceros</u>	--	--	--	--	--	--	--	--
<u>R.</u> sp.	--	--	--	--	--	--	--	--
<u>Rhizosolenia</u> sp.	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Rhoicosphenia curvata</u>	--	0.1	--	--	--	--	--	--
<u>Skeletonema costatum</u>	--	--	--	--	--	--	--	--
<u>Synedra affinis</u>	--	0.2	--	0.5	0.8	0.4	--	0.2
<u>S. affinis</u> var. <u>tabulata</u>	--	--	--	--	--	0.1	--	--
<u>S. fasciculata</u>	--	--	--	0.2	--	--	--	--
<u>S. fasciculata</u> var. <u>tabulata</u>	--	0.1	--	--	--	0.2	--	0.5
<u>S. fasciculata</u> var. <u>truncata</u>	--	0.2	--	--	--	--	--	--
<u>S. fulgens</u>	--	--	--	--	--	--	--	--
<u>S. gaillonii</u>	1.1	--	--	--	1.1	0.3	--	--
<u>S. radians</u> var.	--	--	--	--	--	--	--	--
<u>S. undulata</u>	--	--	--	0.1	--	--	--	--
<u>S. sp.</u>	--	--	--	--	--	--	--	--
<u>Stauroneis salina</u>	--	--	--	--	--	--	--	--
<u>S. spicula</u>	--	--	0.1	--	--	--	--	--
<u>Surirella litoris</u>	--	--	0.2	--	--	--	--	--
<u>S. ovata</u>	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	WH	JB	SH	MIX	WH	JB	SH	MIX
TAXON	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28
<u>Striatella interrupta</u>	--	--	--	0.3	--	--	--	2.2
<u>S. unipunctata</u>	0.3	1.0	0.5	0.1	0.8	0.2	0.4	0.2
<u>Tabellaria fenestrata</u>	--	0.5	--	--	0.3	--	--	0.1
<u>T. flocculosa</u>	--	--	--	--	--	--	--	--
<u>Thalassionema nitzschioides</u>	0.1	0.1	--	--	0.6	0.1	--	0.1
<u>T. nitzschioides</u> var. <u>lanceolata</u>	--	--	--	--	--	--	--	--
<u>Tropidoneis lepidoptera</u>	--	--	--	--	--	--	--	--
<u>T. maxima</u> var. <u>adriatica</u>	--	--	--	--	--	--	--	--
<u>T. sp.</u>	--	--	--	--	--	--	--	--
<u>Thalassiosira eccentricus</u>	--	--	--	--	--	--	--	--
<u>T. pseudonana</u>	2.2	0.6	0.6	1.1	1.1	4.7	--	--
<u>T. sp. 5</u>	--	--	--	--	--	--	--	--
<u>Terpsinae americana</u>	--	--	--	--	--	--	--	--
<u>Trachyeis aspera</u>	--	--	--	--	--	--	0.1	--

--Indicates not present in count

Table 15. Percent abundance of taxa identified from diatom communities treated with various metallic ions and #2 crude oil.

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Achnanthes chilensis</u>	--	0.1	0.1	--	--	--	--	--	0.3	--	--	--
<u>A. conspicua</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. haukiana</u>	6.4	5.8	7.9	8.9	5.0	9.6	4.4	11.7	9.2	4.9	4.8	8.9
<u>A. haukiana</u> var. <u>rostrata</u>	--	0.1	--	--	--	--	--	--	0.3	0.1	0.4	0.5
<u>A. hustedii</u>	--	--	--	--	--	--	--	--	--	--	--	0.4
<u>A. lanceolata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. pinnata</u>	--	--	--	--	--	--	--	--	--	--	0.1	--
<u>A. lemmermanni</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. linearis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. longipes</u>	7.8	2.3	3.7	1.4	4.2	2.3	1.3	3.0	0.6	1.0	1.6	1.2
<u>A. lorenziana</u>	--	--	0.7	0.4	--	--	0.1	--	0.2	--	--	--
<u>A. mintuissima</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. wellsiae</u>	0.3	0.1	--	--	--	--	--	--	--	--	--	--
<u>A. pseudosolea</u>	2.0	0.7	0.2	1.0	0.2	1.0	0.5	0.8	0.7	1.0	0.4	0.5
<u>Actinoptychus undulatus</u>	0.1	0.1	--	0.1	0.4	--	0.1	0.2	0.1	--	--	--
<u>Amphiprora alata</u>	--	0.4	0.2	0.3	--	--	--	0.1	0.3	--	0.1	0.6

-- Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Amphiprora decipiens</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Amphora acutiuscula</u>	2.8	6.3	9.3	4.8	4.9	8.5	1.5	5.7	2.5	1.7	3.3	5.0
<u>A. angusta</u> var. <u>ventricosa</u>	--	--	0.1	--	--	--	0.2	0.4	0.3	--	--	0.3
<u>A. beaufortiana</u>	1.3	0.5	--	0.3	0.2	--	0.2	0.5	0.3	--	0.1	0.2
<u>A. coffeaeformis</u>	--	--	--	--	--	0.2	0.1	--	0.2	0.6	--	--
<u>A. costata</u>	--	--	--	--	--	--	0.4	--	0.3	--	--	0.1
<u>A. cymbifera</u>	0.3	--	--	0.4	0.2	--	0.1	0.2	0.1	--	--	--
<u>A. exigua</u>	--	--	--	--	--	--	--	--	0.2	--	--	0.1
<u>A. hyalina</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>A. macilenta</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. osterearia</u> var.	--	0.3	--	--	--	--	--	--	--	--	--	--
<u>A. ovalis</u> var. <u>affinis</u>	0.6	--	0.1	0.2	0.2	0.2	--	0.1	--	--	0.1	--
<u>A. ovalis</u> var. <u>pediculus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. quadrata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. rhombica</u> var.	--	--	--	--	--	--	--	--	0.1	--	--	--
<u>A. sublaevis</u>	0.2	0.3	0.1	0.3	--	0.1	--	0.2	0.4	0.1	0.1	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Amphora tenuissima</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. tumida</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. turgida</u>	--	0.1	--	--	--	--	--	--	0.1	0.4	0.1	--
<u>A. veneta</u>	--	--	--	--	--	--	--	--	--	0.7	0.1	--
<u>A. sp. 139</u>	0.8	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 140</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 140.4</u>	0.2	--	--	--	0.1	--	--	--	--	--	--	0.1
<u>A. obtusa</u>	0.1	0.1	0.2	--	--	--	0.1	0.1	--	0.1	--	--
<u>A. sp. 140.8</u>	1.3	0.2	0.9	0.6	0.7	0.6	0.3	0.3	0.5	0.2	0.4	0.4
<u>A. sp. 146</u>	--	--	0.2	--	--	--	--	0.1	--	--	--	--
<u>A. sp. 150</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 150.2</u>	0.5	--	0.4	--	0.3	0.2	--	0.5	--	--	--	0.5
<u>A. sp. 152</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 162</u>	0.1	--	1.8	0.1	--	0.1	--	--	--	--	--	--
<u>A. sp. 140.1</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. proteus</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Amphora pusio</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Amphipleura rutilans</u>	--	0.1	--	--	--	--	--	--	--	0.1	--	--
<u>A. micans</u>	--	0.1	--	--	--	--	--	--	0.1	--	--	--
<u>Anorthoneis hummii</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>Auliscus punctatus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Auricula insecta</u>	0.5	0.1	--	--	--	--	0.1	0.1	--	0.1	--	0.1
<u>Biddulphia pulchella</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Caloneis westii</u>	--	--	--	--	--	0.1	--	--	--	--	--	--
<u>Campylodiscus sp.</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Chaetoceros affine</u>	--	--	0.4	--	--	--	--	--	--	0.1	--	--
<u>Cocconeis dirupta</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. discoloides</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. disculus</u>	--	--	--	--	--	0.5	0.1	0.1	--	--	--	--
<u>C. fluminensis</u>	--	0.3	0.5	--	--	--	0.1	--	--	0.1	0.1	0.1
<u>C. pediculus</u>	--	--	0.1	--	--	0.3	--	1.3	--	0.1	0.3	0.3
<u>C. placentula</u>	--	0.5	--	0.1	0.1	0.1	0.6	0.1	0.4	0.2	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Cocconeis placentula</u> var. <u>euglypta</u>	--	--	--	--	--	--	--	--	--	0.2	--	0.1
<u>C. scutellum</u>	0.6	0.4	0.6	0.8	0.2	0.1	--	--	--	0.1	0.1	0.3
<u>C. scutellum</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. sp.</u> 84	--	--	--	--	--	--	--	--	--	1.6	--	--
<u>Coscinodiscus lineatus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. marginatus</u>	0.3	0.3	0.2	0.3	0.2	--	0.3	0.4	--	0.2	0.2	0.2
<u>C. micans</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. nitidus</u>	--	0.2	--	--	--	--	--	--	--	--	--	--
<u>C. oculus iridis</u>	--	--	--	--	0.1	--	--	--	--	--	0.1	--
<u>C. pygmae</u> var. <u>micropunctata</u>	0.7	0.4	0.6	0.1	0.2	0.3	0.2	0.2	0.1	0.3	0.3	0.2
<u>C. radiatus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. sp.</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>Cyclotella caspia</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. meneghiniana</u>	1.5	--	--	--	--	--	--	0.2	--	0.2	0.5	--
<u>C. striata</u>	0.1	0.2	0.3	0.5	0.1	--	0.2	--	--	0.3	0.3	0.4
<u>Cylindrotheca closterium</u>	--	0.3	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Cymbella affinis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. pusilla</u>	0.4	0.3	0.1	--	0.3	--	--	0.2	--	0.2	0.5	0.3
<u>Denticula subtilis</u>	0.5	0.9	0.9	0.6	0.3	1.1	1.1	0.3	0.5	1.0	2.5	3.1
<u>Diatoma</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--
<u>Dimmerogramma dubium</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>D. minor</u>	0.1	--	0.4	0.2	--	0.2	0.1	--	--	--	--	--
<u>D. sp.</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Diploneis crabro</u>	0.9	0.1	0.2	0.2	0.6	0.3	0.3	0.9	0.3	--	--	0.2
<u>D. smithii</u>	0.7	0.1	0.3	0.1	--	0.3	0.4	0.7	0.3	0.1	0.4	0.5
<u>D. pseudovalles</u>	0.4	--	--	--	--	--	--	--	--	--	--	--
<u>Endictya oceanica</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>Fragilaria lapponica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>F. construens</u> var. <u>subsalina</u>	10.3	--	--	--	15.6	6.5	1.3	3.5	2.5	0.5	2.5	1.6
<u>F. construens</u> var. <u>venter</u>	7.7	25.9	8.8	15.5	13.5	18.2	28.2	15.0	47.7	40.3	21.4	28.8
<u>Gomphonema olivaceum</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. parvulum</u>	--	--	--	--	--	--	--	--	--	--	--	--

Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Grammatophora angulosa</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. marina</u>	--	0.1	0.3	--	--	--	--	0.3	0.1	0.2	--	--
<u>G. oceanica</u> var. <u>minuscula</u>	--	--	--	--	--	--	0.8	--	--	0.1	--	--
<u>G. serpentina</u>	--	--	--	--	1.1	--	--	--	--	--	--	--
<u>Gyrosigma accumatum</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. balticum</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. fascicola</u> var. <u>arcuata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. febigenii</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. peisonis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. sp.</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Hantzschia amphioxys</u>	--	--	0.2	--	--	--	--	0.1	--	--	--	--
<u>H. virgata</u>	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>Licmophora abbreviata</u>	--	--	--	0.6	0.3	0.2	--	0.2	--	--	--	--
<u>L. dalmatica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>L. ehrenbergerii</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>L. lynebyei</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Licmophora</u> sp. 22	--	--	--	--	--	--	--	--	--	--	--	--
<u>L.</u> sp. 20	--	0.2	0.2	--	--	--	--	0.6	0.1	--	--	0.1
<u>Hastogloia</u> <u>augulata</u>	--	--	--	--	--	--	--	--	0.1	--	--	--
<u>M. braunii</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>M. danseii</u> var. <u>elliptica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M. exigua</u>	6.5	1.4	2.8	3.4	1.0	0.6	15.6	1.3	0.9	4.0	1.1	1.1
<u>M. pumila</u>	--	--	--	--	--	--	--	--	--	--	--	0.2
<u>M. pusilla</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M. smithii</u>	0.4	0.1	--	0.6	--	0.1	0.7	0.4	--	0.3	0.2	--
<u>M. smithii</u> var.	--	--	--	--	--	--	--	0.3	--	--	--	--
<u>Melosira</u> <u>distans</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M. jurgensii</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M. nummuloides</u>	--	3.2	12.1	4.9	9.7	3.2	1.6	4.5	2.2	1.1	3.6	3.8
<u>M. subflexilis</u>	8.1	--	--	--	--	--	--	--	--	--	--	--
<u>M. sulcata</u>	0.3	--	0.9	1.8	0.7	0.3	1.0	2.5	0.2	0.3	0.4	0.2
<u>M. sulcata</u> var. <u>coronata</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Navicula abunda</u>	--	--	--	0.2	0.5	--	--	--	--	--	--	--
<u>N. approximata</u> fo. <u>elongata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. arenaria</u>	--	0.9	--	--	--	--	--	0.4	--	--	--	0.1
<u>N. biconica</u> var.	--	--	--	--	--	--	0.1	--	--	--	--	--
<u>N. cancellata</u>	--	--	0.6	--	--	--	--	--	--	--	--	--
<u>N. cincta</u>	0.7	--	0.8	0.1	0.1	0.4	--	0.2	0.1	0.2	0.7	0.2
<u>N. confervacea</u> var. <u>peregrina</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. cryptocephala</u>	4.7	4.1	1.3	5.5	0.6	1.7	2.4	1.9	2.9	4.7	7.3	1.7
<u>N. cryptocephala</u> var. <u>veneta</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. digito-radiata</u>	1.0	0.1	2.1	0.5	0.6	1.1	0.4	0.9	0.4	0.3	0.7	0.8
<u>N. diserta</u>	0.1	--	0.1	0.4	--	0.9	2.1	0.2	1.0	0.2	0.1	0.2
<u>N. diverstriata</u>	--	--	--	1.2	--	--	--	--	--	--	--	--
<u>N. elegans</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. forcipita</u>	--	0.1	0.2	--	0.2	--	--	0.9	--	0.1	--	--
<u>N. gottlandica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. granulata</u>	--	0.2	0.2	0.1	--	--	0.2	0.2	0.4	0.1	0.1	0.1

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Navicula gregaria</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. halophila</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. hennedyi</u>	0.1	--	0.1	--	0.1	0.2	--	0.1	0.2	0.1	--	--
<u>N. integra</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. litoricola</u>	--	--	--	--	--	--	--	0.3	--	--	--	--
<u>N. lyra</u>	0.6	--	0.4	--	0.1	--	--	0.2	--	0.1	--	0.1
<u>N. maculata</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>N. marina</u>	--	--	--	--	--	0.5	0.2	--	--	--	--	--
<u>N. menisculus</u>	--	--	0.3	--	--	--	0.1	1.1	0.4	0.5	0.7	0.9
<u>N. menisculus</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. monilifera</u>	--	--	--	--	--	--	--	--	--	--	--	0.2
<u>N. misella</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. muralis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. mutica</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>N. mutica</u> var. <u>cohnii</u>	0.1	--	--	--	--	--	0.1	0.5	--	--	0.1	0.1
<u>N. opima</u>	--	--	0.2	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Navicula patrickae</u>	--	3.4	0.6	3.8	1.1	1.8	0.3	1.7	2.0	1.0	2.9	2.9
<u>N. paleopebralis</u> var. <u>angulosa</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. pavillardii</u>	2.6	--	--	--	--	--	--	--	0.1	0.2	--	0.1
<u>N. peregrina</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. plagiostoma</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. platyventris</u>	--	--	--	0.2	0.2	--	--	--	--	--	--	--
<u>N. pullus</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>N. placentula</u>	--	0.2	--	--	--	--	--	--	--	--	--	--
<u>N. pygmae</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. radiosa</u> var. <u>cuneata</u>	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>N. regularis</u>	--	--	--	--	--	--	--	--	0.3	--	--	0.5
<u>N. rhynchocephala</u>	--	--	--	0.1	--	0.4	--	--	--	0.1	--	--
<u>N. salinarum</u>	0.2	--	0.3	0.8	1.4	1.3	0.6	0.2	0.2	0.2	0.1	0.2
<u>N. simplex</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>N. spectabilis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. subapiculata</u>	--	--	--	0.4	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Navicula subdiffusa</u>	0.7	--	0.2	--		0.2	0.1	--	--	--	--	--
<u>N. tripunctata</u> var. <u>schizonemoides</u>	0.1	0.2	--	--		--	0.1	0.1	0.2	0.2	--	0.2
<u>N. vara</u>	--	--	--	--		--	--	--	--	--	--	--
<u>N. viridula</u>	--	--	--	--		--	--	0.1	--	0.1	0.7	0.1
<u>N. yarrensii</u>	0.1	--	--	--		--	--	--	--	0.3	0.1	--
<u>N. sp. 89</u>	--	--	--	--		--	--	--	--	--	--	--
<u>N. sp. 95</u>	--	--	--	--		--	--	--	--	--	--	--
<u>N. sp. 100.10</u>	--	--	--	--		--	--	--	--	--	--	--
<u>N. sp. 100.12</u>	--	--	--	--		--	--	--	--	--	--	--
<u>N. sp. 100.60</u>	--	--	--	--		--	--	--	--	--	--	--
<u>N. sp. 104</u>	--	0.1	0.1	--		--	--	--	--	--	--	--
<u>N. sp. 104.1</u>	--	--	--	--		--	--	--	--	--	--	0.1
<u>N. sp. 105</u>	--	--	--	0.1		--	--	--	--	--	--	--
<u>N. accomoda</u>	--	0.2	--	--		--	--	--	--	--	--	--
<u>N. sp. 108</u>	0.1	--	0.1	--		--	0.2	--	--	--	--	--
<u>N. sp. 109</u>	--	--	--	--		--	--	--	--	--	0.1	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Navicula</u> sp. 114	0.1	--	--	0.1	--	--	--	--	--	--	--	--
<u>N.</u> sp. 117	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp. 120.1	--	--	--	0.1	--	0.1	--	--	--	--	--	--
<u>N.</u> sp. 120.2	--	--	--	--	--	--	--	0.1	--	--	--	--
<u>N.</u> sp. 120.4	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp. 120.5	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp. 130.2	--	--	--	--	0.2	--	--	--	--	--	--	--
<u>N.</u> sp. 130.5	--	--	--	--	--	0.1	--	--	--	--	--	--
<u>N.</u> sp. 140	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--
<u>Nitzschia acuminata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> <u>acicularis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> <u>amphibia</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> <u>apiculata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> <u>australis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> <u>capitellata</u>	--	0.3	0.3	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Nitzschia clausii</u>	--	--	0.3	--	--	--	--	--	--	--	--	--
<u>N. communis</u>	--	0.6	--	0.2	--	--	--	--	--	--	--	--
<u>N. duboides</u>	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>N. epithemioides</u>	--	0.3	--	--	--	--	--	--	--	--	--	--
<u>N. filiformis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. fonticola</u>	--	0.1	--	--	--	--	--	--	--	--	0.5	--
<u>N. frustulum</u>	0.3	0.2	0.2	--	--	0.3	0.2	0.1	--	--	--	0.1
<u>N. frustulum</u> var. <u>perminuta</u>	--	--	--	0.2	--	--	--	--	0.1	0.1	--	--
<u>N. frustulum</u> var. <u>perpusilla</u>	0.1	0.4	0.1	--	0.1	0.3	--	--	--	--	--	--
<u>N. frustulum</u> var. <u>subsalina</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. grossistriata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. hungarica</u>	--	--	1.4	0.1	--	--	--	--	0.1	--	--	--
<u>N. hybrida</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. incurva</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. kutzingiana</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. laevis</u>	--	--	--	0.2	--	--	--	--	--	0.2	--	0.2

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Nitzschia lanceolata</u> var. <u>minima</u>	--	2.0	0.5	6.4	0.8	1.0	0.4	0.5	1.1	2.6	0.2	0.6
<u>N. longa</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. longissima</u>	--	--	--	0.1	--	--	--	--	--	--	--	--
<u>N. lorenziana</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. lorenziana</u> var. <u>subtilis</u>	--	--	--	--	--	--	0.2	--	--	--	--	--
<u>N. microcephala</u>	1.1	0.9	0.1	0.8	0.7	2.0	3.1	0.4	1.4	6.6	2.8	2.9
<u>N. microcephala</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. obtusa</u>	1.0	0.2	0.4	0.7	0.7	1.1	--	1.1	--	0.4	0.1	0.5
<u>N. obtusa</u> var. <u>scapelliformis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. palea</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. panduriformis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. paradoxa</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. proxima</u>	--	0.1	--	--	--	--	--	--	--	--	--	0.3
<u>N. punctata</u> var. <u>coaracta</u>	--	--	0.1	--	--	--	--	--	0.1	--	--	0.1
<u>N. recta</u>	--	--	0.1	--	--	--	--	0.3	--	--	0.1	--
<u>N. rhombica</u>	0.1	--	0.2	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Nitzschia rigida</u> var. <u>rigidula</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sigma</u>	0.3	--	--	0.1	0.1	0.1	0.1	0.2	0.1	0.1	--	0.1
<u>N. sigma</u> var. <u>intercedens</u>	--	--	0.4	--	--	--	0.1	--	--	--	--	--
<u>N. socialis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. spathulata</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>N. sublinearis</u>	--	--	--	--	--	--	--	--	--	--	--	0.1
<u>N. subtilis</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>N. thermalis</u> var. <u>minor</u>	--	--	--	0.1	--	--	--	--	--	--	--	--
<u>N. tryblionella</u>	0.1	--	0.2	--	--	--	--	--	--	--	--	--
<u>N. tryblionella</u> var. <u>salinarum</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 165</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 167</u>	--	--	--	--	--	--	--	--	0.1	--	--	--
<u>N. sp. 168</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. angularis</u> var. <u>affinis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 170.1</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 171</u>	--	--	--	--	--	--	--	--	--	--	0.1	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Nitzschia</u> sp. 190.1	--	--	--	--	--	--	--	--	--	--	0.3	--
<u>N.</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--
<u>Oestrupia powelli</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Opephora martyi</u>	3.2	14.4	4.5	7.3	3.3	4.0	11.8	5.7	2.7	2.4	2.4	4.5
<u>O. pacifica</u>	0.1	0.1	0.2	--	--	--	--	--	--	0.3	--	--
<u>O. martyi</u> var.	--	--	--	--	--	0.1	--	0.2	0.6	0.1	--	--
<u>Pinnularia</u> sp. 100.8	--	--	--	--	--	--	--	--	--	--	--	--
<u>Plagiogramma staurophorum</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>Pleurosigma angulatum</u>	--	--	0.1	--	--	0.1	--	0.3	--	--	--	--
<u>P. salinarum</u>	0.5	--	--	--	0.1	--	--	--	--	--	--	0.1
<u>P.</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--
<u>Rhopolodia gibberula</u>	3.7	--	1.0	1.5	1.4	0.9	3.4	0.5	0.9	1.0	1.6	0.8
<u>R. musculus</u>	--	--	--	--	0.2	--	--	--	--	--	0.1	--
<u>Rhaponeis ampiceros</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>R.</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--
<u>Rhizosolenia</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Rhoicosphenia curvata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Skeletonema costatum</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Synedra affinis</u>	1.3	0.6	1.7	0.1	0.5	0.9	0.1	1.1	1.1	0.2	0.8	0.8
<u>S. affinis</u> var. <u>tabulata</u>	2.1	0.6	--	--	--	--	--	--	--	--	--	--
<u>S. fasciculata</u>	--	0.2	--	--	--	--	--	--	--	--	--	--
<u>S. fasciculata</u> var. <u>tabulata</u>	--	--	1.0	0.6	1.0	0.3	0.2	0.3	--	--	0.5	0.1
<u>S. fasciculata</u> var. <u>truncata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. fulgens</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. gaillonii</u>	1.3	--	1.1	0.9	--	0.4	0.7	1.4	0.2	0.3	0.5	0.1
<u>S. radians</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. undulata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. sp.</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Stauroneis salina</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>S. spicula</u>	--	--	0.1	--	--	--	--	0.2	--	--	--	--
<u>Suriirella litoris</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. ovata</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	7/17	7/17	7/17	7/17	7/17	7/17	7/31	7/31	7/31	7/31	7/31	7/31
<u>Striatella interrupta</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. unipunctata</u>	0.8	0.3	0.6	--	--	0.3	--	0.6	0.2	--	--	0.1
<u>Tabellaria fenestrata</u>	--	--	--	--	--	--	0.1	0.4	--	--	--	--
<u>T. flocculosa</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Thalassionema nitzschioides</u>	2.3	0.5	3.1	1.1	1.1	--	0.3	2.5	0.3	1.3	1.1	0.6
<u>T. nitzschioides</u> var. <u>lanceolata</u>	--	0.7	--	--	--	--	--	--	--	--	--	--
<u>Tropidoneis lepidoptera</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>T. maxima</u> var. <u>adriatica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>T. sp.</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Thalassiosira eccentricus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>T. pseudonana</u>	5.6	12.1	17.5	17.3	25.3	22.8	11.9	18.6	10.2	13.1	32.3	19.0
<u>T. sp. 5</u>	--	--	0.1	0.2	--	--	--	--	--	--	--	--
<u>Terpsinae americana</u>	--	--	--	--	--	--	--	--	0.1	--	--	--
<u>Trachyeis aspera</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Achnanthes chilensis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. conspicua</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. haukiana</u>	4.4	10.6	11.3	3.3	6.2	0.3	1.4	9.9	1.3	5.8	10.2	9.4
<u>A. haukiana</u> var. <u>rostrata</u>	0.1	--	--	--	--	0.2	--	0.3	--	--	0.4	--
<u>A. hustedii</u>	--	0.2	--	0.1	0.3	--	--	--	--	--	--	--
<u>A. lanceolata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. pinnata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. lemmermanni</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. linearis</u>	0.1	--	--	--	0.2	0.1	--	--	0.3	--	0.5	--
<u>A. longipes</u>	1.4	2.4	2.3	0.3	2.0	1.9	0.2	2.2	0.3	1.3	2.6	1.6
<u>A. lorenziana</u>	--	--	--	--	--	--	--	--	--	0.1	--	--
<u>A. mintuissima</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. wellsiae</u>	1.9	--	--	6.0	--	--	0.7	--	3.7	--	--	--
<u>A. pseudosolea</u>	10.7	--	0.5	34.3	--	0.7	4.2	0.8	21.4	0.1	1.0	0.3
<u>Actinoptychus undulatus</u>	0.2	--	0.2	0.2	--	--	0.2	0.1	--	--	0.1	0.1
<u>Amphiprora alata</u>	0.1	0.1	0.4	--	0.1	0.8	0.2	0.2	0.3	0.1	0.1	0.4

-- Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Amphiprora decipiens</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Amphora acutiuscula</u>	1.6	3.9	4.3	0.7	1.9	3.2	0.3	2.7	0.3	2.1	5.3	3.5
<u>A. angusta</u> var. <u>ventricosa</u>	--	0.1	0.2	--	--	--	0.1	0.1	0.1	--	--	--
<u>A. beaufortiana</u>	--	0.4	0.1	--	--	0.4	--	0.1	--	0.2	1.1	0.5
<u>A. coffeaeformis</u>	--	--	--	0.1	--	--	--	--	--	--	--	--
<u>A. costata</u>	0.1	0.1	0.2	--	0.1	--	--	0.3	--	0.2	0.1	0.2
<u>A. cymbifera</u>	--	--	--	0.1	--	--	--	--	0.1	--	--	--
<u>A. exigua</u>	--	--	--	0.1	--	0.2	--	--	--	--	--	--
<u>A. hyalina</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. macilenta</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. osterearia</u> var.	--	--	--	--	0.2	--	--	--	--	--	--	--
<u>A. ovalis</u> var. <u>affinis</u>	0.3	0.5	0.4	--	0.2	--	0.2	--	0.1	0.1	--	--
<u>A. ovalis</u> var. <u>pediculus</u>	--	--	--	--	--	--	--	--	--	--	0.1	0.2
<u>A. quadrata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. rhombica</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sublaevis</u>	--	0.3	0.1	--	0.1	--	--	--	0.2	0.4	0.6	0.2

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Amphora tenuissima</u>	0.1	0.3	--	--	--	--	--	--	--	--	--	--
<u>A. tumida</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. turgida</u>	--	--	0.1	--	--	0.4	--	--	0.1	--	--	--
<u>A. veneta</u>	0.1	0.2	--	--	--	--	0.7	--	0.1	5.6	--	--
<u>A. sp. 139</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 140</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 140.4</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. obtusa</u>	--	--	0.4	--	--	--	0.1	0.1	--	--	0.2	0.1
<u>A. sp. 140.8</u>	0.3	1.0	0.7	0.2	0.1	0.2	0.3	0.6	0.1	0.2	0.3	0.2
<u>A. sp. 146</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 150</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 150.2</u>	--	0.3	--	--	--	0.3	--	--	0.2	--	--	0.1
<u>A. sp. 152</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 162</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. sp. 140.1</u>	--	--	0.1	--	--	--	--	0.2	--	--	--	--
<u>A. proteus</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Amphora pusio</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>Amphipleura rutilans</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>A. micans</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Anorthonhis hummii</u>	--	--	0.1	--	--	--	--	--	--	--	--	0.1
<u>Auliscus punctatus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Auricula insecta</u>	--	--	0.2	--	0.2	0.2	--	--	0.1	0.1	0.1	0.1
<u>Biddulphia pulchella</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Caloneis westii</u>	--	--	--	--	--	--	--	--	--	--	0.1	--
<u>Campylodiscus sp.</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Chaetoceros affine</u>	--	0.1	--	--	--	--	0.1	--	0.4	0.1	--	--
<u>Cocconeis dirupta</u>	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>C. discoloides</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. disculus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. fluminensis</u>	0.1	0.1	0.3	0.3	0.2	0.4	--	0.1	0.1	--	--	0.1
<u>C. pediculus</u>	0.2	0.8	0.2	--	0.3	0.3	0.1	0.4	--	--	--	--
<u>C. placentula</u>	--	0.1	0.4	0.2	0.1	0.5	--	0.2	0.1	0.9	0.3	1.0

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Cocconeis placentula</u> var. <u>euglypta</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>C. scutellum</u>	--	--	0.3	--	0.3	0.4	--	0.7	0.3	0.2	0.4	--
<u>C. scutellum</u> var.	--	--	0.2	--	--	--	--	--	--	--	--	--
<u>C. sp. 84</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Coscinodiscus lineatus</u>	--	0.2	--	--	--	--	--	--	--	--	--	--
<u>C. marginatus</u>	--	0.4	--	--	0.1	--	0.1	0.1	--	0.1	0.1	0.3
<u>C. micans</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. nitidus</u>	--	--	0.1	--	--	--	--	--	--	--	--	--
<u>C. oculus iridis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. pygmae</u> var. <u>micropunctata</u>	0.2	0.7	0.2	--	--	0.2	--	0.5	0.2	0.1	0.2	0.1
<u>C. radiatus</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. sp.</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Cyclotella caspia</u>	--	0.1	--	1.0	--	--	--	--	--	--	--	--
<u>C. meneghiniana</u>	0.2	0.2	0.3	0.1	0.7	0.3	0.1	0.7	3.5	0.4	1.0	--
<u>C. striat.</u>	0.3	--	--	0.5	0.1	--	--	--	--	0.6	--	--
<u>Cylindrotheca closterium</u>	--	0.2	--	--	--	--	--	0.1	--	0.5	--	0.2

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Cymbella affinis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>C. pusilla</u>	0.4	0.1	0.5	0.2	0.2	0.3	0.4	0.3	--	0.4	0.2	0.1
<u>Denticula subtilis</u>	1.0	0.3	0.3	1.4	0.5	2.5	0.3	1.0	0.1	0.9	0.7	2.4
<u>Diatoma</u> sp.	--	--	--	--	0.2	--	--	--	--	--	--	--
<u>Dimmerogramma dubium</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>D. minor</u>	--	--	--	0.1	--	--	--	--	--	--	--	--
<u>D. sp.</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Diploneis grabro</u>	0.3	0.7	0.2	0.3	0.1	0.5	0.6	0.8	--	0.2	0.3	0.3
<u>D. smithi</u>	0.6	1.0	0.4	--	0.2	0.3	--	0.4	0.3	0.1	0.3	0.2
<u>D. pseudopalles</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Endictya oceanica</u>	0.2	0.1	--	--	--	--	--	--	--	--	--	--
<u>Fragilari lapponica</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>F. construens</u> var. <u>subsalina</u>	0.5	--	3.1	0.2	--	4.5	--	--	--	--	--	10.0
<u>F. construens</u> var. <u>venter</u>	25.5	19.5	28.8	4.7	6.3	9.6	5.8	27.0	2.4	8.4	23.5	22.4
<u>Gomphonema olivaceum</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. parvulum</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
AXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Grammatophylla angulosa</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. marina</u>	1.0	0.2	0.3	0.1	0.3	--	0.5	0.5	0.1	0.1	--	--
<u>G. oceanica</u> var. <u>minuscula</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. serpentina</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Gyrosigma cumatum</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. baltica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. fascicula</u> var. <u>arcuata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. febrigeri</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. peisonii</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>G. sp.</u>	--	--	0.1	--	--	--	--	0.1	0.2	--	--	--
<u>Hantzschia amphioxys</u>	--	--	--	--	--	--	--	--	--	0.1	--	--
<u>H. virgata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Licmophora abbreviata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>L. dalmatica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>L. ehrenbergerii</u>	--	--	--	--	--	--	--	0.1	--	--	--	--
<u>L. lynebyei</u>	--	--	--	--	--	0.2	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES		Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON		8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Licmopho</u>	sp. 22	--	--	--	--	--	--	--	--	--	--	--	--
<u>L.</u>	sp. 2	--	0.2	0.1	--	0.2	0.2	--	0.1	0.4	--	0.1	0.2
<u>Mastoglo</u>	<u>augulata</u>	1.1	--	--	--	--	--	17.3	--	0.4	--	--	--
<u>M. braun</u>	var.	--	--	--	--	--	--	0.2	--	--	--	--	--
<u>M. danse</u>	var. <u>elliptica</u>	0.5	--	--	--	--	--	--	--	--	--	--	--
<u>M. exigua</u>		14.9	4.5	1.2	5.0	0.9	0.7	11.8	0.7	35.8	0.5	0.6	0.5
<u>M. pumila</u>		--	0.6	0.1	--	--	--	8.0	--	2.2	--	--	--
<u>M. pusilla</u>		--	--	--	0.6	--	--	0.5	--	--	--	--	--
<u>M. smithi</u>		0.7	0.2	0.1	--	0.2	0.1	13.6	0.9	6.1	--	--	--
<u>M. smithi</u>	var.	--	--	--	3.3	--	--	--	--	--	--	--	--
<u>Melosira</u>	<u>distans</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M. jurgen</u>	<u>ii</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M. nummul</u>	<u>ides</u>	0.3	3.4	3.3	--	3.2	2.5	--	2.6	1.5	2.2	2.5	2.2
<u>M. subfle</u>	<u>tilis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>M. sulcat</u>		0.6	1.6	0.9	0.7	0.4	0.4	0.8	0.7	--	0.1	0.1	0.5
<u>M. sulcat</u>	var. <u>coronata</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	TAXON	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
		8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Navicula</u>	<u>unda</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. approx</u>	<u>ata fo. elongata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. arenar</u>		--	--	--	--	0.5	0.1	--	0.3	--	0.2	0.2	0.3
<u>N. bicon</u>	<u>var.</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. cancel</u>	<u>ata</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>N. cincta</u>		0.7	0.4	0.3	0.3	--	0.5	0.2	0.1	--	0.2	--	0.1
<u>N. confes</u>	<u>cea var. peregrina</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. crypte</u>	<u>phala</u>	0.9	2.1	2.7	1.8	14.7	1.6	0.7	3.0	0.4	7.7	5.6	4.0
<u>N. crypte</u>	<u>phala var. veneta</u>	1.2	--	0.2	0.5	--	--	--	--	--	--	--	--
<u>N. digit</u>	<u>radiata</u>	0.7	0.6	0.1	--	0.2	0.6	0.1	0.5	0.1	--	--	0.7
<u>N. disers</u>		0.5	0.7	--	--	0.6	0.3	--	0.2	--	1.1	0.2	--
<u>N. divers</u>	<u>ata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. elegar</u>		--	0.1	--	--	--	--	--	--	--	--	--	--
<u>N. forcip</u>	<u>a</u>	--	0.5	0.1	--	0.2	--	--	0.5	0.1	0.3	--	--
<u>N. gottla</u>	<u>ica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. granu</u>	<u>a</u>	0.5	--	0.1	--	0.1	0.1	--	0.1	--	--	0.2	0.2

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
AXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Navicula</u> <u>garia</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. haloph</u>	--	--	0.3	--	--	--	--	--	--	--	--	--
<u>N. henned</u>	--	0.2	--	--	--	--	--	0.2	--	--	--	--
<u>N. integr</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. litori</u> <u>la</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. lyra</u>	0.4	0.3	--	0.2	0.3	0.2	0.1	--	--	0.1	0.1	--
<u>N. macula</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. marina</u>	0.5	--	--	0.2	--	0.1	0.3	0.2	--	0.1	--	--
<u>N. menisc</u> <u>is</u>	--	0.9	0.3	--	0.5	1.2	--	0.6	0.1	0.1	0.4	0.5
<u>N. menisc</u> <u>is</u> var.	--	--	0.4	--	--	--	--	--	--	--	--	--
<u>N. monili</u> <u>ca</u>	0.1	0.1	--	--	--	0.1	--	--	--	--	--	--
<u>N. misell</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. murali</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. mutica</u>	0.2	--	--	--	--	--	--	--	--	0.1	--	--
<u>N. mutica</u> ar. <u>cohnii</u>	--	--	--	--	--	--	0.1	--	--	--	--	--
<u>N. opima</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicate not present in count

C	COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
		8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
	MAXON												
Navicula	<u>erickae</u>	0.6	2.3	1.5	--	1.0	2.4	0.6	3.5	0.5	0.6	1.6	5.0
N. paleo	<u>alis</u> var. <u>angulosa</u>	--	--	--	--	--	--	--	--	--	--	--	--
N. pavill	<u>li</u>	--	--	--	0.2	--	--	--	--	--	--	--	--
N. peregr	<u>a</u>	--	--	0.6	--	--	--	--	--	--	--	0.7	0.3
N. plagio	<u>ma</u>	--	--	--	--	--	--	--	--	--	--	--	--
N. platyv	<u>tris</u>	--	0.1	0.1	--	--	--	--	--	--	--	--	--
N. pullus		--	--	--	--	--	--	--	--	--	--	--	--
N. placent	<u>la</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
N. pygmae		--	--	--	--	--	--	--	--	--	--	--	--
N. radios	var. <u>cuneata</u>	--	--	--	--	--	--	--	--	--	0.3	--	--
N. regula	<u>s</u>	--	--	--	--	--	--	--	--	--	--	--	--
N. rhynch	<u>cephala</u>	--	--	--	--	--	--	--	--	--	--	--	--
N. salina	<u>m</u>	--	0.3	0.2	--	0.8	0.2	--	--	--	--	--	--
N. simple		--	--	--	--	--	--	--	--	--	--	--	--
N. specta	<u>lis</u>	--	--	--	--	--	--	--	--	--	--	--	--
N. subapi	<u>lata</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indic t present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	b	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	28	8/28
<u>Navicula subdiffusa</u>	--	0.2	--	--	--	--	--	0.1	--	--	-	0.1
<u>N. tripunctata</u> var. <u>schizonemoides</u>	0.1	0.1	0.9	--	--	0.3	--	0.2	--	--	-	0.3
<u>N. vara</u>	--	--	--	3.0	--	--	0.2	--	--	--	-	--
<u>N. viridula</u>	0.4	--	--	--	--	--	0.2	--	--	--	-	--
<u>N. yarrensii</u>	--	--	--	--	--	0.1	--	0.2	0.1	0.2	.1	--
<u>N. sp. 89</u>	--	--	--	--	--	--	--	--	--	0.2	-	--
<u>N. sp. 95</u>	--	--	--	--	--	--	--	--	--	--	-	--
<u>N. sp. 100.10</u>	--	--	--	--	--	--	--	--	--	--	-	--
<u>N. sp. 100.12</u>	--	--	--	--	--	--	--	--	--	--	-	--
<u>N. sp. 100.60</u>	--	--	--	--	--	--	--	--	--	--	-	--
<u>N. sp. 104</u>	--	--	0.1	--	--	--	--	--	--	--	-	--
<u>N. sp. 104.1</u>	--	--	--	--	--	--	--	--	--	--	-	--
<u>N. sp. 105</u>	--	--	0.1	--	--	--	--	--	--	--	-	--
<u>N. accomoda</u>	--	--	--	--	--	--	--	--	--	--	-	--
<u>N. sp. 108</u>	--	--	--	--	--	--	--	--	--	--	-	--
<u>N. sp. 109</u>	--	--	--	--	--	--	--	--	--	--	-	--

--Indicates not present in count

C	UNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
	AXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Navicula</u>	114	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 11</u>		0.2	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 12</u>		--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 12</u>		--	0.1	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 12</u>		--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 12</u>		--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 13</u>		--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 13</u>		--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 14</u>		--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp.</u>		--	--	--	--	--	--	--	--	--	--	--	--
<u>Nitzschia</u>	<u>luminata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. acicul</u>	<u>is</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. amphib</u>		--	--	--	--	--	--	--	--	--	--	--	--
<u>N. apicul</u>		--	--	--	--	--	--	--	0.2	--	--	--	--
<u>N. austra</u>	<u>s</u>	--	--	--	--	--	--	--	--	0.1	--	--	--
<u>N. capite</u>	<u>ata</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicat not present in count

UNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
AXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Nitzschia ausii</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>N. commun</u>	--	--	--	0.9	0.3	--	--	0.3	--	--	--	--
<u>N. duboid</u>	--	--	--	--	--	0.1	--	--	--	--	--	0.1
<u>N. epithe</u> <u>ides</u>	--	--	--	--	--	--	--	--	--	--	--	0.2
<u>N. filifo</u> <u>s</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. fontic</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. frustu</u>	--	--	--	--	--	0.2	--	0.1	--	0.1	--	--
<u>N. frustu</u> <u>var. perminuta</u>	0.1	--	0.1	0.5	--	0.5	0.5	--	--	--	--	--
<u>N. frustu</u> <u>var. perpusilla</u>	--	--	--	--	--	--	--	--	--	--	0.1	0.2
<u>N. frustu</u> <u>var. subsalina</u>	--	--	--	--	--	0.1	--	--	--	--	--	--
<u>N. grossi</u> <u>iata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. hungar</u>	--	0.1	--	--	0.1	--	--	--	--	--	0.2	--
<u>N. hybrid</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. incurv</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. Kutzin</u> <u>ana</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. laevis</u>	0.1	--	0.1	0.4	0.4	0.6	--	0.3	--	0.1	--	0.4

--Indicat not present in count

UNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
AXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<i>Nitzschia</i> <u>anceolata</u> var. <u>minima</u>	0.7	0.2	0.4	6.3	0.8	3.4	8.9	0.7	5.6	3.4	0.4	0.4
<i>N. longa</i>	--	--	--	--	0.1	--	0.4	0.1	--	--	0.1	--
<i>N. longis</i>	--	--	0.1	--	--	--	--	--	--	--	--	--
<i>N. lorenz</i>	--	0.1	--	--	--	--	--	--	--	--	--	--
<i>N. lorenz</i> var. <u>subtilis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<i>N. microc</i> <u>ala</u>	4.9	0.7	0.2	3.5	5.1	0.6	2.1	0.2	0.3	4.4	1.8	3.4
<i>N. microc</i> <u>ala</u> var.	--	--	--	--	--	--	--	--	--	--	--	--
<i>N. obtusa</i>	0.1	0.3	0.2	--	--	0.5	--	0.3	0.2	0.3	0.3	0.2
<i>N. obtus</i> <u>scapelliformis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<i>N. palea</i>	--	--	--	0.2	--	--	--	--	--	--	--	--
<i>N. pandur</i> <u>mis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<i>N. parado</i>	--	--	--	--	--	--	--	--	--	--	--	0.3
<i>N. proxim</i>	--	--	0.1	0.2	--	--	--	--	--	--	--	--
<i>N. puncta</i> var. <u>coaracta</u>	--	--	--	--	--	--	--	--	--	--	--	--
<i>N. recta</i>	--	--	--	0.1	0.9	0.2	0.1	0.1	4.3	4.3	0.1	0.4
<i>N. rhombi</i>	--	--	--	--	--	--	--	--	--	--	--	0.2
--Indicat	not present in count											

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Nitzschia rigida</u> var. <u>rigidula</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sigma</u>	--	0.2	--	0.2	--	--	--	0.1	--	--	--	--
<u>N. sigma</u> var. <u>intercedens</u>	0.1	--	--	--	--	--	--	--	--	--	--	--
<u>N. socialis</u>	--	0.8	--	--	--	--	--	--	--	--	--	--
<u>N. spathulata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sublinearis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. subtilis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. thermalis</u> var. <u>minor</u>	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>N. tryblionella</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. tryblionella</u> var. <u>salinarum</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 165</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 167</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 168</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. angularis</u> var. <u>affinis</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 170.1</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>N. sp. 171</u>	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Nitzschia</u> sp. 190.1	--	--	--	--	--	--	--	--	--	--	--	--
<u>N.</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--
<u>Oestrupia powelli</u>	--	--	--	--	--	--	0.1	--	--	--	--	--
<u>Opephora martyi</u>	12.5	3.9	8.3	7.4	8.4	14.1	13.2	10.5	2.2	3.4	12.0	11.8
<u>O. pacifica</u>	0.1	--	--	--	--	0.1	--	--	--	--	--	--
<u>O. martyi</u> var.	--	0.3	--	0.2	0.2	--	0.5	--	--	--	--	--
<u>Pinnularia</u> sp. 100.8	--	--	--	--	--	--	--	--	--	--	--	--
<u>Plagiogramma staurophorum</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Pleurosigma angulatum</u>	--	0.4	--	--	--	--	--	--	--	0.1	--	--
<u>P. salinarum</u> ✓	--	0.2	0.2	--	--	--	--	0.3	--	0.1	--	0.1
<u>P.</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--
<u>Rhopolodia gibberula</u>	2.1	1.4	1.3	0.5	2.0	1.4	1.1	0.7	0.5	0.9	1.6	1.0
<u>R. musculus</u>	0.3	--	0.1	--	--	--	0.3	--	--	--	--	--
<u>Rhaponeis amphiceros</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>R.</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--
<u>Rhizosolenia</u> sp.	--	--	--	--	--	--	--	--	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Rhoicosphenia curvata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Skeletonema costatum</u>	--	--	--	--	--	--	--	--	0.5	--	--	--
<u>Synedra affinis</u>	0.2	1.4	1.4	--	1.4	0.2	0.1	0.5	0.1	--	0.2	0.2
<u>S. affinis</u> var. <u>tabulata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. fasciculata</u>	--	--	--	--	--	--	--	0.4	0.1	2.3	1.0	2.2
<u>S. fasciculata</u> var. <u>tabulata</u>	--	0.1	0.4	0.1	1.4	0.8	0.1	--	--	--	--	--
<u>S. fasciculata</u> var. <u>truncata</u>	--	--	--	--	--	--	--	0.2	--	--	--	--
<u>S. fulgens</u>	--	--	--	--	--	--	0.1	--	--	--	--	--
<u>S. gaillonii</u>	--	1.3	0.1	1.0	0.6	0.9	0.2	0.5	--	--	0.3	--
<u>S. radians</u> var.	--	0.1	--	--	--	--	--	--	--	--	--	--
<u>S. undulata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. sp.</u>	--	0.2	--	--	--	--	--	--	--	--	--	--
<u>Stauroneis salina</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. spicula</u>	--	--	--	--	0.1	0.1	--	--	--	--	--	--
<u>Surirella litoris</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. ovata</u>	--	--	--	--	--	--	--	0.1	--	--	--	--

--Indicates not present in count

COMMUNITIES	Fe	Cu	Zn	Cr	Pb	Oil	Fe	Cu	Zn	Cr	Pb	Oil
TAXON	8/14	8/14	8/14	8/14	8/14	8/14	8/28	8/28	8/28	8/28	8/28	8/28
<u>Striatella interrupta</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>S. unipunctata</u>	--	0.2	0.3	0.2	--	0.3	--	0.2	0.6	--	0.1	0.1
<u>Tabellaria fenestrata</u>	--	5.3	0.1	--	--	--	0.8	0.2	0.1	--	0.1	--
<u>T. flocculosa</u>	--	0.2	--	--	--	--	--	--	--	--	--	--
<u>Thalassionema nitzschioides</u>	0.4	1.4	0.4	1.5	0.5	1.0	--	1.1	--	0.1	0.5	0.2
<u>T. nitzschioides</u> var. <u>lanceolata</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Tropidoneis lepidoptera</u>	--	--	--	--	--	--	--	0.2	--	--	--	0.2
<u>T. maxima</u> var. <u>adriatica</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>T. sp.</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Thalassiosira eccentricus</u>	0.3	--	--	--	--	0.2	--	0.2	0.1	--	--	0.3
<u>T. pseudonana</u>	2.8	15.1	13.6	6.4	32.7	24.3	0.6	17.0	1.4	37.4	19.1	16.4
<u>T. sp. 5</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Terpsinae americana</u>	--	--	--	--	--	--	--	--	--	--	--	--
<u>Trachyeis aspera</u>	--	0.1	--	0.1	--	--	--	--	--	--	--	--

--Indicates not present in count

- C. Field and laboratory studies aimed at characterizing the changes in the bacterial and unicellular algal communities over a summer growing season.

For the last few years we have been broadening and extending our knowledge of the natural community. The study of the diatom assemblage was finally completed this year and is included in this progress report. The bacterial population structure of the community is still being studied by one of our graduate students, Miss Eileen Kennedy. Her methods for collection and enumeration of the bacterial colonies were detailed in the progress report 4 years ago (NYO 3995-20; pp 14-15).

About 18 hrs after incubation, all plates were examined and any bacterial growth recorded. They were then incubated at 20° C in a 12 L/12 D environmental chamber and rechecked for growth after 4 and 10 days.

Bacterial colony types were described on the basis of relative size, pigmentation, whole colony appearance, edge and surface. The frequency of each was noted. Each different type was isolated by restreaking on a fresh plate of its initial isolation medium. Pure cultures were originally maintained on slants of the same medium but as a matter of practicality were transferred to a medium containing the following: yeast extract (Difco), 0.5%; Bactotryptone (Difco), 0.5%, Base B without B₁₂ (Lee et al. 1966) 100 ml. pH was adjusted to ~ 7.5.

The results were quite dramatic. The natural sea water based media, which are the standard media for this type of work, were quite inferior to the artificial sea water in both the isolation of bacteria and algae. The algal component of the microbial community was simpler to evaluate than the bacterial, since we were able to recognize easily the growth of the same species on different media. The total number of bacteria per gram (dry weight) of the community was estimated variously by individual media. Only after we identify each species and see the range of media on which each

species grew well will we be able to estimate accurately the bacterial component. Three species grew very well on unenriched sea water alone (Fig. 29). The number of bacteria growing on sea water agar fluctuated from $< 1 \times 10^6$ - 2×10^6 /g in early summer to a peak of $\sim 6 \times 10^6$ /g on field trip #9 in early August (Fig. 31). Only 1-4 species were isolated on the sea water agar plates. Two species were consistently isolated on the sea water agar plates. Two species were consistently isolated on erdschreiber throughout the summer (Fig. 30). Although there were slight fluctuations in the populations, both species were quite abundant ($\sim 3 \times 10^6$ /g; Fig. 31). The number of different species isolated on this medium gradually increased over the summer from 1 in early June to 7 in mid-August. Among the natural sea water based media, marine nutrient agar (Difco, Bacto Nutrient Agar 23 g/l, distilled sea water 0.5 l, sea water 0.5 l) and marine trypticase soy agar (B.B.L. trypticase soy agar 40 g/l, distilled water 0.5 l, sea water 0.5 l) best showed fluctuations in the natural community. Two peaks in the total number of bacteria/g were observed (Fig. 31), a peak in late June (field trip #3) and another peak in early August (Field trips 8,9). These peaks coincide in time with the 2 annual summer blooms of foraminifera (see Matera and Lee, in last year's progress report). The 2 peaks were observable in all of the sea water based media except erdschreiber [sea water KNO_3 0.01% (w/v), $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ 0.01% (w/v), and soil extract 5% (w/v)] and medium d. Growth on erdschreiber was depressed during the first peak. The second summer peak on other media was preceded by a late July peak on these latter media (Fig. 31). The growth of species b2, b3, c4, c5, d1, e3, and e4 were possibly correlated with both peaks. Species a2, d3, e1, e3 and e4 were depressed in numbers during the first peak. The greatest total numbers of species were isolated on marine trypticase agar (13 colony types; Fig. 32); on marine nutrient agar 10 types were isolated. Five colonial types were isolated on unenriched sea water agar and 7 types were isolated on erdschreiber. Medium d (sea water

enriched with KNO_3 10 mg% and $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ 10 mg%) was more selective, since it promoted the growth of 2 species of bacteria and only a few other species grew on the medium all summer.

The seasonal changes in the community reflected by growth on the series A media are quite interesting. Many species which grew on this medium were agar digesters. On medium A 1, unenriched artificial sea water, there was a steady increase in total number of bacteria/g throughout the summer (Fig. 33). Of the 3 species which grew on the medium only 2, A 1-1 and A 1-2, grew in the early part of the summer (Fig. 32). The first isolation of species A 1-3 was in mid-August (Fig. 33). The pattern of colony growth on medium A 2 (enriched with NaNO_3) and A 3 (enriched with NH_4Cl) was similar. The same progressive general increase in number of bacteria/g was observed although the peak population was not as great as in medium A 1 (Fig. 33). The number of species growing on the media gradually increased throughout the summer (Fig. 32). A total of 7 species grew on both media (Figs. 35, 36). We found nitrite inhibited bacterial growth. Only on August 19 did we grow a small number of colonies of a single species on medium A 4 (Figs. 30, 32). The growth on medium A 5, which is enriched with NH_4NO_3 and NaH_2PO_4 , was very interesting since it paralleled the growth pattern observed in medium D the sea water media also enriched with NO_3^- and H_2PO_4^- . Growth on medium A 5 was minimal during the 2 seasonal peaks on other media (Fig. 30). Two peaks, one in week 7 and one in week 9, immediately preceding and immediately following those observed on other media, were noted. Species A 5-1 was present in both peaks and greatly depressed in the collections on August 5. Species A 5-3 was present in large numbers only during weeks 6 and 7 (Fig. 37).

Throughout the season, 2 species of bacteria were consistently isolated on medium B 1 (Fig. 38). Though there were minor fluctuations, populations of species B 1-1 numbered $\sim 2.5 \times 10^6/\text{g}$ of the epiphytic community while species B 1-2 numbered $\sim 2 \times 10^5/\text{g}$. Small numbers of 6 other species were collected in late summer. In terms

of total numbers of bacteria, the peptone enriched medium B 2, was the best. On it 4 species grew well ($> 1 \times 10^6$). Peaks in the population were observed on field trips 3, 7, and 10 (Figs. 39, 40). Only 1 species, B 3-1, grew well on medium B 3, the medium enriched with urea (Fig. 41). Substantial growth was noted on this medium from the 6th field collection (July 23) until a decline which began on the 11th collection (Fig. 39). From mid-July on, there was a progressive increase in the number of species collected on this medium (Fig. 42).

The same trend of progressive increase in the number of species isolated from the community on successive collections which we observed on media A-5 and B 3 was observed on all the series C media (Fig. 42). Ten species grew on media enriched with B_{12} (C 1) and 11 species grew on the media enriched with thiamin, biotin and B_{12} (C 2) (Figs. 43-46). Organisms with these requirements were not isolated from the community until the 6th or 5th field collections respectively. Though the population trends on both media at first seem quite similar (Fig. 47) closer examination of the growth patterns of individual species on both media shows that different species were isolated on each of the media. Peaks in the portion of the community isolated on these media were observed on either the 6th and 9th collections in medium C 1 or the 5th and 8th weeks on medium C 2. Although medium C 3 could be described as an artificially based erdschreiber, the growth on both media (Figs. 31, 32, 42, 47) were quite dissimilar in respect to the seasonal trends in both the total numbers and types of bacteria isolated. The growth of one organism, C 3-1, which was one of the most abundant species at the beginning of the season, gradually declined over the course of the summer (Fig. 48). Another species, C 3-4, grew well from mid-July to the end of August. One species, C 4-1, grew well from the 4th to the 11th field collection on medium C 4 (Fig. 49). During this period, the fluctuations in the number of organisms isolated on this vitamin enriched medium were minimal.

Though there were exceptions, there was a general trend of seasonal succession and increasing numbers of species which grew on the series D media (Figs. 42, 50, 51, 52). On medium D 1 which contained acetate, lactate and glucose as substrates, only 1 species, D 1-1, was found in quantity throughout the summer (Fig. 52). Species D 1-2 was abundant in early summer and gradually diminished in numbers. Species D 1-4 was found from weeks 3-8, species D 1-5 from 7-8, species D 1-6 from 8-10, and species D 1-7 was found only in weeks 11 and 12. The increase in the total numbers of bacteria isolated on the glutamate enriched medium (D 2) as the summer progressed was due both to the increase in the populations of species D 2-1 and D 2-3 and to the increase in the total number of species which grew on this medium (Fig. 54). Peak growth on medium D 2 was observed on collections from weeks 7, 9, 10. We observed peak growth on medium D 4 during weeks 3, 5-7 and 10. Though the species isolated were different, the population trends observed on medium D 2 were also observed on media 4-8. Mannitol, glycerol and extracts of Enteromorpha each stimulated the growth of 7 species while only 5 species grew on the acrylic acid enriched plates. The pattern of growth observed on medium D 7 (autoclaved Enteromorpha community) was similar to the growth observed on medium C 4 (vitamins 8A; Figs. 47, 50). It seems probable that autoclaved Enteromorpha stimulated the bacteria.

The 127 bacterial isolates have been subjected to 54 morphological and physiological tests. The results (Table 16) describe 117 "unit characters" of each organism and these will be scored for analysis by computer. The Jaccard coefficient, S_j , will be used to determine the similarities between each of the isolates. The strains will be clustered by a single linkage technique using the GTP-2 program supplied to us by Dr. Rita Colwell of the University of Maryland. We have just finished entering the program into our computer and are presently coding our data in the required form.

Number of Bacteria $\times 10^6$ / Gram

Medium A1

— Number of Bacteria
-- Number of Colony Types

Number of Colony Types

Number of Bacteria $\times 10^6$ / Gram

Medium A2

— Number of Bacteria
-- Number of Colony Types

Number of Bacteria $\times 10^6$ / Gram

Medium A3

— Number of Bacteria
-- Number of Colony Types

Number of Colony Types

TOTAL NUMBER OF BACTERIA X 10⁶/GRAM

B1

B2

B3

TIME

TIME

Medium D5

Number of Bacteria $\times 10^6$ / Gram

Number of Bacteria
Number of Colony Types

Number of Colony Types

Number $\times 10^6 / g$

TIME wks

number x 10⁷/g

C2-9

C2-10

C2-11

TIME wks

Results are tabulated (Tables 17, 18). As expected, and as can be seen by inspection of Table 16, most of the isolated organisms are gram negative rods which demonstrate diverse physical characteristics. Close inspection of the data strongly indicates that organisms isolated on our series of differential media demonstrate varied ability to attack glucose, sucrose and lactose (Table 16). Such results begin to point out the utility and importance of diverse complex and synthetic media in the isolation and enumeration of the bacterial inhabitants of the salt marsh community. By employing such media, we have obtained a more comprehensive picture of the metabolic capabilities of salt marsh bacteria. We hope in the next year to complete this project as a companion to the diatom assemblage paper (COO 3254-9) included in this progress report. Together they should give us a cohesive picture of auxotrophic pathways of carbon cycling in the microbial assembly of the marsh.

Table 16. Characteristics of the bacteria isolated from epiphytic communities of Enteromorpha intestinalis.

Organism	Shape			Ends		Length (μm)				L:W		Diameter (μm)		Occurrence						
	Straight Rod	Curved Rod	Coccus	Tapered	Square	≤ 0.5	0.6 - 1.2	1.3 - 3.0	≥ 3.0	3 : 1	2 : 3:1	1 : 1	≤ 0.5	≥ 0.6	Singles	Pairs	Short Chains	Long Chains	Gram	Motility
a3	+				+			+			+				+				-	+
a4			+		+									+	+				-	
a6	+				+		+				+				+	+			-	+
a6*	+				+		+				+				+				-	+
a7	+				+			+		+					+				-	+
c2	+				+			+			+				+			+	-	+
c4	+				+			+				+			+				-	+
c6	+				+			+				+			+		+		-	+
c7	+				+			+				+			+		+		-	+
c8	+				+			+				+			+				-	
c9	+				+			+				+			+		+		-	
c711			+		+								+		+		+		-	
c712	+				+			+			+				+		+		-	
c715	+				+			+		+					+		+		-	
d1	+				+			+			+					+	+		-	

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rganism

	Glucose, Aer. Acid	Glucose, Anaer. Acid	Glucose, Aer. Alk.	Glucose, Anaer. Alk.	Glucose, Gas	Lactose, Aer. Acid	Lactose, Anaer. Acid	Lactose, Aer. Alk.	Lactose, Anaer. Alk.	Lactose, Gas	Sucrose, Aer. Acid	Sucrose, Anaer. Acid	Sucrose, Aer. Alk.	Sucrose, Anaer. Alk.	Sucrose, Gas	Mannitol, Aer. Acid	Mannitol, Anaer. Acid	Mannitol, Aer. Alk.	Mannitol, Anaer. Alk.	Mannitol, Gas	Mannose, Aer. Acid	Mannose, Anaer. Acid	Mannose, Aer. Alk.	Mannose, Anaer. Alk.	Mannose, Gas
a3			+	+				+	+				+	+				+	+				+	+	
a4	+	+						+	+		+	+				+	+				+	+			
a6			+	+				+	+				+	+				+	+				+	+	
a6*			+	+				+	+				+	+				+	+				+	+	
a7			+	+				+	+				+	+				+	+				+	+	
c2	+	+						+	+		+	+				+	+				+	+			
c4			+	+				+	+				+	+				+	+				+	+	
c6			+	+				+	+				+	+				+	+				+	+	
c7			+	+				+	+				+	+				+	+				+	+	
c8			+	+				+	+				+	+				+	+		+	+			
c9	+	+						+	+		+	+				+	+				+	+			
c711	+	+						+	+		+	+				+	+				+	+			
c712			+	+				+	+				+	+				+	+				+	+	
c715			+	+				+	+				+	+				+	+				+	+	
d1			+	+				+	+				+	+				+	+		+	+			

ganism

	Galactose, Aer. Acid	Galactose, Anaer. Acid	Galactose, Aer. Alk.	Galactose, Anaer. Alk.	Galactose, Gas	Maltose, Aer. Acid	Maltose, Anaer. Acid	Maltose, Aer. Alk.	Maltose, Anaer. Alk.	Maltose, Gas	Arabinose, Aer. Acid	Arabinose, Anaer. Acid	Arabinose, Aer. Alk.	Arabinose, Anaer. Alk.	Arabinose, Gas	Sorbitol, Aer. Acid	Sorbitol, Anaer. Acid	Sorbitol, Aer. Alk.	Sorbitol, Anaer. Alk.	Sorbitol, Gas	Xylose, Aer. Acid	Xylose, Anaer. Acid	Xylose, Aer. Alk.	Xylose, Anaer. Alk.	Xylose, Gas
a3			+	+		+	+				+	+				+	+				+				
a4			+	+		+	+				+	+				+	+				+	+			
a6			+	+		+	+				+	+				+	+				+				+
a6*			+	+		+	+				+	+				+	+				+	+			
a7			+	+		+	+				+	+				+	+				+	+			
c2	+	+				+	+				+	+				+	+				+	+			
c4			+	+		+	+				+	+				+	+				+	+			
c6			+	+		+	+				+	+				+	+				+	+			
c7			+	+		+	+				+	+				+	+				+	+			
c8			+	+				+	+				+	+		+	+						+	+	
c9	+	+				+	+						+	+		+							+	+	
c711	+	+				+	+				+	+				+	+				+	+			
c712			+	+		+	+				+	+				+	+				+	+			
c711			+	+		+	+				+	+				+	+				+	+			
d1	+	+				+	+				+	+				+	+				+	+			

Organism

	Inositol, Aer. Acid	Inositol, Anaer. Acid	Inositol, Aer. Alk.	Inositol, Anaer. Alk.	Inositol, Gas	Methyl Red Reaction	Voges-Proskauer Test	Oxidase (Kovacs)	Starch Hydrolysis	Gelatin Hydrolysis, ≤ 8 da	Gelatin Hydrolysis, ≥ 9 da	Indole	Lysine Decarboxylase	Ornithine Decarboxylase	Arginine Decarboxylase	Ammonification	Nitrate Reduction $\rightarrow$ NO_2	Nitrate Reduction $\rightarrow$ Gas	Catalase
a3	+	+						+								+	+	+	+
a4	+	+				+		+			+	+				+	+		+
a6	+	+						+							+	+	+		+
a6*	+	+						+								+	+		+
a7	+	+						+	+							+	+	+	+
c2	+	+				+		+			+	+				+	+		+
c4	+	+						+		+				+		+	+		+
c6	+	+							+					+		+	+		+
c7	+	+						+	+					+		+	+		+
c8			+	+				+						+		+	+	+	+
c9			+	+		+		+		+				+	+	+	+		+
c711	+	+				+		+		+		+		+	+	+	+		+
c712	+	+						+		+						+	+		+
c715	+	+						+	+	+						+	+		+
d1			+	+				+	+	+			+	+		+	+		+

Organism

	Medium a	Medium b	Medium c	Medium d	Medium e	Medium A1	Medium A2	Medium A3	Medium A4	Medium A5	Medium B1	Medium B2	Medium B3	Medium C1	Medium C2	Medium C3	Medium C4	Medium D1	Medium D2	Medium D4	Medium D5	Medium D7	Medium D8
a3			+		+							+						+	+	+	+		
a4			+		+							+						+	+			+	
a6			+		+							+						+	+	+			
a6*			+		+							+						+	+				
a7			+		+							+						+	+	+	+		
c2			+		+							+						+	+	+	+		
c4			+		+						+	+						+	+				
c6			+		+							+						+	+	+			
c7			+		+							+						+	+	+	+		
c8			+		+						+	+						+	+	+	+		
c9			+		+							+						+	+	+	+		
c711			+		+							+						+	+	+	+		
c712			+		+						+	+											
c715			+		+							+								+	+		
d1			+		+							+						+	+	+	+		

Organism	Shape			Ends		Length (μm)				L:W			Diameter (μm)		Occurrence					
	Straight Rod	Curved Rod	Coccus	Tapered	Square	≤ 0.5	0.6 - 1.2	1.3 - 3.0	≥ 3.0	3 : 1	2 -3:1	1 : 1	≤ 0.5	≥ 0.6	Singles	Pairs	Short Chains	Long Chains	Gram	Motility
e2	+				+				+	+					+				-	+
e5	+				+		+				+				+		+		-	+
e7	+				+				+	+					+				-	+
e8	+				+			+		+					+		+		-	+
A1-1	+				+			+		+					+		+		-	+
A1-2	+				+			+		+					+		+		-	
A1-712	+				+			+			+				+	+			-	
A1-714	+				+			+			+				+	+			-	
A1-714*			+		+				+	+					+		+		-	
A2-1	+				+			+		+					+		+		-	+
A2-2	+				+			+		+					+				-	
A2-3	+				+			+		+					+				-	+
A2-3*	+				+			+		+					+		+		-	+
A2-4			+		+			+		+					+				-	+
A2-714*			+		+				+	+					+				-	+

Organism	Glucose, Aer. Acid	Glucose, Anaer. Acid	Glucose, Aer. Alk.	Glucose, Anaer. Alk.	Glucose, Gas	Lactose, Aer. Acid	Lactose, Anaer. Acid	Lactose, Aer. Alk.	Lactose, Anaer. Alk.	Lactose, Gas	Sucrose, Aer. Acid	Sucrose, Anaer. Acid	Sucrose, Aer. Alk.	Sucrose, Anaer. Alk.	Sucrose, Gas	Mannitol, Aer. Acid	Mannitol, Anaer. Acid	Mannitol, Aer. Alk.	Mannitol, Anaer. Alk.	Mannitol, Gas	Mannose, Aer. Acid	Mannose, Anaer. Acid	Mannose, Aer. Alk.	Mannose, Anaer. Alk.	Mannose, Gas
e2	+	+						+	+		+	+				+	+					+	+		
e5	+	+						+	+		+	+				+	+					+	+		
e7	+	+						+	+		+	+				+	+					+	+		
e8	+	+						+	+		+	+				+	+							+	+
A1-1	+	+						+	+		+	+				+	+					+	+		
A1-2			+	+				+	+				+	+		+	+					+	+		
A1-712				+	+			+	+				+	+		+		+				+			+
A1-714				+	+			+	+				+	+		+		+				+	+		
A1-714*	+	+						+	+		+	+				+	+					+	+		
A2-1			+	+				+	+				+	+		+	+							+	+
A2-2				+	+			+	+				+	+				+	+					+	+
A2-3	+	+						+	+				+	+				+	+				+	+	
A2-3*	+			+				+	+				+	+				+	+				+	+	
A2-4	+	+						+	+				+	+				+	+				+	+	
A2-714*			+	+				+	+				+	+		+	+					+	+		

Organism	Inositol, Aer. Acid	Inositol, Anaer. Acid	Inositol, Aer. Alk.	Inositol, Anaer. Alk.	Inositol, Gas	Methyl Red Reaction	Voges-Proskauer Test	Oxidase (Kovacs)	Starch Hydrolysis	Gelatin Hydrolysis, ≤ 8 days	Gelatin Hydrolysis, ≥ 9 days	Indole	Lysine Decarboxylase	Ornithine Decarboxylase	Arginine Decarboxylase	Ammonification	Nitrate Reduction $\rightarrow$ NO ₂	Nitrate Reduction $\rightarrow$ Gas	Catalase
e2	+	+					+	+	+	+		+	+	+		+	+		+
e5	+	+							+	+			+	+		+	+		+
e7	+	+					+		+	+			+	+		+	+		+
e8	+	+					+		+	+			+	+		+	+	+	+
Al-1	+	+						+	+	+		+	+	+		+	+		+
Al-2	+	+											+	+		+	+	+	+
Al-712	+			+				+					+	+		+	+		+
Al-714			+	+		+							+	+		+	+		+
Al-714*	+	+					+		+	+		+	+	+		+	+		+
A2-1			+	+					+	+	+		+	+		+	+		+
A2-2			+	+					+	+	+		+	+		+	+		+
A2-3			+	+					+	+	+		+	+	+	+	+		+
A2-3*			+	+					+	+		+	+	+		+	+		+
A2-4			+	+					+	+	+		+			+	+		+
A2-714*			+	+					+	+	+		+	+		+	+		+

Organism	Medium a	Medium b	Medium c	Medium d	Medium e	Medium A1	Medium A2	Medium A3	Medium A4	Medium A5	Medium B1	Medium B2	Medium B3	Medium C1	Medium C2	Medium C3	Medium C4	Medium D1	Medium D2	Medium D4	Medium D5	Medium D7	Medium D8
e2			+		+							+						+					
e5			+		+							+						+					
e7			+		+							+						+					
e8			+		+							+						+					
A1-1			+		+						+	+						+	+		+		
A1-2			+		+						+	+						+			+		
A1-712			+		+						+	+						+			+		
A1-714			+		+	+	+	+		+	+	+		+	+	+	+	+	+	+	+	+	+
A1-714*			+		+							+	+					+	+	+	+		
A2-1			+		+						+	+									+		
A2-2			+		+							+						+					
A2-3			+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
A2-3*			+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
A2-4			+		+						+	+						+					
A2-714*			+		+			+		+	+	+	+	+	+	+	+	+	+	+	+	+	+

Organism	Shape			Ends		Length (μm)				L:W		Diameter (μm)		Occurrence						
	Straight Rod	Curved Rod	Coccus	Tapered	Square	≤ 0.5	0.6 - 1.2	1.3 - 3.0	≥ 3.0	3 : 1	2 - 3:1	1 : 1	≤ 0.5	≥ 0.6	Singles	Pairs	Short Chains	Long Chains	Gram	Motility
A3-1	+				+			+		+					+				-	+
A5-1	+				+			+			+				+	+			-	+
A5-1*	+				+			+		+					+		+		-	+
A5-1'	+				+			+		+					+				-	+
A5-3	+				+			+		+					+		+		-	+
A5-4	+				+		+				+				+		+		-	+
A5-5	+				+			+		+					+		+		-	+
A5-5*	+				+			+		+					+		+		-	+
A5-6		+			+			+		+					+				-	+
A5-7	+				+			+		+					+				-	+
B1-2	+				+			+			+				+	+			-	+
B1-6	+				+			+		+					+	+			-	+
B1-7	+				+			+		+					+				-	+
B2-2	+				+			+			+				+	+			-	+
B2-4	+				+				+	+					+		+		-	

Organism

	Glucose, Aer. Acid	Glucose, Anaer. Acid	Glucose, Aer. Alk.	Glucose, Anaer. Alk.	Glucose, Gas	Lactose, Aer. Acid	Lactose, Anaer. Acid	Lactose, Aer. Alk.	Lactose, Anaer. Alk.	Lactose, Gas	Sucrose, Aer. Acid	Sucrose, Anaer. Acid	Sucrose, Aer. Alk.	Sucrose, Anaer. Alk.	Sucrose, Gas	Mannitol, Aer. Acid	Mannitol, Anaer. Acid	Mannitol, Aer. Alk.	Mannitol, Anaer. Alk.	Mannitol, Gas	Mannose, Aer. Acid	Mannose, Anaer. Acid	Mannose, Aer. Alk.	Mannose, Anaer. Alk.	Mannose, Gas
A3-1			+	+				+	+				+	+		+			+		+			+	
A5-1			+	+				+	+				+	+				+	+				+	+	
A5-1*			+	+				+	+				+	+				+	+				+	+	
A5-1'			+	+				+	+				+	+		+	+				+	+			
A5-3	+			+				+	+				+	+				+	+				+	+	
A5-4	+	+						+	+				+	+				+	+		+	+			
A5-5	+	+						+	+		+	+				+	+				+	+			
A5-5*	+	+				+			+		+	+				+	+				+	+			
A5-6	+	+			+	+			+		+	+				+	+				+	+			
A5-7	+			+				+	+		+			+		+			+		+				+
B1-2	+	+						+	+		+	+				+	+				+	+			
B1-6	+	+						+	+		+	+				+	+				+	+			
B1-7	+	+						+	+		+	+				+	+				+	+			
B2-2	+	+			+	+	+				+	+						+	+				+	+	
B2-4	+	+				+			+		+	+						+	+				+	+	

Organism	Galactose, Aer. Acid	Galactose, Anaer. Acid	Galactose, Aer. Alk.	Galactose, Anaer. Alk.	Galactose, Gas	Maltose, Aer. Acid	Maltose, Anaer. Acid	Maltose, Aer. Alk.	Maltose, Anaer. Alk.	Maltose, Gas	Arabinose, Aer. Acid	Arabinose, Anaer. Acid	Arabinose, Aer. Alk.	Arabinose, Anaer. Alk.	Arabinose, Gas	Sorbitol, Aer. Acid	Sorbitol, Anaer. Acid	Sorbitol, Aer. Alk.	Sorbitol, Anaer. Alk.	Sorbitol, Gas	Xylose, Aer. Acid	Xylose, Anaer. Acid	Xylose, Aer. Alk.	Xylose, Anaer. Alk.	Xylose, Gas
A3-1	+			+		+			+				+	+				+	+					+	+
A5-1			+	+		+	+						+	+				+	+		+	+			
A5-1*			+	+		+	+						+	+				+	+		+	+			
A5-1'	+	+				+	+						+	+				+	+		+	+			
A5-3			+	+				+	+				+	+				+	+				+	+	
A5-4	+	+				+	+						+	+				+	+		+	+			
A5-5	+	+				+	+						+	+		+	+				+	+			
A5-5*	+	+				+	+						+	+		+	+				+	+			
A5-6			+	+		+	+						+	+		+	+				+	+			
A5-7			+	+		+			+				+	+		+		+	+		+			+	
B1-2	+	+				+	+						+	+				+	+				+	+	
B1-6	+	+				+	+						+	+		+	+				+	+			
B1-7	+	+				+	+						+	+		+	+				+	+			
B2-2	+			+		+	+						+	+		+	+				+	+			
B2-4			+	+		+	+						+	+		+	+				+	+			

Organism	Inositol, Aer. Acid	Inositol, Anaer. Acid	Inositol, Aer. Alk.	Inositol, Anaer. Alk.	Inositol, Gas	Methyl Red Reaction	Voges-Proskauer Test	Oxidase (Kovacs)	Starch Hydrolysis	Gelatin Hydrolysis, ≤ 8 day	Gelatin Hydrolysis, ≥ 9 day	Indole	Lysine Decarboxylase	Ornithine Decarboxylase	Arginine Decarboxylase	Ammonification	Nitrate Reduction $\rightarrow$ NO ₂	Nitrate Reduction $\rightarrow$ Gas	Catalase
A3-1			+	+				+	+		+					+	+		+
A5-1			+	+				+	+	+						+	+		+
A5-1*			+	+				+	+	+						+	+		+
A5-1'			+	+				+	+	+						+	+		+
A5-3			+	+				+	+	+							+		+
A5-4			+	+				+									+		+
A5-5			+	+		+		+	+	+		+	+	+		+			+
A5-5*			+	+		+		+	+	+		+	+	+		+			+
A5-6			+	+		+		+	+	+		+	+	+		+	+		+
A5-7			+	+				+				+	+	+		+	+	+	+
B1-2			+	+				+	+		+	+	+	+			+		+
B1-6			+	+		+		+			+	+			+	+	+		+
B1-7			+	+					+	+			+	+	+	+	+		+
B2-2			+	+				+	+		+		+	+		+	+		+
B2-4			+	+		+		+					+	+	+	+	+		+

Organism	Medium a	Medium b	Medium c	Medium d	Medium e	Medium A1	Medium A2	Medium A3	Medium A4	Medium A5	Medium B1	Medium B2	Medium B3	Medium C1	Medium C2	Medium C3	Medium C4	Medium D1	Medium D2	Medium D4	Medium D5	Medium D7	Medium D8
A3-1			+		+						+	+									+		
A5-1			+		+						+	+						+					
A5-1*			+		+						+	+						+					
A5-1'			+		+						+	+						+					
A5-3	+		+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+
A5-4			+		+							+											
A5-5			+		+						+	+						+	+		+		
A5-5*			+		+						+	+						+	+		+		
A5-6			+		+						+	+						+	+	+	+		
A5-7			+		+						+							+	+	+	+		
B1-2			+		+													+	+	+	+		
B1-6			+		+						+							+		+	+		
B1-7			+		+						+	+						+	+	+	+		
B2-2					+						+	+						+					
B2-4			+		+						+	+						+	+	+	+		

Organism	Shape			Ends		Length (μm)				L:W			Diameter (μm)		Occurrences					
	Straight Rod	Curved Rod	Coccus	Tapered	Square	≤ 0.5	0.6 - 1.2	1.3 - 3.0	≥ 3.0	3 : 1	2 -3:1	1 : 1	≤ 0.5	≥ 0.6	Singles	Pairs	Short Chains	Long Chains	Gram	Motility
B2-Rh	+				+			+		+					+		+		-	+
B2-Rh*	+				+			+		+					+				-	+
B3-1		+			+			+			+				+				-	+
B3-5	+				+				+	+					+		+		-	+
B3-711	+				+			+			+				+		+		-	+
B3-712	+				+			+			+				+	+			-	+
B3-Ps	+				+			+		+					+				-	+
B3-Rh	+				+			+		+					+				-	+
C1-1	+				+		+					+			+	+			-	+
C1-1*	+				+			+		+					+				-	+
C1-1'	+				+		+					+			+				-	+
C1-2	+				+				+	+					+				-	+
C1-2*	+				+			+				+			+				-	+
C1-3*	+				+				+	+					+				-	+
C1-4	+				+			+			+				+				-	+

Organism	Glucose, Aer. Acid	Glucose, Anaer. Acid	Glucose, Aer. Alk.	Glucose, Anaer. Alk.	Glucose, Gas	Lactose, Aer. Acid	Lactose, Anaer. Acid	Lactose, Aer. Alk.	Lactose, Anaer. Alk.	Lactose, Gas	Sucrose, Aer. Acid	Sucrose, Anaer. Acid	Sucrose, Aer. Alk.	Sucrose, Anaer. Alk.	Sucrose, Gas	Mannitol, Aer. Acid	Mannitol, Anaer. Acid	Mannitol, Aer. Alk.	Mannitol, Anaer. Alk.	Mannitol, Gas	Mannose, Aer. Acid	Mannose, Anaer. Acid	Mannose, Aer. Alk.	Mannose, Anaer. Alk.	Mannose, Gas
B2-Rh	+	+						+	+				+	+		+	+				+	+			
B2-Rh*	+	+						+	+		+	+				+	+				+	+			
B3-1	+	+						+	+				+	+				+	+				+	+	
B3-5	+	+						+	+				+	+				+	+				+	+	
B3-711	+	+						+	+		+	+						+	+				+	+	
B3-712	+	+						+	+				+	+				+	+		+	+			
B3-Ps	+			+				+	+				+	+				+	+		+			+	
B3-Rh	+	+						+	+				+	+				+	+				+	+	
C1-1	+	+						+	+		+	+			+			+	+				+	+	
C1-1*	+	+						+	+		+			+				+	+		+	+			
C1-1'	+	+				+	+				+	+						+	+				+	+	
C1-2	+	+				+	+				+	+						+	+				+	+	
C1-2*	+	+				+	+				+	+				+	+				+	+			
C1-3*	+	+				+	+				+	+				+	+				+	+			
C1-4	+	+				+	+				+	+						+	+					+	+

Organism	Galactose, Aer. Acid	Galactose, Anaer. Acid	Galactose, Aer. Alk.	Galactose, Anaer. Alk.	Galactose, Gas	Maltose, Aer. Acid	Maltose, Anaer. Acid	Maltose, Aer. Alk.	Maltose, Anaer. Alk.	Maltose, Gas	Arabinose, Aer. Acid	Arabinose, Anaer. Acid	Arabinose, Aer. Alk.	Arabinose, Anaer. Alk.	Arabinose, Gas	Sorbitol, Aer. Acid	Sorbitol, Anaer. Acid	Sorbitol, Aer. Alk.	Sorbitol, Anaer. Alk.	Sorbitol, Gas	Xylose, Aer. Acid	Xylose, Anaer. Acid	Xylose, Aer. Alk.	Xylose, Anaer. Alk.	Xylose, Gas
B2-Rh	+	+				+	+						+	+		+			+				+	+	
B2-Rh*			+	+		+			+		+	+						+	+		+		+	+	
B3-1			+	+				+	+		+	+						+	+				+	+	
B3-5			+	+		+	+				+	+						+	+				+	+	
B3-711			+	+		+	+				+	+						+	+				+	+	
B3-712	+	+				+	+				+	+				+	+						+	+	
B3-Ps			+	+		+			+		+			+				+	+				+	+	
B3-Rh			+	+		+	+				+	+						+	+				+	+	
C1-1			+	+		+	+				+	+				+	+				+	+			
C1-1*	+	+				+	+						+	+		+	+				+	+			
C1-1'			+	+		+	+				+	+				+	+				+	+			
C1-2			+	+		+	+				+	+				+	+				+	+			
C1-2*	+	+				+	+				+	+				+	+				+	+			
C1-3*	+	+				+	+				+	+				+	+				+	+			
C1-4			+	+		+	+				+	+				+	+				+	+			

Organism	Inositol, Aer. Acid	Inositol, Anaer. Acid	Inositol, Aer. Alk.	Inositol, Anaer. Alk.	Inositol, Gas	Methyl Red Reaction	Voges-Proskauer Test	Oxidase (Kovacs)	Starch Hydrolysis	Gelatin Hydrolysis, ≤ 3 day	Gelatin Hydrolysis, ≥ 9 day	Indole	Lysine Decarboxylase	Ornithine Decarboxylase	Arginine Decarboxylase	Ammonification	Nitrate Reduction $\rightarrow$ NO ₂	Nitrate Reduction $\rightarrow$ Gas	Catalase
B2-Rh			+	+									+	+	+	+	+		+
B2-Rh*			+	+									+	+	+	+	+	+	+
B3-1	+	+						+					+	+		+	+		+
B3-5	+	+						+			+		+	+	+	+	+		+
B3-711	+	+				+		+	+	+			+	+		+		+	+
B3-712	+	+						+	+	+			+	+	+	+	+		+
B3-Ps	+			+				+	+		+		+	+	+	+	+		+
B3-Rh	+	+						+	+	+			+	+	+	+	+		+
C1-1	+	+				+			+		+					+	+		+
C1-1*	+	+							+	+					+	+	+		
C1-1'	+	+									+					+	+		+
C1-2	+	+							+		+					+	+		+
C1-2*	+	+			+	+		+	+	+		+			+	+	+		+
C1-3*	+	+				+		+			+				+	+	+		+
C1-4	+	+			+			+	+	+					+	+	+		+

Organism

Medium a
Medium b
Medium c
Medium d
Medium e
Medium A1
Medium A2
Medium A3
Medium A4
Medium A5
Medium B1
Medium B2
Medium B3
Medium C1
Medium C2
Medium C3
Medium C4
Medium D1
Medium D2
Medium D4
Medium D5
Medium D7
Medium D8

B2-Rh			+		+						+	+					+	+	+	+		
B2-Rh*			+		+						+	+					+	+	+	+		
B3-1			+		+						+	+					+					
B3-5			+		+																	
B3-711			+		+							+					+		+	+		
B3-712	+		+		+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+
B3-Ps			+		+					+	+											
B3-Rh			+		+																	
C1-1			+		+						+						+	+	+	+		
C1-1*			+		+					+	+											
C1-1'			+		+					+	+							+				
C1-2			+		+					+	+											
C1-2*			+		+					+	+											
C1-3*			+		+						+						+		+			
C1-4	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Organism	Shape			Ends		Length (μm)				L:W			Diameter (μm)		Occurrence				Gram	Motility
	Straight Rod	Curved Rod	Coccus	Tapered	Square	≤ 0.5	0.6 - 1.2	1.3 - 3.0	≥ 3.0	3 : 1	2 - 3:1	1 : 1	≤ 0.5	≥ 0.6	Singles	Pairs	Short Chains	Long Chains		
C1-4*	+				+			+		+					+	+			-	+
C1-5	+				+				+	+					+		+		-	+
C1-8	+				+			+		+					+				-	+
C1-10	+				+			+			+				+	+			-	+
C2-2	+				+				+	+					+		+		-	+
C2-3	+				+			+			+				+				-	+
C2-4	+				+		+					+			+				-	+
C3-1	+				+			+		+					+	+			-	+
C3-2	+				+			+		+					+				-	+
C3-4	+				+			+		+					+				-	+
C3-4*	+				+			+		+					+				-	+
C3-5	+				+			+		+					+				-	+
C3-7*	+				+			+			+				+	+			-	+
C3-711	+			+				+		+					+				-	+
C3-712	+				+			+		+					+				-	+

Organism	Glucose, Aer. Acid	Glucose, Anaer. Acid	Glucose, Aer. Alk.	Glucose, Anaer. Alk.	Glucose, Gas	Lactose, Aer. Acid	Lactose, Anaer. Acid	Lactose, Aer. Alk.	Lactose, Anaer. Alk.	Lactose, Gas	Sucrose, Aer. Acid	Sucrose, Anaer. Acid	Sucrose, Aer. Alk.	Sucrose, Anaer. Alk.	Sucrose, Gas	Mannitol, Aer. Acid	Mannitol, Anaer. Acid	Mannitol, Aer. Alk.	Mannitol, Anaer. Alk.	Mannitol, Gas	Mannose, Aer. Acid	Mannose, Anaer. Acid	Mannose, Aer. Alk.	Mannose, Anaer. Alk.	Mannose, Gas
C1-4*	+			+				+	+		+			+											
C1-5	+			+		+			+		+			+				+						+	+
C1-8			+	+		+	+						+	+				+						+	+
C1-10	+	+				+	+				+	+				+	+					+	+		+
C2-2	+			+		+			+		+			+			+					+		+	+
C2-3	+			+				+	+		+			+			+							+	+
C2-4			+	+		+	+						+	+			+				+	+	+		+
C3-1	+	+				+	+				+	+				+	+				+	+	+		+
C3-2			+	+		+	+						+	+		+	+					+	+	+	+
C3-4	+			+				+	+				+	+		+	+				+	+		+	+
C3-4*			+	+		+	+						+	+			+	+			+	+	+		+
C3-5			+	+		+	+						+	+			+	+			+	+	+		+
C3-7*	+	+				+	+				+	+				+	+				+	+			+
C3-711	+			+				+	+				+	+				+					+	+	+
C3-712	+			+		+		+	+		+		+	+		+	+				+	+		+	+

Disaccharide	Galactose, Aer. Acid	Galactose, Anaer. Acid	Galactose, Aer. Alk.	Galactose, Anaer. Alk.	Galactose, Gas	Maltose, Aer. Acid	Maltose, Anaer. Acid	Maltose, Aer. Alk.	Maltose, Anaer. Alk.	Maltose, Gas	Arabinose, Aer. Acid	Arabinose, Anaer. Acid	Arabinose, Aer. Alk.	Arabinose, Anaer. Alk.	Arabinose, Gas	Sorbitol, Aer. Acid	Sorbitol, Anaer. Acid	Sorbitol, Aer. Alk.	Sorbitol, Anaer. Alk.	Sorbitol, Gas	Xylose, Aer. Acid	Xylose, Anaer. Acid	Xylose, Aer. Alk.	Xylose, Anaer. Alk.	Xylose, Gas
-4*			+	+		+			+		+			+						+	+		+	+	
-5	+			+		+			+		+			+		+			+			+		+	
-8			+	+		+	+				+	+				+	+					+		+	
-10																									
-2	+			+		+			+		+			+		+			+		+	+		+	
-3			+	+			+		+		+			+				+	+				+	+	
-4	+	+				+	+				+	+				+	+				+	+			
-1	+	+				+	+				+	+				+	+				+	+			
-2	+	+				+	+				+	+				+	+				+	+			
-4			+	+			+	+			+			+				+	+			+	+		
-4*	+	+					+	+			+	+				+	+				+	+			
-5	+	+				+	+				+	+				+	+				+	+			
-7*	+	+				+	+				+	+				+	+				+	+			
-711	+			+		+			+		+			+		+			+		+	+		+	
-712	+			+		+			+		+			+		+			+		+	+		+	

Organism	Inositol, Aer. Acid	Inositol, Anaer. Acid	Inositol, Aer. Alk.	Inositol, Anaer. Alk.	Inositol, Gas	Methyl Red Reaction	Voges-Proskauer Test	Oxidase (Kovacs)	Starch Hydrolysis	Gelatin Hydrolysis, ≤ 8 day	Gelatin Hydrolysis, ≥ 9 day	Indole	Lysine Decarboxylase	Ornithine Decarboxylase	Arginine Decarboxylase	Ammonification	Nitrate Reduction $\rightarrow$ NO ₂	Nitrate Reduction $\rightarrow$ Gas	Catalase
C1-4*			+	+				+	+	+				+		+	+		+
C1-5	+	+						+	+		+			+		+	+		+
C1-8	+	+						+	+	+						+	+		+
C1-10	+	+				+		+	+	+		+	+	+		+	+		+
C2-2			+	+							+					+	+		+
C2-3			+	+				+								+	+		+
C2-4	+	+						+			+			+		+	+		+
C3-1	+	+						+	+	+		+	+	+		+	+		+
C3-2	+	+						+	+	+			+	+		+	+		+
C3-4			+	+				+					+	+		+	+		+
C3-4*	+	+											+	+		+	+		+
C3-5	+	+						+	+	+			+	+		+	+		+
C3-7*	+	+						+	+		+	+	+	+		+	+		+
C3-711	+			+				+	+		+		+	+		+	+	+	+
C3-712			+	+				+	+		+		+	+		+	+		+

Organism	Medium a	Medium b	Medium c	Medium d	Medium e	Medium A1	Medium A2	Medium A3	Medium A4	Medium A5	Medium B1	Medium B2	Medium B3	Medium C1	Medium C2	Medium C3	Medium C4	Medium D1	Medium D2	Medium D4	Medium D5	Medium D7	Medium D8
C1-4*			+		+						+	+						+	+				
C1-5	+		+	+	+		+	+		+		+	+	+	+	+	+	+		+	+	+	+
C1-8			+		+						+	+						+					
C1-10			+		+						+	+						+	+	+	+		
C2-2	+		+	+	+	+		+				+		+	+	+	+	+		+	+		+
C2-3			+		+													+		+	+		
C2-4	+	+	+	+	+	+	+	+			+	+		+	+	+	+	+	+	+	+	+	+
C3-1			+		+						+	+			+			+	+	+	+		
C3-2			+		+						+	+							+				
C3-4			+		+														+				
C3-4*			+		+																		
C3-5			+		+							+	+	+				+	+	+	+		
C3-7*			+		+						+	+						+	+	+	+		
C3-711			+		+						+	+						+		+	+		
C3-712	+	+	+	+	+	+	+	+		+		+	+	+	+	+	+	+	+	+	+	+	+

Organism	Shape			Ends		Length (μm)				L:W			Diameter (μm)		Occurrence					
	Straight Rod	Curved Rod	Coccus	Tapered	Square	≤ 0.5	0.6 - 1.2	1.3 - 3.0	≥ 3.0	3 : 1	2 - 3:1	1 : 1	≤ 0.5	≥ 0.6	Singles	Pairs	Short Chains	Long Chains	Gram	Motility
C3-712*		+			+		+				+				+				-	
D1-1	+				+			+		+					+	+			-	+
D1-1*	+				+			+			+				+	+			-	+
D1-2	+				+				+	+					+		+		-	+
D1-3	+				+			+			+				+	+			-	+
D1-4	+				+			+		+					+	+			-	+
D1-5	+				+				+	+					+				-	+
D1-7	+				+			+		+					+	+			-	+
D1-7*	+				+			+				+			+				-	+
D2-1	+				+		+					+			+				-	+
D2-2	+				+				+	+					+		+		-	+
D2-3	+				+			+		+					+		+		-	+
D2-3*	+				+			+		+					+	+	+		-	+
D2-5	+				+			+		+					+	+			-	+
D2-5*	+				+			+			+				+				-	+

Organism

	Glucose, Aer. Acid	Glucose, Anaer. Acid	Glucose, Aer. Alk.	Glucose, Anaer. Alk.	Glucose, Gas	Lactose, Aer. Acid	Lactose, Anaer. Acid	Lactose, Aer. Alk.	Lactose, Anaer. Alk.	Lactose, Gas	Sucrose, Aer. Acid	Sucrose, Anaer. Acid	Sucrose, Aer. Alk.	Sucrose, Anaer. Alk.	Sucrose, Gas	Mannitol, Aer. Acid	Mannitol, Anaer. Acid	Mannitol, Aer. Alk.	Mannitol, Anaer. Alk.	Mannitol, Gas	Mannose, Aer. Acid	Mannose, Anaer. Acid	Mannose, Aer. Alk.	Mannose, Anaer. Alk.	Mannose, Gas
C3-712*	+	+				+	+																		
D1-1			+	+				+	+				+	+				+	+			+	+		
D1-1*			+	+				+	+				+	+				+	+			+			+
D1-2			+	+				+	+				+	+				+	+				+	+	
D1-3			+	+				+	+				+	+				+	+				+	+	
D1-4	+	+				+	+				+	+						+	+			+	+		
D1-5	+			+		+		+	+		+	+		+		+		+	+				+	+	
D1-7	+	+				+		+	+		+	+		+				+	+				+	+	
D1-7*	+	+						+	+				+	+		+	+						+	+	
D2-1	+	+						+	+		+	+				+	+					+	+		
D2-2	+	+				+	+				+	+						+	+			+	+		
D2-3	+			+				+	+		+			+				+	+				+	+	
D2-3*	+	+				+		+	+		+	+				+	+					+	+		
D2-5	+			+				+	+		+			+				+	+			+		+	
D2-5*	+			+				+	+		+			+				+	+			+		+	

Organism

Galactose, Aer. Acid
 Galactose, Anaer. Acid
 Galactose, Aer. Alk.
 Galactose, Anaer. Alk.
 Galactose, Gas
 Maltose, Aer. Acid
 Maltose, Anaer. Acid
 Maltose, Aer. Alk.
 Maltose, Anaer. Alk.
 Maltose, Gas
 Arabinose, Aer. Acid
 Arabinose, Anaer. Acid
 Arabinose, Aer. Alk.
 Arabinose, Anaer. Alk.
 Arabinose, Gas
 Sorbitol, Aer. Acid
 Sorbitol, Anaer. Acid
 Sorbitol, Aer. Alk.
 Sorbitol, Anaer. Alk.
 Sorbitol, Gas
 Xylose, Aer. Acid
 Xylose, Anaer. Acid
 Xylose, Aer. Alk.
 Xylose, Anaer. Alk.
 Xylose, Gas

C3-712*

+

D1-1

+

+

+

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D1-1*

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D1-2

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D1-3

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D1-4

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D1-5

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D1-7

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D1-7*

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D2-1

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D2-2

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D2-3*

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D2-5

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D2-5*

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Organism

Inositol, Aer. Acid

Inositol, Anaer. Acid

Inositol, Aer. Alk.

Inositol, Anaer. Alk.

Inositol, Gas

Methyl Red Reaction

Voges-Proskauer Test

Oxidase (Kovacs)

Starch Hydrolysis

Gelatin Hydrolysis, ≤ 8 dayGelatin Hydrolysis, ≥ 9 day

Indole

Lysine Decarboxylase

Ornithine Decarboxylase

Arginine Decarboxylase

Ammonification

Nitrate Reduction $\rightarrow \text{NO}_2$ Nitrate Reduction $\rightarrow \text{Gas}$

Catalase

C3-712*

+

+

+

+

+

+

+

+

D1-1

+

+

+

+

+

+

+

+

D1-1*

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D1-2

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D1-3

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D1-4

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D1-5

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D1-7

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D1-7*

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D2-1

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D2-3

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D2-5

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D2-5*

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Organism	Medium a	Medium b	Medium c	Medium d	Medium e	Medium A1	Medium A2	Medium A3	Medium A4	Medium A5	Medium B1	Medium B2	Medium B3	Medium C1	Medium C2	Medium C3	Medium C4	Medium D1	Medium D2	Medium D4	Medium D5	Medium D7	Medium D8
C3-712*			+		+							+											
D1-1			+		+						+	+						+			+		
D1-1*			+		+						+	+						+			+		
D1-2			+		+													+					
D1-3			+		+						+	+						+	+				
D1-4			+		+																		
D1-5	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
D1-7	+	+	+	+	+						+	+		+	+	+	+	+	+	+	+	+	+
D1-7*			+		+							+						+	+	+	+		
D2-1			+		+							+						+	+	+	+		
D2-2	+		+	+	+	+	+	+		+		+	+	+	+	+	+	+	+	+	+	+	+
D2-3			+		+							+						+					
D2-3*			+		+						+	+						+	+		+		
D2-5			+		+						+	+						+					
D2-5*			+		+						+	+						+					

Organism	Shape			Ends		Length (μm)				L:W			Diameter (μm)		Occurrence					
	Straight Rod	Curved Rod	Coccus	Tapered	Square	≤ 0.5	0.6 - 1.2	1.3 - 3.0	≥ 3.0	3 : 1	2 - 3:1	1 : 1	≤ 0.5	≥ 0.6	Singles	Pairs	Short Chains	Long Chains	Gram	Motility
D2-6	+				+			+		+					+	+			-	+
D2-7	+				+			+		+					+	+			-	+
D2-711	+				+			+			+				+				-	+
D2-712	+				+				+	+					+				-	+
D4-1	+				+			+		+					+		+		-	+
D4-4	+				+			+			+				+				-	+
D4-4*	+				+			+		+					+				-	
D4-6	+				+		+				+				+				-	+
D4-7	+				+				+	+					+				-	+
D5-1	+				+				+	+					+	+			-	+
D5-1*	+				+			+		+					+				-	+
D5-2	+				+			+		+					+				-	+
D5-2*	+				+			+		+					+		+		-	+
D5-4	+				+			+		+					+				-	+
D5-5	+				+			+		+					+		+		-	+

Organism

	Glucose, Aer. Acid	Glucose, Anaer. Acid	Glucose, Aer. Alk.	Glucose, Anaer. Alk.	Glucose, Gas	Lactose, Aer. Acid	Lactose, Anaer. Acid	Lactose, Aer. Alk.	Lactose, Anaer. Alk.	Lactose, Gas	Sucrose, Aer. Acid	Sucrose, Anaer. Acid	Sucrose, Aer. Alk.	Sucrose, Anaer. Alk.	Sucrose, Gas	Mannitol, Aer. Acid	Mannitol, Anaer. Acid	Mannitol, Aer. Alk.	Mannitol, Anaer. Alk.	Mannitol, Gas	Mannose, Aer. Acid	Mannose, Anaer. Acid	Mannose, Aer. Alk.	Mannose, Anaer. Alk.	Mannose, Gas
D2-6	+	+						+	+		+	+				+	+				+	+			
D2-7	+			+				+	+		+	+		+				+	+		+	+		+	
D2-711	+	+			+			+	+		+	+				+	+	+	+		+	+			
D2-712	+	+				+	+				+	+				+	+				+	+			
D4-1	+			+		+			+		+		+	+		+					+				
D4-4	+	+						+	+		+	+				+	+				+	+			
D4-4*	+			+				+	+				+	+				+	+		+			+	
D4-6	+			+		+			+		+		+	+		+		+	+		+			+	
D4-7	+			+		+			+		+		+	+		+		+	+		+			+	
D5-1	+	+						+	+		+	+				+	+			+	+	+			
D5-1*	+	+			+			+	+		+	+			+	+	+			+	+	+			
D5-2	+	+						+	+		+	+				+	+				+	+			
D5-2*			+	+				+	+				+	+				+	+		+	+			
D5-4			+	+				+	+				+	+				+	+				+	+	
D5-5	+	+				+	+				+	+			+	+	+				+	+			

Organism	Galactose, Aer. Acid	Galactose, Anaer. Acid	Galactose, Aer. Alk.	Galactose, Anaer. Alk.	Galactose, Gas	Maltose, Aer. Acid	Maltose, Anaer. Acid	Maltose, Aer. Alk.	Maltose, Anaer. Alk.	Maltose, Gas	Arabinose, Aer. Acid	Arabinose, Anaer. Acid	Arabinose, Aer. Alk.	Arabinose, Anaer. Alk.	Arabinose, Gas	Sorbitol, Aer. Acid	Sorbitol, Anaer. Acid	Sorbitol, Aer. Alk.	Sorbitol, Anaer. Alk.	Sorbitol, Gas	Xylose, Aer. Acid	Xylose, Anaer. Acid	Xylose, Aer. Alk.	Xylose, Anaer. Alk.	Xylose, Gas
D2-6	+	+				+	+				+	+				+	+						+	+	
D2-7	+			+		+		+					+	+				+	+		+			+	
D2-711	+	+				+	+				+	+				+	+						+	+	
D2-712	+	+				+	+				+	+				+	+						+	+	
D4-1	+			+		+		+			+		+			+			+				+	+	
D4-4	+	+				+	+				+	+				+	+				+	+			
D4-4*	+			+		+	+	+					+	+				+	+				+	+	
D4-6	+			+		+	+	+	+	+			+	+				+	+		+			+	
D4-7	+			+		+	+	+			+		+					+	+		+			+	
D5-1	+	+				+	+				+	+				+	+				+	+			
D5-1*	+	+				+	+				+	+				+	+				+	+			
D5-2	+	+				+	+				+	+				+	+				+	+			
D5-2*			+	+		+	+				+	+				+	+				+	+			
D5-4	+	+				+	+				+	+						+	+		+	+			
D5-5	+	+				+	+						+	+		+	+				+	+			

Organism

Inositol, Aer. Acid

Inositol, Anaer. Acid

Inositol, Aer. Alk.

Inositol, Anaer. Alk.

Inositol, Gas

Methyl Red Reaction

Voges-Proskauer Test

Oxidase (Kovacs)

Starch Hydrolysis

Gelatin Hydrolysis, ≤ 8 dayGelatin Hydrolysis, ≥ 9 day

Indole

Lysine Decarboxylase

Ornithine Decarboxylase

Arginine Decarboxylase

Ammonification

Nitrate Reduction $\rightarrow$ NO_2 Nitrate Reduction $\rightarrow$ Gas

Catalase

D2-6

D2-7

D2-711

D2-712

D4-1

D4-4

D4-4*

D4-6

D4-7

D5-1

D5-1*

D5-2

D5-2*

D5-4

D5-5

		+	+		+		+	+	+	+		+		+	+	+	+	+	+	+		+
+			+				+	+	+				+	+	+	+	+	+	+		+	
+	+						+	+	+			+	+	+	+	+	+	+	+		+	
			+	+			+	+	+	+	+	+	+	+	+	+	+	+	+		+	
	+	+		+	+		+	+	+			+	+	+	+	+	+	+	+		+	
			+	+				+	+	+	+	+	+	+	+	+	+	+	+		+	
								+	+	+	+	+	+	+	+	+	+	+	+		+	
			+	+			+	+	+	+	+	+	+	+	+	+	+	+	+		+	
+	+					+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	
+	+					+		+	+	+	+	+	+	+	+	+	+	+	+		+	
+	+					+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	
+	+						+	+	+	+	+	+	+	+	+	+	+	+	+		+	
			+	+			+			+	+	+		+	+		+	+			+	
			+	+	+		+		+		+	+	+		+	+	+	+	+		+	
							+		+		+	+	+	+	+	+	+	+	+		+	

Organism	Medium a	Medium b	Medium c	Medium d	Medium e	Medium A1	Medium A2	Medium A3	Medium A4	Medium A5	Medium B1	Medium B2	Medium B3	Medium C1	Medium C2	Medium C3	Medium C4	Medium D1	Medium D2	Medium D4	Medium D5	Medium D7	Medium D8
D2-6			+		+						+	+						+		+	+		
D2-7	+		+	+	+						+	+			+		+	+	+	+		+	+
D2-711			+		+							+						+	+	+	+		
D2-712			+		+							+											
D4-1			+		+																		
D4-4			+		+						+	+						+	+	+	+		
D4-4*			+		+																		
D4-6			+		+						+	+		+				+	+	+	+	+	+
D4-7			+		+													+			+		
D5-1			+		+						+	+						+	+	+	+	+	+
D5-1*			+		+						+	+						+	+	+	+	+	+
D5-2			+		+						+	+						+	+	+	+	+	+
D5-2*			+		+						+	+						+		+	+	+	+
D5-4			+		+							+						+		+	+	+	+
D5-5			+		+						+	+						+	+	+	+	+	+

Organism	Shape			Ends		Length (μm)				L:W			Diameter (μm)		Occurrence					
	Straight Rod	Curved Rod	Coccus	Tapered	Square	≤ 0.5	0.6 - 1.2	1.3 - 3.0	≥ 3.0	3 : 1	2 - 3:1	1 : 1	≤ 0.5	≥ 0.6	Singles	Pairs	Short Chains	Long Chains	Gram	Motility
D5-5*	+				+			+		+					+				-	+
D5-8	+				+			+		+					+		+		-	+
D5-711	+				+			+		+					+				-	+
D7-1	+				+			+		+					+		+		-	+
D7-1*	+				+				+	+					+		+		-	+
D7-2	+				+			+			+				+				-	+
D7-3	+				+			+		+					+				-	+
D7-6	+				+			+		+					+				-	+
D7-6*	+				+				+	+					+		+		-	+
D7-7	+				+				+	+					+		+		-	+
D7-7*	+				+			+		+					+		+		-	+
D7-7'	+				+			+		+					+		+		-	+
D7-711	+				+			+			+				+				-	+
D7-Ps	+				+			+			+				+				-	+
D8-1	+				+			+				+			+	+			-	+

Organism	Glucose, Aer. Acid	Glucose, Anaer. Acid	Glucose, Aer. Alk.	Glucose, Anaer. Alk.	Glucose, Gas	Lactose, Aer. Acid	Lactose, Anaer. Acid	Lactose, Aer. Alk.	Lactose, Anaer. Alk.	Lactose, Gas	Sucrose, Aer. Acid	Sucrose, Anaer. Acid	Sucrose, Aer. Alk.	Sucrose, Anaer. Alk.	Sucrose, Gas	Mannitol, Aer. Acid	Mannitol, Anaer. Acid	Mannitol, Aer. Alk.	Mannitol, Anaer. Alk.	Mannitol, Gas	Mannose, Aer. Acid	Mannose, Anaer. Acid	Mannose, Aer. Alk.	Mannose, Anaer. Alk.	Mannose, Gas
D5-5*			+	+				+	+				+	+				+	+					+	+
D5-8			+	+				+	+				+	+				+	+		+	+		+	+
D5-711	+			+		+			+		+			+			+	+		+	+	+		+	+
D7-1	+	+				+	+				+	+					+	+		+	+	+	+		+
D7-1*			+	+				+	+		+	+					+	+		+	+	+	+		+
D7-2			+	+				+	+				+	+			+	+		+	+	+	+		+
D7-3	+			+				+	+				+	+			+	+		+	+	+	+	+	+
D7-6			+	+				+	+				+	+		+	+		+	+	+	+	+	+	+
D7-6*	+	+						+	+		+			+		+	+		+	+	+	+	+	+	+
D7-7	+	+						+	+		+			+			+	+		+	+	+	+	+	+
D7-7*	+	+						+	+		+	+				+	+		+	+	+	+	+	+	+
D7-7'	+	+						+	+		+	+				+	+		+	+	+	+	+	+	+
D7-711			+	+				+	+				+	+		+	+		+	+	+	+	+	+	+
D7-Ps	+			+				+	+				+	+			+	+		+	+	+	+	+	+
D8-1	+	+				+	+				+	+				+	+				+	+		+	+

Organism	Galactose, Aer. Acid	Galactose, Anaer. Acid	Galactose, Aer. Alk.	Galactose, Anaer. Alk.	Galactose, Gas	Maltose, Aer. Acid	Maltose, Anaer. Acid	Maltose, Aer. Alk.	Maltose, Anaer. Alk.	Maltose, Gas	Arabinose, Aer. Acid	Arabinose, Anaer. Acid	Arabinose, Aer. Alk.	Arabinose, Anaer. Alk.	Arabinose, Gas	Sorbitol, Aer. Acid	Sorbitol, Anaer. Acid	Sorbitol, Aer. Alk.	Sorbitol, Anaer. Alk.	Sorbitol, Gas	Xylose, Aer. Acid	Xylose, Anaer. Acid	Xylose, Aer. Alk.	Xylose, Anaer. Alk.	Xylose, Gas
D5-5*	+			+		+			+				+	+				+	+		+			+	
D5-8	+	+				+	+						+	+		+	+				+	+			
D5-711	+			+		+			+				+	+				+	+		+			+	
D7-1	+	+						+	+		+	+						+	+				+	+	
D7-1*			+	+				+	+		+	+						+	+		+	+		+	
D7-2	+			+		+		+	+				+	+				+	+				+	+	
D7-3			+	+				+	+				+	+				+	+				+	+	
D7-6	+	+				+	+				+	+						+	+		+	+		+	
D7-6*	+	+				+	+				+	+						+	+				+	+	
D7-7			+	+		+	+						+	+				+	+				+	+	
D7-7*	+	+				+	+				+	+						+	+				+	+	
D7-7'	+	+				+	+						+	+				+	+		+	+		+	
D7-711	+	+				+	+						+	+				+	+		+	+		+	
D7-Ps			+	+		+			+				+	+				+	+				+	+	
D8-1	+			+		+			+		+	+				+	+				+	+			

Organism

Inositol, Aer. Acid

Inositol, Anaer. Acid

Inositol, Aer. Alk.

Inositol, Anaer. Alk.

Inositol, Gas

Methyl Red Reaction

Voges-Proskauer Test

Oxidase (Kovacs)

Starch Hydrolysis

Gelatin Hydrolysis, ≤ 8 dayGelatin Hydrolysis, ≥ 9 day

Indole

Lysine Decarboxylase

Ornithine Decarboxylase

Arginine Decarboxylase

Ammonification

Nitrate Reduction $\rightarrow$ N_2 Nitrate Reduction $\rightarrow$ Gas

Catalase

D5-5*		+	+				+	+	+		+	+		+	+		+
D5-8		+	+				+				+	+					+
D5-711		+	+				+	+	+		+	+					+
D7-1		+	+		+			+	+		+	+					+
D7-1*		+	+		+			+	+		+	+					+
D7-2		+	+				+	+	+		+	+	+				+
D7-3		+	+				+	+			+	+					+
D7-6		+	+				+	+	+		+	+					+
D7-6*		+	+				+	+	+		+	+					+
D7-7		+	+		+			+	+	+	+	+					+
D7-7*		+	+		+		+	+	+	+	+	+					+
D7-7'		+	+		+		+	+	+	+	+	+					+
D7-711		+	+				+				+	+	+	+			+
D7-Ps		+	+				+	+	+		+	+					+
D8-1	+	+			+						+	+					+

Organism	Medium a	Medium b	Medium c	Medium d	Medium e	Medium A1	Medium A2	Medium A3	Medium A4	Medium A5	Medium B1	Medium B2	Medium B3	Medium C1	Medium C2	Medium C3	Medium C4	Medium D1	Medium D2	Medium D4	Medium D5	Medium D7	Medium D8
D5-5*	+		+	+	+	+	+	+	+	+	+	+						+	+	+	+	+	+
D5-8			+		+							+		+			+	+					
D5-711			+		+						+	+		+	+	+	+	+		+	+		+
D7-1			+		+							+											
D7-1*			+		+						+	+						+	+	+	+		
D7-2			+		+			+			+	+		+	+	+	+	+	+	+			+
D7-3			+		+							+								+	+		
D7-6	+	+	+	+	+		+	+			+	+		+	+	+	+	+		+	+	+	+
D7-6*			+		+						+	+						+			+		
D7-7			+		+						+	+						+	+	+	+		
D7-7*			+		+						+	+						+	+	+	+		
D7-7'			+		+						+	+						+	+	+	+		
D7-711					+						+	+						+			+		
D7-Ps			+		+						+	+											
D8-1			+		+						+	+						+	+	+	+		

Organism	Shape			Ends		Length (μm)				L:W		Diameter (μm)		Occurrence						
	Straight Rod	Curved Rod	Coccus	Tapered	Square	≤ 0.5	0.6 - 1.2	1.3 - 3.0	≥ 3.0	3 : 1	2 - 3:1	1 : 1	≤ 0.5	≥ 0.6	Singles	Pairs	Short Chains	Long Chains	Gram	Motility
D8-2	+				+			+		+					+		+		-	
D8-2*		+			+			+		+					+				-	+
D8-3	+				+			+		+					+		+		-	+
D8-6	+				+			+			+				+		+		-	+
D8-7	+				+			+		+					+		+		-	+
D8-711*	+				+			+		+					+				-	+
D8-712	+				+			+		+					+		+		-	+

Organism	Glucose, Aer. Acid	Glucose, Anaer. Acid	Glucose, Aer. Alk.	Glucose, Anaer. Alk.	Glucose, Gas	Lactose, Aer. Acid	Lactose, Anaer. Acid	Lactose, Aer. Alk.	Lactose, Anaer. Alk.	Lactose, Gas	Sucrose, Aer. Acid	Sucrose, Anaer. Acid	Sucrose, Aer. Alk.	Sucrose, Anaer. Alk.	Sucrose, Gas	Mannitol, Aer. Acid	Mannitol, Anaer. Acid	Mannitol, Aer. Alk.	Mannitol, Anaer. Alk.	Mannitol, Gas	Mannose, Aer. Acid	Mannose, Anaer. Acid	Mannose, Aer. Alk.	Mannose, Anaer. Alk.	Mannose, Gas
D8-2	+	+				+	+				+	+				+	+							+	
D8-2*	+	+						+	+		+	+						+	+			+	+		
D8-3	+	+				+	+						+	+				+	+			+	+		+
D8-6	+	+						+	+				+	+				+	+			+	+		+
D8-7			+	+				+	+				+	+			+	+				+	+		
D8-711*	+	+				+	+				+	+						+	+			+	+		+
D8-712	+	+						+	+		+	+				+	+					+	+		

Organism

D8-2	+	Galactose, Aer. Acid
D8-2*	+	Galactose, Anaer. Acid
D8-3	+	Galactose, Aer. Alk.
D8-6	+	Galactose, Anaer. Alk.
D8-7	+	Galactose, Gas
D8-711*	+	Maltose, Aer. Acid
D8-712	+	Maltose, Anaer. Acid
	+	Maltose, Aer. Alk.
	+	Maltose, Anaer. Alk.
	+	Maltose, Gas
	+	Arabinose, Aer. Acid
	+	Arabinose, Anaer. Acid
	+	Arabinose, Aer. Alk.
	+	Arabinose, Anaer. Alk.
	+	Arabinose, Gas
	+	Sorbitol, Aer. Acid
	+	Sorbitol, Anaer. Acid
	+	Sorbitol, Aer. Alk.
	+	Sorbitol, Anaer. Alk.
	+	Sorbitol, Gas
	+	Xylose, Aer. Acid
	+	Xylose, Anaer. Acid
	+	Xylose, Aer. Alk.
	+	Xylose, Anaer. Alk.
	+	Xylose, Gas

Organism	Inositol, Aer. Acid	Inositol, Anaer. Acid	Inositol, Aer. Alk.	Inositol, Anaer. Alk.	Inositol, Gas	Methyl Red Reaction	Voges-Proskauer Test	Oxidase (Kovacs)	Starch Hydrolysis	Gelatin Hydrolysis, ≤ 8 day	Gelatin Hydrolysis, ≥ 9 day	Indole	Lysine Decarboxylase	Ornithine Decarboxylase	Arginine Decarboxylase	Ammonification	Nitrate Reduction $\rightarrow$ NO ₂	Nitrate Reduction $\rightarrow$ Gas	Catalase
D8-2			+	+			+		+		+				+	+	+		+
D8-2*			+	+		+		+	+	+					+	+	+		+
D8-3			+	+				+							+	+	+		+
D8-6			+	+				+						+	+	+	+		+
D8-7	+	+						+					+		+	+	+		+
D8-711*			+	+				+	+	+			+			+	+		+
D8-712			+	+				+	+	+		+	+	+		+	+		+

Organism	Medium a	Medium b	Medium c	Medium d	Medium e	Medium A1	Medium A2	Medium A3	Medium A4	Medium A5	Medium B1	Medium B2	Medium B3	Medium C1	Medium C2	Medium C3	Medium C4	Medium D1	Medium D2	Medium D4	Medium D5	Medium D7	Medium D8
D8-2		+		+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+
D8-2*			+		+							+							+				
D8-3			+		+						+	+						+	+				
D8-6			+		+						+	+						+	+				
D8-7			+		+						+	+						+	+	+	+		
D8-711*			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
D8-712			+		+							+						+	+	+	+		+

TABLE 17

Synopsis of data obtained thus far on the characteristics of bacteria isolated from epiphytic communities living on Enteromorpha intestinalis.

Total number of isolates: 128

Characteristic (s)	# of organisms	% of organisms tested
rod	126	98
coccus	2	2
gram negative	127	99
gram positive	1	1
motile	111	87
non-motile	17	13
gram negative, motile rod	111	87
gram negative, non-motile rod	14	11
gram negative, non-motile coccus	2	2
ferment glucose	67	54
oxidize glucose	27	22
(-) glucose	29	24
ferment sucrose	45	42
oxidize sucrose	24	23
(-) sucrose	37	35
ferment lactose	21	20
oxidize lactose	17	17
(-) lactose	65	63
ferment mannose	27	
oxidize mannose	17	
(-) mannose	15	
ferment galactose	16	35
oxidize galactose	6	13
(-) galactose	24	52
ferment mannitol	30	39
oxidize mannitol	16	20
(-) mannitol	33	41
nitrate reduction to NO ₂	80	93
nitrate reduction to NH ₄	86	100
nitrate reduction to gas	2	2

TABLE 18

Synopsis of characteristics of isolates from individual media.

Medium	GLUCOSE				SUCROSE				LACTOSE			
	# tested	# fermenting	# oxidizing	# negative	# tested	# fermenting	# oxidizing	# negative	# tested	# fermenting	# oxidizing	# negative
a	5	1	0	4	5	1	3	1	5	0	0	5
c	9	3	0	6	9	3	2	4	8	0	1	7
d	1	0	1	0	1	0	1	0	1	0	0	1
e	4	4	0	0	4	4	0	0	4	0	0	4
A 1	5	2	0	3	5	2	0	3	5	0	0	5
A 2	6	2	2	2	6	0	0	6	6	0	0	6
A 3	1	0	0	1	1	0	0	1	1	0	0	1
A 5	9	5	1	3	8	4	0	4	8	0	2	6
B 1	3	3	0	0	2	2	0	0	2	0	0	2
B 2	3	3	0	0	3	3	0	0	3	1	1	1
B 3	4	4	0	0	5	0	4	1	5	0	1	4
C 1	10	7	2	1	8	4	3	1	6	4	0	2
C 2	3	0	2	1	3	0	2	1				
C 3	9	3	3	3	10	3	1	6				
D 1	8	3	4	1	8	1	5	2	8	1	5	2
D 2	10	6	4	0					10	2	2	6
D 4	5	1	4	0					5	0	3	2
D 5	9	7	1	1	9	9	0	0	9	3	2	4
D 7	11	6	3	2	10	4	4	2	10	2	2	6
D 8	8	7	0	1	8	5	0	3	6	4	0	2

D. Mixed culture studies on the synergistic or antagonistic effects of algae and bacteria from natural associations including:

- i) the effects of epiphytes on the growth and differentiation of Enteromorpha
- ii) the effects of Enteromorpha on its epiphytes
- iii) the isolation and identification of extra cellular, possibly community regulatory, substances released into the media.

1) Nitrogen budget of the aufwuchs community (Dissertation project of Ms Patricia Sullivan).

Preliminary experiments in the summer of 1973, using the acetylene reduction technique (Hardy et al. 1968), have suggested that N_2 fixation does occur among the epiphytes of Enteromorpha. Published data indicate that the blue green algae are the most important nitrogen fixers in the sea (Stewart, 1966; Brooks et al. 1971). Therefore, attempts are currently being made to isolate the blue-green epiphytes of Enteromorpha. The technique being followed is basically that of Van Baalen (1961) who succeeded in isolating a number of blue-greens occurring in coastal marine environments, many from the Long Island area. A small piece of Enteromorpha is transferred into an enrichment media (a modification of Provasoli's 1957, ASP-2 media) and incubated in a light bank with aeration. Later, plates are inoculated with 0.1 ml, sealed and incubated in the light for up to 3 months. After growth, algal colonies were picked and transferred.

Temperature has been used as a selective factor in isolating blue-greens from water and soil (Allen and Stainer, 1967). Incubation at 35 C suppressed eukaryotic algae development. This technique was not successful with the salt marsh Enteromorpha epiphytes, due to the ability of these organisms to tolerate high temperatures (Saks and Lee 1973).

The addition of cyclohexamide (actidione) to media is now being used to inhibit eukaryotic algae (McCurdy and Hodgson 1973). Pure cultures of blue-greens are difficult to obtain because bacteria live in the gelatinous sheaths. Vibration of algal samples with glass beads in a Bradson Sonifier followed by washing with sterile modified ASP-2 media and low pressure ($2\frac{1}{2}$ lbs/in²) filtration through 0.8 μ filters has been tried in an attempt to obtain axenic cultures. But these efforts have met with little success.

So far, the best results have been from picking algae which seem bacteria-free when viewed under the binocular microscope and streaking on new plates. Repeated transfers should yield axenic cultures.

2. Enteromorpha culture

Cultures of Enteromorpha intestinalis presently being maintained have been clones from one culture which demonstrated good growth, slight differentiation and zoospore production. Attempts at removing the bacterial contaminant by washing, dragging and using antibiotics have been unsuccessful. Cultures which may appear to be bacteria-free within 1-3 weeks of transfer (i.e., no visible turbidity in the liquid overlay or around the germlings) have been found to contain a fine film of bacteria on the solid substrate. In cultures where this film is extensive, the transferred germlings, as well as those resulting from zoospore production seem to be able to successfully attach to the substrate and survive but do not differentiate. In cultures where attachment does not occur, the algae become surrounded by a slight cloud of bacteria, bleach and die.

Routine maintenance of Enteromorpha has been bothered by an increasing proportion of unsuccessful transfers. Within the last few months, various changes have been introduced into the culturing program. Stock medium S is being used in place of Base B for the Enteromorpha medium and 150 ml Ehrlenmeyer flasks with some solid substrate and 25 ml liquid overlay have replaced tubes in a portion of the transfers. Both changes have been successful. We have obtained hundreds of germlings from the flask cultures alone.

Screening experiments to determine the effect of the parabiotic growth of each of the isolated bacteria on the development of Enteromorpha have begun. Shallow agar slants of medium S (Lee et al. 1970) without vitamins are overlaid with 5 ml of the liquid medium and inoculated with 1 or 2 small germlings from axenic but morphologically abnormal cultures of the macroalga. Bacteria are grown for 24-48 hrs in liquid bacterial stock medium, centrifuged and resuspended in 5 ml of a basal salts medium. The washing process is repeated twice and after the final resuspension, 0.1 ml aliquot of each bacterium are inoculated into duplicate tubes containing the germlings. Control tubes without the bacteria are prepared and all cultures are incubated at room temperature under high intensity fluorescent lights set at an 18 L/6 D cycle. Observations are made and recorded at weekly intervals.

During the 6 weeks incubation, the 127 mixtures of bacteria plus Enteromorpha have been found to give a variety of responses differing not only in rate but also order of occurrence. Table 19 encompasses the 9 basic patterns that were observed. Some of these have been previously noted not only with Enteromorpha but also Ulva, Polysiphonia and Monostroma (Provasoli and Pintner 1964, personal communication). Only 1 organism, B1-2, was capable of stimulating the differentiation of the original germling. Its morphological and physiological characteristics are given in Table 16, and it has been tentatively identified as a species of Aeromonas.

TABLE 19

Qualitative responses of parabiologically grown germ-lings of Enteromorpha intestinalis and isolated strains of its bacterial epiphytes. (See Lee et al. for types of Enteromorpha growth.)

Ia.	No change in germling	40
b.	No change in bacterium	
II.	Increased growth of bacterium	70
III.	Feathery outgrowth of original germling (Fig. 1C)	35
IV.	Feathery outgrowth of original germling, zoospore production, development of rhizoids and mold-like colonies by new germ-lings (Fig. 1C)	25
V.	Like IV, but new colonies apohchlorotic (Fig. 1C)	10
VI.	Like IV, but some elongation (≤ 2 mm) of thalli of new germ-lings before degeneration to mold-like colonies (Figs. 1C and 1E)	8
VII.	Like IV with production of a third generation of <u>Enteromorpha</u> . (Fig. 1C)	2
VIII.	Like VI with production of a third generation of <u>Enteromorpha</u> . (Figs. 1C and 1E)	3
IX.	Differentiation of original germling, zoospore production. (Fig. 1B)	1

E. Microcosm experiments

A number of our experiments with model microcosms were directed toward competition between Euplotes vannus, a surface feeding ciliate with apparently few dietary requirements and known information processing abilities (COO 3254-17) and Allogromia laticollaris, a foraminiferan with complex dietary requirements best satisfied by a mixture of food organisms. Experimental microcosms were gnotobiotic, but bacterized (monoxenic), since Allogromia, as do all foraminifera studied in this respect, has an absolute requirement for a growth factor (or factors) found only in living bacteria (see Muller and Lee 1974). In one important respect the competitors reported here differ from the pair in the completed subproject (COO 3254-17). In the completed study both ciliates had simple dietary requirements and neither seems to be able to combine food quality for growth enhancement. An unidentified chlorophyte (S 94) was used in the Allogromia-Euplotes microcosms since it is a good food organism for both species. Allogromia laticollaris has a lower threshold for feeding on most foods ($\sim 1 \times 10^2$ cells/ml; Lee et al. 1966) than does Euplotes vannus (Fig. 55). Above lower threshold, feeding generally follows Lotka-Volterra kinetics to a maximum of $\sim 1 \times 10^7$ or 10^8 cells/ml for Allogromia, whereas feeding saturation density is reached at a much lower level ($\sim 1 \times 10^5$) for Euplotes vannus (Fig. 55). Undoubtedly this is a reflection of the relative sizes of the 2 herbivores.

Since we lacked some data on the growth responses of several species to changes in salinity and temperature, these preliminary experiments were also done (Figs. 56-58).

The experimental medium was limiting in nutrients required by the alga so that algal populations would themselves be limited during the experiment. Under experimental conditions control populations of Euplotes reached maximum density 2×10^3 in ~ 4 -5 weeks at 25°C and declined rapidly thereafter (Fig. 59). At 15°C the population grew slowly to $\sim 1/2$ that level over the 9 week incubation

Fig. 55

The effect of food concentration on feeding rate in Euplotes vannus.
(determined respirometrically)

<u>curve</u>	<u>Concentration of food/ml</u>
1	10^2
2	10^4
3	10^6
4	10^8

Fig. 56

The effect of temperature on the growth (number of cells/ml) of a marine ciliate, Euplotes vannus.

<u>curve</u>	<u>days</u>
1	42
2	35
3	27
4	20
5	10

Fig. 57

The effect of salinity on the growth of a marine ciliate, Euplotes vannus.

<u>curve</u>	<u>days</u>
1	11
2	28
3	21
4	56

Fig. 58

The effect of salinity on the growth (cells/ml) of a marine nematode,
Chromadorina germanica.

<u>curve</u>	<u>days</u>
1	21-42
2	56

Fig. 59

A microcosm experiment with Euplotes vannus and Allogromia latcollaris. I. The effect of temperature and inoculum size on the growth of Euplotes.

<u>Curve</u>	<u>Incubation temperature</u>	<u>Number of organisms in inoculum</u>	
		<u>Allogromia</u>	<u>Euplotes</u>
1	25° C	10	10
2	25° C	control	10
3	25° C	10	20
4	15° C	10	10
5	15° C	10	20
6	15° C	control	10

NUMBER OF ORGANISMS X 10⁻⁴

Fig. 60 (complementary to Fig. 59)

A microcosm experiment with Euplotes vannus and Allogromia latcollaris. I. The effect of temperature and original inoculum on the growth of Allogromia.

<u>Curve</u>	<u>Incubation temperature</u>	<u>Number of organisms in inoculum</u>	
		<u>Allogromia</u>	<u>Euplotes</u>
1	25° C	10	control
2	25° C	10	10
3	15° C	10	control
4*	25° C	10	20
	15° C	10	10
	15° C	10	20

* Inoculum did not reproduce and remained same throughout.

period. Allogromia populations also reached carrying capacity ($\sim 1.4 \times 10^3$) in ~ 4 -5 weeks at 25°C but characteristically did not decline (Fig. 60). Growth at 15°C was approximately 15% that at 25°C . When equal numbers of both Euplotes and Allogromia were incubated at 25°C , neither organism grew well (Figs. 59, 60). Allogromia was least effected; populations reached $\sim 30\%$ of their biotic potential in about 4-5 weeks. Initial population growth of Euplotes paralleled the controls for the first 2 weeks and then rapidly declined as the numbers of Allogromia increased. At maximum Euplotes populations were only $\sim 13\%$ of controls. When initial conditions were changed and twice as many Euplotes were inoculated as Allogromia the outcome of the competition was quite different. Allogromia did not reproduce at all. Euplotes populations reached $\sim 25\%$ control levels and then declined very slowly (Fig. 59). At 15°C Allogromia did not reproduce in the presence of Euplotes (Fig. 60). As a result, the populations of the latter grew better.

A similar microcosm experiment studied the interactions of Euplotes vannus and Chromadorina germanica. As do Euplotes populations at 25°C , Chromadorina populations also reach maximum density in 4-5 weeks. At 25°C when inocula were evenly matched, Chromadorina populations paralleled those of controls for the first 2 weeks and then slowly declined (Fig. 61). Under the same conditions, Euplotes populations bloomed ($\sim 70\%$ of controls) in less than a week and then rapidly declined. Perhaps the more rapid early growth of Euplotes was due to the stimulation of bacterial growth by the feces of the worm but this was not measured. The same phenomenon was also observed when Euplotes initial inocula were increased 5 fold over Chromadorina (Fig. 62). Under the same conditions Chromadorina populations did not begin to increase until after Euplotes populations declined (Fig. 61). As with Allogromia in the previous experiment Chromadorina could not compete at all with Euplotes at 15°C . In the presence of Chromadorina, Euplotes populations at 15°C also grew initially at a more rapid rate than controls.

Fig. 61

A microcosm experiment with Euplotes vannus and Chromadorina germanica. I. The effect of temperature and initial inoculum on the growth of Chromadorina.

<u>Curve</u>	<u>Incubation temperature</u>	<u>Number of organisms in inoculum</u>	
		<u>Chromadorina</u>	<u>Euplotes</u>
1	25° C	10	10
2	15° C	10	control
3	25° C	10	control
4	25° C	50	10
5	15° C	10	10
	15° C	10	50

Fig. 62. (complementary to Fig. 61)

A microcosm experiment with Euplotes vannus and Chromadorina germanica. I. The effect of temperature and inoculum size on the growth of Euplotes.

<u>Curve</u>	<u>Incubation temperature</u>	<u>Number of organisms in inoculum</u>	
		<u>Chromadorina</u>	<u>Euplotes</u>
1	25° C	control	10
2	15° C	control	10
3	25° C	10	10
4	15° C	10	10
5	25° C	10	50
6	15° C	10	50

In a succeeding experimental microcosm, food was not limited because the medium (erdschreiber) supported the growth of the algae. In this medium the growth of both control populations was similar to growth in unenriched media. (Compare Figs. 61, 62, 63) Synergistic effects were noted when both species were inoculated together. In the presence of Euplotes and excess food, Chromadorina populations reached maximum density (3 x controls) 3 1/2 weeks earlier than controls, declined, and grew again to almost twice the levels of controls (Fig. 63). Initial growth of Euplotes populations was retarded until Chromadorina was stimulated by the presence of Uronema (Fig. 64). In a microcosm experiment with Allogromia laticollaris, Chromadorina germanica and Euplotes vannus under conditions which allowed food to be in excess, all three organisms grew more rapidly than in controls (Figs. 61, 62, 63, 65).

Since competitive interaction seemed so closely coupled with food density, several experiments were designed to study the effect of food concentration on growth (Figs. 66 a, b). In the light, populations continued to increase in size, whereas in the dark they did not. The importance of the algal food in the diet was shown by the minimal population size developed in both the light and the dark. Grazing more greatly affected the algal populations in the dark than in the light (Figs. 66 c, d). As noted earlier (COO 3254-17) initial concentrations of predator and prey were extremely important characteristics of the system. When algal food was in low concentration in the dark, the ciliates were able to reduce the population to such a small size that they themselves became extinct. When ciliate populations were more balanced with their food ($1 \times 10^4 - 10^6$ cells/ml) growth of the system seemed more stable (Figs. 66 a-d). When the initial concentration of food was high, eventually the ciliates became too numerous for the algal populations. In all cases the system, if unperturbed, is expected to eventually oscillate around some stable relationship. If the aufwuchs conditions change far too rapidly for this to occur.

Fig. 63

A microcosm experiment with Euplotes vannus and Chromadorina germanica. II. Competition when food concentration is not limiting.*

Curve

1	<u>Chromadorina</u> control
2	<u>Euplotes</u> control
3	<u>Chromadorina</u> in the presence of <u>Euplotes</u>
4	<u>Euplotes</u> in the presence of <u>Chromadorina</u>
(see curve 3)

* Algal and bacterial growth stimulated by 5% (v/v) soil extract and 10 mg% (w/v) nitrate; incubation at 25° C.

Fig. 64

A microcosm experiment with Euplotes vannus, Chromadorina germanica and Uronema marinum. I. The effect of food concentration and competition on the growth of Chromadorina.

<u>Curve</u>	<u>Medium</u>	<u>Other Organisms</u>
1	erdschreiber*	control
2	sea water	control
3	erdschreiber	<u>Uronema</u>
4	sea water	<u>Euplotes</u>
5	erdschreiber	<u>Euplotes</u>
6	sea water	<u>Uronema</u>

* Erdschreiber is a medium made from sea water enriched with 5% soil extract (v/v) and 10 mg% (w/v) nitrate; incubation at 25° C.

Fig. 65

A microcosm experiment with Allogromia laticollaris, Chromadorina germanica and Euplotes vannus under conditions in which food is in excess.*

Curve

1	<u>Allogromia laticollaris</u>
2	<u>Euplotes vannus</u>
3	<u>Chromadorina germanica</u>

* Medium erdschreiber, incubation 25° C.

Figs. 66 a-d

The effect of algal food concentration on the growth of monoxenic
(bacterized) Euplotes vannus.*

<u>Curve</u>	<u>Algal Concentration</u>
1	non-fed control
2	10^4
3	10^5
4	10^6
5	10^8

Fig. 66

- a Growth of Euplotes in cultures incubated in the dark
- b Growth of Euplotes in cultures incubated in the light
- c Number of algae (S 94) in cultures incubated in the light
- d Number of algae (S 94) in cultures incubated in the dark

* medium erdschreiber

The results of a microcosm experiment in which Euplotes vannus and Allogromia laticollaris were inoculated with varying concentrations of 2 species of food were quite interesting. When equal numbers of both species were inoculated, secondary production was quite low. Both species grew better on bacterial diets (though out of phase with each other) than they did with algae (Figs. 68 a, b). Allogromia reproduced fairly rapidly on an algal diet of 1×10^4 or more cells once Euplotes populations stabilized or diminished. When the ratio of Euplotes:Allogromia in the inoculum was increased to 20:1, Euplotes grew much better. For the first 5 weeks, Euplotes numbers were proportional to the food density. Allogromia populations could not compete with those of Euplotes at either high or low concentrations of food ($0, 10^8$) but grew after some delay (3 weeks) at intermediate levels ($1 \times 10^4 - 10^6$). Changing the inoculum ratio of Euplotes:Allogromia to 10:1 did not greatly change the growth pattern of either species although populations of Euplotes were slightly smaller (Fig. 68 b). When the ration was diminished to 2:1, Euplotes populations were much smaller and Allogromia populations were correspondingly higher (Fig. 69 c).

In another microcosm experiment, large inocula of each species were incubated in an illuminated thermal gradient block in the presence of excess food (S 94). Both species grew well over a range of 16-28° C (Figs. 70 a, b). In controls and in competition Allogromia did better at higher temperatures ($> 20^\circ \text{C}$) and Euplotes $< 20^\circ \text{C}$ (Figs. 70 c, d). Only at low food density did Euplotes successfully compete with Allogromia above 20° C. Population sizes were generally proportional to initial food concentration. When food was limiting, populations of Euplotes were smaller and restricted to lower temperatures with optimum growth at 19-20° C (Fig. 71).

Acidicase (an acid hydrolysate of milk protein) was added to Allogromia-Euplotes microcosms to stimulate bacterial growth and

Fig. 67

The growth of monoxenic (bacterized) Euplotes vannus as a function of food concentration.

<u>Curve</u>	<u>Incubation time</u>
1	20 days
2	30 days
3	40 days

Figs. 68 a, b.

A microcosm experiment with Euplotes vannus and Allogromia latcollaris. II. Inoculum equal, food concentration varied.* **

<u>Curve</u>	<u>Organism Plotted</u>	<u>Initial concentration of alga</u>
1	<u>Euplotes</u>	no add
2	<u>Euplotes</u>	10^4
3	<u>Euplotes</u>	10^6
4	<u>Euplotes</u>	10^8
5	<u>Allogromia</u>	no add
6	<u>Allogromia</u>	10^4
7	<u>Allogromia</u>	10^6
8	<u>Allogromia</u>	10^8

* Fig. 68 a = unidentified chlorophyte (S 94);

Fig. 68 b = alga Chlorococcum sp (41).

** inoculum = 5 Euplotes and 5 Allogromia; incubation 25° C (in the light).

Fig. 69 a-c

A microcosm experiment with Euplotes vannus and Allogromia lat-
collaris. II. Inoculum unequal, food concentration varied. * **

<u>Curve</u>	<u>Organism Plotted</u>	<u>Initial concentration of alga</u>
1	<u>Euplotes</u>	0, control
2	<u>Euplotes</u>	10^4
3	<u>Euplotes</u>	10^6
4	<u>Euplotes</u>	10^8
5	<u>Allogromia</u>	0, control
6	<u>Allogromia</u>	10^4
7	<u>Allogromia</u>	10^6
8	<u>Allogromia</u>	10^8

*

Fig. 69 a = Allogromia inoculum 5 organisms
 b = Allogromia inoculum 10 organisms
 c = Allogromia inoculum 50 organisms

**

Euplotes inoculum 100 Organisms; incubation 25° C
 (in light); food organisms unidentified chlorophyte
 (S 94).

Fig. 70 a, b.

A microcosm experiment with Euplotes vannus and Allogromia latius -
collaris. III. The effect of temperature and food on competition. * **

<u>Curve</u>	<u>Incubation Period</u>
1	1 week
2	2 weeks
3	3 weeks
4	4 weeks

* Fig. 70 a = Euplotes control;
 Fig. 70 b = Allogromia control

** Inoculum 50 organisms of each species; food (S 94) in excess; incubation in thermal gradient block.

Fig. 70 c, d

A microcosm experiment with Euplotes vannus and Allogromia latcollaris. III. The effects of temperature and food concentration on competition.*

<u>Curve</u>	<u>Incubation Period</u>	<u>Food concentration (S 94)</u>
1	2 weeks	10^2
2	4 weeks	10^2
3	2 weeks	10^4
4	4 weeks	10^4
5	2 weeks	10^6 & 10^8
6	4 weeks	10^6 & 10^8

* Fig. 70 c Euplotes populations plotted

** Fig. 70 d Allogromia populations plotted

simulate organic pollution. Quite unpredictably, the growth of Allogromia was unaffected while that of Euplotes was totally inhibited (Fig. 72) over a wide concentration of acidase. On the other hand, the growth of Euplotes vannus was stimulated in the presence of relatively high concentrations of nitrate (35-80 mg%) while Allogromia laticollaris was inhibited until Euplotes populations began to decline (Fig. 73). At very low concentrations of nitrates, reproduction of Allogromia was stimulated while Euplotes was inhibited in the microcosms. Rosalina leei was non-competitive in microcosms containing both Euplotes vannus and Allogromia laticollaris. At the highest level of nitrate tested (100 mg%), E. vannus was totally inhibited (Fig. 73). In another microcosm, phosphate enrichment (5-30 mg%) stimulated early growth of Euplotes vannus but the population declined earlier (Fig. 74). Higher concentrations of phosphate were inhibitory. Every concentration of phosphate tested (5-30 mg%) inhibited population growth of both Allogromia and Rosalina in the model microcosms.

Fig. 71

The effect of temperature on the growth of Euplotes vannus in competition with a marine foraminifer, Allogromia laticollaris when both are feeding on limiting concentrations of a chlorophyte, Chlamydomonas subehrenberghii (93).

<u>Curve</u>	<u>Days</u>
1	control - 14 days
2	control - 35 days
3	14 days*
4	35 days*

* C. subehrenberghii 1×10^2 cells/ml.

Initial inocula contained 50 E. vannus
and 50 A. laticollaris.

Fig. 72

The growth of Allogromia laticollaris and Euplotes vannus in competition under organic stress.

<u>Curve</u>	<u>Organism and organic add</u>
1	<u>A. laticollaris</u> with acidibase 0.001-0.01%
2	<u>A. laticollaris</u> no add
3	<u>E. vannus</u> no add
4	<u>E. vannus</u> with acidibase 0.001-0.5%

Fig. 73

The effect of nitrates on competition among Euplotes vannus, Allogromia laticollaris, and Rosalina leei.

<u>Legend</u>	<u>Organism and Nitrate concentration</u>	
1	<u>E. vannus</u>	
2	<u>A. laticollaris</u>	
3	<u>R. leei</u>	
4	<u>E. vannus</u>	5-10 mg%
5	<u>A. laticollaris</u>	5-10 mg%
6	<u>R. leei</u>	5-10 mg%
7	<u>E. vannus</u>	15-30 mg%
8	<u>A. laticollaris</u>	15-30 mg%
9	<u>R. leei</u>	15-30 mg%
10	<u>E. vannus</u>	35-80 mg%
11	<u>A. laticollaris</u>	35-100 mg%
12	<u>R. leei</u>	35-100 mg%
13	<u>E. vannus</u>	100 mg%

Fig. 74

The effect of phosphates on competition among Euplotes vannus, Allogromia laticollaris, and Rosalina leei.

<u>Curve</u>	<u>Organism and Phosphate concentration</u>
1	control - <u>E. vannus</u> in presence of <u>A. laticollaris</u> and <u>R. leei</u> with no phosphate
2	control - <u>A. laticollaris</u> in the presence of <u>E. vannus</u> and <u>R. leei</u> with no phosphates
3	control - <u>R. leei</u> in the presence of <u>E. vannus</u> and <u>A. laticollaris</u> with no phosphates
4	<u>E. vannus</u> in the presence of <u>A. laticollaris</u> 5-30 mg% PO_4
5	<u>A. laticollaris</u> in the presence of <u>E. vannus</u> 5-30 mg% PO_4
6	<u>E. vannus</u> in the presence of <u>A. laticollaris</u> 31-100 mg% PO_4
7	<u>A. laticollaris</u> in the presence of <u>E. vannus</u> 31-100 mg% PO_4