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Dynamics of meiofauna communities in association with *Zostera noltii* seagrass beds in the Mira estuary (SW Portugal)

Dinâmica das comunidades de meiofauna em sedimentos associados aos povoamentos de *Zostera noltii* no estuário do rio Mira

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The Cover

"Sampling"

Painted by Paula Godinho

SUMMARY

Most estuarine primary consumers are found on the bottom of the estuary, where a rich benthic community is usually very abundant, and they are directly involved in most physical and chemical processes that occur in estuaries, such as interaction with sediments, the nutrient cycle and energy flux. The meiobenthos is an important benthic component in marine and estuarine sediments, and is composed of animals of small body size, with a range between 31-1000 µm. In estuarine sediments, meiofauna: (i) facilitate biomineralization of organic material and enhance nutrient regeneration, (ii) serve as food for a variety of higher trophic levels, and (iii) exhibit high sensitivity to environmental modification. The spatial, temporal and vertical distribution, abundance, species composition and fluctuations of the meiobenthic communities are deeply influenced by several biotic and abiotic factors: food resources, oxygen, salinity, temperature, turbidity, hydrodynamic regime, sediment grain size characteristics and topography, trophic relationships, biogenic structures, bioturbation, disturbance effects. In sediments, the most abundant taxon of meiofauna is usually nematodes, and copepods are typically second.

In shallow estuaries there are often dense communities of monocotyledonous flowering plants, seagrass beds, which extend mainly by under-sediment rhizome systems. In temperate regions, the seagrass beds of *Zostera* are the most common of these plants, occurring in mud and sandy soft sediments. In recent years, there has been a surge of interest in the faunal composition and ecology of the invertebrates inhabiting seagrass beds. The impetus for such research effort has largely been based upon a recognition of the role seagrass beds play in the energy flux of estuaries, either through their release of dissolved organic carbon directly into the water column, or, after defoliation and the fragmentation of leaves, by contributing to the detritus pool.

There are several studies that have focused on the meiobenthic communities associated with seagrass beds; however, only two studies were identified concerning meiofauna associated with seagrass beds of *Zostera noltii*, which were studied in terms of density, biomass and seasonality based on major taxa.

The meiobenthos studies in Portugal are documented by only three studies: Austen *et al.* (1989) studied the community structure of the macrobenthos and meiobenthos in the Ria

Formosa; Rosado (1996) studied the meiofauna from different sediments of the Sado estuary and Franco (1999) studied the vertical distribution of meiofauna in the Tejo estuary.

The current study essentially centres on the study of the meiofauna of the sediments associated with seagrass beds of *Zostera noltii* in the Mira estuary, through the study of the temporal variation of the meiofauna communities, focusing on the ecology of the free-living marine nematodes. Its aim is to relate the temporal and vertical variation patterns of meiobenthic composition communities to variations in the environmental factors, and to discuss how strong is the influence of the temporal changing environment on the structural characteristics of the meiofauna taxa, and the trophic and age composition of the nematodes.

The study was carried out at two sampling sites to compare meiofauna composition, Nematoda assemblages and density temporal and vertical variation patterns, and to discuss structuring factors of meiofauna and Nematoda assemblages at both sampling sites.

The higher abundances and composition of meiofauna and Nematoda assemblages observed throughout the study agree with the results of previous observations carried out in the vegetated intertidal muddy sediments of several estuaries.

A total of 17 meiofauna taxa were registered, with Nematoda the dominant taxon (>87%). The higher relative densities of Nematoda taxon structured the temporal variations, and consequently the seasonality of meiofauna assemblages. The study of the temporal variation of the dominant genera, age and trophic composition and the several relationships with environmental factors allowed an explanation of the structuring factors of the temporal dynamics of meiofauna communities.

The temporal variations of the important factors structuring meiofauna and Nematoda communities, such as temperature, salinity, pH, amount of dissolved oxygen (DO) and concentrations of nutrients in the water and in sediment proportions of silt and clay, were similar between stations, which seems to explain the similarity of meiofauna and

Nematoda composition between the stations. However, there were clear differences between both sampling sites concerning the temporal variations of some environmental factors, such as organic matter content of the sediment, which determined differences in ammonia sediment concentration and phosphate sediment concentration. There are also differences in the temporal variation of the biomass of *Zostera noltii* and in clay proportions.

The analysis of the temporal variations of meiofauna and Nematoda assemblages, at both sampling stations, indicated an evident seasonality. However, the densities and seasonal patterns between sampling stations were different. The seasonality found for Nematoda at both stations contradicted the seasonality generally observed in other studies, which usually peaks in the warmest months. In this study the densities of the dominant genera *Paracomesoma*, *Terchellingia*, *Odontophora*, *Linhomoeus*, *Paramonoshystera*, *Daptonema*, *Chromodora*, *Pthycholaimellus* and *Camacolaimus* rose in autumn and/or in winter-spring.

The temporal patterns of the vertical variations of meiofauna densities and Nematoda assemblages showed clear seasonality at both sampling sites. The density patterns of the uppermost sediment layer structured the seasonality of the sediment layer between 0-10 cm depth, due to the majority of the meiofauna and nematodes being concentrated in the uppermost 3 cm.

The temporal variation of environmental factors considered determinant of the seasonality in temperate regions, such as temperature, salinity, pH, amount of dissolved oxygen (DO) and granulometry were not of fundamental importance for structuring the seasonality and composition of meiofauna and Nematoda assemblages. The range of environmental factors at both sampling sites did not allow any specific factor to be identified. However, it was possible recognize that the combined effect of a given set of parameters creates the habitat conditions able to explain the seasonal variations.

The temporal variation patterns in trophic structure and the life history of the Nematoda genera assemblages seem to be very important in explaining the seasonality obtained and the differences between sampling sites. The temporal variation patterns of the

juveniles were closely associated with the temporal variation patterns of the populations. The juveniles were present throughout the sampling period, and the highest densities were coupled with peak densities of the populations and consequently an increase in reproduction activity. In contrast, the lowest densities of the populations corresponded to a decline in reproduction activity. The other important biological factor that could explain the seasonality obtained at each sampling station was trophic dynamic fluctuations. Indeed, an evident changing of the trophic group dominance was observed, suggesting changes in food availability.

RESUMO

INTRODUÇÃO

A comunidade bentónica constitui a maioria dos consumidores primários nos sedimentos estuarinos e está envolvida na maioria dos processos físicos, biogeoquímicos e biológicos relacionados com os fluxos de matéria e energia nos ecossistemas estuarinos.

A meiofauna bentónica (=meiobentos) é uma componente importante da fauna associada aos sedimentos marinhos e estuarinos, é constituída por pequenos organismos com representação filogenética em quase todos os phyla de invertebrados: Vinte três taxa dos trinta e três fila que constituem os metazoários têm representação na meiofauna, nomeadamente: Nematoda, Turbellaria, Oligochaeta, Polychaeta, Copepoda, Ostracoda, Mystacocarida, Halacaroidea, Hydrozoa, Nemertina, Entoprocta, Gastropoda, Aplacophora, Brachiopoda, Holothuroidea, Tunicata, Priapulida e Sipunculida. A definição metodológica de meiofauna tem como base a malha da rede dos crivos utilizados para a sua extracção, incliu todos os organismos metazoários bentónicos que atravessam uma rede de malha 1000 μm e ficam retidos numa malha de 31 μm. São organismos com ciclos de vida curta, dias ou semanas e de reprodução contínua ao longo do ano.

Em sedimentos estuarinos não perturbados o meiobentos apresenta densidades que podem atingir 10^6 ind m^{-2}, com valores tendencialmente mais elevados nos sedimentos ricos em matéria orgânica e mais baixos nas areias limpas. Os nemátodes geralmente são o grupo taxonómico dominante, podendo atingir 60-90% das comunidades meiobentónicas estuarinas, e os copépodes o segundo grupo mais abundante, podendo ocasionalmente serem outros taxa os dominantes.

A meiofauna não constitui um grupo ecológico homogéneo, a estrutura e composicão das comunidades são específicas de cada ecossistema. Assim, as comunidades existentes nas vasas, nas areias, nos diferentes ambientes epibenticos ou ao longo dos gradientes de salinidade de um estuário diferem significamente. A grande diversidade de estratégias alimentares destes organismos explica a sua presença numa grande diversidade

habitats, inclui detritívoros de superfície, detritívoros escavadores, herbívoros, filtradores ou suspensívoros, omnívoros e predadores

A distribuição, abundância, composição e variações temporais das comunidades meiobentónicas são controladas por factores físicos e biológicos. Os factores abióticos descritos como determinantes na estrutura e dinâmica das comunidades são: granulometria do sedimento, temperatura, salinidade, oxigénio, topografia dos sedimentos, regime hidrodinâmico e perturbações físicas e químicas de natureza antropogénica. Factores bióticos como as relações tróficas, disponibilidade de alimento, bioturbação e a presença de estruturas biogénicas são interacções biológicas condicionantes das comunidades.

Os organismos meiobentónicos têm um papel importante nos processos de fluxo de energia através das comunidades bentónicas. São consumidos por organismos dos níveis tróficos superiores, tendo sido demonstrado sua importância como presa da macrofauna e outros invertebrados e ainda por juvenis de peixes; são também consumidores de microfitobentos e estão relacionados com os micro-organismos decompositores. As interacções da meiofauna com as populações bacterianas e os detritos coloca-a numa cadeia detrítica complexa, através do incremento da biomineralização da matéria orgânica e regeneração dos nutrientes: a fragmentação mecânica dos detritos vegetais acelera o seu processo de decaimento, o consumo de bactérias, produção de muco e excrecção de nutrientes que são consumidos directamente pelas populações bacterianas, mantêm o seu crescimento em "log phase".

A composição e abundância das comunidades variam geralmente de uma forma sazonal, ocorrendo um evidente padrão anual de abundância e de sucessão de espécies. Em diferentes ecossistemas os ciclos sazonais são muito variáveis, dependendo das condições ambientais e da composição de espécies. Nos climas temperados as populações atingem os valores máximos de abundância nos meses com temperaturas mais elevadas, apesar das espécies, individualmente, poderem atingir a máxima abundância noutros períodos. Os factores que regulam os padrões sazonais estão pouco descritos, sendo difícil separar os efeitos da temperatura, disponibilidade de alimento, tipo

de sedimento e salinidade devido ao facto destas variáveis se encontrarem profundamente relacionadas.

O oxigénio penetra apenas nas camadas superficiais dos sedimentos, condicionando fortemente a distribuição em profundidade da fauna, que fica restrita à superfície. Nas vasas, mais de 70% da meiofauna encontra-se nos primeiros 5 cm de profundidade, pois a maioria das espécies necessita de oxigénio para metabolizar. As interacções existentes entre factores físicos e biológicos são também determinantes na distribuição vertical da meiofauna, nomeadamente a granulometria do sedimento, temperatura, água insterticial, a presença de estruturas biogénicas, e.g. os rizomas das plantas intertidais, o padrão vertical de distribuição dos recursos alimentares e as interacções biológicas.

Nos últimos anos tem sido crescente o interesse pelo estudo da composição e estrutura das comunidades dos sedimentos associados às plantas intertidais. As fanerogâmicas em geral e as Zosteráceas em particular são consideradas como uma das principais fontes de matéria orgânica nos ecossistemas costeiros de clima temperado. Estes povoamentos desempenham um papel importante nos processos de fluxo de energia na rede trófica dos ecossistemas estuarinos. A *Zostera* é um macrófito com rizomas que retira os nutrientes maioritariamente dos sedimentos, é responsável pela transferência de elevado teor de carbono orgânico para a coluna de água e através de elevada produção de detritos tem um contributo importante para cadeia detrítica. Tem influência directa na estrutura trófica dos vertebrados, nomeadamente de peixes que encontram aí uma zona de alimento, de "nursery" para estadíos juvenis de peixes e epibentos. Apesar do género *Zostera* estar presente em inúmeros estuários e rias da costa portuguesa os estudos realizados até à data são escassos e pontuais.

Existem alguns estudos sobre as comunidades meiobentónicas associados às plantas intertidais das regiões temperadas e subtropicais *Thalassia testudinum*, *Posidonia oceanica*, *Spartina* e *Zostera*. No entanto, só se conhecem dois trabalhos relacionados com as comunidades meiobentónicas dos sedimentos associados aos povoamentos de *Zostera noltii* e foram realizados na baía de Arcachon, France. Teve como objectivo a identificação da variação da densidade e da sazonalidade dos grandes grupos taxonómicos da comunidade da meiofauna identificada. No sul do Japão foi estudado a

variação temporal das comunidades meiobentónicas associadas aos povoamentos de *Zostera marina*, tendo sido focalizado na comunidade de nemátodes, identificada como mais abundante.

Em Portugal os estudos relacionados com as comunidades de meiofauna são muito escassos, sendo apenas conhecidos três trabalhos que estudaram a composição das comunidades meiobentónicas, ao nível das grandes grupos taxonómicos, em diferentes tipos de sedimentos nos estuários do Tejo, Sado e Ria Formosa. Não existem estudos relacionados com as comunidades de meiobentos nos povoamentos de fanerogâmicas marinhas.

Com a finalidade de conhecer e compreender a estrutura e dinâmica das comunidades meiobentónicas dos povoamentos de fanerogâmicas marinhas intertidais, o presente trabalho estuda a variação temporal dessas comunidades nos sedimentos associados aos povoamentos de *Zostera noltii*, no estuário do rio Mira, na Costa Sudoeste de Portugal, cujos os objectivos podem ser resumidos da seguinte forma:

- Relacionar o padrão de distribuição temporal e vertical de abundância e composição das comunidades meiobentónicas com a variação dos parâmetros ambientais.
- Relacionar o padrão de distribuição temporal e vertical de abundância e composição das comunidades de nemátodes, taxon identificado como mais abundante, com a variação dos parâmetros ambientais.
- Relacionar o padrão temporal e vertical da composição trófica e estrutura etária, dos nemátodes com a variação temporal dos factores ambientais.
- Comparar a variação temporal e vertical da abundância e composição de duas comunidades em duas estações de amostragem.
- Identificar e discutir os factores abióticos e bióticos estruturantes da dinâmica destas comunidades.

Foram identificados 17 taxa em que o taxon Nematoda é claramente dominante (87%). A elevada abundância deste grupo permitiu verificar que tem um papel relevante na estruturação da dinâmica das comunidades meiobentónicas observadas. Deste modo

para identificar e discutir os factores abióticos e bióticos estruturantes da dinâmica temporal das comunidades de meiofauna, realizou-se também o estudo da variação temporal da abundância, estrutura etária e composição trófica das comunidades de nemátodes até ao nível taxonómico do género.

LOCALIZAÇÃO E ESTRATÉGIA DE AMOSTRAGEM

A amostragem da meiofauna que permitiu efectuar este estudo foi realizada quinzenalmente, durante quinze meses (Junho de 1994 e Julho de 1995), em duas estações localizadas a jusante do estuário do rio Mira (estação A e estação B), na área intertidal da margem esquerda onde de localiza um povoamento de *Zostera noltii*. As amostras foram colhidas nos períodos de baixa-mar de marés vivas.

Para amostrar a meiofauna utilizaram-se cores com 3.18 cm de diâmetro que foram introduzidos no sedimento até à profundidade de 10 cm. Cada amostra foi seccionada em três niveis de profundidade: 0-3 cm, 3-6 cm e 6-10 cm. Utilizaram-se cores com diâmetro de 3.60 cm para amostrar o sedimento, que também foi introduzido até 10 cm de profundidade. O TASM revelou-se capaz de de amostrar de forma eficiente o coberto vegetal.

A decantação da meiofauna do sedimento foi realizada com dois crivos sobrepostos com malhas de 1 mm e 38 μm e a extracção foi realizada através da centrifugação das amostras numa solução de Ludox HS 40, silica coloidal. Todos os organismos meiobentónicos extraídos foram identificados e contados utilizando uma lupa binocular. A cada amostra foram retirados 200 nemátodes ao acaso e após o processamento e montagem em lâminas definitivas, foram identificados ao microscópio com ampliação de 1000x até ao nível taxonómico do género.

Simultaneamente à amostragem do material biológico foram considerados e quantificados vários parâmetros ambientais relativos à água, sedimento e foi determinado a variação da biomassa *Zostera noltii*. Na água foram determinados os valores de

salinidade, temperatura, oxigénio dissolvido, amónia, nitritos, nitratos e fosfatos e no sedimento a granulometria, fosfatos, amónia, nitritos, nitratos e fosfatos.

ANÁLISE DE DADOS

Em geral, para as diferentes amostras os dados foram sumariados em termos de média, com intervalo de confiança de 95% e identificado o valor mínimo e máximo.

Análise de variância (ANOVA) foi usada para testar a igualdade dos valores médios das diferentes amostras de cada estação de amostragem e entre as duas estações. Os testes não paramétrico de Kruskal-Wallis e Mann-Whitney foram usados em substituição da análise de variância, sempre que os principais pressupostos eram violados.

A correlação não paramétrica de Spearman foi utilizada para determinar o grau de associação linear entre duas variávies através do valor do coeficiente de correlação de Spearman (r). A significância do coeficiente de correlação foi avaliada por um test t-Student. Para correlacionar sucessivamente os diferentes factores abióticos estudados foi usada a regressão múltipla por passos (stepwise).

Foram utilizados métodos de análise muitivariável para o estudo da variação temporal das amostras e sua relação com os factores abióticos. A Análise em Componentes Principais (ACP) é um método de ordenação em espaço reduzido que permite interpretação das grandes tendências de variabilidade dos dados multivariados. A Análise Canónica de Correspondência (ACC) é também um método de ordenação, que relaciona uma matriz principal com uma segunda matriz, que em ecologia das comunidades a matriz principal contém os dados de abundância de espécies e a segunda matriz refere-se às variáveis ambientais. A ordenação das amostras e das espécies é baseada na relação com os parâmetros ambientais, através da análise de regressão múltipla que inclui as variáveis ambientais da segunda matriz.

As matrizes de dados utilizadas na análise multivariável foram construídas a partir do cálculo da média móvel para cada variável.

Em todos os testes o nível de confiança utilizado foi de 5% (α=0.05) e, portanto a hipótese nula foi regeitada sempre que o "p-value" foi inferior a 0.05.

PARÂMETROS AMBIENTAIS

Com o objectivo de relacionar a variação temporal dos grandes grupos que compõem as comunidades de meiofauna identificadas com as condicões ambientais existentes nas duas estações de amostragem, foram quantificados e comparados vários parâmetros ambientais relativos à água, sedimento e ainda foi determinada a variação temporal da biomassa de *Zostera noltii*.

Os resultados obtidos mostram que as estações amostradas reflectem uma forte dependência do ambiente marinho, devido ao facto de se localizarem na embocadura do estuário o rio Mira. Além disso, a penetração para montante da massa de água de características marinhas é facilitada pela morfologia da secção terminal do rio e pela estrutura e climatologia da bacia que condicionam um escoamento médio anual reduzido.

Ao longo do período de amostragem a salinidade e pH foram sempre constantes e com valores semelhantes à água do mar, a variação da temperatura mostrou-se relacionada com as características climatológicas, mais elevada no Verão e mais baixa no Inverno. A variação do teor do oxigénio dissolvido não se mostrou positivamente correlacionada com a temperatura, o que poderá ser explicado pelo facto do estudo ter sido realizado num povoamento de fanerogâmicas intertidais, cuja complexidade, heterogeneidade e processos biológicos associados, influenciam o consumo e libertação de oxigénio.

Os sedimentos são os característicos dos povoamentos de Zosteráceas, finos com elevada percentagem de vasa e teor de matéria orgânica. Os siltes registaram sempre a percentagem mais elevada, seguido das argilas e areias.

As duas estações de amostragem mostraram diferenças significativas relativamente aos valores da biomassa de *Zostera noltii*, concentração de fosfatos e silica nos sedimentos,

concentração de nitratos na água e percentagem de argilas, que foram mais elevados na estação mais próxima da embocadura do estuário (estação A). Na estação mais afastada da embocadura do estuário (estação B), o teor de matéria orgânica e concentração de amónia nos sedimentos foram mais elevados.

O estudo da variação vertical da concentração de nutrientes e granulometria dos sedimentos mostrou a existência de diferenças significativas entre as três profundidades estudadas. Na estação A, o teor de matéria orgânica, a concentração de amónia, nitritos, nitratos, silica e fosfatos e percentagem de argilas diferem significativamente, enquanto na estação B as diferenças foram obtidas relativamente à concentração de nitratos e fosfatos.

O estudo da variação temporal da concentração de azoto inorgânico pode reflectir o estado redox dos sedimentos. Assim, a variação temporal da concentração de amónia, nitratos e nitritos sugere que os processos de nitrificação ocorreram contínuamente ao longo de todo o período de amostragem, indicando a existência condições aeróbicas nos sedimentos. No entanto, os resultados obtidos sugerem que nos dois períodos amostrados de Verão, os sedimentos encontravam-se com menor potencial de oxidação-redução, enquanto no final do Outono e no príncipio do Inverno a capacidade de oxidação seria maior.

A variação temporal dos parâmetros ambientais medidos seguem um evidente padrão sazonal , as amostras claramente seguem a ordem Verão 94, Outono, Inverno, Primavera e Verão 95. A variação temporal da temperatura, salinidade, pH, teor de oxigénio dissolvido, concentração de nutrientes na água e nos sedimentos e a percentagem de silte e areia são semelhantes entre as duas estações. No entanto, ocorreram diferenças na variação temporal do teor de matéria orgânica, concentração nos sedimentos de amónia e fosfatos, percentagem de argila e na biomassa da *Zostera noltii*.

Os padrões de sazonalidade identificados relativamente aos factores ambientais estudados nas duas estações amostragem resultam, fundamentalmente, dos fenómenos sazonais relacionados com as características climáticas e fluxos de água de origem marinha no estuário.

MEIOBENTOS

Entre as duas estações de amostragem existem diferenças significativas relativamente à variação temporal da composição e densidade das comunidades meiobentónicas. Na estação B a meiofauna é mais abundante, mas a composição das comunidades é semelhante.

Um total de 17 grupos foram identificados nos dois locais de amostragem: Nematoda, Copepoda, Polychaeta, Kinorhyncha, Oligochaeta, Nauplii larvae, Ostracoda, Turbellaria, Bivalvia, Amphipoda, Gastropoda, Ciliophora, Gastrotricha, Halacaroidea, Cnidaria, Tardigrada, Insecta e Acari. Nematoda foi sempre o grupo mais abundante (estação A - 87%; estação B – 88%), o segundo grupo mais abundante foi Copepoda (estação A - 7%; estação B - 6%). Outros grupos registados ao longo de todo o período de amostragem, na estação A foram os Polychaeta, Kinorhyncha, Oligochaeta, Nauplii larvae, Ostracoda Turbellaria, Bivalvia e Amphipoda, na estação B, Kinorhyncha é o terceiro grupo mais abundante seguido Polychaeta, Oligochaeta, Nauplii larvae, Ostracoda Turbellaria, Bivalvia e Gastropoda.

O estudo da distribuição vertical da meiofauna foi realizado em três níveis de profundidade: 0-3 cm, 3-6 cm, 6-10 cm. A maior densidade da meiofauna foi registada na camada de sedimentos dos 0-3 cm (estação A - 87%; estação B – 88%), a maior profundidade, 3-10 cm, registaram-se densidades muito baixas. O grupo Nematoda foi dominante em todas as camadas de sedimentos, tendo sido registada uma densidade média de 89%, Copepoda foi o segundo grupo mais abundante seguido dos grupos Polychaeta e Kinorhyncha. Na estação B, os Kinorhyncha foram o terceiro grupo mais abundante em todas profundidades estudadas.

A variação temporal da densidade das comunidades meiobentónicas mostram um evidente padrão de sazonalidade, no entanto as duas estações registaram padrões diferentes.

Com base nos métodos de análise multivariável (classificação-Twinspan e ordenação-PCA), foi possível dividir as comunidades obtidas ao longo da amostragem em 4 grupos

sazonais distintos: Estação A – grupo 1 (Junho 94 – Julho 94), grupo 2 (Agosto 94 – Dezembro 94), grupo 3 (Dezembro 94 – Maio 95), grupo 4 (Maio 95 – Agosto 95); Estação B - group 1 (Junho 94), grupo 2 (Julho 94 – Dezembro 94), grupo 3 (Dezembro 94 – Maio 95) e grupo 4 (Maio 95 – Agosto 95). Na estação A, a variação temporal das densidades de nemátodes é responsável pela divisão das comunidades amostradas em dois grandes grupos: O grupo 1 (Verão 94) e grupo 3 (Inverno - ínicio da Primavera) que apresentam elevada densidade de nemátodes, e o grupo 4 (Verão 95) que apresenta um significativo decréscimo. Nesta estação de amostragem os taxa registados com elevada densidade no Verão 94 apresentam um padrão oposto no Verão 95, registando um decréscimo acentuado, particularmente os grupos Nematoda, Copepoda, Kinorhyncha, Bivalvia, Ostracoda, Nauplii larvae e Amphipoda. Na estação B, os grupos Kinorhyncha e Nematoda são importantes para determinação do padrão de sazonalidade. O grupo Kinorhyncha apresenta maior densidade nas comunidades meiobentónicas pertences ao grupo 2 (Verão 94 –Outono). O grupo 3 (Inverno - ínicio da Primavera) e o grupo 4 (Verão 95) possuem maior densidade de nemátodes.

O padrão de sazonalidade obtido no estudo da variação temporal da densidade da meiofauna na camada de sedimento 0-3 cm de profundidade é semelhante aquele obtido para a camada de sedimento global (0-10 cm de profundidade). A elevada densidade da meiofauna da camada mais à superfície dos sedimentos determinou os padrões de sazonalidade obtidos nas duas estações de amostragem.

Nas duas estações o grupo Nematoda registou maior abundância no Inverno e ínicio da Primavera, contrariando a sazonalidade observada nas populações meiobentónicas dos climas temperados, que atingem maiores densidades nos meses com temperatura mais elevada.

A semelhança entre as duas estações de amostragem relativamente à composição das comunidades meiobentónicas poderá ser explicada pelo facto dos factores estruturantes como a temperatura, salinidade, pH, oxigénio dissolvido, concentração de nutrientes na água e a percentagem de siltes e argilas serem também semelhantes nas duas estações.

Os resultados obtidos não permitiram individualizar nenhum factor ambiental específico responsável pelos os padrões de variação sazonal da abundância e composição das comunidades meiobentónicas identificadas. No entanto, é possivel identificar o efeito conjugado de alguns factores abióticos na criação de condições ambientais que explicam a sazonalidade obtida.

Os factores abióticos estudados não explicam a distribuição sazonal das comunidades meiobentónicas nas duas estações amostradas. Os factores bióticos como a disponibilidade de alimento, ciclo de vida e condições tróficas poderão desempenhar um papel fundamental na estruturação dos padrões obtidos, no entanto não foram consideradas neste estudo.

NEMATODA

Com objectivo de identificar o padrão de distribuição temporal e vertical de abundância e composição das comunidades de nemátodes e discutir os factores abióticos e bióticos estruturantes da dinâmica temporal das comunidades de meiofauna identificadas, realizou-se o estudo da variação temporal da composição, abundância, estrutura etária e composição trófica das comunidades de nemátodes.

As elevadas densidades obtidas relativamente ao género Nematoda estão de acordo com estudos desenvolvidos nas vasas intertidais de vários estuários. A composição das comunidades são semelhantes entre as duas estações, foram identificados 70 géneros de 23 famílias. Nas duas estações de amostragem os géneros mais abundantes foram *Terchellingia*, *Paracomesoma*, *Spirinia*, *Odontophora*, *Linhomoeus*, *Chromadorella* e *Paramonohystera*.

O estudo da distribuição vertical das comunidades de nemátodes foi realizado em três níveis de profundidade: 0-3 cm, 3-6 cm, 6-10 cm, como esperado os géneros identificados apresentam as densidades mais elevadas (80%) na camada de sedimento que se encontra mais à superfície e os valores mais baixos 6-10 cm de profundidade (7%). Nas três profundidades estudadas os géneros *Terchellingia*, *Paracomesoma*,

Odontophora e Spirinia foram dominantes. O género *Paramonohystera*, *Viscosia*, *Linhomoeus* e *Camacolaimus* apresentaram maior densidade nas camadas de sedimento a maior profundidade que na camada mais à superfície.

De acordo com a classificação trófica de Wieser (1953) a comunidade de nemátodes foi agrupada em detritívoros não selectivos; detritívoros selectivos, consumidores epibênticos e predadores/omnivoros. Na estação A, os detritívoros não selectivos foram o grupo trófico dominante, seguido dos consumidores epibênticos, detritívoros selectivos e os predadores/omnívoros. Na estação B, os consumidores epibênticos foram o grupo dominante, seguido dos detritívoros não selectivos, detritívoros selectivos e predadores/omnívoros.

O estudo da estrutura populacional dos géneros dominantes mostou a presença de juvenis ao longo de todo o período de amostragem, indicando a existência de reprodução contínua com distintos períodos de recrutamento, claramente identificados e associados aos períodos de maior densidade da população.

A variação temporal da densidade e composição das comunidades de nemátodes mostram um evidente padrão de sazonalidade, no entanto as duas estações registaram padrões diferentes.

Com base nos métodos de análise multivariável (classificação-Twinspan e ordenação-PCA), foi possível dividir as comunidades obtidas ao longo do periodo de amostragem em 5 grupos sazonais distintos: Estação A – grupo 1 (Junho 94 – Julho 94), grupo 2 (Agosto 94 –Setembro 94), grupo 3 (Outubro 94 – Dezembro 95), grupo 4 (Dezembro 95 – Maio 95) e grupo 5 (Maio 95 –Agosto 95); Estação B - group 1 (Junho 94 – Julho 94), grupo 2 (Agosto 94 –Setembro 94), grupo 3 (Setembro 94 – Janeiro 95), grupo 4 (Janeiro 95 – Maio 95) e grupo 5 (Maio 95 – Agosto 95).

O padrão de sazonalidade obtido no estudo da variação temporal da densidade dos diferentes géneros na camada de sedimento à superfície (0-3 cm) é semelhante aquele obtido na camada de sedimento global dos 0-10 cm de profundidade. A elevada

densidade dos nemátodes que ocorreu na superfície dos sedimentos determinou o padrão de sazonalidade obtido nas duas estações.

O estudo da variação temporal da composição trófica mostrou que as comunidades do Verão 94 e do Verão 95 tinham composição diferente. No Verão 94 dominaram os detritívoros não selectivos, enquanto no Verão 95 os consumidores epibênticos são mais abundantes, o que poderá indicar uma alteração do tipo de alimento disponível.

A semelhança entre as duas estações relativamente à composição das comunidades de nemátodes poderá ser explicada pelo facto dos factores abióticos considerados estruturantes como a temperatura, salinidade, pH, oxigénio dissolvido, concentração de nutrientes na água e a percentagem de siltes e argilas serem também semelhantes nas duas estações.

Os resultados obtidos, tal como para os grandes grupos da meiofauna, não permitiram individualizar nenhum factor ambiental específico responsável pelos os padrões de variação sazonal de abundância e composição das comunidades identificadas. No entanto, é possivel identificar o efeito conjugado de alguns factores abióticos na criação de condições ambientais que explicam a sazonalidade obtida.

O estudo da variação temporal da abundância, estrutura etária e composição trófica das populações dominantes das comunidades de nemátodes permitiu identificar importantes factores bióticos estruturantes da dinâmica das populações, nomeadamente o ciclo de vida e tipo de alimento disponível.

A presença de juvenis ao longo de todo o período de amostragem, indicaram a existência de reprodução contínua, com distintos períodos de recrutamento, geralmente associados aos períodos de maior densidade da população, e os periodos de menor abundância corresponderam ao declínio de juvenis e consequentemente da actividade reprodutiva. A alteração da dominância dos grupos tróficos sugerem alteração do tipo de alimento disponível.

CONCLUSÃO GERAL

A composição e abundância das comunidades identificadas de meiofauna são característicos das condições ambientais dos sedimentos associados aos povoamentos de plantas intertidais.

A variação temporal e a evidente sazonalidade da densidade e composição das comunidades de meiofauna e do taxon Nematoda nos sedimentos associados aos povoamentos de *Zostera noltii* do estuário do Mira, parecem estruturadas, fundamentalmente pelos factores bióticos, tais como o ciclo de vida e dinâmica trófica.

Os factores descritos como importantes para explicar as variações sazonais destas comunidades nas regiões temperadas não parecem ser fundamentais, como a temperatura, salinidade, pH, oxigénio dissolvido e granulometria, devido à pequena amplitude da variação registada ao longo do período de amostragem. No entanto, foi possível identificar o efeito combinado dos factores abióticos e bióticos na criação de condições que explicam sazonalidade obtida nos habitat.

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Dynamics of meiofauna communities in association with *Zostera noltii* seagrass beds in the Mira estuary (SW Portugal)

"....partiu para os trabalhos, para as tormentas, para as misérias – para a delícia das coisas imperfeitas"

Eça de Queirós - "A perfeição"

1 - GENERAL INTRODUCTION

1. GENERAL INTRODUCTION

1.1 SCOPE OF THE WORK

The meiobenthos is an important benthic component in marine and estuarine sediments, and is composed of animals of small size, with the range between 31-1000 µm. They have short generation times (mostly days and weeks) with continuous reproduction all year round. The metazoan meiobenthos includes nematodes and harpaticoid copepods; foraminiferans and ciliates are not considered in this work. The meiobenthic communities generally have high densities and high diversity, especially in fine sands with a high silt content. Nematodes are by far the numerically dominant representatives of the meiofauna, they can occur up to thousands per cm^2.

The aims of the early meiofauna studies were essentially taxonomic descriptions and systematic investigations. However, during the last thirty years, this approach has changed considerably. Today, research on meiofauna has as prime general goal the understanding of the ecological role of this group of organisms in the benthic ecology of estuarine and marine sediments.

In the last decades, the target of meiobenthos investigations has been to answer different ecological questions: a) vertical and spatial distribution patterns, abundance, and the diversity of the meiobenthic communities and their relationship with the environment; b) interactive relationship of meiofauna to other faunal elements, and their contribution to the energy flux through the benthic ecosystem; c) the close links between micro-organisms, detritus and meiofauna, integrated into a detrital throphic complex; d) meiofauna bioturbation in the activation of geochemical fluxes; e) the grazing impact of meiobenthos on phytobenthos as important consumers of this primary production; f) the effects of predation and pollution effects on meiobentos communities. Laboratory manipulations have opened up possibilities for the manipulation of meiobenthic communities, although it still has a very limited part in the research.

In Portugal, many studies have already been carried out concerning the structure of the benthic communities and their role in estuarine processes. In recent years, the studies

have emphasied the role of the benthic communities in the nutrient cycle, and trophodynamics is clearly a central theme, mainly in terms of the quantification of energy flux in the trophic chain. Nevertheless, despite the meiobenthos being an important component of the benthic estuarine system, and despite their contribution to the benthic ecology, meiofauna have not been considered in studies about the estuarine system in the scope of biological processes.

The meiobenthos studies in Portugal are very scarce, documented by only three works: Austen *et al.* (1989) studied the community structure of the macrobenthos and meiobenthos in the Ria Formosa; Rosado (1996) studied the meiofauna from different sediments of the Sado estuary; Franco (1999) studied the vertical distribution of meiofauna in the Tejo estuary. The current study considers the meiofauna of the seagrass beds of the Mira estuary.

There are significant data available on the Mira Estuary from research carried out during the last two decades: the biological characterisation of the macrobenthic and fish communities, the ecology of decapodes crustaceans and the role of the salt marsh in nutrients is documented. However, in the Mira estuary, as in other estuaries in Portugal, data about meiofauna are missing.

In recent years, there has been a growing interest in the faunal composition and ecology of the invertebrates inhabiting seagrass beds. The impetus for such research effort has largely been based upon a recognition of the role of seagrass beds in the energy flux of estuaries, either through the release of dissolved organic carbon directly into the water column, or, after defoliation and fragmentation of leaves, by contributing to the detritus pool. Moreover, seagrass beds are used as nurseries and feeding areas for the young of many commercial fish species. Costa *et al.*, (1994) identified the seagrass beds of *Zostera* in the Mira estuary as an important nursery area for a large number of fish species, which become of vital importance for marine fish, especially those with economic value.

The aim of the present study is to contribute to a better understanding of the role of meiobenthos in benthic estuarine processes, mainly in *Zostera noltii* sediments. Therefore, the temporal variability of the structural characteristics (density, population

structure, diversity) of the meiobenthic communities from sediments of *Zostera noltii* beds is investigated. It is also a major concern to contribute to the knowledge of meiofauna in Portugal.

1.2. OBJECTIVES

This work essentially centres on the study of the meiofauna of the sediments associated with the seagrass beds of *Zostera noltii* in the Mira estuary (southwest coast of Portugal), through the study of the temporal variation of the meiofauna communities, focusing on the ecology of free-living marine nematodes. The specific objectives are:

- To identify the temporal variation distribution patterns of the abundance of the meiobenthic taxa.
- To describe the temporal variation patterns of the environmental factors of the sediments and water associated with the seagrass beds of *Zostera noltii.*
- To identify the temporal and vertical patterns of the meiobenthic taxa density and composition.
- To compare the distribution patterns of the meiobenthic taxa in two sampling stations
- To relate the temporal variation patterns of the meiobenthic taxa to the temporal variation of the environmental factors.
- To identify the temporal and vertical patterns of the nematode genera density and composition.
- To relate the temporal and vertical pattern in genus, age and trophic composition of the nematodes to the variation in the environmental factors.
- To compare the temporal and vertical patterns of the nematode genera at the two sampling stations.
- To discuss how strong is the influence of the temporal changing environment on the structural characteristics of the meiofauna taxa, trophic and age composition of the nematode communities.

Estuarine meiofauna studies have been very scarce in Portugal. The aim of the following review is to provide information for those not familiar with the subject of this work.

2 - CHARACTERISTICS OF ESTUARIES AND ESTUARINE MEIOFAUNA

2. CHARACTERISTICS OF ESTUARIES AND ESTUARINE MEIOFAUNA

2.1. GENERAL FEATURES OF ESTUARIES

Estuaries are transitional habitat, intermediate between the sea, the land and fresh waters. Therefore the estuarine environment is characterized
by having a constantly changing mixture of salt and freshwater, and by being dominated by fine sedimentary material carried into the estuary from the sea and from rivers which accumulates in the estuary to form mudflats. Consequently, estuaries have an ecology that is very different from the adjacent freshwater and coastal systems; the complex physical and chemical changes in the estuary impose physiological limits on organisms (McLusky, 1989).

The most useful definition of an estuary has been given by Pritchard (1967): "an estuary is a semi-enclosed coastal body of water, which has a free connection with the open sea, and within which sea water is measurably diluted with fresh water derived from land drainage". This definition makes no specific mention of tide, although the mixing of sea water and fresh water implies this.

In an attempt to address the limitations of Pritchard`s definition, Fairbridge (1980) gave a more comprehensive definition of an estuary (In: Day *et al.*, 1989): "An estuary is an inlet of the sea reaching into a river valley as far as the upper limit of the tidal rise, usually being divisible into three sectors; (a) a marine or lower estuary, in free connection with the open sea; (b) a middle estuary subject to strong salt and fresh water mixing; and (c) an upper or fluvial estuary, characterized by fresh water but subject to daily tidal action. This definition also excludes some coastal geomorphic features such as lagoons, deltas, and sounds, and also non-tidal estuaries.

The existing definitions of estuaries are neither satisfying nor useful to the modern problems of the estuarine environment or to the diversity of environments considered above. Day *et al.* (1989) propose a new functional definition: "an estuarine system is a coastal indentation that has a restricted connection to the ocean and remains open at least intermittently. The estuarine system can be subdivided into three regions: (a) a tidal river zone, a fluvial zone characterized by lack of ocean salinity but subject to tidal rise and fall of sea level. (b) a mixing zone (the estuary proper) characterized by water

mass mixing and by the existence of strong gradients of physical, chemical, and biotic quantities reaching from the tidal river zone to the seaward location of a rivermouth bar or ebb-tidal delta; (c) a nearshore turbid zone in the open ocean between the mixing zone and the seaward edge of the tidal plume at full ebb tide. This definition significantly increases the limits of estuaries, as it includes the adjacent coastal waters.

According to the definitions above, it becomes very clear that estuarine physical and chemical factors are closely linked to: a) the tidal amplitude, current and wave strength, and their role in the deposition and transport of the sediments; b) the salinity and temperature distribution patterns; c) the water and the dissolved oxygen content in the sediments (McLusky, 1989). To add to these factors, nowadays the estuaries are under pressure as conduits for the effluent discharges from anthropogenic activities.

The wind, the range of the tidal amplitude and land drainage are important factors in explaining the dynamic of the mixes between the seawater and the fresh water (Pritchard, 1967). However, in wide estuaries, the wind is not a relevant factor (Pritchard, 1967; Barnes, 1974) and mixing is a result of circulation processes (Barnes, 1974).

The most noticeable gradient in an estuary is that of the decreasing salinity upstream. The salinity of fresh water is always less than 0.5 psu, while sea water salinity is approximately 35 psu. The salinity of estuarine water is between 0.5 psu and 35 psu. This pattern of salinity distribution is dependent on several factors: the difference of the density of the sea water and fresh water; the volume of the water; the water evaporation rates within the estuary; topography; the volume of the water mass, etc. In the case where the high evaporation rates exceed the freshwater run-off entering the estuary, this produces hypersaline waters. This is typical of the negative estuaries described by McLusky (1989).

The tides have an important role in the estuarine environment because the semidiurnal tides (high tide; low tide) result in an inflow and outflow of the water due to the tidal wave at the mouth (Barnes, 1974; Arthur, 1975).

Fine sedimentary deposits, or muds, are a very characteristic feature of estuaries. Sedimentary material is transported into the estuary from rivers or the sea, or is

washed in from the land surrounding the estuary. Whatever the source of the sediments, in fast-flowing rivers and strong tidal currents at either end of the estuary, all sizes of the sedimentary particles may be eroded and transported. As the currents start to slacken within the estuary, so the coarser pebbles and sands will be the first to be deposited, and the finer silts and clays will remain in suspension. Only in the calmer middle and upper reaches of an estuary, where the river and tidal currents meet, and especially in the slack water at high tide overlying the intertidal areas, will the currents be slow enough for mud to be deposited.

Mud deposition is encouraged by the process of flocculation, which occurs with lower salinity. The flocculation causes aggregation of very fine particles, increasing their weight and their tendency to be precipitated (Pritchard, 1967). Without this process, the estuaries will not have fine sediments.

Muds are rich in organic matter, but the small particle size leads to small interstices, reducing oxygen penetration. In addition, the high bacterial oxygen demand associated with the decomposition of the organic matter, leads to anoxic conditions away from the surface. The organic detritus within estuaries is in the form of flocculus with low density, nearly that of the water. Therefore, it can be transported in suspension a long way off. The sedimentation process is complex. However, the slack water at high tide in intertidal areas has an important role.

Whatever the source of the sediments, the deposition of them within the estuary is controlled by the speed of the currents and the particle size of the sediments, and the degree of consolidation is related to the content of the water.

In the major groups of species living within estuaries, a clear generalised pattern of declining diversity can be seen as one enters the estuary from either end. The number of species of true estuarine animals in the sea or freshwater is low or nil, but increases within estuaries with a maximum number of species in the 5 to 18‰ region. On the other hand, although estuaries may contain relatively few species, the abundance of total organisms in a unit area of the estuarine bottom is normally very high, exceeding the average density of organisms in a freshwater or a marine environment.

The ecological factors of salinity and substrate are thus closely interwoven in explaining the distribution of estuarine organisms. In most estuaries there is a close connection between salinity distribution and substrate type, with reduced salinity associated with finer substrates, often making it difficult to distinguish their effects.

The estuarine habitat is thus not a simple overlapping of factors extended from the sea and from the land, but a unique set of its own physical, chemical and biological factors. The estuarine habitat has provided the environment for the evolution of some true estuarine organisms, but, even more, has provided a productive environment for those species which have entered it from the river, or, more commonly, the sea (Day *et al.*, 1989; McLusky, 1989).

2.2. SALT MARSH AND ESTUARINE SEAGRASS BEDS

Salt marshes are beds of intertidal rooted vegetation, which are alternately inundated and drained by the tides. Numerous studies of intertidal salt marshes show that they are among the most productive plant communities in the world, and are often a large proportion of the total area of the estuaries. In addition, they are important to other components of the estuarine ecosystem because they (1) provide a food source for both estuarine and coastal consumers, (2) serve as habitat for larger numbers of both young and adult estuarine organisms, and (3) regulate important components of estuarine chemical cycles (Day *et al.*, 1989).

In many estuaries of the European coast, typical salt marshes are confined to the upper part of the shore, which is less frequently flooded; therefore they are inundated only during the higher tides (e.g. new and full moons). The upper part of the shore is often dominated by *Juncus maritimus* and *Atriplex spp*, while the lower part is dominated by *Spartina maritima*. Many estuaries along the Atlantic coast of North America are often dominated by *Spartina spp* (e.g. *S. maritima*, *S. alterniflora*).

The productivity of salt marshes represents an important contribution to the estuarine ecosystem, mainly through the inputs of organic detritus, which forms the basis of the estuarine food web. In marshes, 80% of the productivity comes from *Spartina*, the remaining 20% coming from the benthic algae (Dobson & Frid, 1998).

Beneath the water surface in shallow estuarine sediments, there are often dense communities of monocotyledenous flowering plants, seagrass beds, which extend mainly by under-sediment rhizome systems. They have an important role in primary production (e.g. *Thalassia*, *Posidonia* and *Cymodocea* in tropical regions, *Zostera*, *Ruppia*, *Potamogeton* and *Zannichelia* in temperate regions). In temperate regions, the seagrass beds of *Zostera* are the most common of these plants, occurring in muddy and sandy soft sediments. However, their distribution is not confined to the intertidal zone (Day, 1989; Levinton, 1995).

2.3. BENTHIC FAUNA OF ESTUARIES

The input of organic matter transported into the estuary or produced *in situ* tends to sediment, providing a rich food source to the primary consumer. Most of the estuarine primary consumers are found on the bottom of the estuary, where a rich benthic community is usually very abundant. Zooplankton is usually present in the water column, but strong tidal currents and river flow which flush out the estuary, coupled with the limitation imposed by turbidity, make zooplancton a less dominant feature of the estuarine food web than food webs in the sea (McLusky, 1989).

The most common nontaxonomic distinction drawn between groups of benthic animals is based on "life style", including habitat preference and mode of feeding: (1) epifauna, especially sessile animals, (2) infauna or soft-sediment animals, or (3) motile animals that crawl over the bottom and dig into it for food or protection. In addition, studies of benthic animals are often limited to either large or small organisms: (1) macrobenthic animals large enough to be retained on screen with a pore size of 500 µm, (2) meiobenthic animals smaller than macrobenthic forms, (3) microbenthic organisms smaller than meiobenthic forms.

Benthic animals are directly or indirectly involved in most physical and chemical processes that occur in estuaries, such as interaction with the sediments, the nutrient cycle and the energy flux (Day *et al.*, 1989).

2.4. ESTUARINE MEIOFAUNA.

2.4.1. Definition

Meiofauna, small animals with phylogenetic representation from almost all the invertebrate phyla, occur in great abundance in estuarine sediments worldwide.

The study of meiofauna is a late component of benthic research, despite the fact that meiobenthic animals have been known since the early days of microscopy. Animals which live in the water-filled spaces of capillary sands have been known to exist since the 1800`s. Interstitial fauna or psammon is faunistically diverse and possesses a number of specialized, convergent adaptations, including the tendency to be vermiform (worm-like) or flattened (Fleeger & Decho, 1987).

The term "meiobenthos" was introduced and defined in 1942 by Mare in her account of the benthos of muddy substrates of Plymouth (England), to describe those benthic metazoans of intermediate size. These are animals smaller than those traditionally called macrobenthos but larger than the microbenthos (bacteria, diatoms and most protozoa).

With the development of more effective sampling techniques, it was possible to observe the abundant and complex fauna of intermediate size, ranging between classical micro- and macrofauna (Higgins & Thiel, 1988). The terms meiobenthos or meiofauna are largely used in many references as synonyms, with meiobentos having been considered as the meiofauna living in sediments (Giere, 1993).

The meiofauna is defined on a methodological basis as all metazoans retained on a sieve of 42 µm (Mare, 1942). Today, the size boundaries of meiobenthos are based on the standardized mesh width of sieves with 500 µm or 1000 µm as upper and 42 µm or 63 µm as lower limits: all fauna passing the coarse sieve, but retained by a finer sieve during sieving is considered meiofauna. In a recent move, a lower size limit of 31µm has been suggested because of deep-sea meiofauna, in order to quantitatively retain even the smallest organisms (Giere, 1993).

From the purely practical aspect, these size distinction are clearly useful, if only because choice of the most efficient collection methods and extraction techniques must be related to the size of the organisms. However, meiofauna defined by sieve size raise some problems, because macrofauna juvenile forms are included among meiofauna, but not developed forms. Many authors have recognized this by distinguishing between temporary and permanent meiofauna (McIntyre, 1969).

Currently, the definition of meiobenthos supported by the size spectra of marine benthic fauna, is considered subjective. Warwick (1984) defined meiofauna as an assemblage of small benthic metazoans, ranging in dry adult body mass from about 0.01 to 50 µg and having a coherent set of life-history and feeding characteristics which sets them apart as a separate evolutionary unit from larger macrofauna. Meiofauna are a result of independent evolutionary history and represent a separate, biologically and ecologically defined group of animals.

Thus, the definition of meiofauna could be summarized as small metazoan organisms which have a distinct biological and operational identity. They are isolated as a peak in the benthic biomass size spectrum, separated from the larger macrofauna and smaller microbes (Schwinghamer, 1981). Soft sediments accommodate a relatively larger number of meiofaunal and macrofaunal sized species, but very few of intermediate size (Warwick, 1984), this latter pattern probably arising from evolutionary optimisation of very different size related to life-history and feeding characteristics in the two groups of animals.

Meiofauna are not a homogenous ecological group; they occur in a large diversity of habitats, either marine or freshwater, from Alpine lakes to a deep sea trenches. Even in estuaries, different meiofaunal assemblages occupy different habitats; those in mud differ from those in sand, those in low salinity differ from those in high salinity. Those meiofaunal assemblages living above the bottom, in or on fouling and plant communities or on various animal structures (e.g. worm tubes, echinoderm spines etc.), differ from the sediment dwellers and are often specific to each epibenthic habitat (Coull, 1999). Thus, most ecological studies on meiofauna have been performed in the marine environment.

Twenty-three higher taxa of the thirty-three metazoan phyla have some meiobenthic representatives: Nematoda, Turbellaria, Oligochaeta, Polychaeta, Copepoda, Ostracoda, Mystacocarida, Halacaroidea, Hydrozoa, Nemertina, Entoprocta, Gastropoda, Aplacophora, Brachiopoda, Holothuroidea, Tunicata, Priapulida, Sipunculida. The phyla Gastrotricha, Gnathostomulida, Kynorhyncha, Loricifera e Tardigrada are exclusively meiobenthic. Nematodes, copepods and turbellarians comprise more than 95% of the meiofauna in most sediments (Vincx, 1996).

2.4.2. Distribution and abundance

Meiobenthic communities have been studied in several estuaries: Blyth, UK (Capstick, 1959), Elbe, Germany (Riemann, 1966), New England, USA (Tietjen, 1969), Exe, UK (Warwick, 1971), North Inlet, South Caroline, USA (Coull & Dudley, 1985) Wieser, Germany (Skoolmun & Gerlach, 1971), Grevelingen, Netherlands (Heip *et al.*, 1977; Willems *et al.*, 1984), Oosterschelde, Netherlands (Smol, 1986; Alkemade *et al.*, 1994; Nienhuis & Smaal, 1994; Smol *et al.*, 1994), Tigris & Euphrate, Iraq (Arlt & Saad, 1977; Saad & Arlt, 1977;), Swartskop, S. Africa (Dye & Furstenberg, 1978), Lynher, UK (Warwick & Price, 1979), Westerschelde, Netherlands Belgium (Van Damme *et al.*, 1980; Van Damme *et al.*, 1984; Li & Vincx, 1993; Soetaert *et al.*, 1994b; Soetaert & Herman, 1995; Li *et al.*, 1997a), Eems- Dollard, Netherlands (Bouwman, 1983; Van Damme *et al.*, 1984), the Wadden Sea, (Witte & Zijlstra, 1984), Wellington, New Zealand (Coull & Wells, 1981), Tamar, UK (Warwick & Gee, 1984; Austen & Warwick, 1989), Hunter, Australia (Hodda & Nicholas, 1985, 1986), Gironde, France (Santos *et al.*, 1996).

Metazoan meiobenthos densities are typically in the range of 10^5 to 10^7 ind.m^{-2}, with, on average, 1 to 2 million ind. m^{-2} in estuarine and shallow coastal environments. This corresponds to a biomass range of 0.01 to 10 g C.m^{-2} and average values approximating 1g C.m^{-2} (Heip *et al.*,1985; Heip *et al.*,1995), especially in fine sands with a high silt content. Values tend to be highest in organically enriched muds, lowest in clean sands. However, the productivity is very high, despite representing only a few grammes of biomass (Vranken *et al.*, 1986). In sediments, nematodes are usually the most abundant taxon, comprising 60-90% of the total fauna; copepods are typically second at 10-40%. Occasionally, a taxon other than nematodes predominates (e.g.

Turbellaria, Alongi 1987a, 1989), or copepods are not second in abundance where gastrotrichs occur second to nematodes (e.g. Coull, 1999).

No matter where one looks, in the world there are a lot of meiofaunal species in estuarine sediments. However, in almost all cases, only a few species comprise most of the fauna; most species are rare and comprise a small percentage of the assemblage (Coull, 1999).

The estuarine environment shows large fluctuation of e.g. salinitiy, temperature and oxygen over different time scales, from a tidal cycle to a year (and longer). Meiobenthic organisms, being bound to the sediment, have to adapt to a range of these conditions, and their present occurrence is based on a past set of environmental conditions. The environmental history could explain their specific distribution and the abundance and characteristics of the species: fast-reproducing and fast-growing species will show a quick response to favourable conditions, while slow growth and slow reproduction result in much larger fluctuations (Soetaert *et al*, 1995).

The biomass and production of benthic animals are generally higher in tidal flats compared to other ecosystems, possibly because of an abundance of food and a preponderance of species characterized by high growth rates and rapid turnover (Castel *et al.*, 1989).

The spatial, temporal, vertical distribution, abundance and species composition of the meiobenthic communities are deeply influenced by several biotic and abiotic factors: food resources, oxygen, salinity, temperature, turbidity, hydrodynamic regime, sediment grain size characteristics and topography, trophic relationships, biogenic structures, bioturbation, and pollution disturbance effects (Heip *et al.*, 1985; Fleeger & Decho, 1987). Density and distribution have been related to the food available and to the organic matter at the bottom of the sediments (Soetaert & Herman, 1995). To Coull (1999), sediment particle size, temperature and salinity are the most important physical factors to explain the control of meiofaunal abundance and species composition.

The heterogeneity of the habitats has a determining role in the high variability of the meiofauna communities. They have a heterogeneous spatial distribution (Coull, 1988),

which often trails their food source, or is influenced by the activities of large macrofauna at the cm-scale to m-scale (Hall *et al.*, 1994). Variation in physical gradients (Km to dm-scale) may also cause variation in meiofauna abundance and community patterns (Soetaert *et al.*, 1994b). Findlay (1981) has suggested that large-scale variability is due to changes in physical factors, especially those associated with sediments, while small-scale variability would be likely due to biological interaction. Pollution effects can also follow physical gradients and change the spatial variability of meiofauna (Olsgard & Gray, 1995).

It has been shown that nematodes and copepodes can be significantly different at sites as close to each other as several metres as they can at sites kilometres apart, and nematodes generally have aggregated distributions on a scale of centimetres. Physical factors may be more important in generating macro-scale (e.g. km-scale) heterogeneity than in generating micro-scale heterogeneity. So, micro-scale changes in the meiofauna spatial distribution can be related to the aggregation of individuals, e.g. patches, which can be caused by patchy food distribution and by social or reproductive behaviour (Li *et al.*, 1997b). The selective attraction of nematodes to food supports the importance of food patchiness in determining the heterogeneous distribution of nematodes (Moens *et al.*, 1999a). Meso-scale variability (in order of kilometres) due to salinity changes or grain size differences is more important than a scale variability of hundreds of kilometres among estuaries (Soetaert *et al.*, 1995).

Meiobenthic communities in European estuaries have only been studied in the U. K. (Capstick, 1959; Warwick, 1971; Warwick & Price, 1979; Warwick & Gee, 1984; Moore, 1987; Austen & Warwick, 1989), Germany (Gerlach, 1953; Riemann, 1966; Skoolmun & Gerlach, 1971), the Netherlands (Van Damme *et al.*, 1980; Bowman, 1983; Smol *et al.*, 1994) and northern France (Gourbault, 1981). Until 1995, no data on more southern estuaries existed.

Meiofauna from the intertidal zone of five European estuaries (Ems, Westerschelde, Somme, Gironde, Tagus) has been investigated (Soetaert *et al.*, 1995). The study focused on nematode species composition. Meiobenthic taxa observed included Nematoda, Copepoda, Gastrotricha, Plathelmintes, Foraminifera, Ciliata, Polychaeta, Oligochaeta, Ostracoda, Halacarida, Cnidaria, Priapulida e Tardigrada. Meiobenthos densities varied from 130 to 14 500 ind cm^{-2}. Nematodes were always the most

abundant taxon and their dominance was in the order of 81 to 99%. Copepods, gastrotrichs and turbellarians also presented some significant densities.

Nematodes are usually the most common taxon, followed by harpaticoid copepods, but local sedimentary conditions can change this; nematodes do best in sediments less than 330 µm, and the other taxa may be locally very abundant (Fleeger & Decho, 1987). Escaravage *et al.*, (1989) observed the dominance of the harpaticoid copepods in tidal flats of Arcachon Bay, and Soetaert *et al.*, (1995) in the Westerschelde, observed the near-absence of this group; this fact was explained by chemical pollution effects.

The correlations of the dominant taxa and sediment granulometry have long been known (McLachlan, 1978). The copepod dominated in coarsest sediments, nematodes generally dominated in finer sediments and tardigrades dominated in the finer volcanic sediments (Gourbault *et al.*, 1998). Nematodes tend to increase and harpacticoids decrease with decreasing particle size (Fleeger & Decho, 1987). The grain size and the silt content have co-control in the distribution and diversity of the meiofauna. Changes in tidal amplitude and current velocity alter the distribution and accumulation of the sediment particles and consequently the meiofauna communities (Smol *et al.*, 1994).

The sediment particle diameter is particularly important. In general, the fauna burrow in sediments with a mean particle size of <125 µm, whereas sediment with larger mean grain sizes tend to have interstitial representatives; the interstitial lacunae are simply too small for species to move in fine sediment. In muddy estuarine sediments, the fauna are restricted to the narrow 2-3 cm, oxic zone, whereas in sandy sediments, the fauna may be distributed to depths of > 10 cm (Coull, 1999).

The diversity of the meiofauna communities decreases in sediments with a high content of detritus and clay, but the abundance increases (Heip *et al.*, 1985) and the variability in abundance at a mud site is approximately twice that at a sand site (Coull, 1985b).

Topographic features like pits and depressions are prevalent and abundant features in muddy sediments. Many studies have found a positive association between sediment

depressions, abundance and the life style of meiofauna. The densities of epibenthic copepods inside depressions is much higher than in non-depression areas. On the other hand, the density of burrowers, such as nematodes and some burrowing or tube-dwelling copepods was lower in depression than in non-depression areas (Sun & Fleeger, 1994).

Bioturbation modifies the sediment texture and topography directly, and influences the meiobenthos structure indirectly (Dye & Lasiak, 1986).

In the Netherlands, in the Oosterschelde (Smol *et al.*, 1994) and Westerschelde (Soetaert *et al.*, 1994b) estuaries, the meiofauna composition, abundance, biomass, distribution and diversity were compared between subtidal and intertidal sampling stations. Meiobenthos densities were higher in intertidal than in subtidal areas. Nematodes were by far the most abundant meiobenthic organisms in the intertidal stations, but were less dominant in other areas. The abundance and diversity of the copepods were usually greater in subtidal stations. In the Westerschelde estuary, the dominance of nematodes was especially well pronounced in the intertidal zone (81-98%). Copepoda, Gastrotricha and, less so, Turbellaria were often, both in absolute and relative terms, more abundant in the permanently submersed areas.

According to Bouwman (1983) and Heip *et al.* (1985), the estuarine environment was invaded by marine species which have adapted to reduced salinities in varying degrees, and these species vanish with decreasing salinity. On its upstream boundary, penetration of freshwater species (up to salinity of about 10 psu) or even species of terrestrial origin add to those of marine origin. Hence, nematode diversity usually increases from about 5‰ salinity towards both the marine and the freshwater zone. Total meiobenthic densities tend to increase exponentially with increasing salinities. The lack of low-salinity tolerance of species of marine origin is usually invoked to explain the decreasing densities in the low salinity ranges of an estuary (Coull, 1988).

In summary, the estuarine meiofauna tend to decrease in abundance and number of species as one moves from the sea to freshwater (Austen & Warwick, 1989). Truly euryhaline estuarine species are rare, and euryhaline freshwater species are non-existint (Warwick, 1971). Since the preponderance of species in estuaries is marine, there is a decrease in species richness as one moves toward freshwater (Coull, 1999).

The importance of such factors as salinity or grain size characteristics on nematode community structure is well documented (Warwick & Gee, 1984; Austen & Warwick, 1989; Vanreusel, 1990; Vincx *et al.*, 1990). Nematoda diversity is positively related to salinity (Soetaert *et al.*, 1995). In an intertidal mud flat of the Gironde Estuary, France, the meiofauna community response to salinity occurred as a chronic effect and as an antecipation of estuarine water salinity changes (Santos *et al.*, 1996).

The salinity and sediment characteristics on the scale of hundreds of metres to kilometres, proved to be more important in explaining community structure than latitudinal differences on the scale of hundreds of kilometres (Soetaert *et al.*, 1995). Heip *et al.* (1985) compiled an extensive list of marine and estuarine species with their salinity tolerances.

However, the Nematoda community present in some studies, demonstrated deviations from the pattern one would expect. For example, the diversity in the Tamar estuary (Southwest Coast of England) was lower in the mid-saline station than in upstream stations. Warwick & Gee (1984); Austen & Warwick (1989) related this lower diversity to the lower degrees of disturbance by macrofauna, and the lower oxygen content in sediments. In fact, there are several factors linked with distribution, abundance and diversity of the meiobenthos; Santos *et al.*, (1996) observed that heavy local rain, during periods of exposure, can influence meiofauna both by a strong variation of interstitial water salinity and by erosion of surface sediments.

The nature of the effects of the altered salinity on nematodes has not been documented. Forster (1998) studied the ability of the subtidal and intertidal nematode species to osmoregulate under various conditions of osmotic stress. The species from the upper shore demonstrated the greatest capacity to osmoregulate and tolerate periods of raised body water content. This ability to overcome salinity fluctuactions is a factor in determining horizontal distribution of nematode assemblages in littoral habitats.

The distribution pattern of interstitial meiofauna is influenced by the water flow regime and grain size composition. Coarse grained and well oxygenated sediment has a significantly increased abundance of interstitial meiofauna where flow rates are

increased, but sediment is not eroded. Where the flow regime causes sediment destabilization and erosion, the abundance of meiofauna decreases significantly (Gamenick & Giere, 1994).

Biological factors play an important role in regulating marine benthic communities. In the soft-bottom habitats, the feeding activity of macrofauna on the sediment surface may affect meiofauna in at least 3 ways: first, by direct predation (Palmer, 1988); second, by competition for food sources; and third, by increased food supply in the form of reworked sediment and faecal pellets (Bell *et al.*, 1978; Ólafsson, *et al.*, 1990). It is likely that such activity mainly affects the surface populations, being affect the deeper-dwelling meiofauna to a much lesser extent. Of the two usually most abundant meiofauna taxa, harpacticoid copepods seem to respond more quickly to reworked sediment. Ólafsson & Ndaro (1997) observed, in microcosm, two borrower crab species in soft sediments. Their presence caused a significant decrease in copepods, but nematodes showed themselves to be quite resilient to the reworking of the sediment surface, and the crabs did not alter the structure of the nematode assemblages.

2.4.3. Temporal distribution

The natural fluctuations of meiofauna abundance and physical variable data as regards salinity, temperature and granulometry were studied during eleven years (1973-1983), at subtidal estuarine sites of sand and mud in South Carolina, USA (Coull, 1985b). The meiofaunal assemblages studied were cyclical with distinct repeatable seasonal periodicites. The order of magnitude of the seasonal abundances was not regular. There were no long-term cycles in fauna or temperature and salinity. However, the abundance maxima were in 1975 and 1977, but these peaks did not correlate with any of the measured physical variables, while having the same seasonal cycle as other years. At the mud site, abundance peaked in late winter/early spring, while the seasonal abundance correlated with salinity changes. In sand, abundance peaked in mid-summer and positively correlated with temperature and negatively with RPD (redox potencial discontinuity). Grain size at the sand site decreased in the 80`s and there was a concomitant decrease in the abundance of copepods.

The eleven years of monitoring of meiobenthic copepods indicates that the two communities of mud and sand were controlled by different mechanisms (Coull & Dudley, 1985). The mud community was distinctly seasonal, whereas at the sand site seasonality was not pronounced. There was no long-term periodicity in both sites. Sand-site copepods declined over the 11 years and their number of species decreased at the rate of about one species per year. There was no significant change at the mud site. The decrease in copepods species at the sand site was correlated with a concomitant decrease in sediment median grain size. There were no significant long-term abundance cycles at the mud site. The absence of any long-term period in the abundance of individual species at the mud site is indicative of the consistent seasonality inherent in this community. This regular, consistent pattern is not surprising. The relative constancy of the habitat has apparently allowed development of an assemblage well tuned to recurring environmental parameters. Consequently, to study the temporal distribution in a muddy area does not require sampling on a longer time scale

The seasonal variations of meiofauna abundance was examined at an intertidal mud flat of the Gironde Estuary, France. Clear seasonal variations were evident. Meiofaunal composition was mainly regulated by temperature, salinity, insolation and the grain size composition (Santos *et al.*, 1996).

In the Oosterchelde estuary, a pronounced seasonality was found for most meiofauna groups, generally with a maximum abundance in the warm seasons and minimum in winter. Nematodes, the dominant taxon, fluctuated according to the same pattern. In the intertidal stations, the density sometimes increased up to 20 times the winter values (Smol *et al.*, 1994).

Many studies clearly demonstrate that meiofaunal assemblages change seasonally, both in abundance and in species composition. The 22-year data set from North Inlet, South Carolina, USA clearly demonstrates (Coull, 1999): (1) the annual pattern of total abundance and species is repeatable from year to year, even though absolute abundances may change between years, and (2) not every site within an estuary has the same annual pattern. The seasonal abundance patterns between a subtidal sand site and a subtidal mud site are different. These patterns are directly tied to either

annual temperature patterns or to temperature-induced controls on food abundance and type, anoxic depth levels, bioturbation and disturbance.

2.4.4. Vertical distribution

Early studies indicated that the majority of the meiofauna were restricted to the upper few centimetres in sandy habitats, and to the upper few millimetres in muddy sediments. However, it was soon realized that, for meiobenthic organisms, the vertical colonization very clearly correlates with the nature of the bottom (Huys *et al.*, 1986). In estuarine sediments, vertical gradients affected by several environmental factors govern the vertical distribution, composition and abundance of meiofauna, which can be substantially different even over a depth of a few centimetres.

The interaction between the physical and biological factors are determinant in the vertical distribution of meiofauna in both sandy and muddy sediments (Joint *et al.*, 1982): penetration depth of oxygen; sediment composition; temperature; water content of the sediment, (McLachlan, 1978); the presence of biogenic structures such as seagrass roots and macro-infauna tubes (Meyers *et al.*, 1987; Escaravage *et al.*, 1989; Palmer *et al.*, 1995); vertical distribution pattern of food sources (Montagna *et al.*, 1989); biological interactions between species.

In almost all meiobenthos studies, the majority of the fauna has been found in the upper 2 cm sediment (Vincx, 1996). Smith & Coull (1987) determined that mud flats contain, in the top first cm, approximately twice as many meiofauna as the first 10 cm of the sandy sediments. In sandy sediments, several studies have established that meiobenthic organisms generally colonise the top 10 centimetres and have been found at a maximum depth of 30-50 cm (Joint *et al.*, 1982). In muddy sediments, most meiobenthic taxa are usually concentrated in the uppermost centimetre. Smol *et al.*, (1994), determined that meiofauna occurred to a depth of 25 cm in the sediment, with 70% inhabiting the upper 10 cm, while on tidal flats, more than 90% were restricted to the upper layer. The decreasing median grain size superimposed by an increasing silt-clay content resulted in a concentration of more than 80% of the meiofauna in the top 5 cm of the sediment. This clearly reflected a response of the meiofauna to two main sediment characteristics, the amount of silt-clay and median grain size.

The vertical distribution of the meiobenthos in sediments is limited by the redox discontinuity layer (RDL), the boundary between aerobic and anerobic sediments. Most of the meiobenthic organisms cannot tolerate the reducing conditions and are thus restricted to the oxidized sediment above this boundary (Coull, 1988). When the redox potencials (Eh) drop below +200 mV, meiofauna densities greatly decrease (McLachlan, 1978). The oxygen concentration decreases rapidly with depth in most sediments and anoxic conditions may be found within a millimetre or so of the sediment surface, with obvious implications for the distribution of meiofauna (Joint *et al.*, 1982). The anoxic sediment zone is closer to the sediment surface in finer sediments; the fauna here are restricted to the uppermost sediment layers, because most meiofauna, but not all, need oxygen to metabolize (Coull, 1999).

Oxygen concentrations in interstitial water with organically loaded sediments is mainly governed by diffusive and advective transport processes. Oxygen is transported below the sediment water interface due to water pumping caused by macro-invertebrates and wave action. The depth distribution of the benthic species, therefore, may depend on chemical microenvironments created by macrofaunal bioturbation and irrigation (Cullen, 1973). The mud-burrowing harpacticoid copepod *Cletocamptus confluens* is often found not only at the top but also deeper in anoxic and sulphidic; sediment layers. It is not necessarily an indication of a high tolerance of anoxia and sulphide; the macrofauna activity could facilitate the colonization of meiobenthos at depth (Vopel *et al.*, 1996).

Low oxygen concentrations and subsequent sulphide exposure may be among the most important structuring factors in soft-bottom communities. Generally, nematodes are considered to be the meiofauna taxa most resistant to low oxygen concentrations and sulphide exposure, and copepods to be more sensitive (Hendelberg & Jensen, 1993). However, this seems to be species specific, as the diversity of nematodes may decrease after a hypoxic event (Austen & Widbom, 1991) and some copepod species, *e.g.Cletocamptus confluens*, appear to be tolerant to low oxygen concentrations and sulphide exposure (Vopel *et al.*, 1996).

Meiofauna colonising the interface between the pool`s mud and stagnant bottom water are exposed to steep and temporally variable gradients of sulphide, oxygen and pH.

The transition zone between oxygen and sulphide (chemocline) is often restricted to sediment strata of some µm thickness, and its position changes diurnally in response to the light cycle. During the night, sulphide can diffuse from the sediment into the overlying water, turning the conditions anoxic. When solar radiation is sufficiently intense, the top sediment layer and the bottom water become oxic again due to oxygenic photosynthesis. A frequent or regular shift between oxic and anoxic sulphidic conditions is a common situation for mud-dwelling meiofauna. Species colonising sulphidic sediments possess such strategies as internal and peripheral mechanisms for sulphide detoxification and a high anaerobic capacity to limit sulphide toxicity and to cope with anoxia. For *Cletocamptus confluens*, the survival of sulphidic periods depends on the duration of anoxia rather than on the concentration of sulphide (Vopel *et al.*, 1998).

The presence of biogenic structures such as roots (Escaravage *et al*, 1989) and tubes built by the benthic organisms (Nehring *et al.*, 1990) modifies the microenvironments of the sediments, and consequently the vertical pattern distribution of meiofauna.

The vertical distribution of the food resources influences the vertical distribution of meiofauna (Montagna *et al.*, 1989). The meiofauna abundance increases with increasing food supply, but is limited by the relatively poor oxygen availability in deeper sediment layers. Because fine sediments are less permeable to oxygen than coarser ones, the number of meiofauna organisms in such sediments is often less than one would predict from food availability alone, thus explaining the indirect effect of sediment granulometry on the vertical zonation of the abundance of meiofauna (Vanreusel *et al.*, 1995).

The vertical zonation of meiofauna is the result of physical and also biological factors. Interaction between the species means that they always seem to occupy the same position relative to each other, irrespective of their depth at any moment. The vertical separation of species will reduce the number of competitive and predative interactions, and this could explain the often very high number of species that coexist in a certain small patch. The nematode species with feeding structures which are almost identical in form showed fine-scale vertical stratification, allowing species with similar food requirements and feeding to co-exist in the same locality. The body morphology is smaller and more slender, and therefore able to penetrate more easily to greater depth

(Joint *et al.*, 1982). The presence of the epibenthic predators also influences the vertical microdistribution of meiofauna. The reduction of the abundance in the top few millimetres of sediment could be explained by the mortality associated with fish predation and disturbance, and also migration downwards in the sediments (Fitzhugh & Fleeger, 1985; Coull *et al.*, 1989).

Diurnal changes in depth distribution have been related to tide periods indicating that harpacticoids from intertidal sand flats may display downward migrations at high tide depth (Joint *et al.*, 1982).

Buffan-Dubau & Castel (1996) studied in Arcachon Bay the diel and seasonal variations of the vertical distribution of the meiobenthic copepods in muddy sediments. The results showed diel changes in depth distribution which followed the diel variation of the superficial sediment temperature. When the temperature of the sediment surface increased, copepods tended to migrate up, and to migrate down in winter. These changes were related to the seasonal variation of the superficial sediment temperature, to the oxygen penetration at depth and to breeding activities. Diurnal changes in depth distribution have been related to tide periods, indicating that the harpacticoids from intertidal sand flats may display downward migrations at high tide depth (Joint *et al.*, 1982).

There are several studies concerning the vertical distribution of marine nematodes (e.g. Fenchel & Jansson, 1966; Fenchel & Riedl, 1970; Boaden & Platt, 1971; Wieser, 1975; Platt, 1977; Joint *et al.*, 1982; Tietjen *et al.*, 1989; Vanreusel *et al.*, 1995). Nematode abundance typically decreases vertically in the sediment. The proportion of nematodes living deeper than 5 cm in the sediment is usually less than 10% (Transpurger & Drews, 1996).

The vertical distribution is controlled mainly by factors related to the food available, and it is limited by oxygen availability at depth in sediment, which is regulated by biological processes in modifying the physico-chemical environment, and which consequently affects the distribution of the benthic organisms (Shirayama, 1984).

2.4.5. Ecological role of meiofauna in estuaries: Trophic relations

In estuarine sediments, meiofauna (1) serve as food for a variety of higher trophic levels, (2) facilitate biomineralization of organic material and enhance nutrient regeneration, and (3) exhibit high sensitivity to anthropogenic inputs, making them excellent organisms for the study of estuarine pollution.

Metazoan meiofauna consume a wide variety of food sources, including bacteria, microalgae, protozoans, detritus and other organic matter. They also have the ability to absorb dissolved organic matter. Meiofauna can shift feeding preferences seasonally and can shift feeding preference from the juvenile to adult stages. Food production is not only the production of bacterial, microalgal and protozoan biomass. Detritus supply can also be important to meiofaunal organisms (Montagna & Yoon, 1991). Dissolved organic matter can be important in the nutrition of meiofauna, especially for juvenile molluscs. Nevertheless, what genus or species feed on is largely unknown (Moens & Vincx, 1997).

Meiofauna have an important role in the functioning of the benthos. Gerlach, (1971) estimated that meiofaunal biomass constitutes up to 4% of macrofaunal biomass. However, with a higher turnover rate, the small meiofaunal biomass accounts for 33% of total benthic production. Warwick, Joint & Radford (1979), estimated meiofaunal biomass at 17% of macrofauna, and meiofaunal production is three times higher than that of macrofauna (In: Gee, 1989).

Despite all this production, for a long time meiofauna were thought to be an energetic dead-end, receiving energetic imputs from the lower trophic levels, primary producers and microheterotrophs, but otherwise not participating in benthic energy flow (McIntyre, 1969). In more recent years, meiofauna have been demonstrated as playing a potentially substantial role in the energy flows to the higher trophic levels, both directly, since meiofauna can be significant prey to macrofauna and other organisms from the high trophic levels (Gee, 1989; Coull, 1990; Feller & Coull, 1995), and indirectly, as they may contribute to nutrient recycling processes. It has been suggested that meiofauna stimulate the heterotrophic breakdown of organic matter in sediments (Montagna, 1995), and through bioturbation of the sediment, which

increases both the penetration depth of oxygen into the sediment and the available space for heterotrophic processes (Cullen, 1973; Alkemade *et al.*, 1992b).

During the 1970`s, little was know about how, what and how much meiofauna consumed. A lot has changed. The kinematics of meiofaunal feeding has been defined. The studies fall into two categories: those done to elucidate meiofaunal feeding biology, and those done to assess the impact and importance of meiofauna in carbon cycling (Montagna, 1995).

Together, nematodes and harpacticoids usually dominate the meiofauna communities, and are classified in feedings groups. There are four harpacticoid feeding groups: point feeders that are selective epistrate pikers, line feeders that scrape edges of particles, plane sweepers that sweep food into their mouths from two-dimensional surfaces, and solid feeders that either eat or clean whole particles. There are also four nematode feeding groups: deposit feeders, epistrates feeders, scavengers and predators. Most metazoan meiofauna behavior is adapted to select specific microbial food items, e.g., microalgae, bacteria, and protozoans. Some workers have referred to this feeding habit as grazing, and have measured how much microbial biomass is consumed by meiofauna (Montagna, 1995).

Meiofauna are an important food source for higher trophic levels (Bell & Coull, 1978; Bell, 1980; Coull & Wells, 1983; De Morais & Bodiou, 1984). Gee (1989) made an ecological and economic review of meiofauna as food for fish, to enhance the epibenthic fishes as an important group in the predation of meiofauna. At least 70 species of estuarine fish, as well as a few decapods and birds, feed on meiofauna (Street, *et al.*, 1998), while it is now accepted that meiofauna are an important food source for numerous juvenile fish (Coull, 1990). Estuarine ecosystems, with copious quantities of rich detrital, mud, particulary salt marshes, are important areas as nurseries for juveniles fish, where the meiofauna is an important component in their diet. Many bottom-feeding juvenile fish pass through an obligatory meiobenthos feeding stage (Feller & Coull, 1995).

Evidence that epibenthic predators can regulate meiofaunal assemblages was first implicated in experimental studies by Bell & Coull (1978). Subsequently, many studies have quantified the effect of epibenthic predators on meiofauna (Bell, 1980; Fleeger,

1985; Ólafsson & Moore, 1992). These studies demonstrated that meiofaunal densities often increase in the absence of epibenthic predators, presumably due to a release from predation. Other experiments utilizing predator enclosures and laboratory mesocosm indicate that fish and crustaceans reduce meiofaunal abundances (Gee *et al*, 1985; Gee, 1987; Ellis & Coull, 1989; Nilsson, 1993) and alter vertical distribution in sediments (Coull *et al.*, 1989). However, the predation pressure in the copepods (Woods & Coull, 1992) and nematode communities (Fitzhugh & Fleeger, 1985) does not have an important impact on their abundances. The predation rate is lower and the organisms removed by the predation are quickly substituted, due to the high reproductive rate of these organisms.

It is clear that predators eat meiofauna, many exclusively. However, in the field, the predator makes little impact on meiofauna prey population. Meiofaunal prey populations tend to be large and the predatory removal relatively small; thus, predation is unlikely to drastically reduce prey populations. Additionally, many meiofauna have life-history characteristics that allow rapid replenishing of the prey population (Coull, 1999).

Some studies have been undertaken regarding the meiofauna taxa most consumed by fish. Despite nematodes being frequently more abundant in meiofauna communities, the number observed in fish guts is very small. Benthic copepods are the predominant prey items in the guts of the fish. However, this dominance may be real, or simply be the result of non-chitinous meiofauna being digested rapidly and thus not being visually present in the fish guts. In microcosm experiments, in detrital mud, the abundance of nematodes is reduced by 54 % and copepod abundance by 56 % over the six hours of the feeding period. Most of the fish from the microcosm had meiofauna in their guts (Coull *et al.*, 1995).

Meiofauna could have an important role in mariculture, especially the harpaticoid copepods as an important nutritional complement of the *Artmia* diet for fish farming (Gee, 1989).

Many laboratory and field studies have demonstrated the potential importance of bacteria and microalgae as food for nematodes and harpaticoid copepods, the dominant representatives of matazoan meiofauna; yet their importance as grazers

remains to be established (Montagna, 1995; Moens & Vincx, 1997). The relationship between meiofauna, macrofauna and their microbial food is obviously very complex and very different in different environments. Meiofaunal grazing response is a function of community structure, and of environmental characteristics of the habitats, apparently responding to nutrient enrichment with higher grazing rates (Montagna & Yoon,1991; Montagna, 1995). Meiofauna graze on small particles of microbial food, and the grazing rates increase when offered increased abundances of microbial food. On average, meiofauna graze at a rate of $0.01.h^{-1}$, or 1% per hour of the standing stock of both heterotrophic bacteria and autotrophic microalgae. As long as the average global microbial turnover time is about 4 days or less, meiofauna grazing will be roughly in equilibrium with microbial production. This suggests that meiofaunal communities are tightly linked to microbial communities. Therefore, meiofauna have a significant global impact on microbially mediated processes by allowing microbial growth rates to be maintained in log phase (Montagna, 1995).

The quantity of organic matter readily available to benthic consumers is not easy to assess; the detritus accumulated in the sediments is not utilisable by benthic consumers. Energy flow studies on seagrass systems have shown that only a small portion of primary production is consumed directly by benthic organisms and that most of the plant material must fractionate before entering the food chain. The role of bacteria as a source of important precursors for heterotrophic metabolism may represent the link between detrital particles and benthic consumers.

In seagrass sediments, the bacterial abundance and biomass are significantly enhanced by the seasonal fluctuations of the organic matter imputs. Bacteria are an important azote (N) source for the higher trophic levels. The significant relationship between meiofauna and nematode abundance and bacteria fluctuations could indicate a preference for bacteria as a food source (Danovaro, 1996). Findlay and Tenore (1982) demonstrated that the deposit-feeder nematodes incorporate more nitrogen from associated bacteria than from detritus itself.

Meiofauna are probably an important component of benthic energy flow because of their high abundance. Moreover, meiofauna function at temporal and spatial scales similar to microbes, allowing close link between microbes and meiofauna. Their rapid turn-over rates would enable meiofauna to respond quickly to changes in microbial

biomass or activity. By the same token, this link implies that meiofauna grazing or physical activity may exert a significant positive or negative effect on microbial biomass and turnover. For these reasons, meiofauna in general, and particularly nematodes, the dominant taxon, affect microbial activity, and thereby affect detrital decomposition. Meiofaunal nematodes can significantly affect benthic carbon flow by their effect on the rate of detritus mineralization (Flindlay & Tenore, 1982).

The close links between micro-organisms, detritus and meiofauna integrate meiofauna into a detrital trophic complex. Tietjen (1980) suggested four ways meiofauna stimulate bacterial growth and subsequent mineralization/nutrient generation: (1) meiofauna mechanically break down detrital particles and cause them to be more susceptible to increased bacterial action; (2) meiofauna directly excrete nutrients into the medium for microbial use; (3) production of meiofaunal slime/mucus attracts and sustains bacteria growth; and (4) by bioturbating sediments, meiofauna act as vertical conveyors within sediments, and between the sediments and overlying waters. By preying on bacteria, meiofauna maintain the bacterial populations in an exponential growth phase (Gerlach 1978). Meiofaunal bioturbation also activates geochemical fluxes. In particular, the diffusion rate of oxygen becomes activated, enlarging the oxic habitats of aerobic bacteria and many meiofauna.

Meiofauna are important in stimulating bacterial growth, which then enhances remineralization (conversion of organic N, P and C to their inorganic form). Meiofauna certainly package organic molecules and, because of their relatively short generation times, this package material is returned to the system rapidly. Meiofauna nutrients then become part of the well-known microbial loop, where they are utilized by bacteria, and converted into dissolved organic carbon for use by higher trophic levels and remineralized for primary producers. These processes are important in all kinds of habitats, but are probably most active in those sediments with high amounts of organic matter, i.e. muds. Sandy sediments with their lower organic content would have much less such activity (Coull, 1999).

With the presence of bacterivorous nematodes was found an increased mineralization of organic carbon (Alkamade *et al.*, 1992a). The mechanism by which nematodes accelerate decomposition processes is still unknown, but three possible mechanisms have been suggested: (1) removal of senescent bacterial cells by grazers might

stimulate bacterial growth by keeping the bacterial population active; (2) mucus produced by nematodes provides a rich food source for bacteria, resulting in increased bacterial growth; (3) the bioturbation enhances the diffusion of oxygen and would thereby stimulate aerobic bacterial activity (Alkamade *et al.*, 1992b).

Microphybenthos are an important food source for meiofauna in intertidal environments. On intertidal mudflats lacking emergent vegetation, the dominant primary producers are microphybenthos. At low tide, they can reach high production rates. Energy flow in this specific type of intertidal environment is controlled by the rate of microphybenthos production, and the transfer of carbon into the coastal food web via meiofauna. As microphybenthos biomass increases, meiofauna respond with greater grazing rates, removing more biomass per unit time, yet taking longer periods of time to deplete the microbial population. Meiofauna taxa may have different feeding responses to changes in microphybenthos production. Nematodes apparently respond to increased production with increased grazing rates, but crustacean groups (harpacticoids and ostracods) do not change their feeding rates (Montagna *et al.*, 1995).

Energy flux diagrams have repeatedly been designed to quantify the energetic connections of meiofauna with other faunal compartments in the benthic system. Bacteria, microfauna, meiofauna and small macrofauna are included in a "small food web", which is incorporated in the energy flow diagram of the estuarine benthic system. The organisms of this "small food web" have a negligible biomass but relatively high production, and consume 70-80% of all organic material available. The incorporation of this small food web in an estuarine flow diagram gives a more realistic view concerning the flow of primary production (Kuipers *et al.*, 1981).

The interactive relations of meiofauna to other faunal elements, and the contribution of meiobenthos to the energy flux through the benthic ecosystem, can be assessed by measuring numerical parameters such as population abundance, biomass and production. The problem is the difficulty of calculation (Vanhove, 1997). While our understanding of the basic qualitative aspects of the meiofauna`s functional position in sediments is still far, from complete, reliable attempts to quantify some of these processes are, thus far, almost non-existent. The key problem is still to obtain a more

profound knowledge of the feeding habitats of the meiofauna, and to develop a reliable methodology for their quantification (Moens & Vincx, 1997).

2.4.6. Effects of physical and chemical disturbance on meiofauna communities

Benthic organisms accumulate organic chemicals from the sediments, thereby becoming susceptible to their deleterious effects. Manifestations of toxicity depend on the extent of exposure and on the specific species exposed to the accumulated compound (Lotufo, 1998a).

Macrofauna have traditionally been the only benthic faunal component examined in pollution monitoring surveys. However, in recent years there has been an increase in studies worldwide which consider the use of meiofauna as potential indicators of anthropogenic disturbance in aquatic ecosystems. This is due to their intimate association with and dependence on sedimentary environments, their high abundance, and their short generation times. Meiobenthos are ideal organisms by which to study the effects of contaminants. Most meiofauna produce multiple generations per year. Sublethal effects of a given toxicant on reproduction, growth rates, genetic expression, longevity, or behavior can be determined in days or weeks. For toxicity tests in the laboratory there are several species easily cultured under laboratory conditions, the entire life cycle taking place in 15-25 days (Coull & Chandler, 1992). Meiobenthic copepods have been successfully used as test-organisms in aquatic hazard assessments, including sediment toxicity testing (Lotufo, 1998a). However, the use of meiobenthos to determine the effects of pollution is not without problems, particulary because of the relatively difficult taxonomy of meiobenthic animals.

The effects of pollutants on meiofauna depend on pollutant type, taxon or assemblage studied, exposure levels, and whether effects have been determined in the field, in the laboratory or in mesocosms studies. In field studies, most investigators have monitored some or all community attributes after a pollution event. Traditionally, abundance of the major taxa, diversity and species composition have been measured. Certain meiofaunal species have been touted as pollution indicators. A few field studies have been conducted with the introduction of the controlled levels of a

pollutant to naturally occuring assemblages. *In vitro* laboratory tests have primarily tested toxicants in the aqueous phase, whereas, in nature, many toxicants are associated with sediments. Most tests have been acute, where the end points are characterized by survival, mortality and modified behaviour. Chronic tests longer than 96 hours have determined full life-cycle and reproductive effects. As an intergrade between *in vitro* and field studies, mesocosm studies have been successfully used to test for the longer term population and community level effects of pollution on meiofauna. Toxicant exposure can be carefully controlled in mesocosms.

In organically polluted habitats, major taxon abundances have increased in half the studies and decreased in others, but species diversities have consistently decreased. Crude oils are generally less toxic to meiofauna than refined oils. Crude fuel oils and oil dispersants are toxic to meiofauna at lower concentrations *in vitro* and in mesocosms than in the field. The oil dispersants alone, mixed, or combined with oil are usually more toxic than oil alone (Coull & Chandler, 1992). Permanent oil discharges from a refinery influence the meiobenthic densities differently; it appears that nematodes are more resistant than the other groups of meiofauna (Beyrem & Aissa, 1998).

With all metals, as concentrations increase, mortality increases and reproductive output decreases *in vitro*. Cadmium is less toxic to meiofauna than other metals, and methylmercury is more toxic than other forms of mercury. Aqueous pesticides cause mortality and inhibit life-history and/or reduce copepod fecundity. Pollutant mixtures inhibit life-history progressions *in vitro*, and in the field they cause synergistic reductions in meiofaunal abundance and diversity (Coull & Chandler, 1992).

Domestic sewage discharges produce organic pollution which can influence the meiobenthic community structure in two ways: (1) by generating changes in the organic matter and nutrient concentrations in the sediments, and (2) by stimulating microbial heterotrophic activity and hence causing hypoxia or even anoxia in the sediment and interstitial waters (Schratzberger & Warwick, 1998).

Man`s activity has resulted in an artificially high input of nutrients and organic matter into many coastal and offshore areas, raising the organic content of the sediment compared to natural levels. An excess of organic inputs into the marine environment

can create an unbalanced ecosystem with high environmental stress (Austen & Warwick, 1995). The environmental management of anthropogenic inputs of organic materials into the sea requires a knowledge of the effects of different intensities and frequencies of input in relation to the nature of the receiving assemblages of organisms. Nematode assemblages from muddy estuaries remain unaffected in low additions, but medium and high additions of organic matter result in significant decreases of the diversity and species richness. These results have management implications for the marine environment; for example to minimise the effects, the same amount of organic matter administered in many small doses has a milder effect on community structure than when administrated in fewer but larger doses (Schratzberger & Warwick, 1998).

The composition of meiofauna along an organic pollution gradient has been studied. Nematodes increase in abundance along a gradient of increasing organic enrichment until the environmental conditions deteriorate excessively, and this taxon is absent. Epi-endobenthic copepods show a differential response: interstitial forms, totally absent within 50 m from a sewage outfall, gradually enhance their numbers moving away from the pollution source, while the epi-endobenthic copepods increase in abundance along a gradient of increasing organic enrichment, reaching the highest densities in proximity to the sewage outfall (Sandulli & Nicola, 1991).

Estuarine meiobenthos have great potential to bioaccumulate; the contaminant transfers from sediments to lower trophic level organisms, and subsequently into higher order consumers (DiPinto & Coull, 1997). Polycyclic aromatic hydrocarbons (PAHs) occur in most coastal systems of the world; their elevated concentration in the aquatic environment is usually associated with human activities, mostly via discharges of petroleum and its derivatives. The greater concentration resides in sediments and bioaccumulates in the benthos by direct absorption of freely dissolved chemicals from the overlying and pore water, and also by direct contact with and ingestion of sediment particles. Estuarine meiofauna bioaccumulate sediment-derived PAHs in their body tissues, and subsequently pass them on to their predators (Marshall & Coull, 1996). Sediment associated with PAHs are toxic to harpaticoid copepods, causing both mortality and sublethal effects such as impaired reproduction and feeding (Lotufo, 1998b).

The benthic microalgal biomass is controlled by meiofaunal grazing pressure, and these meiofauna may compete for limited algal resources. Carman *et al.*, (1997) studied, in microcosm, the effects of diesel-contaminated sediment on microalgae, meiofauna and meiofauna-microalgae trophic interactions. A large increase in microalgal biomass was observed in contaminated sediments, and was probably a consequence of reduce meiofaunal grazing. Grazing on microalgae by copepods as a group was reduced because of high mortality. The nematode response was quite different from that of copepods. Concurrent with reduced grazing by copepods, nematode grazing rates increased significantly and decreased thereafter. The general response observed in microcosms was also observed in a field study of PAH contamination.

Physical disturbance is an important factor affecting the structure and composition of marine benthic communities (Hall, 1994). Effects will depend on the nature of the disturbance, its frequency and intensity. The meiobenthos of the mobile sediments is more resilient to physical disturbance than the meiobenthos of the stable muddy sediments (Schratzberger & Warwick, 1998). Sediment disturbance also results from the activities of an organism, such as movement through the sediment matrix, feeding behaviour or the creation of tubes, burrows and casts in or on the sediment. The physical disturbance can cause sediment resuspension and instability, and it can also affect associated macrobenthic and meiobenthic community structure and diversity. Numerous studies indicate that predation and sediment disturbance caused by individual species can affect associated macrobenthic and meiobenthic community structure and diversity (Austen *et al.*, 1998).

Recently, the studies have been used to measure the responses of meiofauna to the disturbance; this is due to the shorter response time and therefore higher sensitivity to antropogenic disturbance (Coull & Chandler, 1992). Furthermore, the meiofauna is abundant and diverse even in habitats which are subjected to considerable natural, physical and chemical stress, and where very few if any macrofauna species remain (Lampadariou *et al.*, 1997).

2.4.7. Communities of free-living estuarine nematodes

2.4.7.1. Abundance, distribution and diversity

Free-living nematodes are the numerically dominant metazoan representatives of the benthos of many marine and brackish-water habitats, attaining densities of up to several million individuals m^{-2} and a corresponding biomass of 0.1 to 10 g $C.m^{-2}$ (Heip, *et al.*, 1985). In coastal areas, this is but a small fraction of the total carbon input, but it by far exceeds the contribution of other meiofauna (Vranken & Heip, 1985 In: Moens & Vincx, 1997), especially in estuaries with a high carbon input (Heip, *et al.*, 1985). In organically polluted sites with a predominance of large nematodes, biomass values of up to 50 g wet weight m^{-2} have been reported (Bett & Moore, 1988 In: Moens & Vincx, 1997). In terms of adenosine triphosphate (ATP), nematodes may comprise up to 92% of living carbon in intertidal sediments (Sikora *et al.*, 1977).

An important feature of nematode communities, perhaps the most important in understanding their ecological success, is the large number of species present in any one habitat (Heip, *et al.*, 1985). Bouwman (1983) attributed nematode dominance in estuarine sediments to three main factors:(1) their burrowing capacity, in combination with their small and slender shape, allowing the occupation of interstitial spaces in coarse grained sediments as well as the invasion of soft sediments; (2) their tolerance, as a taxon, of a variety of environmental stresses; (3) the diversification in buccal structures, enabling nematodes to exploit a broad range of food items present in the benthos.

The marine nematode communities often have high diversity. It is not uncommon to find 50 species in a 10 cm^3 core, and, for example, some 800 species have been reported for the North Sea alone (Vincx, 1989). In deep sea, diversity may even be considerably higher (Lambshead, 1993). Lowest values of diversity were found in polluted subtidal muddy communities (Vincx, 1990). The nematodes tend to increase their density in muddy sediment but the diversity increases in sandy sediments (Heip *et al.*, 1985).

Diversity indices have been particularly popular because of the presumed relationship between species diversity and environmental quality. However, any index involves an inevitable loss of information compared to the data from which it was calculated. In the case of species diversity measures, the information lost includes the identity of the species in the community. For this reason, diversity indices should never be used alone, and must be coupled with population data or multivariate analysis, which reflect qualitative community composition (Vincx, 1990).

2.4.7.2. Reproduction and Life Cycle

Most marine nematodes are dioecious, fertilisation is by copulation, and there is direct benthic development of the egg through four juvenile stages to the adult. A few species are viviparous, the eggs hatching in the uterus. Developmental changes are associated with each of the four moults. The practical consequence of this is that juvenile stages of some species are difficult and often impossible to identify in terms of species (Warwick, 1981).

Marine and estuarine nematode species develop and reach sexual maturity within days, weeks or a few months, depending on a variety of external factors such as temperature and food. Reproduction is usually continuous, and the nematodes fertile period is often relatively long compared to the preadult phase (Woombs & Laybourn-Parry, 1984). Consequently, generations strongly overlap in the field. It is therefore extremely difficult to study species "cohorts".

2.4.7.3. Classification

The ecological studies of the nematode community have been complicated by taxonomic difficulties. Especially in the past, the chaotic and disperse information made this taxon only accessible to the specialist (Gerlach,1980). Since the publication of a pictorial key (Platt & Warwick, 1983; 1988), nematoda identification is now much easier, at least to the genus level. The variability studies of the nematode communities could be more exact and introduce more consistency into the results.

The whole Phylum Nematode currently contains some 20 000 nominal species. About 4000 species are freeliving marine forms. The phylum Nematoda consists of two classes, the Secernentea and the Adenophorea. Only two species from the Secernentea, both members of the genus *Rhabiditis*, have been found as freeliving organisms in the marine environment. The rest of the freeliving marine nematodes are classified as adenophoreans.

In the classification present by Platt & Warwick (1988), the Adenophorea follows that of Lorenzen (1981), which excludes the Order Dorylaimida (terrestrial and freshwater forms). The genera included in the key represent about 60% of the genera considered valid by Lorenzen (1981). The omitted genera are freshwater forms.

2.4.7.4. Trophic relations

Although a large body of literature exists on the systematics and ecology of free-living marine and brackish-water nematodes, their role in the benthic food web is, however, poorly understood. Nematodes may graze a significant fraction of microalga and or bacterial production (Montagna, 1995); their bioturbatory activity may influence sediment diffusion coefficients for a variety of solutes, including O_2 (Alkemade *et al.*, 1992b), and may enhance the surface area available for microbial degradation processes, while their mucous secretions may serve as a substrate for a variety of micro-organisms (Riemann & Marion 1978; Jensen, 1996). Nematodes may also serve as a food source for epi-and hyperbenthic predators (Bell & Coull, 1978; Gee, 1989; Coull, 1990; Service *et al.*, 1992). The magnitude of all these interactions, however, remains largely unknown for lack of experimental evidence on the nematodes` activity and production. The study of these aspects in the animals natural environment is severely hampered by methodological constraints (Moens & Vincx, 1998).

Wieser (1953) linked buccal morphology of free-living aquatic nematodes to feeding ecology. Wieser discriminated between four feeding types, mainly on the basis of the mouth size and presence or absence of prominent buccal armature (Moens & Vincx, 1997):

Group 1: Without a buccal armature:

1A - selective deposit feeders.

1B - non-selective deposit feeders.

Group 2: With buccal armature:

2A - Epistrate - feeders

2B - Omnivores or predators

This scheme has been widely used since. However, the reduction of a huge species diversity into four feeding types, suggesting a very limited functional diversity, is likely to underestimate the true functional complexity of nematode communities. Moens & Vincx (1997) proposed modifications to Wieser's scheme supported by study on live nematodes in the presence of different candidate food particles. They observed a variety of species from an intertidal mudflat in the Westerschelde estuary (SW Netherlands) and recognized six feeding guilds which may mediate energy flows through the benthos via a variety of pathways: (1) microvores; (2) ciliate feeders; (3) deposit feeders *sensu stricto*, all nematodes without a distinct buccal armature (in the first two groups, bacteria and protozoa, respectively are the major particle food sources); (4) epigrowth feeders; (5) facultative predators; (6) predators. Diatoms and other microalgae are an important particulate food for many epigrowth feeders. A strictly or mainly predatory behaviour has been described for only a few species from the study area. Several nematodes, however, are facultative predators.

The main conclusion from this study is that nematodes are in fact opportunistic feeders, which may change their feeding strategies in response to available food, and that very complex and intricate nematode-food interactions must exist in order to explain the coexistence of functionally-related species. Selectivity between food particles could be a function of particle size, but sometimes resides at the level of digestion rather than ingestion. Adaptations and ability also explain the feeding strategies of the several species.

2.4.8. Meiofauna communities of the seagrass beds of *Zostera*

Several studies have shown significantly higher animal abundance, biomass and species diversity in vegetated areas than in adjacent bare substrates (Edgar *et al.*, 1994). *Zostera* beds contribute significantly to biodiversity and production.

The biotic and abiotic factors regulating benthic community structure in *Zostera* beds are numerous: high complexity, high food availability, high organic content, low flow velocity, fine sediment, high shelter, low predation, low competition, enhanced deposition, high sediment stability, and the network of these couplings is complex. The mechanisms causing the observed spatial distribution patterns of the fauna vary in space and time. This leads to site-specific conditions, underlining the importance of the different factors involved. The *Zostera* habitat provides more potential niches than bare sand, and the presence of dense vegetation alters the hydrodynamic environment, causing enhanced deposition of organic matter, which constitutes an important resource of food, but also increases oxygen consumption (Boström & Bonsdorff, 1997).

There are some studies that have focused on the meiobenthic communities associated with seagrass beds: (Hopper & Meyers, 1967; Bell, 1979, 1980; Novak, 1982: review; Osenga & Coull, 1983; Bell *et al*, 1984a; Sogard, 1984; Decho *et al*, 1985; Hicks, 1986; Walters & Bell, 1986; Bell *et al.*, 1988; Alkemade *et al.*, 1992b; Webb & Parsons, 1992; Hall & Bell, 1993; Walters & Bell, 1994; Edgar & Shaw, 1995; Aryuthaka & Kikuchi, 1996; Danovaro, 1996; Gregg & Fleeger, 1998; Guerrini *et al.*, 1998; Bortolus & Iribarne, 1999). These studies, in temperate and subtropical regions, have been carried out in seagrass beds of *Thalassia testudinum*, *Posidonia oceanica*, *Spartina* and *Zostera*, and have aimed to investigate the composition, abundance, distribution, trophic relations and production of the associated meiofauna.

Two studies were identified concerning the meiofauna associated with seagrass beds of *Zostera noltii* in Arcachon Bay, France. The meio- and macrofauna were studied concurrently, in terms of density, biomass, and external factors, seasonally, for a year, at seven stations. A comparison was made between bare sands, oyster beds and vegetated sediment in semi-exposed conditions and in sheltered areas. These studies

showed that both meio- and macrofauna abundances were significantly greater inside seagrass bed sediments than on closely adjoining unrooted sandflats. The nematodes were the main component of meiofauna in abundance, followed by copepods. Macrofaunal biomass is more variable both spatially and temporally than meiofauna biomass. It is likely that the macrofauna is more sensitive to external factors such as predation, anoxia and exposure, than meiofauna. Meiofauna abundance and biomass are more usually a function of food abundance and physical properties of the sediment. Escaravage *et al.* (1989) studied the meiofaunal contribution to the trophic system of these biotopes. In the sheltered seagrass and the oyster park, the nematode communities are dominated by deposit and epistrate feeders.

3 - SEASONAL VARIABILITY OF THE ENVIRONMENTAL FACTORS IN *Zostera noltii* Hornem SEDIMENTS IN THE MIRA ESTUARY

Abstract

The aim of this chapter is to study the temporal variation of the important environmental factors structuring meiofauna composition and Nematoda assemblages, at two sampling sites. They were measured simultaneously with sampling of the meiofauna, in order to investigate the relationship with the temporal variation of meiofauna communities.

The temporal variation of the environmental factors studied exhibited a similar pattern at both stations. The seasonality was evident, the samples clearly following the order, summer 94, autumn, winter, spring and summer 95.

The temporal variations of environmental factors such as temperature, salinity, pH, amount of dissolved oxygen (DO) and concentrations of nutrients in the water and in sediment proportions of silt and clay were similar between stations. However, there were clear differences concerning organic matter content of the sediment, which determined differences in ammonia sediment concentration and phosphate sediment concentration. There were also differences in the temporal variation of the biomass of *Zostera noltii* and in clay proportions of the sediments.

At both stations, the sediments were always in aerobic conditions. However, in summer the sediments seemed to be more reduced.

Temporal and vertical variations of the environmental factors of the seagrass beds of *Zostera noltii* in the Mira estuary were influenced mainly by the climate seasonal variations and by the exchange of water with the adjacent open sea.

3. SEASONAL VARIABILITY OF THE ENVIRONMENTAL FACTORS IN *Zostera noltii* Hornem SEDIMENTS IN THE MIRA ESTUARY

3.1. INTRODUCTION

The biomass and production of benthic animals are generally higher in tidal flats in comparison to other ecosystems, possibly because of an abundance of food and a preponderance of species characterized by high growth rates and a rapid turnover (Castel *et al.*, 1989). The estuarine environment shows large fluctuations of e.g. salinity, temperature and oxygen over different time scales, from a tidal cycle to a year and longer. In estuaries, meiofauna densities are typically very high, and the communities are structured by the extremely variable environmental conditions. Meiobenthic organisms are intimately associated with sedimentary environments. Many physical and chemical factors vary in estuarine sediments, and may dictate the distribution, density and composition of the meiofauna communities (Soetaert *et al.*, 1995).

The estuarine seagrass habitat has an important role in the productivity of the coastal ecosystem. It supports higher densities of animals and higher species diversity than nearby unvegetated sediments. Seagrass beds exert a strong influence on the communities of associated fauna by modifying the hydrodynamic environment (Fonseca & Fisher, 1986). The presence of dense vegetation alters the hydrodynamic environment, stabilising the sediment and causing enhanced deposition of organic matter, which constitutes an important resource of food, provides new habitats, and alters predator-prey relationships due to increased habitat complexity, providing more potential niches (Boström & Bonsdorff, 1997).

To fully understand the ecology of meiofauna of the sediments of seagrass beds of *Zostera noltii* implies studying the environmental factors which exert a strong influence on communities, because the short life span and high turnover rate of meiofauna make them sensitive to environmental modification (Vincx & Heip, 1991). Many abiotic and biotic factors influence temporal, vertical and horizontal distributions and the abundance and composition of the meiobenthic communities, factors such as oxygen concentration, salinity, temperature, hydrodynamic regime, sediment grain

characteristics and topography, food resources, trophic relationships, biogenic structures, bioturvation, and pollution disturbance effects (Heip *et al.*, 1985; Fleeger & Decho, 1987; Coull & Chandler, 1992).

Temporal and spatial variability in the composition and structure of meiobenthic assemblages within the estuarine system is often controlled by the physical conditions preferred by the organisms (Coull & Dudley, 1985; Coull, 1988). Santos *et al.*, (1996) concluded that the major temporal variations of the meiofaunal community are controlled physically, mainly by temperature, salinity, insolation and sand content of sediment.

Most meiobenthos have a heterogeneous spatial distribution, since the variation of the physical gradients (km- to dm-scale) may cause variation in meiofaunal abundance (Montagna, 1991) and community patterns (Soetaert *et al.*, 1994b). It has, for instance, been shown that the nematode and copepode fauna can be as significantly different at sites as close as several metres as they can kilometres apart, and nematodes generally have aggregated distributions on a scale of centimetres. Physical factors may be more important in generating macro-scale (e.g. km-scale) heterogeneity than in generating micro-scale heterogeneity. So, micro-scale changes in the meiofaunal spatial distribution can be related to the aggregation of individuals, e.g. patches, which can be caused by patchy food distribution and by social or reproductive behaviour (Li *et al.*, 1997b). Mesoscale variability (in order of kilometre) due to salinity changes or grain size differences is more important than a scale variability of hundreds of kilometre between estuaries (Soetaert *et al.*, 1995).

The sediment granulometry and the percentage of silt play a key role in the structure of meiofauna communities. In sediments with a high content of silt and detritus, meiofauna has low diversity and high density (Heip *et al.*, 1985). According to Castel (1986), the percentage of silt, clay and organic content in the sediment are the most important variables in determining species distribution and variability in abundance. The temporal variability in the abundance of meiofauna in mud was approximately twice that of sand (Coull, 1985b).

The high stability of the intertidal environment increases the densities, diversity and biomass of meiofauna communities. Changes in tidal amplitude and current velocity

will alter the distribution of the sediment grain size and their stability and therefore the communities (Smol *et al.*, 1994). Bioturbation is an important phenomenon in superficial marine sediments (Cullen, 1973), modifying the sediment texture and topography directly and influencing benthic structure indirectly (Dye & Lasiak, 1986). Topographic features like pits and depressions are abundant features in muddy sediments. Many studies have found a positive association between sediment depressions and the abundance of meiofauna (Sun & Fleeger, 1994).

Salinity fluctuation has generally been assumed to be the major limiting factor in the distribution of estuarine benthos (Coull, 1985b). Estuaries have strongly pronounced gradients of various characteristic substances, the most obvious being the gradient salinity, and many abiotic factors (nutrients, suspended matter, grain size composition) change in parallel with it (Soetaert *et al.*, 1994a). The importance of such factors as salinity or grain size characteristics to meiobenthos community structure is well documented (Warwick & Gee, 1984; Austen & Warwick, 1989; Vanreusel, 1990; Vincx *et al.*, 1990). The study of the meiobenthos variability in several estuaries (Soetaert *et al.*, 1995; Santos *et al.*, 1996) identifies the salinity as an important independent determining factor of the structure of the communities.

Earlier studies indicated that the majority of the meiofauna were restricted to the upper few centimetres in sandy habitats, and to the upper few millimetres in muddy sediments (Huys *et al.*, 1986). Smith & Coull (1987) determined that mud flats contain, in the top first cm, approximately twice as many meiofauna as the first 10 cm of the sand sediment. Meiofauna densities decrease with sediment depth, the penetration depth of oxygen being a very important factor in explaining the vertical distribution. Oxygen diffusion into sediments is limited by the redox discontinuity layer, and the presence of biogenic structures such as seagrass roots and macro-infauna tubes are very important in increasing the depth distribution of meiofauna into anoxic sediments (Escaravage *et al.*, 1989; Nehring *et al.*, 1990). Other environmental factors control vertical distribution patterns such as food sources (Montagna *et al.*, 1989) and the effects of the presence of predators (Coull *et al.*, 1995).

Meiofauna are an important food source for higher trophic levels. At least 70 species of estuarine fish, as well as a few decapods and birds, feed on meiofauna (Gee, 1989), and therefore the role of predation pressure is an important factor in species

composition and the abundance of the meiobenthic communities (Woods & Coull, 1992).

Numerous studies indicate sediment disturbance can affect associated meiobenthic community composition, structure and diversity (Austen *et al.*, 1998). Meiofauna live in close association with sediment, where they are often chronically exposed to a chemical disturbance from an array of contaminants. There is evidence that meiofauna living in contaminated sediments bioaccumulate contaminants rapidly in the body (DiPinto & Coull, 1997) and these can be transferred through the food web (Street *et al.*, 1998). Benthic organisms accumulate organic chemicals from sediment, thereby becoming susceptible to their deleterious effects. Disturbance may also take physical form, and it is a key factor influencing the structure and composition of the communities. Effects will depend on the nature of the disturbance, its frequency and intensity (Schratzberger & Warwick, 1998).

The objective of this chapter is to study the temporal variation of the environmental factors of the sampling sites. Environmental and biological factors were measured simultaneously with sampling of the meiofauna, in order to investigate the relationship with the temporal variation of meiofauna communities.

Several environmental factors that could influence meiofauna communities were measured in the water and sediments during the period of the study. In the water were measured salinity, temperature, pH and dissolved oxygen. The amount of the organic matter and some grain size variables were determined in sediment. Also determined were some nutrients of the water and sediments such as phosphates, ammonia, silica, nitrites and nitrates.

3.2. STUDY AREA: THE MIRA ESTUARY

3.2.1. General features

The Mira Estuary is located on the southwest coast of Portugal (37°20' and 37° 45'N; 8°45' W). The hydrological basin of the Mira River has a total of area about 1576 Km^2, delimited in the north by the hydrological basin of the Sado river, in the south by the hydrological basins of the small Algarve rivers, in the east by the hydrological basin of the Guadiana River and in the west by the Atlantic coast (Loureiro *et al.*, 1984, *in* Andrade, 1986).

The Mira estuary extends between two towns, small, but the most important in the area, Vila Nova de Milfontes at the mouth and Odemira at its upper limit. It is a narrow, entrenched estuary, 32 km long, about 150 m wide in the lower part and 30 m wide in the upper reaches, with a mean depth of about 6 m (Costa *et al.*, 1994).

This estuary and the surrounding area forms the Natural Park, "Parque Natural do Sudoeste Alentejano e Costa Vicentina". The landscape is characterized by irrigated fields, well-preserved eucalyptus and cork-oak woods and undergrowth (Raposo, 1996). Because of this, the Mira estuary is considered, to a certain extent, representative of what a pristine estuary should be.

The climate of the area of the Mira River is a sub-humid regime, the dry season being from May to September and the wet season from October to April. The mean annual atmospheric temperature is variable, between 20-21°C in July and August (the hottest period) and 8-11°C in December and January (the coldest period). The mean annual precipitation is 667 mm and the mean annual insolation is approximately 2950 hours (Loureiro *et al.*, op.cit.).

To Andrade (1986), the Mira estuarine gradient pattern downstream to upstream is characterized by: (a) dilution in salinity; (b) increase in turbidity; (c) decrease in thermic differential in relation to the atmosphere; (d) decrease in dissolved oxygen content (saturation percentage). Vertically, the estuarine gradient pattern from the surface to the bottom is characterized by: (a) increase in salinity; (b) increase in turbidity; c)

increase in the thermic differential in relation to the atmosphere; (d) decrease in dissolved oxygen content (saturation percentage).

The physical and chemical fluctuations of the Mira estuary are explained by Andrade (1986) as result of:

- Estuarine morphology, the absence of unevenness in the terminal section of the river, almost 45 Km, that facilitates the penetration upstream of dynamic tides.
- The concentration of rainfall between January and March associated with a reduced annual mean outflow, because of the dryness during the year.
- The retention of annual mean outflow, nearly 30%, in Stª Clara-a-Velha dam.

In several periods of the year it is a deficit estuary, the tidal inflow being greater than fresh water outflow. Tides have an important influence in the vertical stratification of the physical and chemical factors of the water column, mainly on the salinity and turbidity. Water varies from vertically homogeneous in spring tides, which occur at new and full moons, to slightly stratified in neap tides during the quarter phases of the moon. Tidal penetration ranges on average from 2.5 km in neap tides to 7.5 km in spring tides (Andrade, 1986).

The seasonal fluctuations resulting from natural phenomena must be taken into account beyond the spatial variability. This is the case with the annual cycle of rainfall, which determines the extension of the saline penetration and the degree of vertical stratification. These are respectively minimum and maximum in the rainfall period (Paula, 1993).

Near the river mouth is a predominantly marine environment, with a narrower range of temperature (12ºC - 22.5ºC) and salinity (27 psu – 35 psu) (annual values) and it supports ecologically important seagrass beds of *Zostera noltii* Hornem, which spread to three metres depth, followed by *Zostera marina* L. beds to 6 metres depth. The middle part of the estuary is bordered by marsh vegetation, dominated by *Spartina maritima* (Curtis). It is an estuarine environment with a high range of temperature (9ºC - 26ºC) and salinity (7 psu – 35 psu) (annual values). The upper estuary is influenced

by the fresh water inflow, with a high range of temperature (8ºC - 26.5ºC) and salinity (0 psu – 23 psu) (annual values) (Costa *et al.*, 1994).

In the last decade, many studies have been carried out in the Mira River, with the target of most being the biological component:

- Andrade (1986) studied the general characterization of the estuarine circulation and its relationships with the distribution of the benthic organisms. This study has been an important support to subsequent studies.

- Costa *et al.* (1987) studied the abundance and distribution of the estuarine fishes.

- Moore (1987) described the morphology of the jelly–fish *Blackfordia virginica* (Mayer, 1910), a planktonic species very abundant in this estuary during the hottest period.

- Ré (1987, 1990) studied the ecology of the planktonic larvae of the anchovy *Engraulis encrasicolus* Linnaeus, 1758.

- Almeida (1988) investigated the dynamic, structure and macrobenthic production of the seagrass *Zostera* beds, which are located close to the estuary mouth.

- Paula (1989, 1993) studied the ecology and recruitment of the decapoda crustacean larvae.

- Guerreiro (1991) studied the populations of *Scrobicularia plana* (da Costa, 1778).

- Cartaxana (1994) studied the distribution, recruitment and movements of decapoda crustacean *Palaemon longirostris* (H. Milne Edwards, 1837).

- Costa *et al.* (1994) discussed the potential zones of the estuary that act as nursery areas to the fish communities.

- Bettencourt *et al.* (1994). Discussed the balance of nutrients between the Mira salt marshes and the water column.

- Trigo (1994) investigated the predation effects of the *Lutra lutra* effects on fish farming.

- Ferreira (1994) studied the trophic structure of the macrobenthic communities of the seagrass beds of *Zostera noltii* and *Zostera marina*.

- Raposo de Almeida (1996) studied the biology and ecology of the two most common migilids of the River Mira estuary (*i.e. Liza ramada and Chelon labrosus*).

- Silva de Almeida (2000) studied the impact of the salt marsh ecosystem on nitrogen nutrient in Mira estuarine waters.

Today, the Mira Estuary is one of the Portuguese estuarine systems on which many studies have been carried out. However, the databases provided are not enough to understand the biological processes and the information is dispersed and divided among several subjects.

3.2.2. Sampling sites

The selection of the sampling sites was chosen according to the aims of this investigation. All samples were collected in the Mira Estuary, at two sampling sites located in the intertidal seagrass beds of *Zostera noltii*.

The intertidal areas of seagrass beds of *Zostera noltii* are located downstream in the estuary (Fig 3.1). These areas are covered during every high tide, and they are influenced directly by environmental marine characteristics. Therefore, the sampling sites were located near the estuary mouth; the first area, station A, was located 1.5 km from the mouth, and the second area, station B, 2.5 km.

3.2.3. Sampling programme

All samples were taken at two week intervals from June 1994 to August 1995. Sampling collections were carried out in the morning, at low tide, during neap tides, in the lower part of each of the intertidal seagrass beds of *Zostera noltii*.

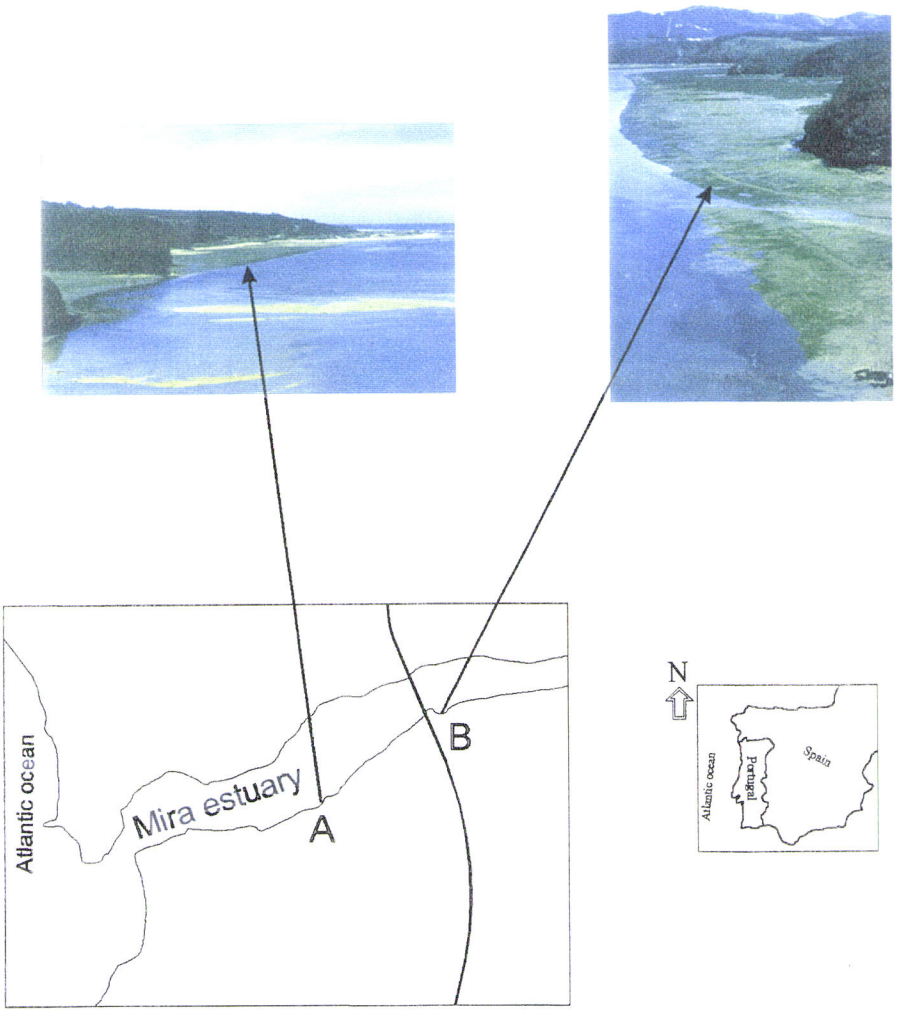


Figure 3.1 – Locations of the sampling stations A and B in the Mira estuary (SW, Portugal).

3.3. MATERIAL AND METHODS

3.3.1. Determination of environmental factors in intertidal seagrass beds of *Zostera noltii*

3.3.1.1. Water

Simultaneously with the meiofauna sampling, several hydrological parameters were measured: salinity, temperature, pH and *dissolved oxygen* (DO). Water samples for nutrient analysis were also collected: phosphate, ammonium, silicate, nitrite and nitrate.

a) Field Measurements

Salinity, temperature, pH, and dissolved oxygen of the overlying 5 cm of the water above the sediment were measured immediately, *in situ*, in three small pools of water randomly chosen at sampling sites. They were taken using different instruments:

- Salinity: measurement was done using a conductivimeter, with 1 precision, a salinometer Y.S.I. model 33 SCT Meter.
- Temperature: readings were made on a microprocessor pH meter WTW pH 96.
- pH: readings were made on a microprocessor pH meter WTW pH 96.
- Dissolved Oxygen: readings were made on an oximeter WTW model OXI 92 with 0.1 mg/l precision.

b) Laboratory analysis

The water samples for nutrient analysis were collected from small pools left by low tide. This method was used because, during low water, the physical and chemical parameters of water pools could have values very close to the values of the natural environment of the intertidal organisms. In fact, during low tide, intertidal organisms depend basically on the water content in sediments (Saldanha, 1974; Newel, 1979).

However, these small pools can be influenced by atmospheric conditions, particulary by precipitation (Smith, 1986).

Water samples were stored in 250 ml plastic bottles and kept at 0°C during transport to the laboratory, and then all samples were frozen at -30°C for the later analysis. The nitrite, nitrate and phosphate measurements were taken by the methods described by Strickland & Parsons (1968) to analyse nutrients in water and by phosphorous reaction. In the case of nitrate, reduction columns were constructed to conform to the specifications described in the American Public Health Association (1971). The procedure adopted to measure the silica and ammonium concentrations in the water analysis kit was:

- Silica was measured by Macherey-Nagel (Test 48, Reagenziensatz Kieselsäure), according to the specifications described in the APHA (1971).
- Ammonium was measured by a method of indofenol blue dosage, according to the specifications described in the APHA (1971).

The concentration of water nutrients was measured in micromoles per litre (µmol/l)

3.3.1.2. Sediments

Concurrent with the meiofauna and water sampling, several sediment nutrients were also sampled: NO_3^-, NO_2^-, PO_4^{2-}, SO_4^{2-}, NH_4^+. The organic matter and sediment grain size were measured. The concentration of oxidized (nitrite and nitrate) and reduced (ammonia) forms of nitrogen as well phosphates were used to evaluate the oxidation status of sediment.

On each occasion of sampling, four sediment samples were taken using separate vertical plastic cores constructed from PVC tubing with an internal diameter of 3.60 cm, to a depth of 10 cm. The tubes were kept at 4°C until arrival at the laboratory, where they were frozen at -30°C for later analysis of the pore water nutrients.

All the measurements were performed on vertical slices of the sediment core (0-1cm; 1-2 cm; 2-3 cm). Sediment slices were extruded under N_2 atmosphere and passed

through Whatmann GF/C filters. The pore water samples were stored at –20ºC. Later, the interstitial water was thawed and the samples were processed for measurement of the concentrations of ammonia, nitrate, nitrite, phosphate and silicate with an A_{II} automatic chain (SAN^{plus} Segmented Flow Analyser, SKALAR). The concentration unit of pore water nutrients was measured in micromoles per litre (µmol/l).

The remaining sediment of each slice was then dried for 2h at 105ºC and split in two parts. The first was ashed at 550ºC for 4 hours after the dry weight had been measured, and reweighed to enable the percentage of ash and the organic material to be determined:

*M.O.(%) =[(Dry weight$_{105ºC}$-Tara weight)- (Weight $_{550ºC}$-Tara weight)/(Dry weight $_{(105ºC)}$-Tara weight)]*100*

The second part was used to characterise the granulometry of the sediment, with an automatic C. A. Coulter^{R} LS Particle Size Analyser. The following characteristics can be calculated from the size frequency distribution of the sediments: the median grain size, the amount of clay (< 4 µm), the amount of silt (between 4 - 63µm) the amount of sand (>63µm).

3.3.1.3. Biological factors

a) Chlorophyll a

As a complement to information of the environmental factors studied in the sampling sites, the concentration of chlorophyll *a* was measured. Each sample had 1,5 l of water and was collected in plastic bottles, and kept at 0ºC until arrival at the laboratory. Total pigments were filtered through Whatmann GF/F glass-fibre filters and extracted in 90% acetone; the chlorophyll *a* concentration was measured by spectrophotometry following the method of Strickland & Parsons (1968). The concentration unit of chlorophyll *a* was measured in mg per m^3 (mg/m^{-3}).

b) *Zostera noltii* biomass

Zostera noltii was collected randomly on each sampling occasion, five replicate core samples, 141 cm^{-2} in area and 30 cm in depth, being taken. The samples were preserved in 4% formalin seawater solution.

The biomass estimates were determined by the organic weight or the ash-free dry weight, AFW (Marques *et al.*, 1997), the method adopted in this kind of study. In the laboratory, the samples were washed through a 500 µm sieve, to remove the formalin. On each sample, the roots were separated from the leaves, than were dried in an oven at ± 60 °C for 48 hours. The weight of the dry material was determined. The ash-free dry weight was obtained as a loss weight of the dry material after combustion at 450 °C for 8 hours, in a muffla (Heraeus KR 170E). In both cases, before weighing, the samples were cooled in an excicator. The weighings were performed using a Ohaus balance with a resolution of 0.01mg.

3.3.2. Data analysis

Physiochemical and biological variables of both sampling sites were summarised by the main descriptors as mean, 95 % confidence level for the mean, minimum and maximum value.

Non-parametric Spearman rank correlation coefficients were calculated ($p<0.05$) to assess the relationship between different variables within and between both sampling sites. The Spearman correlation coefficient (r) measures the monotonic association between two variables in terms of ranks. It measures whether one variable increases or decreases with another even when the relationship between the two variables is not linear or bivariate normal. This nonparametric correlation coefficient is a good measure of the association between two variables when outliers, nonnormality, nonconstant variance, and nonlinearity may exist between the two variables being investigated (Zar, 1984; Sokal & Rohlf, 1995).

Analysis of variance (ANOVA) was used to check for the existence of significant differences between physicochemical parameters and biological factors in relation to

the two sampling sites studied. Although a t-test is traditionally used when only two samples are involved, ANOVA is preferable because it is a more general test, which allows the testing of two or more samples (Sokal & Rohlf, 1995). Furthermore, ANOVA is a robust test even with considerable heterogeneity of variances, as long as samples size is equal or nearly equal (Glass, Peckham & Sanders in Zar, 1984).

The application of the ANOVA makes certain assumptions: the data follow the normal probability distribution, the variances of the populations are equal and the groups are independent (Zar, 1984; Sokal & Rohlf, 1995). The normal distribution of the data was checked by the Kolmogorov-Smirnov test (Norusis, 1992; Sokal & Rohlf, 1995) and the homogeneity of the variance was checked with the Levene test (Norusis, 1992). When conditions for the use of a parametric test were not fulfilled, the nonparametric Mann-Whitney U test (Z statistic Mann-Whitney Test; $p<0.001^{***}$ - very highly significant; $p<0.01^{**}$ - highly significant; $p<0.05^{*}$ - significant) was employed at two independent samples. Comparisons between sampling stations and sediment depths for nutrients and grain size parameters were examined by the Kruskal-Wallis Z test, (H statistic Kruskal-Wallis: $p<0.001^{***}$- very highly significant; $p<0.01^{**}$- highly significant; $p<0.05^{*}$ - significant) that was applied to several independent samples (Norusis, 1992; Sokal & Rohlf, 1995).

The influence of the abiotic factors of the water (temperature, salinity, dissolved oxygen, nitrate, nitrite, phosphate, ammonia and silica) and sediments (organic matter, nitrate, nitrite, phosphate, ammonia, silica and sediment grain size) in *Zostera noltii* biomass was analysed by stepwise regression.

Multiple regression analysis refers to a group of techniques for studying the straight-line relationships among two or more variables. Multiple regression estimates the β_p in the equation:

$$Y' = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p + \varepsilon$$

Y' is the dependent variable and β_p are the independent variables. The $\beta_0, \beta_1, \beta_2 \ldots \beta_p$ are the unknown regression coefficients. ε is the random error because points do not all fall on the line. In stepwise regression analysis, all variables in the model are checked to see if their significance has reduced below the specified tolerance level. If

a non-significant variable is found, it is removed from the model. Stepwise regression requires two significant levels: one for adding variables and one for removing variables. The variables were added in the regression equation, $p<0.05$, and they were removed with the introduction of the new variables, $p>0.1$. The following assumptions must be considered when using multiple regression analysis: linearity, constant variance, normality and independence (Norusis, 1992).

Multivariate statistical techniques were used to assess the seasonal variation of the environmental and biological factors; correlation-based Principal Component Analysis (PCA) was done. The multivariate approach consists of representing the scatter of objects in a multidimensional diagram, with as many axes as there are descriptors. The PCA is an ordination method in reduced space, projecting the multidimensional scatter diagram onto bivariate graphs, whose axes represent a large fraction of the variability of the multidimensional data matrix in space with reduced dimensionality, relative to original data. The first principal axis is the line passing through the greatest dimension of the concentration ellipsoid describing the distribution. In the same way, the following principal axes (orthogonal to one another) pass through several dimensions, corresponding to the successive directions of maximum variance of the scatter points (Legendre & Legendre, 1998).

Sediment data matrix input for the statistical analysis were the averages of the two replicates of each sampling date, per station; water temperature, salinity, pH and dissolved oxygen were the average of three replicates and *Zostera noltii* biomass was the average of six replicates; the running mean was calculated per date for each station.

All statistical analysis was performed using MICROSOFT EXCEL, SPSS 10.0 and PC-Ord 4.0 software.

3.4. RESULTS

3.4.1. Temporal variation of physicochemical factors

3.4.1.1. Water

Data concerning the measured physicochemical water factors at the two sampling sites A, B in *Zostera* seagrass are shown in tables 3.1 and 3.2, respectively. The temperature was fairly high over the study period at station A, ranging between 14.3°C in November and 29.1°C in August 95, and at station B varying between 14.7°C in January and 31.5°C in August 95. As expected, the temporal variation of temperature was very similar at both sampling sites (Fig. 3.2). The temperature followed a clear seasonal pattern: the highest values were in summer and the lowest in winter, presenting a gradual cooling from the summer 94 to the winter 95, followed by a gradual increase between spring and summer 95.

Table 3.1- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of temperature, salinity, oxygen and pH of the water at station A.

Physicochemical Parameters	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
Temperature (°C)	21.0	19.4 – 22.5	14.3 – 29.1
Salinity (psu)	34.2	33.4 – 35.1	28.4 – 36.6
Oxygen ($mg.l^{-1}$)	13.1	12.1 – 14.1	6.8 – 16.4
pH	8.6	8.5 – 8.7	8.0 – 9.0

Table 3.2- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of temperature, salinity, oxygen and pH of the water at station B.

Physicochemical Parameters	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
Temperature (°C)	21.5	19.7 – 23.3	14.7 – 31.5
Salinity (psu)	34.7	34.2 – 35.2	32.7 – 37.1
Oxygen ($mg.l^{-1}$)	12.9	12.2 – 13.5	9.4 – 15.1
pH	8.6	8.6 – 8.7	8.3 – 9.0

At both sites, the values of salinity were usually high, at station A ranging between a minimum of 28.4 psu (October 94) and a maximum 36.6 psu (May 95), at station B ranging between 32.7 psu (August 94) and 37.1 psu (August 95). The temporal pattern

was similar at both sampling stations, although at station A, the low values of October and November 94 were atypical and were related to heavy rainfall which influenced the water salinity (Fig 3.3). The salinity was positively correlated with oxygen saturation and temperature: results from correlation analysis between water salinity and oxygen saturation were R=0.863, p<0.00,1 N=28 (station A) and R=0.508, p<0.01, N=28 (station B) and between water salinity and temperature were R=0.692, p<0.001, N=28 (station A) and R=0.728, p<0.001, N=28 (station B).

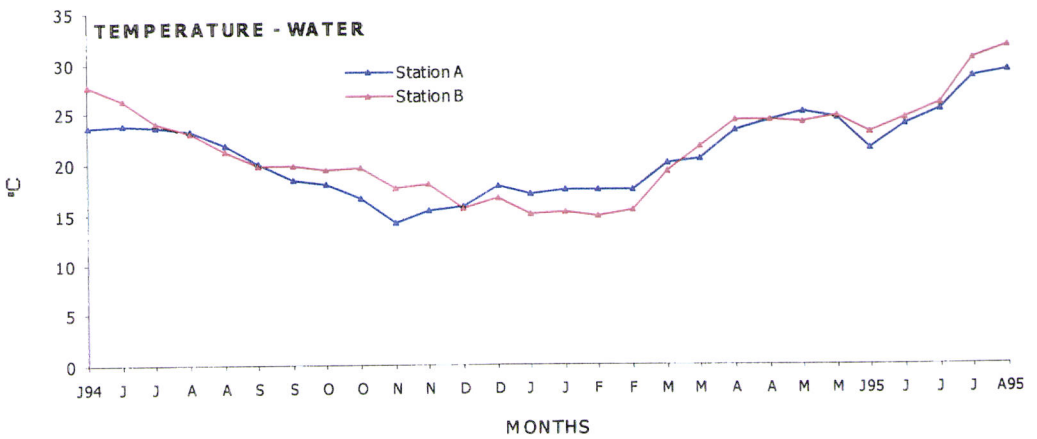


Figure 3.2 - Fortnightly variation of temperature in water from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

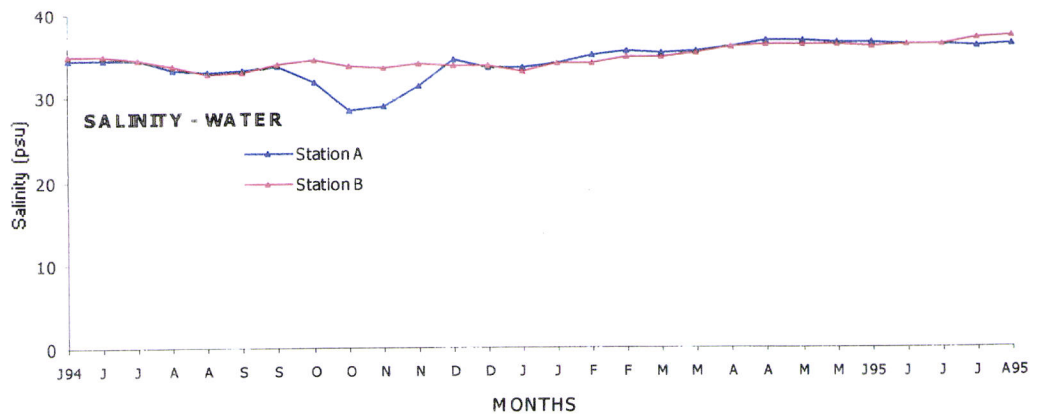


Figure 3.3 - Fortnightly variation of salinity in water from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

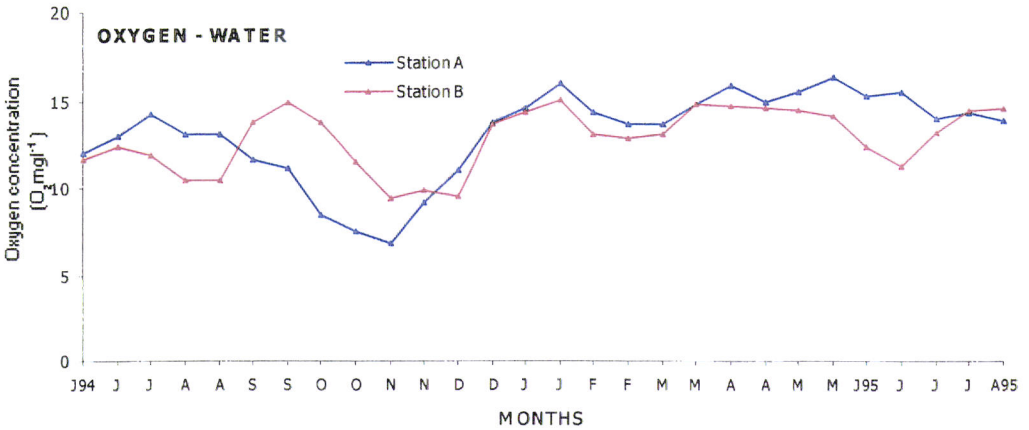


Figure 3.4 - Fortnightly variation of dissolved oxygen in water from June 1994 to August 1995, in both studied sampling stations, in a *Zostera noltii* seagrass bed of Mira estuary.

The values of DO were similar at both stations, at station A varying between a minimum of 6.8 mg.l^{-1} (November 94) and a maximum of 16.4 mg.l^{-1} (May 95). At station B, they varied between a minimum of 9.4 mg.l^{-1}, (December 94) and a maximum of 15.1 mg.l^{-1} (January 95). Dissolved oxygen (DO) variation was usually similar in both areas; however, for short periods it was somewhat different (Fig 3.4). A clear opposite trend could be observed in November 94 and May 95. At station B, November 94 presented a notably higher value compared with station A, which showed a slight decrease from July 94 until November 94, while between May 95 and June 95 an accentuated decrease was observed. The temperature showed a significant correlation with oxygen saturation (R=0.728, p<0.001, N=28), at station A. However, at station B, we could not observe a significant correlation between these parameters.

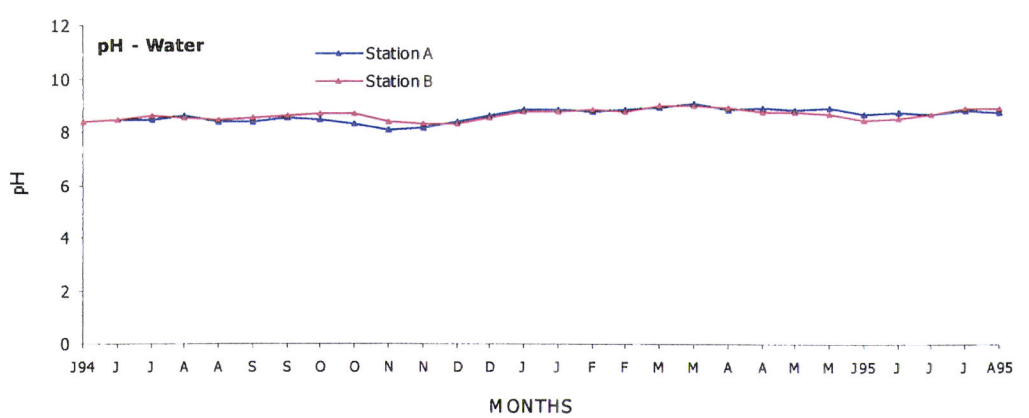


Figure 3.5 - Fortnightly variation of pH in water from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

Over the study period, water pH did not vary significantly, being similar at both sampling stations (Fig. 3.5).

Water nutrient data at sampling sites A and B are shown in tables 3.3 and 3.4, respectively. The mean values of ammonium, nitrite and nitrate water concentrations were very similar at the two sites studied. Water ammonium concentration presented a seasonal variation, with higher values in autumn and early winter and lower concentration in summer (Fig. 3.6). However, at station A, there was a significant gradual decrease in ammonium concentration from later winter until spring, while at station B, after an accentuated decrease in later autumn, no significant variations were observed.

Table 3.3- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the nutrients in the water (nitrite, nitrate, ammonium, phosphate and silicate) of station A. Units are μmoles per litre.

Nutrients	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
NO_2^- ($\mu mol.l^{-1}$)	0.29	0.25 – 0.33	0.14 – 0.49
NO_3^-($\mu mol.l^{-1}$)	1.19	1.00 – 1.39	0.39 – 2.49
NH_4^+($\mu mol.l^{-1}$)	15.66	12.67 – 18.65	5.19 – 31.64
PO_4^-($\mu mol.l^{-1}$)	0.29	0.24 – 0.35	0.08 – 0.59
Si ($\mu mol.l^{-1}$)	5.10	4.24 – 5.97	1.75 – 9.80

Table 3.4- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the nutrients in the water (nitrite, nitrate, ammonium, phosphate and silicate) of station B. Units are μmoles per litre.

Nutrients	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
NO_2^- ($\mu mol.l^{-1}$)	0.21	0.19 – 0.24	0.05 – 0.35
NO_3^-($\mu mol.l^{-1}$)	1.42	1.00 – 1.84	0.45 –4.34
NH_4^+($\mu mol.l^{-1}$)	18.54	16.14 – 20.94	7.81 – 35.45
PO_4^- ($\mu mol.l^{-1}$)	0.38	0.29 – 0.46	0.03 – 0.82
Si ($\mu mol.l^{-1}$)	10.45	8.09 – 12.82	2.00 – 22.25

The temporal variation of nitrate concentration was similar at both stations, the highest values being found between November 94 and January 95, while the lowest values were found in summer at station A, and autumn at station B (Fig. 3.7). Nitrite water concentration presented the same type of seasonal variation at both stations. The

highest values occurred in early autumn and early spring, with lower values in summer 94 and late spring 95 (Fig. 3.8).

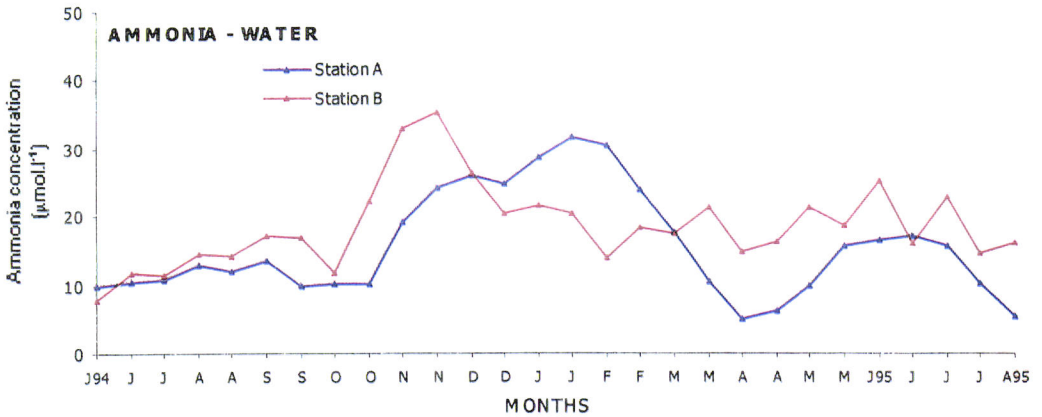


Figure 3.6 - Fortnightly variation of ammonium concentration in the water, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

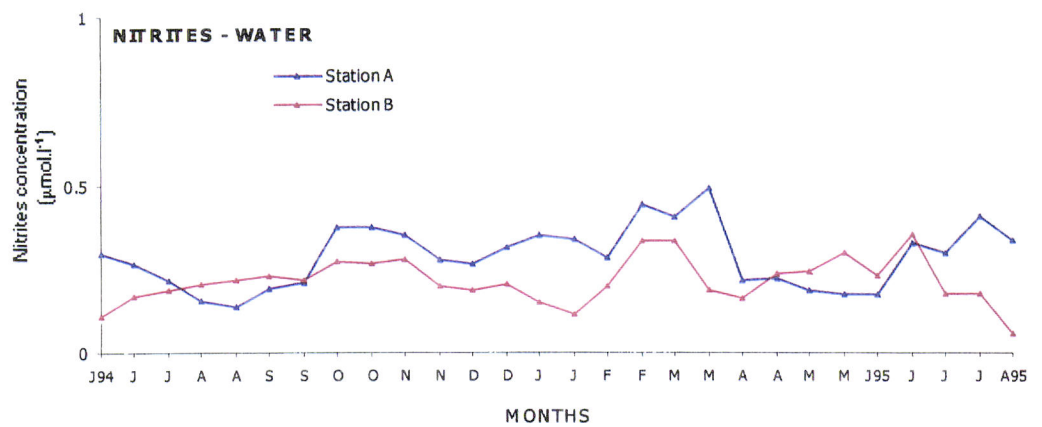


Figure 3.7 - Fortnightly variation of the nitrites concentration in the water from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

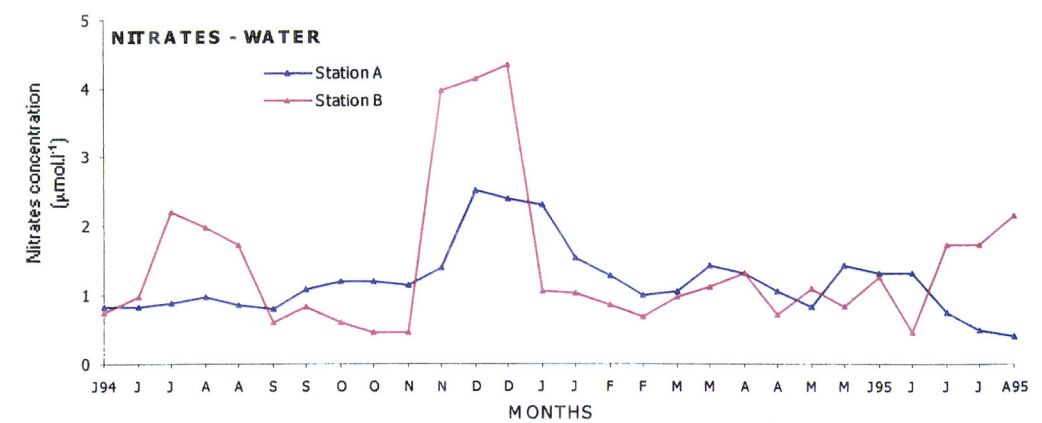


Figure 3.8 - Fortnightly variation of the nitrates concentration in the water, from June 1994 to August 1995, to both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

The mean value of phosphate water concentration and the seasonal pattern were similar at both stations (Fig. 3.9). The highest values occurred in summer 94 and the lowest in spring. However, the concentration was very different in the two analysed summers.

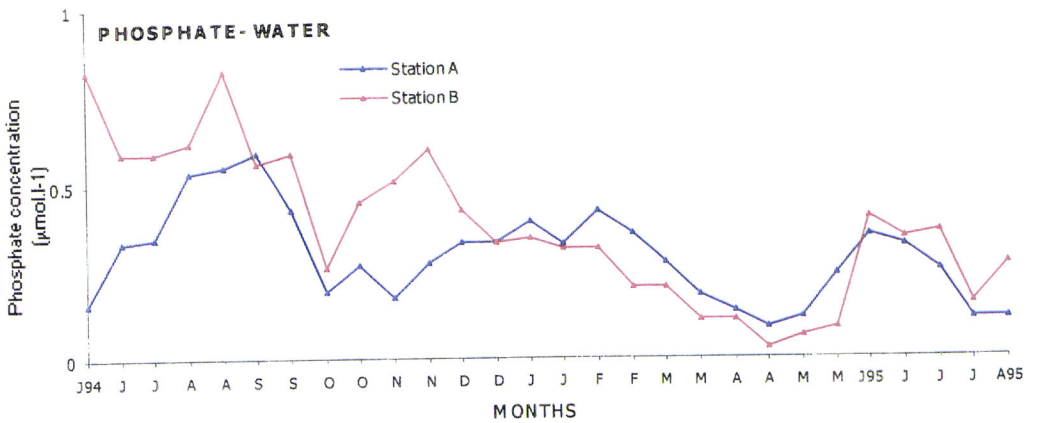


Figure 3.9 - Fortnightly variation of phosphates concentration in the water, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

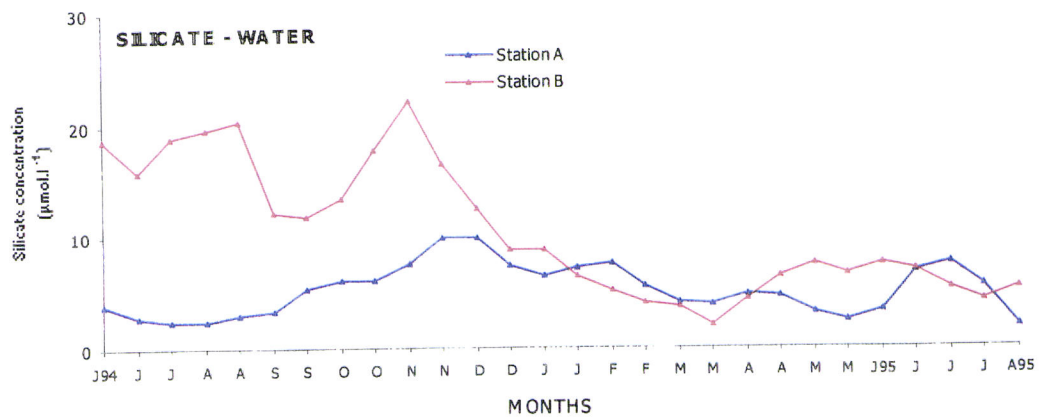


Figure 3.10 - Fortnightly variation of silicate concentration in the water, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

Temporal variation of water silica concentration was different at both stations, the mean value being greater at station B (Fig. 3.10). At station A, a gradual increase from summer 94 until winter occurred, followed by a gradual decrease until spring. A new increase was observed during summer 95. At station B, in summer 94, the silica water concentration observed was higher compared with station A, and fluctuated until it reached peak value in November 94, followed by a gradual decrease until spring.

3.4.1.2. Sediments

a) Global results

Data concerning nutrients and organic matter of sediments in both sampling sites are shown in tables 3.5 and 3.6. The predominant nitrogen form was ammonium. Regarding seasonal variations, the highest concentrations were registered in autumn and winter. Sediment ammonium concentration was different in the two studied sites, the mean values being higher at station B. Temporal variation was similar at both stations; however an opposite trend can be observed from October 94 to January 95 (Fig. 3.11). The highest values were registered in winter (January 95) for station A, and later autumn for station B, (November-December 94). The lowest values were registered in spring and in early summer at both stations.

Table 3.5- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the organic matter content (%) and nutrients in the sediment (nitrite, nitrate, ammonium, phosphate and silicate) of station A. Units are μmoles per litre.

Nutrients	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
NO_2^- ($\mu mol.l^{-1}$)	1.6525	1.42 – 1.89	0.68 – 3.09
NO_3^- ($\mu mol.l^{-1}$)	10.16	8.90 – 11.42	3.36 – 17.46
NH_4^+ ($\mu mol.l^{-1}$)	340.77	305.65 – 375.88	147.43 – 475.43
PO_4^- ($\mu mol.l^{-1}$)	16.55	13.95 – 19.16	5.43 – 31.70
Si($\mu mol.l^{-1}$)	35.37	32.14 – 38.60	23.36 – 56.14
Organic matter (%)	9.48	9.16 – 9.80	7.66 – 10.58

Table 3.6- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the organic matter content (%) and nutrients in the sediment (nitrite, nitrate, ammonium, phosphate and silicate) of station B. Units are μmoles per litre.

Nutrients	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
NO_2^- ($\mu mol.l^{-1}$)	1.42	1.22 – 1.62	0.61 – 2.90
No_3^- ($\mu mol.l^{-1}$)	6.65	5.99 – 7.31	3.56 – 9.63
NH_4^+ ($\mu mol.l^{-1}$)	411.78	375.46 – 448.11	265.11 – 624.00
PO_4^- ($\mu mol.l^{-1}$)	12.35	10.69 – 14.01	5.08 – 21.88
Si ($\mu mol.l^{-1}$)	29.14	26.90 – 31.38	13.39 – 39.60
Organic matter (%)	9.93	9.70 – 10.15	8.85 – 11.30

Sediment nitrate concentration presented the highest values in autumn and in winter and the temporal variation was similar in both areas. Nevertheless, the concentration was higher at station A than station B (Fig. 3.12). Temporal variation of sediment nitrite concentration showed a similar trend at the two sites studied (Fig. 3.13). The highest values occurred in winter (January 95 and February 95) and the mean values were similar.

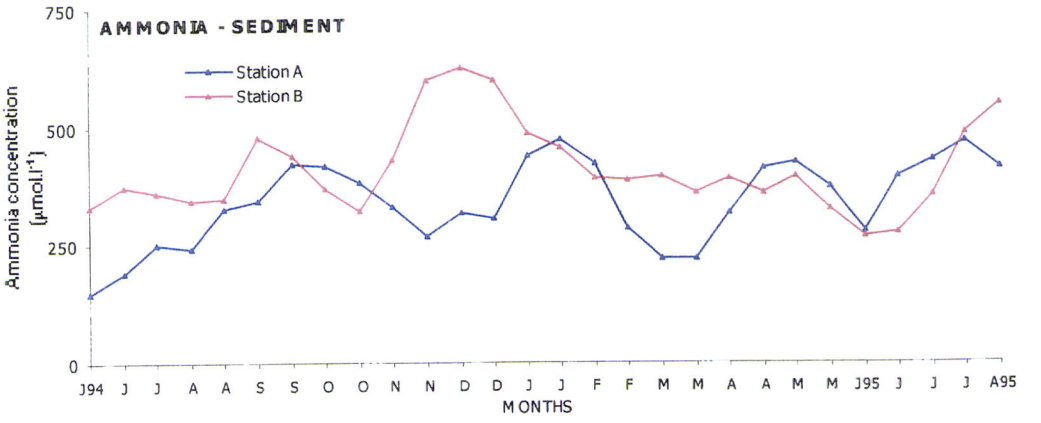


Figure 3.11 - Fortnightly variation of ammonium concentration in the sediment, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

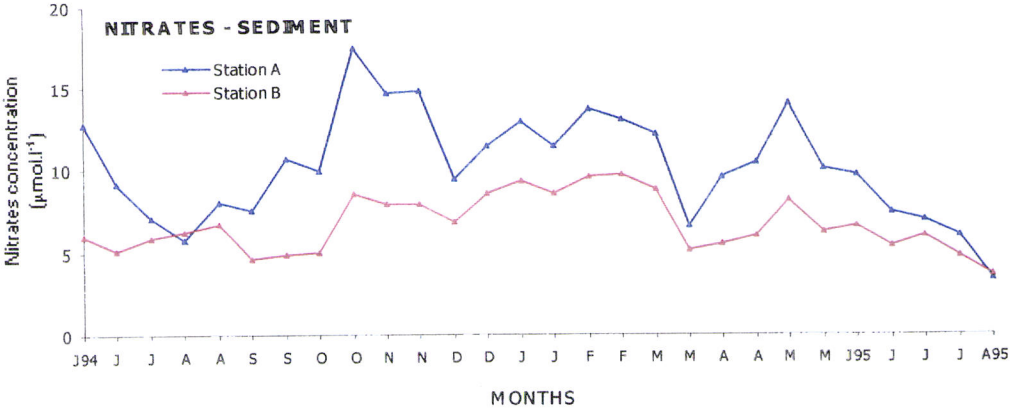


Figure 3.12 - Fortnightly variation of nitrates concentration in the sediment, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

The temporal variation of sediment phosphate concentration obtained was similar at both stations, the salient features being in the summer time. The lower values were obtained in summer 94 and the highest values in summer 95 (Fig. 3.14). The sediment phosphate concentration was higher at station A.

Sediment silica concentration was higher at station A and temporal variation presented the same pattern at both stations, the decrease of concentration in autumn being evident (Fig. 3.15).

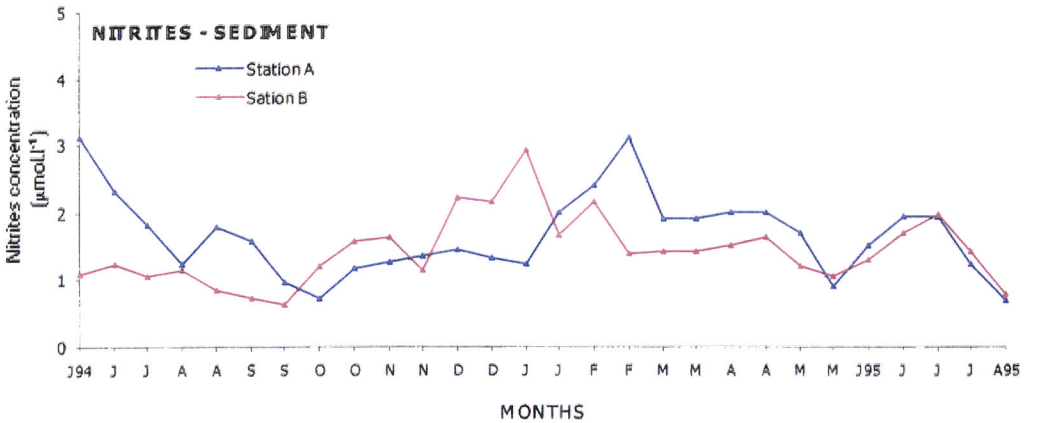


Figure 3.13 - Fortnightly variation of nitrites concentration in the sediment, from June 1994 to August 1995,at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

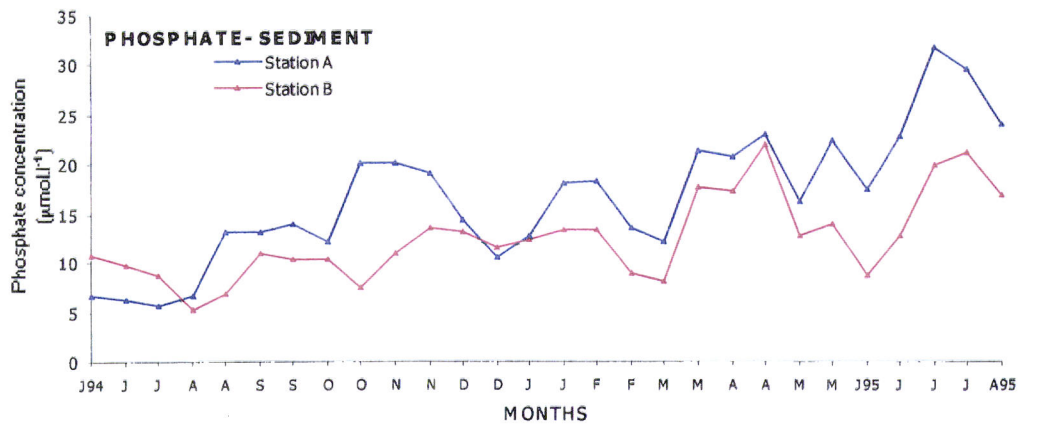


Figure 3.14 - Fortnightly variation of phosphate concentration in the sediment, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary

The organic matter content of the sediments remained fairly constant and fairly high throughout the study period, and temporal variation was similar at both stations (Fig. 3.16).

Data concerning sediment proportions of silt, clay, sand and median grain size at both sampling sites are shown in tables 3.7 and 3.8.

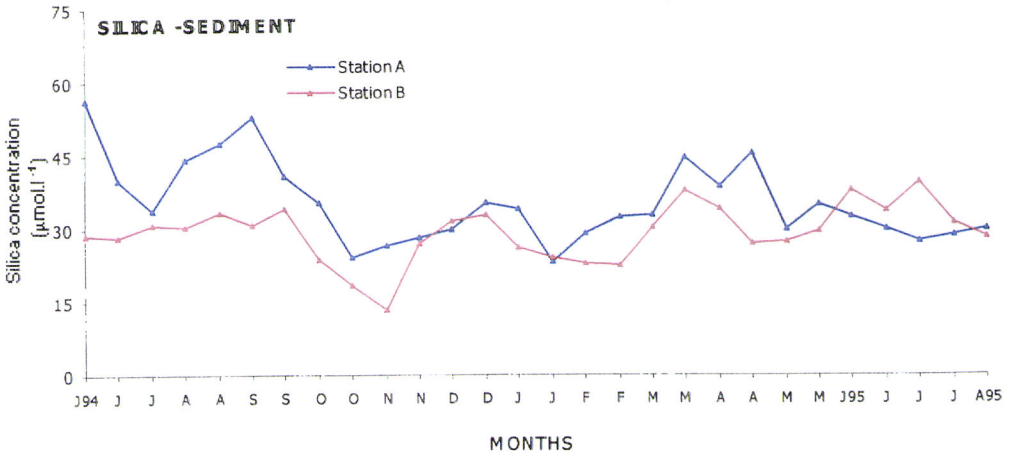


Figure 3.15 - Fortnightly variation of silicate concentration in the sediment, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira. Estuary.

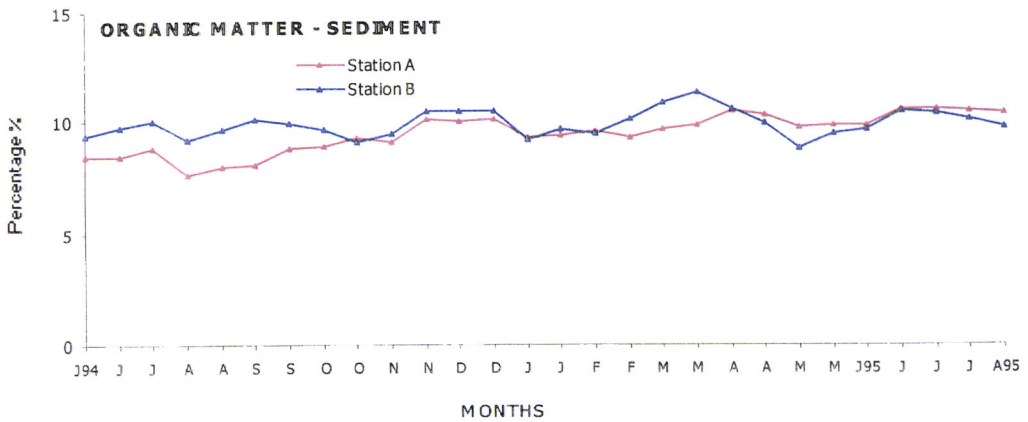


Figure 3.16 - Fortnightly variation of organic matter content of the sediment, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

Table 3.7- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the sediment granulometry: grain size (µm), percent sand, silt and clay at station A.

Sediment Granulometry	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
Median grain size (µm)	30.39	26.87 – 33.92	18.92 – 48.98
Silt (%)	54.26	51.82 – 56.70	39.88 – 64.21
Clay (%)	15.31	14.29 – 16.32	9.74 – 20.02
Sand (%)	30.44	27.20 – 33.68	16.02 – 46.46

As expected, sediments consisted mainly of fine sediment with higher mud content, mean grain size ranging between 18.9 - 49 µm (station A) and 18.8 - 46.2 µm (station B) (Fig. 3.17).

Table 3.8- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the sediment granulometry: grain size (μm), percent sand, silt and clay at station B.

Sediment granulometry	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
Median grain size (μm)	32.29	29.39 – 35.18	18.75 – 46.17
Silt (%)	51.88	50.27 – 53.49	43.74 – 60.54
Clay (%)	13.81	12.81 – 14.81	9.25 – 19.82
Sand (%)	34.41	31.89 – 36.89	21.57 – 45.09

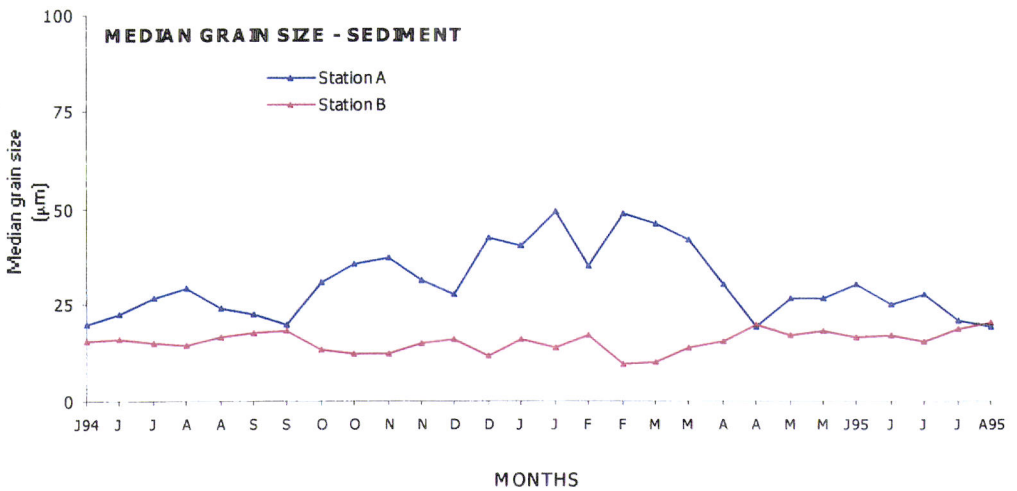


Figure 3.17 - Fortnightly variation of median grain size of the sediment, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of Mira estuary.

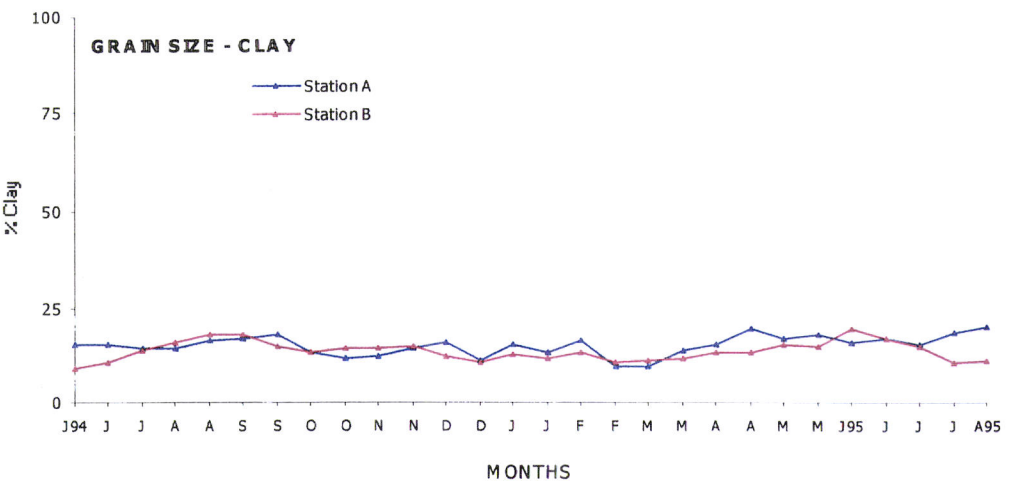


Figure 3.18 - Fortnightly variation of clay percentage of the sediment, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

Sediment showed the silt content was always the highest proportion at both stations (Fig. 3.18, Fig. 3.19 and Fig. 3.20). Temporal variation of the sediment median grain size was different at both stations, especially in the summer. The variation is explained

by the proportion of the sand, especially at station B, showing an accentuated decrease in summer 94 and an increase in summer 95.

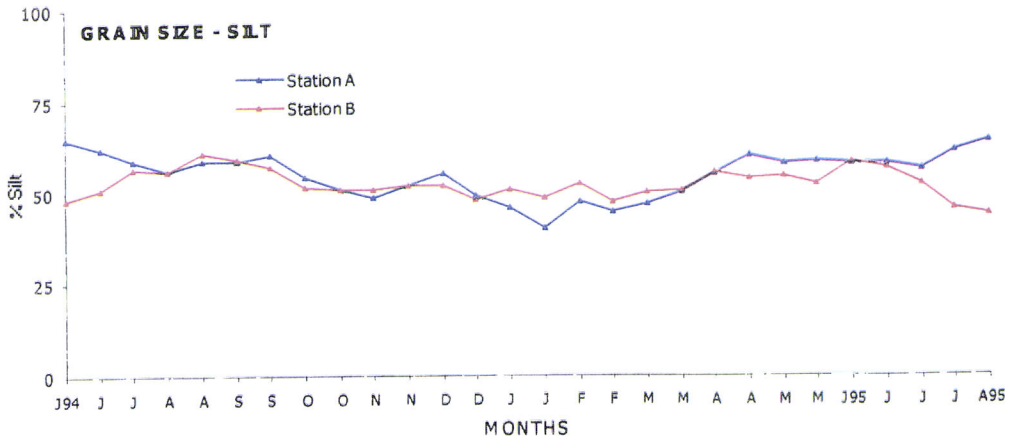


Figure 3.19 - Fortnightly variation of silt percentage of the sediment, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

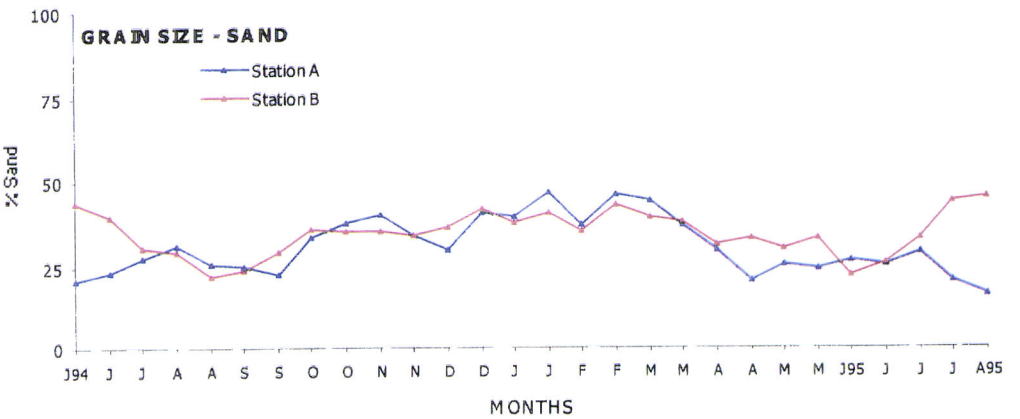


Figure 3.20 - Fortnightly variation of sand percentage of the sediment, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of the Mira.

b) Results per sediment layer

Temporal variations of vertical sediment concentrations of ammonium, nitrite, nitrate, phosphate and organic matter were studied at three depths: level 1 (0-1 cm), level 2 (1-2 cm), level 3 (2-3 cm). Data concerning these, as well as the organic matter of each sediment depth layer studied at the sampling sites, are shown in tables 3.9 and 3.10.

Taking into account Kruskal-Wallis Test (H statistic Kruskal-Wallis: $p<0.001^{***}$) results, at station A, significant differences were detected between sediment layers in organic matter content ($H=13.35$; $p<0.001^{***}$), ammonia sediment concentration ($H=9.01$;

p<0.01**), nitrate sediment concentration (H=9.7; p<0.01**), nitrite sediment concentration (H=6.8; p<0.05*), phosphate sediment concentration (H=21.3; p<0.001***), silicate sediment concentration (H=4.1; p<0.001***) and clay percentage (H=15.6; p<0.001***). At station B, significant differences were detected between sediment layers only in nitrates sediment concentration (H=20.54; p<0.001***) and phosphate sediment concentration (H=17.6;p<0.001***).

Table 3.9- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the organic matter content (%) and nutrients in the sediment layers (nitrite, nitrate, ammonium, phosphate and silicate) at station A. Units are μmoles per litre.

Nutrients	Mean	95% Confidence Interval for Mean	Minimum-Maximum
NO_2^- ($\mu mol.l^{-1}$)			
(0 – 1)	1.88	1.57 – 2.20	0.13 – 4.26
(1 – 2)	1.27	1.09 – 1.46	0.38 – 2.10
(2 – 3)	1.76	1.29 – 2.23	0.36 – 5.00
NO_3^- ($\mu mol.l^{-1}$)			
(0 –1)	11.80	10.81 – 12.79	5.48 – 17.07
(1 –2)	9.50	7.75 – 11.26	2.67 – 21.27
(2 –3)	9.06	7.16 – 10.96	1.92 – 20.36
NH_4^+ ($\mu mol.l^{-1}$)			
(0 –1)	372.96	341.86 – 404.07	185.20 – 506.92
(1 –2)	364.75	309.99 – 419.51	111.17 – 651.33
(2 –3)	293.38	256.89 – 329.86	145.08 – 491.77
PO_4^- ($\mu mol.l^{-1}$)			
(0 –1)	10.58	8.50 – 12.66	3.57 – 24.15
(1 –2)	19.51	15.67 – 23.34	5.55 – 47.92
(2 –3)	18.66	15.87 – 21.45	5.49 – 29.43
Si ($\mu mol.l^{-1}$)			
(0 –1)	33.91	28.61 – 39.21	20.40 – 72.50
(1 –2)	35.10	29.84 – 40.37	15.35 – 84.27
(2 –3)	36.41	32.29 – 40.52	18.05 – 65.77
Organic matter (%)			
(0 –1)	9.93	9.45 – 10.41	7.20 – 12.60
(1 –2)	8.89	8.61 – 9.16	7.65 – 10.36
(2 –3)	9.68	9.16 – 10.20	7.74 – 13.43

At station A, in early summer 94, the top layer presented the highest percentage of organic matter, while, at station B. in summer 94 and early autumn, the middle (1-2 cm) and bottom layers exhibited the highest values (Fig. 3.21 and Fig. 3.22). At both stations, in later autumn, the top layer showed an evident increase. In spring, at station A, the bottom layer registered an increase, though at station B it was the middle layer

that showed the highest percentage. In summer 95, as in summer 94, the bottom layer exhibited the highest percentages of organic matter content.

Table 3.10- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the organic matter content (%) and nutrients in the sediment layers (nitrite, nitrate, ammonium, phosphate and silicate) at station B. Units are μmoles per litre.

Nutrients	Mean	95% Confidence Interval for Mean	Minimum-Maximum
NO_2^- ($\mu mol.l^{-1}$)			
(0 – 1)	1.54	1.32 – 1.77	0.62 – 2.93
(1 – 2)	1.53	1.23 – 1.83	0.52 – 3.58
(2 – 3)	1.20	1.04 – 1.36	0.33 – 2.20
NO_3^- ($\mu mol.l^{-1}$)			
(0 –1)	9.06	7.16 – 10.96	1.92 – 20.36
(1 –2)	6.19	5.49 – 6.89	3.61 – 10.14
(2 –3)	4.70	4.27 – 5.12	1.48 – 7.16
NH_4^+ ($\mu mol.l^{-1}$)			
(0 –1)	414.93	376.96 – 452.90	269.43 – 607.56
(1 –2)	438.52	386.35 – 490.70	198.66 – 806.84
(2 –3)	381.90	341.73 – 422.06	208.90 – 631.47
PO_4^- ($\mu mol.l^{-1}$)			
(0 –1)	8.79	7.18 – 10.41	3.29 – 17.47
(1 –2)	13.36	11.32 – 15.40	5.68 – 31.18
(2 –3)	15.59	12.71 – 18.47	6.18 – 33.59
Si ($\mu mol.l^{-1}$)			
(0 –1)	29.06	25.81 – 32.30	14.02 – 46.05
(1 –2)	29.00	26.28 – 31.72	15.42 – 41.94
(2 –3)	28.76	25.64 – 31.87	10.71 – 51.85
Organic matter (%)			
(0 –1)	9.64	9.15 – 10.13	5.92 – 12.52
(1 –2)	9.97	9.54 – 10.40	7.94 – 12.13
(2 –3)	10.16	9.85 – 10.48	8.28 – 11.80

The ammonium profiles at both sites showed the highest mean values in the top layer. In terms of temporal variations of vertical concentrations, at station A, in summer 94 and early autumn, concentrations were higher in the top and middle layers (Fig. 3.23 and Fig. 3.24), while at station B, the highest concentrations were obtained in the middle and bottom layers. At station A, in later autumn, the highest concentration values were registered in the top layers, while in winter, the bottom layer presented the highest concentrations. However, at station B, in later autumn, the highest concentrations were obtained in the middle and bottom layers, but later higher concentrations were in the top layer. At station A, in spring and summer 95,

concentrations increased in the middle layer, although, at station B, it was only in summer 95 that an increase was observed.

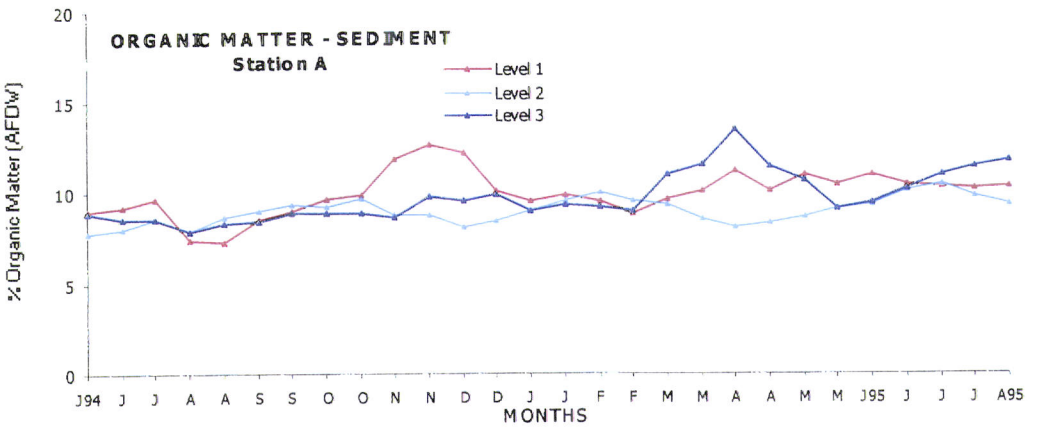


Figure 3.21 - Temporal and vertical variations of the sediment organic matter content at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station A.

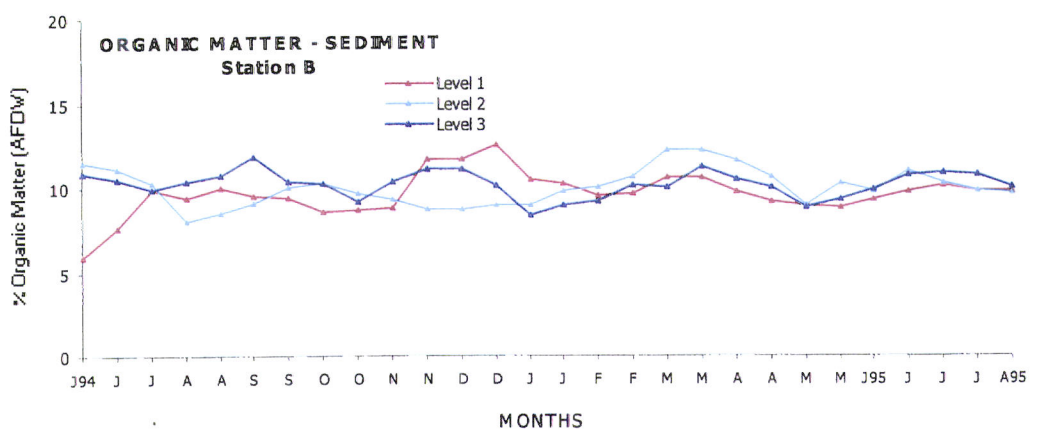


Figure 3.22 - Temporal and vertical variations of the sediment organic matter content at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station B.

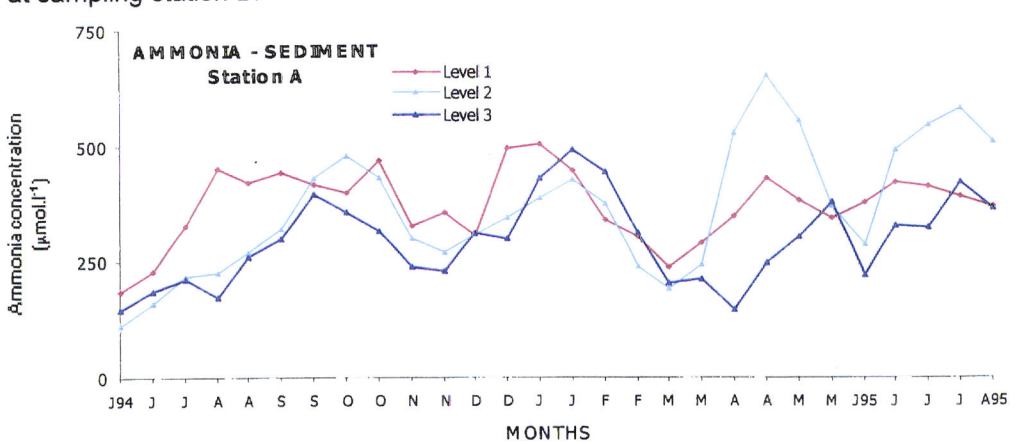


Figure 3.23 - Temporal and vertical variations of the sediment ammonium concentrations at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station A.

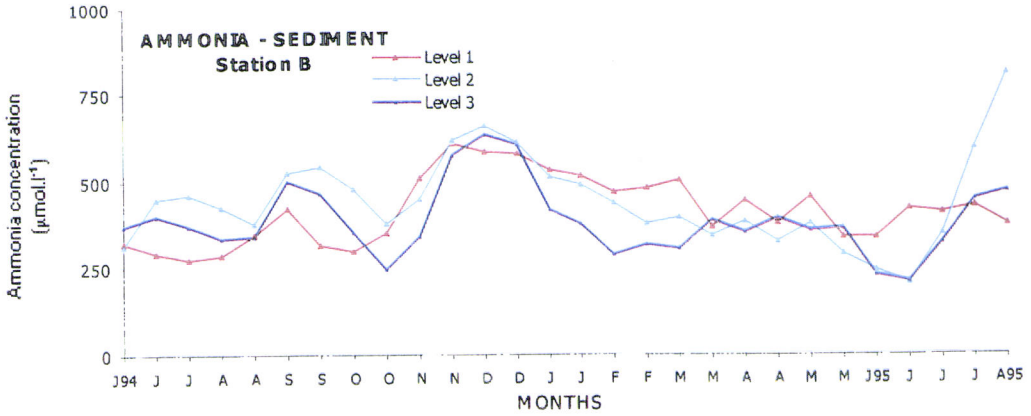


Figure 3.24 - Temporal and vertical variations of the sediment ammonium concentration at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station B.

Nitrate concentrations in the top sediment layer at both sites showed the highest mean values. However, temporal variations of vertical concentrations differ clearly at both stations (Fig. 3.25 and Fig. 3.26). At station A, the deepest nitrate concentrations (1-3 cm) showed strong fluctuations throughout the study, though, at station B, the top layer sediment (0-1 cm), was the one that presented strong fluctuations. At station A, in summer 94 and in summer 95, concentrations were highest in the top layer, in spite of the other decreases observed. Conversely, in both summers at station B, the highest concentrations were in the middle and bottom layers. At station A, the deepest autumn concentrations (1-3 cm) were the highest, and in winter the accentuated increase occurred in the bottom layer. At station B, the top layer presented the highest concentrations with the exception of summer and December.

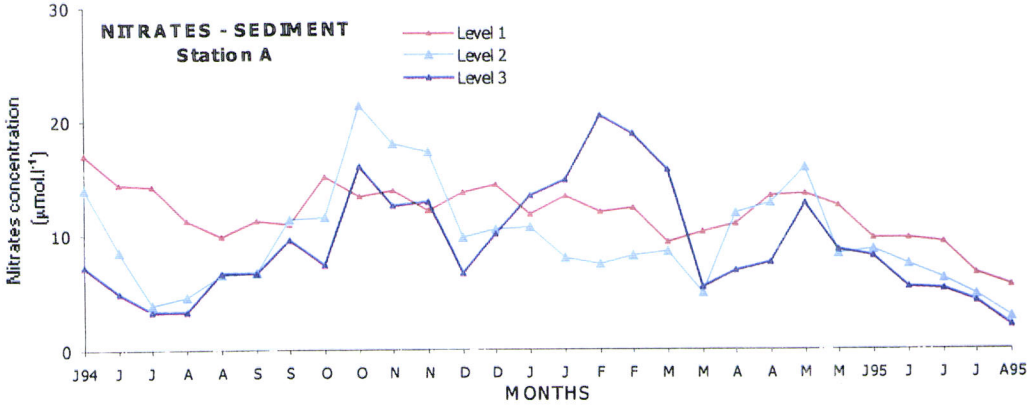


Figure 3.25 - Temporal and vertical variations of the sediment nitrate concentration at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station A.

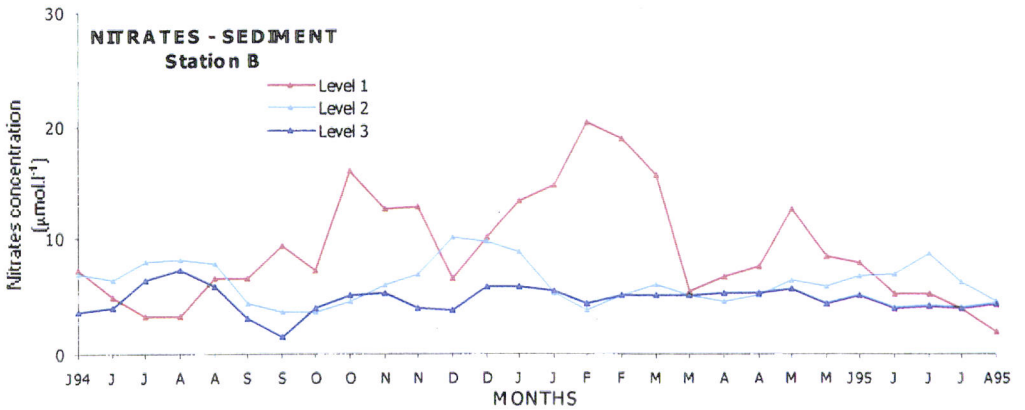


Figure 3.26 - Temporal and vertical variations of the sediment nitrate concentration at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station B.

Temporal variations of vertical nitrite concentrations differ clearly at both stations (Fig. 3.27 and Fig. 3.28). In the winter, at station A, the bottom layer showed strong increase, while concentrations of middle layer sediment decreased. In the spring, concentrations were highest in the middle and bottom layers and, in summer, the top layer presented the highest values. In the later autumn and early winter, at station B, the highest concentrations were found in the middle and top layers. In later winter and spring, the top layer exhibited the highest concentrations. In summer 95, the highest values occurred in the middle layer.

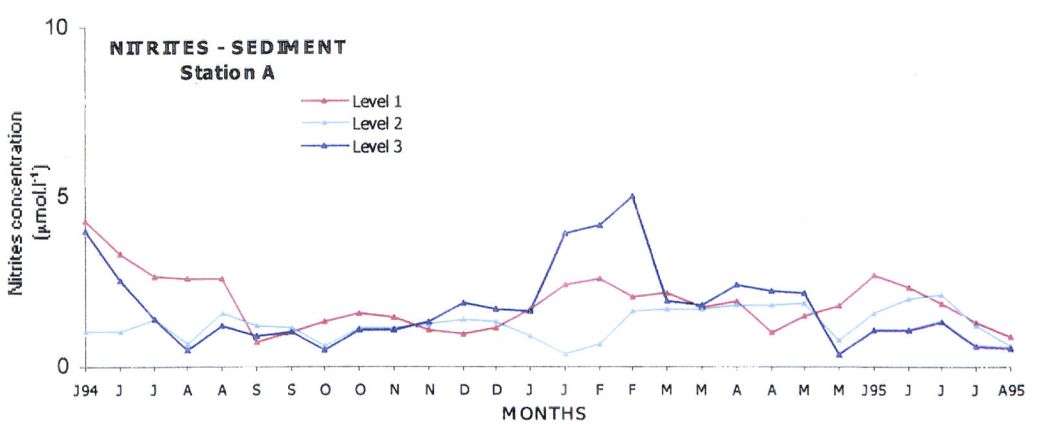


Figure 3.27 - Temporal and vertical variations of the sediment nitrite concentration in the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station A.

Temporal variations of vertical phosphate concentrations at both stations showed strong fluctuations. However, the middle and bottom layers showed a higher concentration than the top layer, except during winter at station B, when the highest values were observed (Fig. 3.29 and Fig. 3.30).

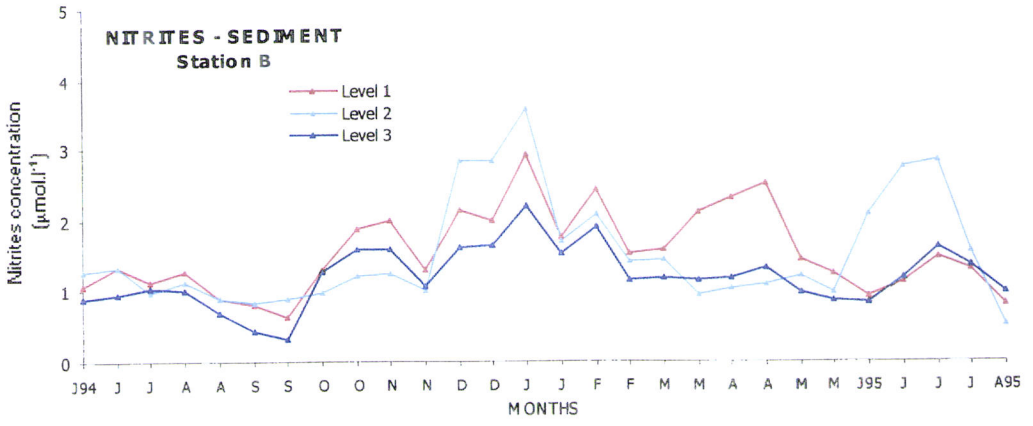


Figure 3.28 - Temporal and vertical variations of the sediment nitrite concentration at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station B.

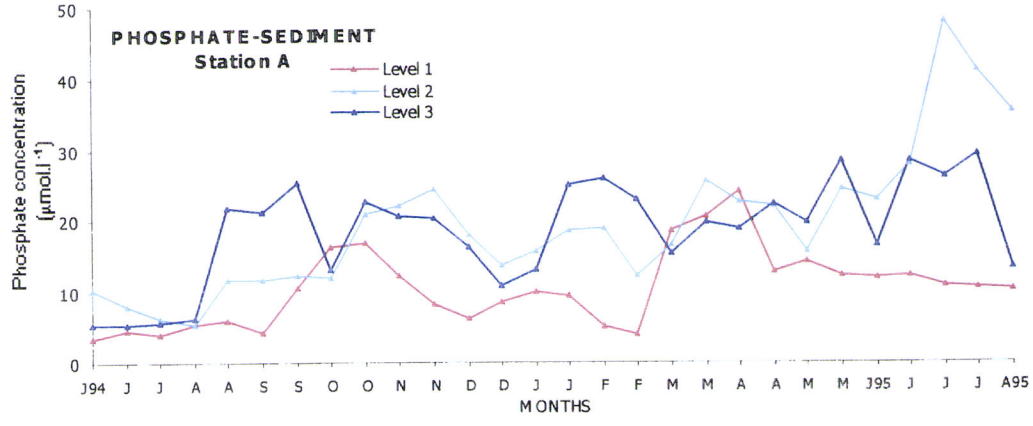


Figure 3.29 - Temporal and vertical variations of the sediment phosphate concentration at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station A

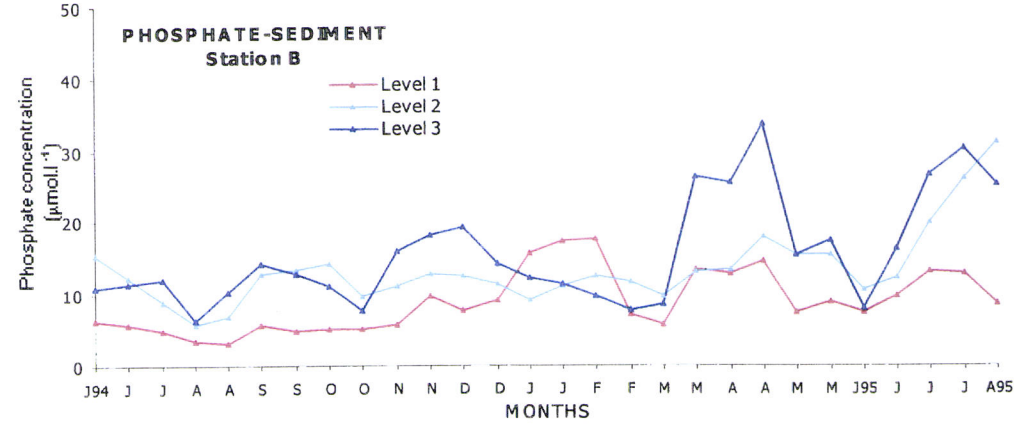


Figure 3.30 - Temporal and vertical variations of the sediment phosphate concentration at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station B.

Temporal variations of vertical silica concentrations at both stations showed, in summer 94, the highest values in the middle and bottom layers (Fig. 3.31 and Fig.

3.32). At station A, in autumn and winter, the highest values were observed in the bottom layer, while at station B, the highest values were found in the middle layer. In spring, the top layer exhibited a period of rapid concentration increase. In summer 95, at station A, the highest values were obtained in the bottom layer and, the middle layer and at station B, in early summer 95, the highest values were registered in the top layer, with an accentuated rapid increase in the bottom layer.

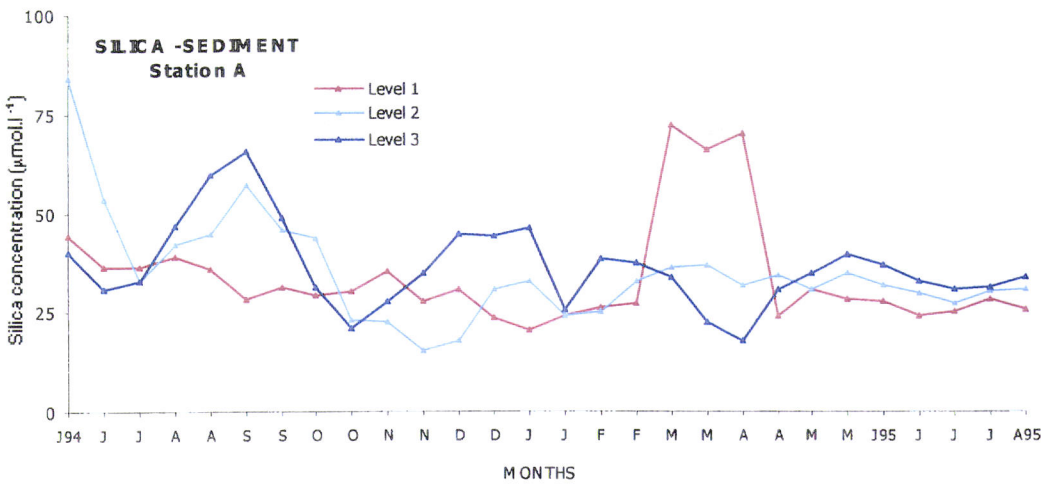


Figure 3.31 - Temporal and vertical variations of the sediment silicate concentration at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station A.

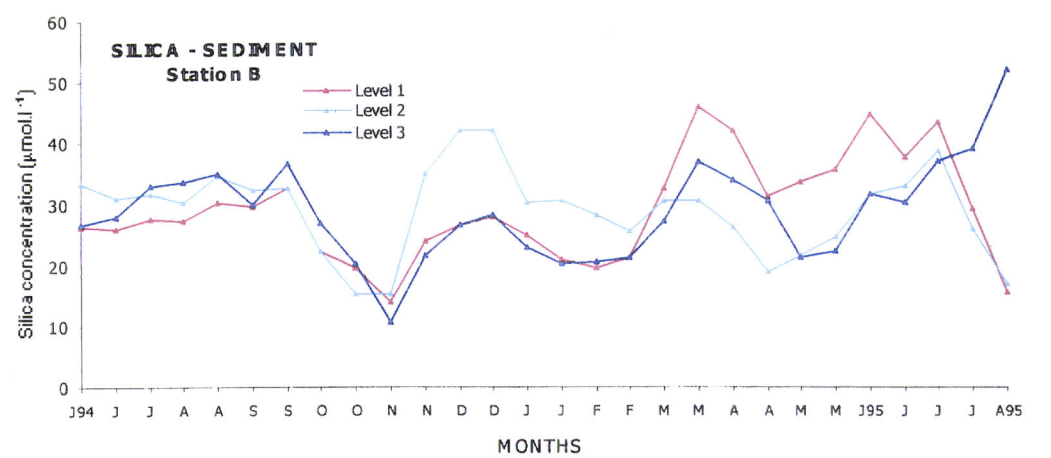


Figure 3.32 - Temporal and vertical variations of the sediment silicate concentration at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station B.

Data concerning sediment proportions of silt, clay, sand and median grain size of each sediment depth layer studied, at both sampling sites, are shown in tables 3.11 and 3.12. Temporal variations of median grain size (µm) profiles at both stations showed the highest values in the middle and bottom layers in both summers, with a sharp

increase registered in summer 95 at station B (Fig. 3.33 and Fig. 3.34). In early autumn, at station A, the highest values were observed in the top layer, while in late autumn and winter, the bottom layer exhibited the highest percentage. Conversely, in early autumn, at station B, the highest values were found in the bottom layer and, in later autumn, the median grain size was higher in the top layer.

Table 3.11- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the sediment granulometry of the three depths (0-1cm, 1-2 cm, 2-3 cm): grain size (μm), percent sand, silt and clay at station A.

Sediment Granulometry	Mean	95% Confidence Interval for Mean	Minimum-Maximum
Grain size (μm)			
(0 – 1 cm)	27.83	24.40 - 31-25	15.90 - 43.54
(1 – 2 cm)	29.73	25.51 - 33.94	14.79 - 5.34
(2 – 3 cm)	28.87	25.40 - 32.73	15.07 – 20.0
Silt (%)			
(0 –1 cm)	53.55	50.36 - 56.74	31.82 -.63.54
(1 –2. cm)	55.30	52.92 - 57.68	42.17 -. 66.46
(2 –3. cm)	53.75	51.10 - 56.39	40.84 - 66.56
Sand (%)			
(0 –1 cm)	28.55	24.89 - 32.26	13.88 - 46.41
(1 –2 cm)	29.62	25.48 - 33.76	10.82 - 50.34
(2 –3 cm)	33.06	29.26 - 36.86	15.06 - 52.06
Clay (%)			
(0 –1 cm)	17.89	16.18 - 19.61	10.32 - 28.17
(1 –2 cm)	14.80	13.33 - 16.27	7.79 - 21.96
(2 –3 cm)	13.49	11.99 - 14.37	7.05 - 18.37

Temporal variations of silt percentage profiles at station A showed a gradual decrease from later autumn until early winter in the top layer, while at station B, the peak values occurred in the bottom layer in November and in February (Fig. 3.35 and Fig. 3.36). Temporal variations of clay percentage profiles were different at both stations, particularity in autumn and in winter (Fig. 3.37 and Fig. 3.38). At station A, a strong increase in clay percentage occurred in the top sediment layer in December, whereas the bottom layer revealed the lowest values. In contrast, at station B, in the bottom sediment layer, the highest clay percentage occurred in autumn and in winter. Temporal variations of sand percentage profiles differed clearly at both stations, particularity in autumn and winter; in fact at station A, the highest percentage occurred

in the bottom layer, while at station B, the lowest percentages was observed (Fig. 3.39 and Fig. 3.40).

Table 3.12- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the sediment granulometry of the three depths (0-1cm, 1-2 cm, 2-3 cm): grain size (μm), percent sand, silt and clay at station B.

Sediment Granulometry	Mean	95% Confidence Interval for Mean	Minimum-Maximum
Grain size (μm)			
(0 – 1 cm)	28.86	28.32 - 36.87	12.92 - 45.80
(1 – 2 cm)	32.60	29.13 - 38.91	16.44 - 58.68
(2 – 3 cm)	34.06	29.25 - 32.53	14.12 - 63.45
Silt (%)			
(0 –1 cm)	52.94	50.90. - 54.98	42.03 - 64.21
(1 –2. cm)	51.82	49.23 - 54.41	36.62 - 63.13
(2 –3. cm)	51.95	48.94 - 54.97	36.48 - 71.98
Sand (%)			
(0 –1 cm)	28.55	24.89 - 32.26	13.70 - 48.24
(1 –2 cm)	29.62	25.48 - 33.76	16.24 - 55.38
(2 –3 cm)	33.06	29.26 - 36.86	11.65 - 57.45
Clay (%)			
(0 –1 cm)	14.78	13.27 - 16.29	9.39 - 22.08
(1 –2 cm)	13.22	11.87 - 14.58	7.69. - 20.63
(2 –3 cm)	13.84	12.43 - 15.24	6.06 - 21.02

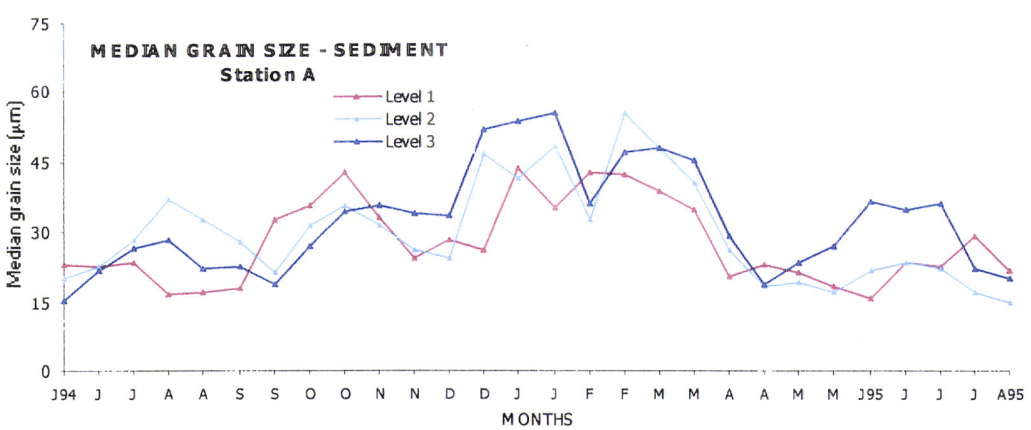


Figure 3.33 - Temporal and vertical variations of the median grain size of the sediment at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station A.

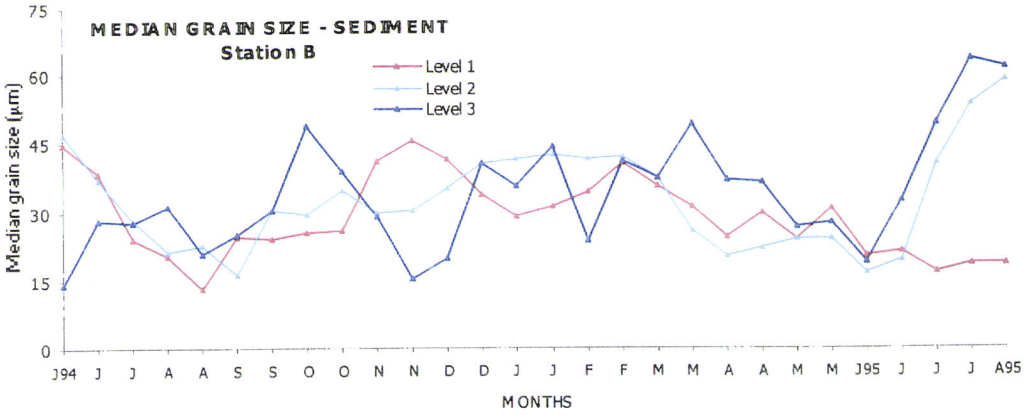


Figure 3.34 - Temporal and vertical variations of the median grain size at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station B.

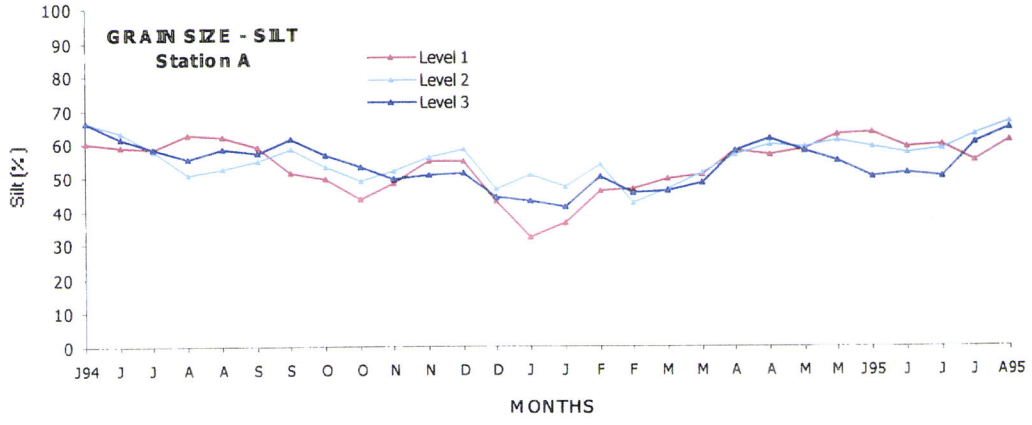


Figure 3.35 - Temporal and vertical variations of silt percentage of the sediment at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station A.

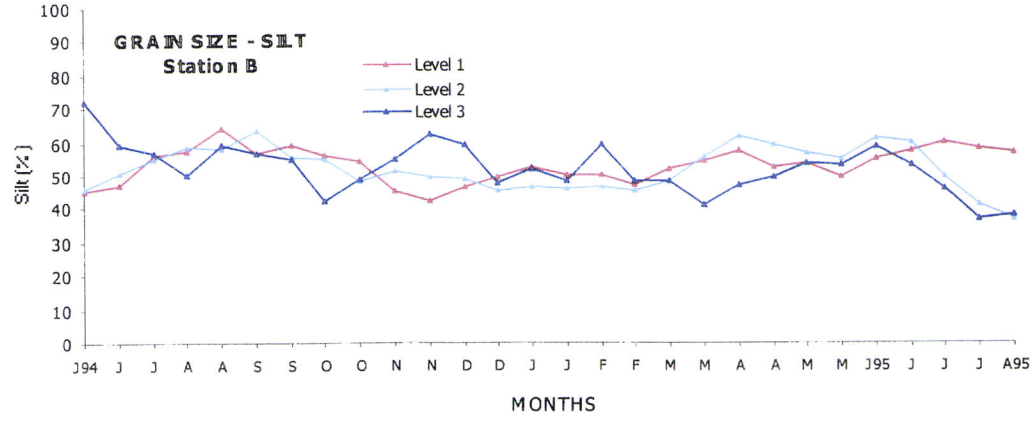


Figure 3.36 - Temporal and vertical variations of silt percentage of the sediment at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station B.

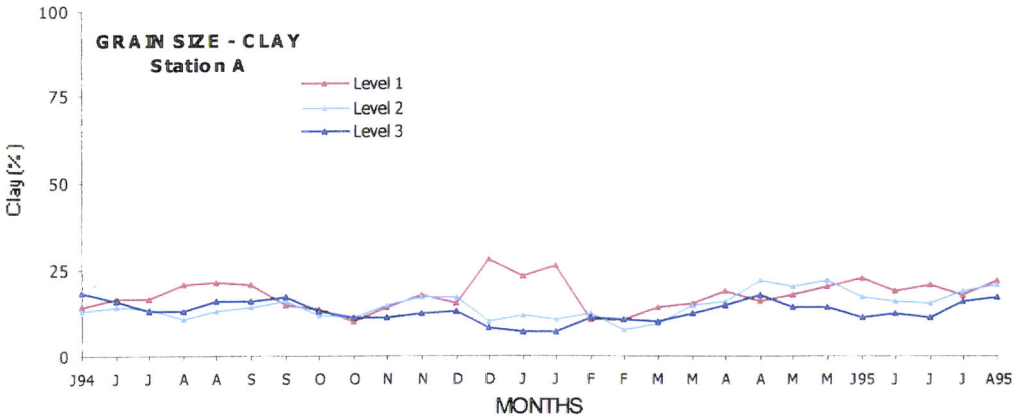


Figure 3.37 - Temporal and vertical variations of clay percentage of the sediment at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station A.

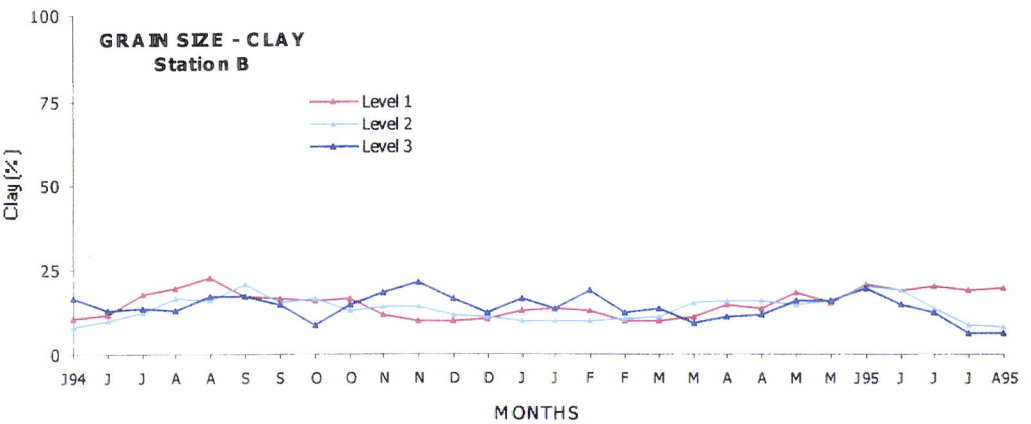


Figure 3.38 - Temporal and vertical variations of clay percentage of the sediment in the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station B.

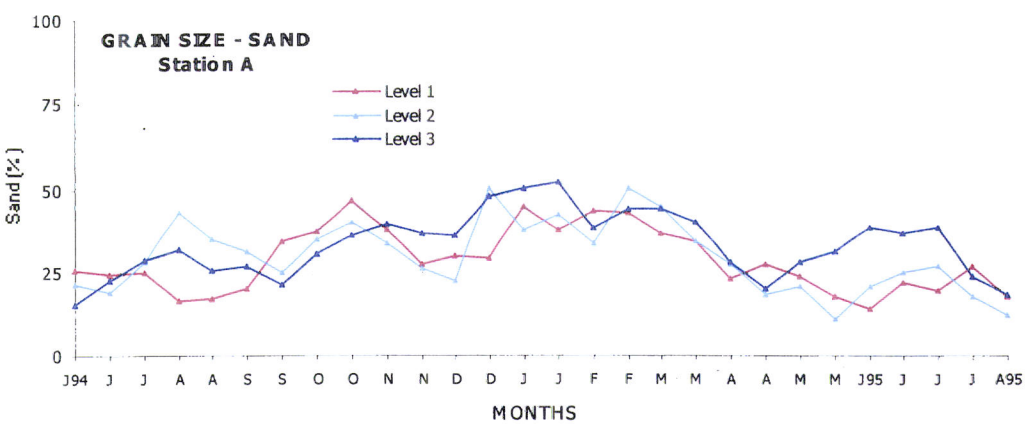


Figure 3.39 - Temporal and vertical variations of sand percentage of the sediment at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station A.

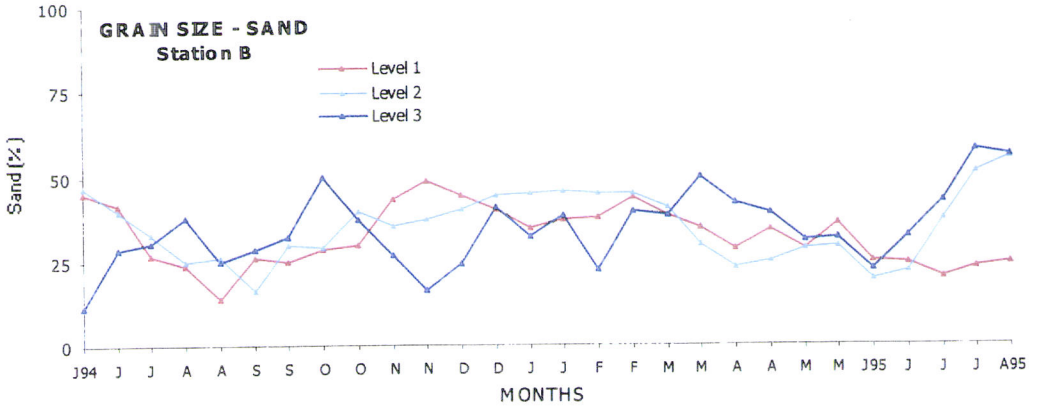


Figure 3.40 - Temporal and vertical variations of sand percentage of the sediment at the three depths: level 1 (0-1cm), level 2 (1-2 cm), level 3 (2-3 cm), from June 1994 to August 1995, at sampling station B.

3.4.1.3. Biological factors

a) Chlorophyll *a*

Data concerning temporal variation of *chlorophyll a* at both sampling sites is shown in table 3.13. Temporal variation of chlorophyll *a* concentration at station B was not consistent with the seasonal pattern expected. Usually, chlorophyll *a* concentration is higher during spring and summer, in agreement with peaks of phytoplankton in northern temperate aquatic systems (Valiela, 1995). However, at station B, the lowest values were obtained in spring (Fig. 3.41). Despite the fluctuations that occurred at station A, the highest values were observed in early autumn 94, with the lowest in winter, increasing during spring. The mean values were similar at both stations.

Table 3.13- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the chlorophyll a concentrations in the water of stations A and B. Units are mg per litre.

Chlorophyll a (mgl^{-1})	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
A	2.30	1.79 – 2.82	0.45 – 5.43
B	2.77	2.12 – 3.43	0.00 – 5.79

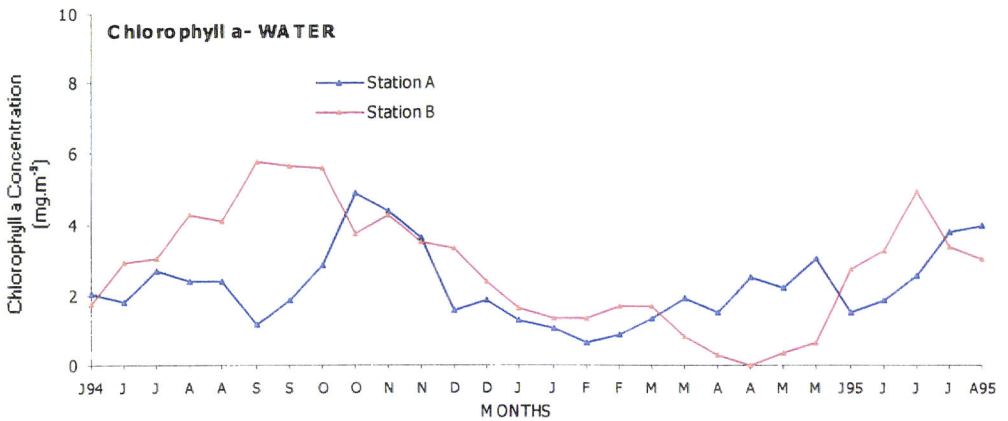


Figure 3.41 - Fortnightly variation of chlorophyll a concentration in the water, from June 1994 to August 1995, at both studied sampling stations, in a *Zostera noltii* seagrass bed of Mira estuary.

b) *Zostera noltii* biomass

Data concerning the temporal variation of total biomass of *Zostera noltii* and leaves biomass and roots biomass at both sampling sites are shown in tables 3.14 and 3.15. Total biomass of *Zostera noltii* followed a clear seasonal pattern, with a period of rapid biomass increase in spring (April-June), reaching maximum values in June 95, whereas the minimum value of biomass occurred in winter (Fig. 3.42 and Fig.3.43). However, at the two sites, the temporal variation of total biomass exhibited some differences. Station A presented a seasonal fluctuation, characterized by maximum values in November 94 (90.3 $g.m^{-2}$) and the other in June 95 (91.1 $g.m^{-2}$). Station B presented one maximum value, in June 95 (78.9 $g.m^{-2}$).

Table 3.14- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the biomass (AFDW) of *Zostera noltii* at station A. Units are grammes per m^{-2}

Biomass (AFDW)	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
Leaves (g. m^{-2})	29.04	25.86 – 32.23	15.26 – 42.22
Roots (g. m^{-2})	40.69	36.77 – 44.61	17.39 – 57.06
Leaves and Roots (g. m^{-2})	69.73	64.37 – 75.10	44.70 – 91.11

Table 3.15- Statistical parameters (mean, 95% confidence level for the mean, minimum and maximum value) of the biomass (AFDW) of *Zostera noltii* at station B. Units are grammes per m^{-2}.

Biomass (AFDW)	Mean	95 % Confidence Interval for Mean	Minimum-Maximum
Leaves (g. m^{-2})	20.82	17.42 – 24.22	10.81 – 38.13
Roots (g. m^{-2})	26.63	24.09 – 29.17	18.63 – 45.04
Leaves and Roots (g. m^{-2})	47.45	42.49 – 52.42	31.70 – 78.93

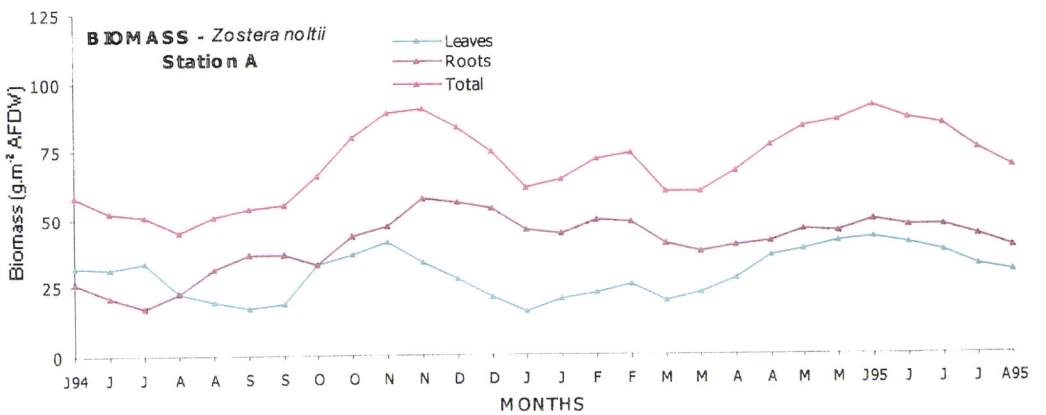


Figure 3.42- Fortnightly variation of *Zostera noltii* biomass from June 1994 to August 1995, at sampling station A.

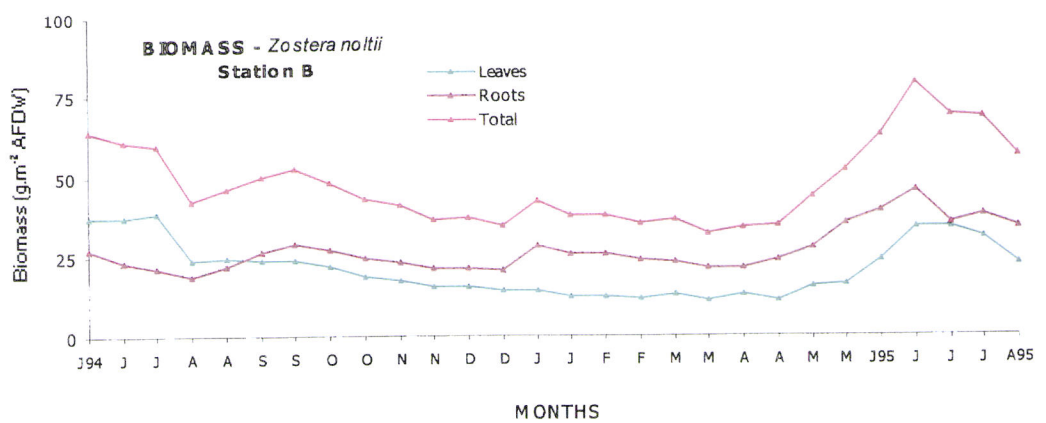


Figure 3.43- Fortnightly variation of *Zostera noltii* biomass from June 1994 to August 1995, at sampling station B.

At both sites, the seasonal pattern of leaves biomass exhibited a close linear relationship with total biomass. Seasonal fluctuations of roots biomass followed those of total biomass, presenting some differences between sites. At station A, there was

an important biomass development of roots in autumn and winter. In contrast, at station B, the lowest values were observed in winter.

The objective interpretation of the environmental factor effects in *Zostera noltii* biomass variation was investigated by the application of multiple stepwise regression analysis. Each sampling station showed different significant environmental factors controlling biomass variation. At station A, the significant environmental factors correlated were sediment organic matter content, pH and sediment nitrate concentration, while at station B they were temperature and pH.

Zostera noltii total biomass (station A) = 80.9 + 14.6 (SOM) -18.7 (pH) + 1.2(SNTA)

SOM – Sediment organic matter; pH ; SNTA – Sediment nitrates concentration;

Zostera noltii total biomass (station B) = 189.9 + 1.9 (TEMP) – 21.2 (pH)

TEMP - Water temperature; pH.

The results from multiple regression stepwise analysis applied only to the leaves biomass of *Zostera noltii* showed, once again, different significant environmental factors controlling biomass variation. At station A, significant factors were water phosphate concentration, sediment nitrite concentration, and sediment silica concentration, while, at station B, the temperature and water phosphate concentration were significant.

Zostera noltii leaves biomass (station A) = 63.4 - 38.5 (WPHOS) - 40.3 (SNI) - 0.323 (SSI)

WPHOS – Water phosphates concentration; SNTI - Sediment nitrites concentration; SNTA – Sediment nitrates concentration; SSI- Sediment silica concentration.

Zostera noltii leaves biomass (station B) = -14.0 -1.21 (TEMP) + 23.3 (WPHOS)

TEMP – Water temperature; WPHOS – Water phosphates concentration.

The results of the same analysis applied only to roots biomass of *Zostera noltii* showed, at station A, sediment silica concentration, sediment organic matter content and water ammonia concentration as significant factors, while, at station B, the

significant factors were salinity, the percentage of clay and the grain size of the sediments.

Zostera noltii roots biomass (station A) = -35.8 -1.19 (WSI) + 6.6 (SOM) + 0.48 (WAM).

WPHOS - Silica concentration in the water; SOM – Amount of sediment organic matter ; WAM – Ammonia concentration in the water ; SSI- Silica concentration in the sediment.

Zostera noltii roots biomass (station B) = -148.7 –2.9 (SAL) + 3.2 (CLAY) + 0.19 (GS).

SAL- Salinity; CLAY – Clay percentage of sediment; GS – Grain size.

3.4.2. Comparison of the two sampling stations based on physicochemical factors

3.4.2.1. Analysis of the differences

Taking into account 1-way ANOVA results, there are significant differences ($p<0.001^{***}$ - very highly significant; $p<0.01^{**}$ - highly significant; $p<0.05^{*}$ - significant) between NO_2^- water concentration ($F=12.3; p<0.001^{***}$), organic matter content of the sediment ($F= 5.6; p<0.05^{*}$), Si sediment concentration ($F=10.6; p<0.01^{**}$) and clay percentage ($F=4.6; p<0.05^{*}$) between station A and station B.

Significant differences were detected by the Mann-Whitney Test, (Z estatistic Mann-Whitney: $p<0.001^{***}$), between NH_4^+ sediment concentration ($Z=-2.3; p<0.05^{*}$), PO_4^- sediment concentration ($Z=-2.589; p<0.01^{**}$), biomass total of *Zostera noltii* (AFDW) ($Z=-4.8; p<0.001^{***}$), leaves biomass of *Zostera noltii* (AFDW) ($Z=-3.2; p<0.001^{***}$) and roots biomass *Zostera noltii* (AFDW) ($Z=-4.6; p<0.001^{***}$) at both stations. The *Zostera noltii* biomass, the sediment clay percentage, ammonia water concentration and silicates sediment concentration were highest at station A, while at station B organic matter content of the sediment and ammonia sediment concentration showed the highest values.

3.4.2.2. Analysis of the differences per sediment layers

The Mann-Whitney Test was applied to analyse the differences of the temporal variation of sediment concentrations of nutrients, organic matter content, sediment granulometry and *Zostera noltii* biomass between sediment layers of the same depth at both stations. In the top layer of sediment (0-1 cm), there were significant differences between nitrate sediment concentration ($Z=-2.6$; $p<0.01^{**}$) and clay percentage ($Z=-2.5$ $p<0.05^{*}$). Regarding the middle depth layer of sediment (1-2 cm), significant differences were detected between the organic matter content of the sediment ($Z= -3.8$ $p<0.001^{***}$), nitrate sediment concentration ($Z=-3.1$; $<0.05^{*}$) and phosphate sediment concentration ($Z=-2.7$; $p<0.01^{**}$). In the bottom sediment layer (2-3 cm), significant differences were detected between the organic matter content of the sediment ($F= -2.0$; $p<0.05^{*}$), silica sediment concentration ($Z=-2.9$; $p <0.05^{*}$), ammonia sediment concentration ($Z=-3.0$; 0.01^{**}) and nitrates sediment concentration ($Z= -4.0$; $p<0.001^{***}$). In the middle and bottom sediment layers, the nitrates and phosphates sediment concentration was highest at station A, while the organic matter content of the deeper sediment layers was highest at station B. In the bottom layer, the silica sediment concentration was highest at station A.

3.4.2.2. Seasonal pattern of variation

The principal components factorial analysis (PCA) was performed in order to identify a seasonal pattern concerning the variation of physiochemical factors during the period of sampling. At both sites, the patterns obtained result from the seasonality of the several environmental factors measured, there being an evident seasonal pattern. The samples clearly followed the order, summer 94, autumn, winter, spring and summer 95 respectively (Fig. 3.44; Fig. 3.45).

At station A, the first axis separated summer 94 and autumn from winter, spring and summer 95, while the second axis separated clearly both sampling summers. As expected, the highest temperature values were obtained in summer 94 and summer 95. Concerning water nutrient concentrations, nitrites showed the lowest values in summer 94 and early spring. The highest values of water nitrates concentration were

in winter and phosphates in summer 95. The pH was highest in winter, spring and summer 95; salinity and oxygen (DO) were lowest in early autumn. The biomass leaves of the *Zostera noltii* showed the lowest values in later summer 94 and winter, while the roots biomass was lowest in summer 94. Regarding the organic matter content of the sediments, the lowest values were detected in summer 94, and the rest of the sampling period showed the values to be very similar. Regarding sediment nutrients concentrations, the highest values for nitrates were obtained in winter, nitrites in early summer 94 and winter, and the phosphate was much lower in summer 94 and winter, while the highest values were in summer 95. Ammonia showed lower values in early summer 94, autumn and early spring. Sediment grain size exhibited the lowest values, at both sampling sites, in summer; therefore, the percentage of sand was higher in winter and autumn.

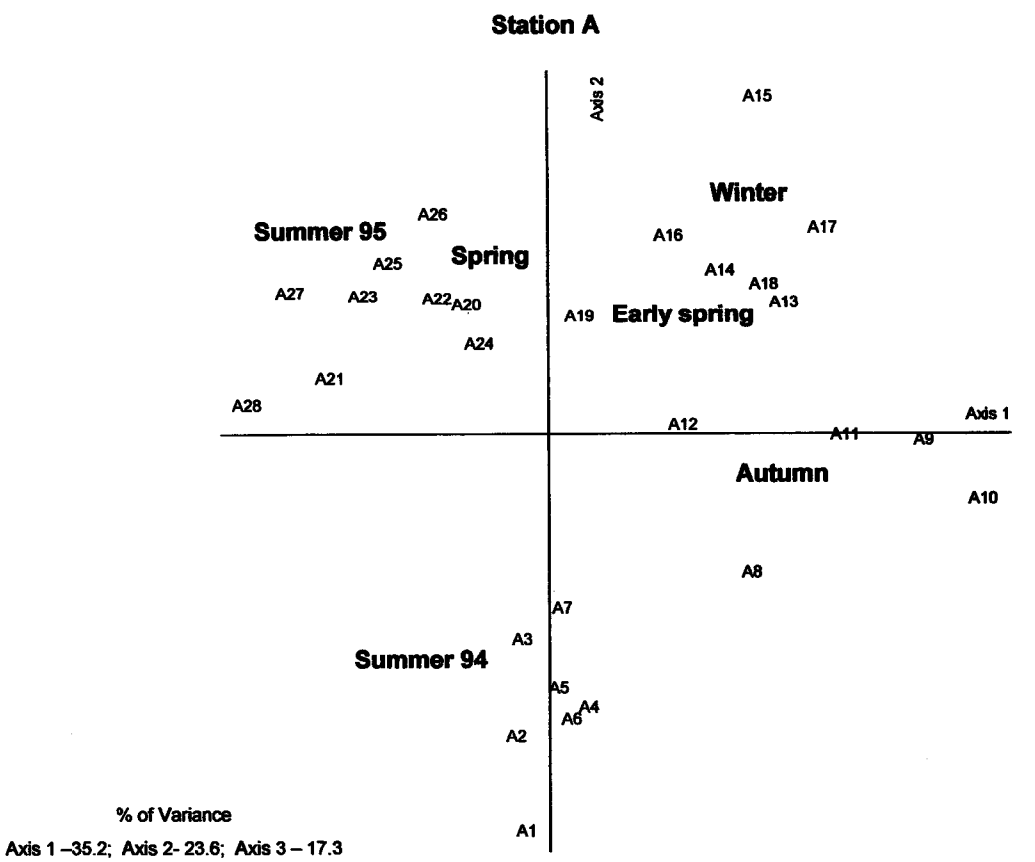


Figure 3.44 - Results of the PCA-ordination based on fortnightly variation of the environmental factors measured (0-3 cm sediment depth) from June 94 (A1) until August (A28) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary. See table 4.3 for full samples dates.

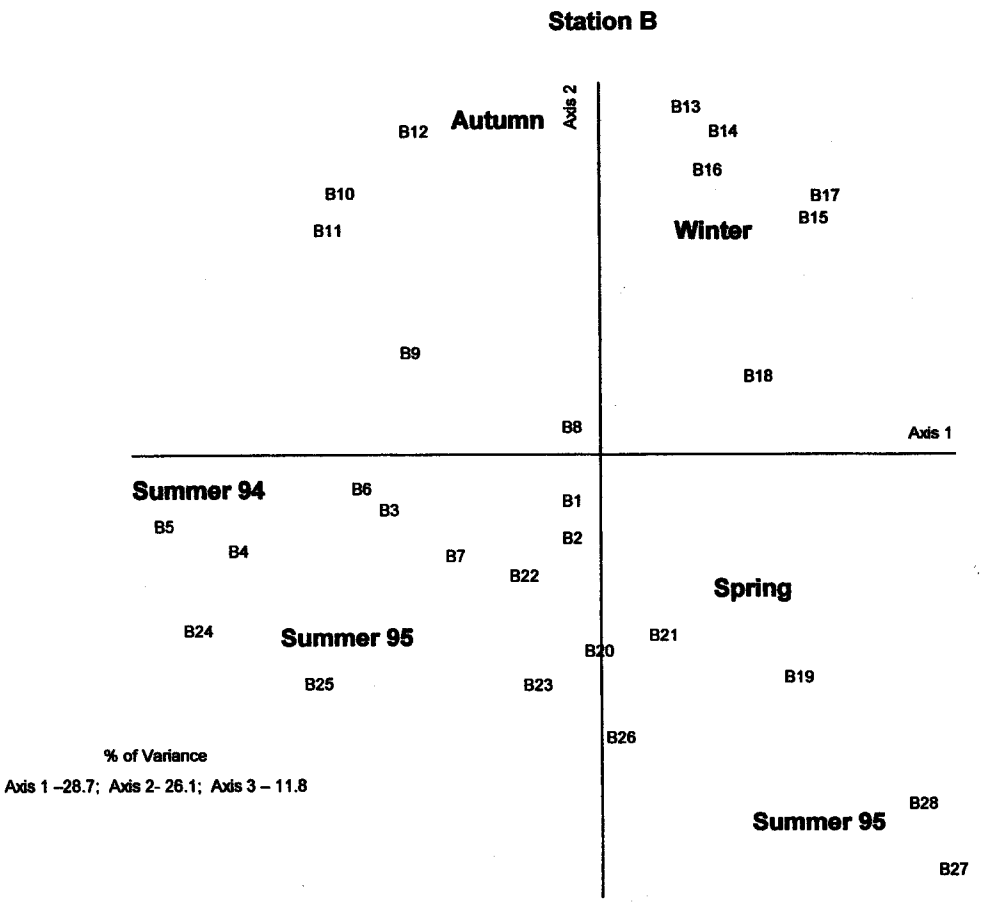


Figure 3.45 - Results of the PCA-ordination based on fortnightly variation of the environmental factors measured (0-3 cm sediment depth) from June 94 (B1) until August (B28) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary. See table 4.3 for full samples dates.

At station B, the first axis separated early summer 94, spring and summer 95 from later summer 94, autumn, and winter, while the second axis separated winter and spring. However some sampling dates stand out, as was the case with summer 95 samples (B27, B28), where the percentage of sand, temperature, dissolved oxygen (DO) and sediment ammonia and phosphate was higher than in other samples of summer 95. As expected, the highest temperature values were obtained in summer 94, spring and summer 95. Concerning water nutrient concentrations, nitrates and ammonia showed the highest values in autumn, phosphates in summer 94 and autumn, while silicates and phosphates showed the lowest values in winter, spring and later summer 95. The dissolved oxygen (DO) was lowest in early autumn, and the pH showed the highest values in winter, spring and summer, as in station A. The salinity was highest in autumn and winter, thereby presenting some differences from station A, which was higher in early autumn. The biomass leaves of the *Zostera noltii* showed the

highest values in both summers, and the roots biomass was lowest in summer 94. Regarding sediment nutrients concentrations of nitrites and nitrates, the highest values were obtained in winter and autumn, while phosphate was lower in summer 94 and winter. Sediment grain size exhibited the lowest values in both sampling summers, except in later summer 95, as previously mentioned. Therefore, the percentage of sand was higher in winter, autumn and spring, while the percentage of clay was highest in summer 94, spring and summer 95. Sediment grain size exhibited the lowest values in both sampling summers; nevertheless, in B27 and B28 samples, the silt percentage was very low. The percentage of sand was higher in winter and autumn.

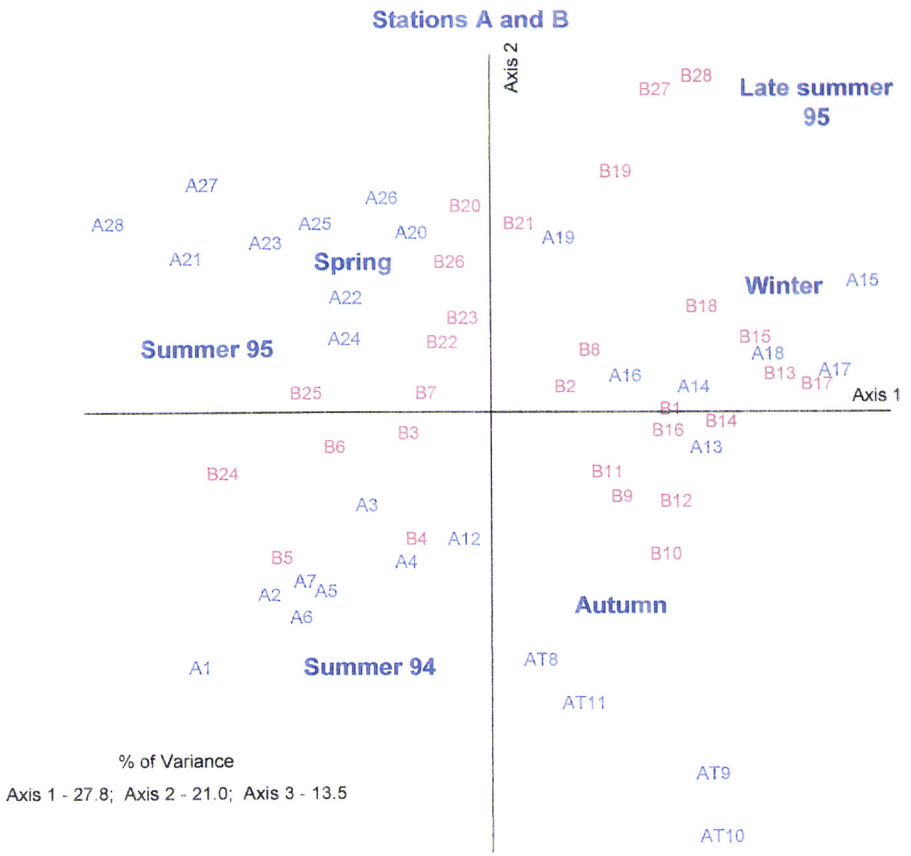


Figure 3.46 - Results of the PCA-ordination based on fortnightly variation of the environmental factors measured (0-3 cm sediment depth) sation A and station B from June 94 (A1;B1) until August (A28;B28) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary. See table 4.4 for full samples dates.

The seasonal patterns found for the several environmental factors studied were very similar between both stations (Fig.3.46). The autumn samples of station A showed some differences from those of station B: higher values of the biomass leaves and

biomass roots of *Zostera noltii*, lower values of the sediment ammonia concentration and the amount of organic matter. The late summer 95 samples, B27 and B28 samples recorded highest values of sand, similar to the winter sample.

3.5. DISCUSSION

The physical and chemical dynamics and the ecology of estuarine areas are strongly influenced by the runoff of freshwater from land, and by the exchange of water with the adjacent open sea. Moreover, the seasonal change effects imposed by the climate determine temporal variations in physical and chemical processes.

The results obtained throughout the study arise from sampling sites located, in intertidal areas of seagrass beds of *Zostera noltii* located downstream. As a consequence, the sampling sites reflected a strong dependence on the marine environment. In addition, the small dimensions of the Mira estuary, with its reduced annual mean outflow and its morphology, with an absence of unevenness in the terminal section of the river, facilitates the upstream penetration of dynamic tides. As expected, the salinity values recorded were usually high and remained constant throughout the study, similar to that of seawater, being remarkably uniform, ranging between 33‰ and 37‰ (Libes, 1992).

The temperature was strongly related to seasonal climatic variations, with the highest values in the summer and the lowest in the winter. However, other factors, such as the hydrographic characteristics of the estuary, the relative magnitude of the river flow and oceanic tidal currents, are relevant factors in explaining the temporal variation of temperature in the estuary.

The temporal variation of the amount of dissolved oxygen did not follow the seasonal trend expected at both stations studied. In fact, the dissolved oxygen usually presented a negative correlation with temperature; however, the results obtained at station A, showed a significant positive correlation between dissolved oxygen and water temperature, although at station B no correlation was obtained.

These results could be related to the complexity exhibited by the seagrass environments which were located at the sampling stations. The dissolved oxygen (DO) temporal variation in seagrass beds could not be explained only by temperature variations, but several other factors had to be taken into account. However, the *Zostera* meadows habitat environment is affected by the same physical and biological mechanisms as bare sand environment, although the mechanisms in this heterogeneous environment, particularly the primary production, organic matter content and detritus production are normally higher (Bonsdorff & Blomqvist, 1993; Boström & Bonsdorff, 1997). Consequently, the decomposition of organic matter and the detritus recycling are of major importance in the seagrass systems. This is largely a microbial process, influenced by the faunal community, which results in an increase of oxygen consumption.

The seawater pH value remained constant at a value of 8.0, the pH values registered throughout the sampling period varying between 8.0 and 9.0, at both stations, which are very close to that of the seawater. Thus, the results obtained clearly reflected the high influence of the marine environment on sampling sites.

Concerning sediment grain size and the amount of sediment organic matter, as expected, the sediments of the sampling stations were mainly fine, with a high percentage of mud and high organic matter content. *Zostera* meadows are usually rich in fine muddy sediments, due to the lower hydrodynamics on the seagrass beds, where the finer sediments tend to accumulate and stabilize (Hillman *et al., 1*989).

It is known that the organic matter concentration in sediments rises as the particle size of the sediments decreases. In fact, silts contain twice as much, and clay four times as much organic matter as sands (Bordovskiy, 1965). This is related to the fact that fine sediments have a higher surface area for organic adsorption (Dale in Parsons *et al.*, 1990). Seagrass meadows are places of high productivity, frequently also supporting high levels of secondary production. Moreover, plant fouling and decay, and the death and excretion of animals, contribute with significant amounts of organic matter to the sediments (Pedersen & Borum, 1992; Viaroli & Cavalca, 1992).

In temperate and higher latitude waters, seagrasses exhibit marked seasonal changes in biomass (Duarte, 1989). The strong seasonality of temperate seagrass has been

extensively studied in a wide range of habitats, in temperate and higher latitude coastal waters. The seasonality exhibited by the *Zostera noltii* variation of the Mira estuary, with higher values of the total biomass in spring and in summer and the lowest in winter, was similar to other studies. The pattern of variation of *Zostera noltii* biomass results obtained by Ferreira (1994) in the Mira estuary, exhibited the period of rapid biomass increase during the summer, reaching maximum values in August-October. Pardal (1998), in the Mondego estuary, registered peak values of total biomass in spring (March) and the highest values in summer. In the Zandkreek (SW Netherlands), the total leaf growth showed maxima in spring and late summer and declining values in autumn (Vermaat *et al.*, 1987).

The correlation between temperate seagrass growth and seasonal variations in light and temperature has been clearly demonstrated (Hillman *et al.*, 1989; Olesen & Sand-Jensen, 1994; Peralta *et al.*, 2002). The seasonality exhibited by *Zostera noltii* biomass variations in the Mira estuary, with high biomass values in spring and in summer and the lowest in winter, could be explained by the temperature and light variations. However, sediment and water nutrients effects on biomass variation were also found by regression analysis results, which could explain the highest values of the biomass observed in autumn at station A. It seems that dissolved nitrogen and phosphorus were limiting nutrients for *Zostera noltii* biomass increase, in certain periods of the year. In contrast, during other periods, the absence of a nutrient effect on biomass variation could be observed. This may be due to dissolved nitrogen and phosphorus being permanently supplied through shellfish metabolism and sediment release, and thus being highly available in the water (De Casabianca *et al.*, 1997; Laugier *et al.*, 1999).

The concentrations of dissolved inorganic nitrogen compounds in the interstitial water sediments are much higher than in the water column. This is due to the large concentrations of organic matter and to the presence of active exchange surfaces in the sediments. The highest concentrations of nitrogen compounds (NH_4-N, NO_2-N and NO_3-N) in the sediments and the water column were reported in the later autumn and early winter, probably related to the higher mineralization rate of the organic matter during this period. The standing higher organic matter content available in the sediments could be the explanation for a high release of ammonium, although, the source of ammonium and nitrate may be difficult to identify in estuaries. Anthropogenic

loadings may be an external source of ammonium to the system, thus leading to an overestimation of the regenerated production. On the other hand, ammonium may also be transferred from reduced deeper sediments to the sediment surface by ascendant diffusion, due to the gradient generated by the high concentration of the NH_4^- in anoxic layers, and the low concentration in oxic layers (Fernex *et al.*, 1989).

The redox state of the sediments determines the relative abundance of inorganic nitrogen compounds. In aerobic sediments organic matter accumulated near the surface is transformed into ammonium, due to the enhancement of microbial activity, this process being helped by a warm temperature (Sfriso *et al.*, 1987, 1988; Valiela, 1995).

The study of the temporal variation of inorganic nitrogen concentration compounds may reflect the redox state of the sediment. In aerobic conditions, ammonium is converted into nitrate by nitrification. Kemp *et al.* (1990) reported a positive correlation between nitrification in sediments and the dissolved oxygen of surface water. In sediments with limited oxygen supply, ammonium is far more abundant than in aerobic conditions, and oxidized inorganic nitrogen is seldom abundant, since denitrification and ammonification remove nitrates (Kemp *et al.*, 1990; Valiela, 1995;).

The temporal variation of the concentrations of ammonia, nitrites and nitrates found in this study suggest that nitrification processes could have occurred continuously throughout the study period, and therefore the sediments were always in aerobic conditions.

In seagrass meadows, sediment provides a major source of nutrients, the amounts of nitrate in the vegetated sediment being four to eight times higher than in a bare bottom system (Flindt *et al.*, 1999). Nitrification rates in seagrass sediments may be slighty higher than in nonvegetated muds because of the aerating effect of photosynthetically produced oxygen, which leaks from plant roots into sediment pore waters (Day *et al.*, 1989; Nielsen *et al.*, 2001). Nitrification is a process mediated by bacterial populations, which require oxygen, and is regulated by temperature. Moreover, high rates of organic matter degradation frequently result in the occurrence of anoxic conditions due to elevated oxygen consumption rates (Viaroli *et al.*, 1992). In fact, in this study, the

major oxygen consumption was observed in autumn and in winter, in the presence of a warm temperature, which could stimulate nitrogen mineralization processes.

The highest values observed in inorganic nitrogen compounds in autumn and winter could be explained by the increase of nitrification rates, probably as a consequence of ammonia enrichment related to the decomposition of *Zostera noltii* leaves and associated with the input of river flow, which increase nutrient concentrations in the water column.

Zostera meadows have a strong influence on the phosphorus dynamics, particularly as the higher amount of organic matter and consequent decomposition process releases dissolved inorganic phosphorous (DIP), increasing P- uptake by plants and roots. As expected, the concentration of phosphate in the sediment observed was higher than in the water column. Porewater concentrations of inorganic nitrogen and phosphorus are often three to ten times higher than in the water column, which explains the preference for taking up these nutrients from sediment (Valiela, 1995; Flindt *et al.*, 1999).

The high phosphate water concentration in summer 94, and the increase observed in summer 95, may be related to the increase of phosphate fluxes from the sediment to the water column, which is a temperature-dependent process. A number of studies have suggested that absorption of phosphorus by benthic sediments represents a buffering mechanisms which helps to control the water column concentrations (Hinga, 1990). Therefore, phosphate sediment-water fluxes in spring and summer increase. Moreover, the disturbance of sediments (Sfriso, 1987, 1988; Valiela 1995), probably caused by bioturbation, increases the fluxes of phosphorus to the water column.

Silica concentration was almost always higher in the sediments of *Zostera* meadows, which is related to the higher content of silica in clay sediments (Day *et al.*, 1989). Higher concentrations in the sediments during spring and summer could be explained by a greater solubilisation of silicates in warmer conditions (Watson & Frickers, 1995). The temporal variation of water column silicate concentrations obtained, throughout this study, was apparently not supported by diffusion rates from the sediment to water. However, the dynamic of diatoms and runoff water is also strongly related to silicate concentrations in the water column; particularly, the increase of diatom population could explain a decrease in water silica concentration (Ittekkot, 2000).

As previously mentioned, the temporal and vertical variations in the porewater concentrations of important oxidized (nitrate and nitrite) and reduced (ammonia) nitrogen compounds, together, could be used to evaluate the oxidation status of the sediment. Caffrey *et al.* (1993) reported nitrification rates decrease at depth, associated with the decrease of oxygen at depth, even with the amount of organic matter available.

At both stations, during the summer, the redox conditions of the sediments seemed to be more reduced. In fact, an increase in ammonium concentration and a decrease in nitrate concentration was evident, suggesting a low nitrification rate. During the autumn, at station A, the middle and bottom layers of sediment seemed more oxidized, with higher nitrates concentration and a decrease in ammonia concentration. In contrast, at station B, the sediments seemed reduced during the autumn, with higher ammonia concentration and lower nitrates concentration. At station A, the sediments in winter seemed to be more oxidized, mainly in the bottom layer. However in spring the middle layer could have been reduced. At station B, the top layer could have been oxidized during winter and spring.

At both stations, the top sediment layer, showed the lowest values of phosphate concentrations. In fact, the vertical profiles of phosphate in the interstitial water of the sediments showed a peak in anaerobic sediments at a relatively shallow depth, presumably where reduced conditions combined to make phosphate salts most soluble. A pronounced decrease was observed toward the surface, suggesting that there is a significant diffusion of phosphate from reduced sediments into the water (Valiela, 1995). However, it was expected that phosphate concentrations in vertical profiles would be quite variable, due to the much stronger phosphate gradient near the rhizosphere, caused by increased P-sorption due to the release of oxygen, and P-uptake by plant roots in the vegetated sediment (Flindt *et al.*, 1999).

At station A, phosphate concentrations increased in the top layer, in early autumn and spring. The likely explanation is that the top layer sediments were reduced, which is supported by the high organic matter content and ammonia concentration and the low nitrate concentration. At station B, the increase of phosphate concentrations in the top

layer only in winter can not be explained by the presence of reduced sediments; instead it was probably caused by the diffusion of phosphate to the top layer.

Silica sediment concentrations in the top layer increased in spring and summer, at both stations. These results can be related to the greater solubilization of silicates in warmer conditions (Watson & Frickers, 1995) and by the dynamic of diatom blooms in spring and summer.

The sediments in the three layers studied consisted of fine sediments with a higher percentage of silt and a lower percentage of sand. No significant differences were found between depths, except at station A, where the percentage of clay was higher in the top layer.

3.6. CONCLUSIONS

The study of temporal and vertical variation of environmental factors in both sampling sites, in order to investigate the ecology of the meiofauna communities of the seagrass beds of *Zostera noltii* in the Mira estuary, leads to the following conclusions:

1 – The comparison of both sampling sites concerning the temporal variations of environmental factors revealed their similarity regarding temperature, salinity, ph, amount of dissolved oxygen (DO) and concentrations of nutrients (ammonia, nitrates, silicates, phosphates) in the water column, as well as proportions of silt and sand.

2 - The temporal variation of the environmental factors studied indicated an evident seasonality, with a similar pattern at both stations.

3 - There are clear differences between both sampling sites concerning temporal variations of some of the environmental factors, such as organic matter content of the sediment, which determined differences in ammonia sediment concentration and phosphate sediment concentration, biomass of *Zostera noltii*, and in clay proportions of the sediment.

4 - Concerning the temporal variations of sediment nutrients and the proportions of silt, clay and sand between sediment layers of the same depths at both stations: a) the top layers (0-1cm) were similar, except for the temporal variations of clay percentage and nitrate sediment concentration, which were higher at station A; b) the middle (1-2cm) and bottom layers (2-3cm) exhibited higher values of organic matter content at station B, while the proportion of silt, clay and sand were similar for both stations.

5 - The sediments were always in aerobic conditions. However, in late autumn and early winter, the results obtained suggest that the sediments were more oxidized, and in summer, the sediments seemed to be more reduced.

6 - At station A, in the middle and bottom layers, in autumn, the sediments seemed to be more oxidized, while, at station B, the sediments seemed to be reduced in autumn. At station A, the sediments in winter seemed to be more oxidized, mainly in the bottom layer. However, in spring, the middle layer could have been reduced. At station B, the top layer could have been oxidized during winter and spring.

7- The temporal and vertical variations of the environmental factors of the seagrass beds of *Zostera noltii* in the Mira estuary were influenced mainly by the climate seasonal variations and by the exchange of water with the adjacent open sea. The characteristics that have made estuaries into eutrophied ecosystems, such as unstable detritus/mineralisation system with frequent oscillations between aerobic and anaerobic states were not observed through the study period

8 - The importance of the seasonal variation of the environmental factors at both stations for the meiobenthic communities will be discussed in the next chapter.

4 - SEASONAL DYNAMICS AND THE VERTICAL DISTRIBUTION OF MEIOFAUNA COMMUNITIES IN SEDIMENTS: RELATIONSHIP WITH THE ENVIRONMENTAL FACTORS

Abstract

The main aims of this chapter are to assess the composition and population densities of the meiofauna in sediments of *Zostera noltii* seagrass, to analyse the temporal and vertical variability of meiofaunal density and composition, and to relate these to seasonal variability of the environmental and biological factors studied at the sampling sites (see Chapter 3).

The higher abundances and meiofauna composition observed throughout the study agree with the results of the previous observations carried out in vegetated intertidal muddy sediments of several estuaries. Nematoda taxon (87%) was the dominant genus, followed by Copepoda (6%), Kinorhyncha, Oligochaeta, Ostracoda, Turbellaria, Bivalvia and Amphipoda. Other taxa were always observed in low numbers: Gastropoda, Ciliophora, Gastrotricha, Halacoiredea, Cnidaria, Insecta and Acari.

The analysis of the temporal variations of the meiofauna assemblages, at both sampling stations, indicated an evident seasonality, was possible to divide into seasonal groups: early summer 94, summer-autumn, winter-spring, and summer 95. However, the densities and seasonal patterns between sampling stations were different.

Seasonal changes in the vertical distribution and densities of meiofauna assemblages were also very evident. The seasonality of the surface sediments was very consistent with the seasonality obtained at 0-10 cm depth.

It was not possible to identify any specific environmental factor to explain the seasonal variation and composition of meiofauna densities and composition, but it was possible recognize the combined effect of several environmental parameters related to the seasonality of the meiofauna.

Abiotic differences between both sites studied seem not to be the main factors affecting the temporal changes of the meiofauna communities.

4. SEASONAL DYNAMICS AND VERTICAL DISTRIBUTION OF MEIOFAUNA COMMUNITIES IN SEDIMENTS: RELATIONSHIP WITH THE ENVIRONMENTAL FACTORS

4.1. INTRODUCTION

Although meiofauna has been the subject of studies in several European estuaries, few data exist about southern estuaries (see references in 2.4.2). In Portugal the studies are very scarce, only intermittent data being available regarding the meiofauna composition of the sediments; so far only three studies have been made, focusing on spacial distribution.

Seasonal variation in plant and animal populations is the rule in nature, and often quite predictable. In benthic communities, seasonal variation is generally more pronounced intertidally than in deeper water (Hichs & Coull, 1983; Heip *et al.*, 1985). Shallow marine meiobenthos are known to vary seasonally with the physico-chemical regime (Ansari & Parulekar, 1993), temperature and trophic dynamics of the environment. However, parameters regulating their standing stocks within a given site are poorly described, and it is difficult to separate the effects of, for example, temperature and food availability (Ólafsson & Elmegren, 1997) or temperature and salinity (Santos *et al.*, 1996), since these variables are generally closely linked. Although, meiobenthic populations usually peak in the warm months, individual species may reach their greatest abundance at other times of the year (McIntyre & Murison, 1973; Bell, 1979). Such patterns may be the result of predation (Sibert, 1979) or competition (Coull & Venberg, 1975). Seasonal cycles can be very different from site to site according to different local environmental conditions and depending on the species composition (Li & Vincx, 1993).

Meiobenthos often show an aggregated spatial distribution within the sediment, both horizontally and vertically. The causes of this patchiness are often complex and involve a variety of biological, physical and chemical variables, including granulometry, salinity, oxygen tension, food availability and chemical compounds in the pore water (Ndaro *et al.*, 1995). The processes that generate and maintain the vertical distribution patterns in different localities are particularly poorly understood and form an important

challenge for contemporary ecological research, particularly in seagrass beds with high complexity. For nematodes, oxygen and hydrogen sulphide are thought to be of prime importance (Giere, 1993; Hendelberg & Jensen, 1993; Wetzel *et al.*, 1995), at least in shallow water. Moreover, both of these ecofactors indirectly or directly determine all other biogeochemical characteristics of the sediment, such as concentrations of nutrients.

The main aims of this study are (1) to assess the composition and population densities of the meiofauna in sediments of *Zostera noltii* seagrass; (2) to analyse the temporal and vertical variability of meiofaunal density and composition; (3) to identify the seasonality of the meiobenthos assemblages; (4) to relate the seasonal and vertical variability of meiofaunal composition and density to the seasonal variability of the environmental and biological factors studied in sampling sites (see Chapter 3); (5) to compare the seasonal variability of the meiofauna density and composition in the Mira estuary (southern Europe) with results obtained in northern Europe estuaries.

4.2. MATERIAL AND METHODS

4.2.1. Meiofauna

4.2.1.1. Sampling strategy

Meiobenthic samples were obtained by forcing a hand core (3.18 cm diameter), to a depth of 10 cm (Higgins & Thiel, 1988). Each sediment sample was cut in three slices according to depth levels: 0-3 cm, 3-6 cm and 6-10 cm. Samples were preserved in 4% formaldehyde solution in polyethylene bottles. Later, two replicates per station for each date were analysed.

4.2.1.2. Extraction techniques

The extraction of meiofauna from mud sediments is done most efficiently by using a density gradient in a centrifugation procedure. The method used was developed in the

Marine Biology Section of Ghent University (Vincx, 1996) and consists of the slightly modified procedure of Heip *et al.* (1985).

The fixed sample is rinsed in a 1 mm sieve to separate shell detritus from the sediment; the rest is retained in a recipient of 5 litres. This part is suspended vigorously with tap water, then poured through a 38 µm sieve. This rinsing is repeated 10 times. Material from the sieve is collect into tubes for centrifugation and a colloidal solution of "Ludox HS40 (60% Ludox and 40% water), which is a silicasol with a density larger than the density of meiofauna (density 1.18 g cm^{-3}), is added. The fraction remaining on the 38 µm sieve is washed and centrifuged three times.

The supernatant is rinsed with water over a 38 µm sieve for some time, because "Ludox" and formalin react and form a gel which is difficult to wash out. After extraction, 4% neutral formalin is added again to the treated sample. In this study, all meiobenthic animals were counted and identified to higher taxa under a stereo microscope (Leica MZ 11). Counting was facilitated by the staining of the entire sample with rose Bengal (1% for 48 hour) and by using a counting dish excluding a border effect (De Grisse, 1963).

4.2.2. Environmental factors

With regard to the determination of environmental factors please refer to chapter 3.

4.2.3. Data Analysis

A variety of multivariate, univariate and graphical methods were imployed in the analysis of meiofauna and environmental data sets. The different techniques were applied to the average densities of two replicates and the running mean was calculated per date for each station.

The nonparametric Kruskal-Wallis Z test (H statistic Kruskal-Wallis: $p<0.001$***- very highly significant; $p<0.01$**- highly significant; $p<0.05$* - significant) was employed to check for the existence of significant differences in the temporal variation of the

densities of meiobenthos taxa between both sampling stations studied. The Mann-Whitney U test (Z statistic Mann-Whitney Test; $p<0.001$***- very highly significant; $p<0.01$**- highly significant; $p<0.05$* - significant) was applied with the aim of analysing the differences in the temporal variation of meiobenthos taxa between layers with the same depth at both stations (Norusis, 1992; Sokal & Rohlf, 1995).

To characterize the communities in terms of temporal variation, meiofauna taxa densities corresponding to each date were estimated by applying them to a moving average (using prior, present, and following dates). The estimated values were then used to build the datamatrix used as input for the Two Way INdicator SPecies ANalysis – TWINSPAN (Hill, 1979). This program simultaneously classifies species and samples, and it is geared towards ecological data. At its core, TWINSPAN is based on dividing a reciprocal averaging ordination space. One of the most useful features of TWINSPAN is the final ordered two-way table. Species names are arrayed along the left side of the table, while sample numbers are along the top. The pattern of zeros and ones on the right and bottom sides define the dendogram of the classification of species and samples respectively. The interior of the table contains the abundance class of each species in each sample. Abundance classes are defined by pseudospecies cutlevels. A transformed percentage datamatrix with cutlevels 0.00, 0.02, 0.05, 0.1, 0.2, 0.5, 0.9 was used.

Multivariate statistical techniques were used to assess the seasonal variation of meiofauna densities taxa, and a correlation-based Principal Component Analysis (PCA) was done (see chapter 3). Prior to the multivariate analysis, the data were percentage transformed prior to analysis.

The relationship between the community assemblages of the meiofauna and environmental variables was examined using the ordinatory Canonical Correspondence Analysis-CCA (Ter Braak, 1994 in PC-ORD, user`s guide). This ordination method seeks structure in the main matrix, in such a way as to maximize the strength of the relationship with the second matrix. Normally, the main matrix contains an abundance of species in a set of sample units, while the second matrix contains environmental variables measured in the same sample units. In community ecology, the ordination of samples and species is constrained by their relationships to environmental variables, the method presuming meaningful environmental variables

that have been measured. Data were fourth-root transformed prior to analysis in order to scale down the effect of abundant species (Field *et al.*, 1982; Clarke & Green, 1988).

All statistical analysis was performed with MICROSOFT EXCEL, SPSS 10.0 and PC-ORD 4.0.

4.3. RESULTS

4.3.1. Temporal variations of densities and meiofauna composition

a) Global results

Significant differences were obtained by the Mann-Whitney Test, (Z statistic Mann-Whitney; $p<0.001^{***}$) between station A and B, concerning temporal variations of the total meiofauna recorded ($Z= -5.38; p< 0.001^{***}$). The densities were highest at station B and showed highest fluctuations compared with station A (Fig. 4.1).

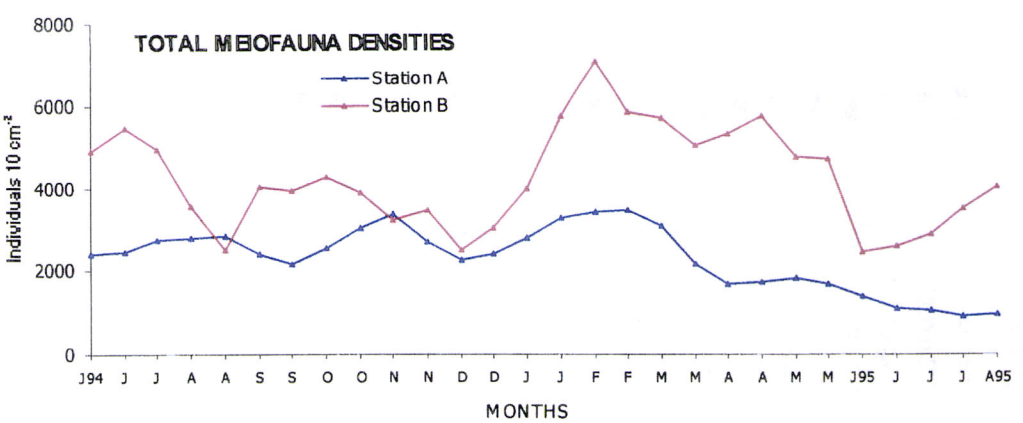


Figure 4.1- Fortnightly variation of total meiofauna density (0-10 cm sediment depth), from June 94 until August 95, at both sampling stations, in a *Zostera noltii* seagrass bed of the Mira estuary.

At both sampling stations 17 groups were observed, with Nematoda always the dominant major taxon, with a mean value of 86.9% at station A, and 88.0% at station B. Harpacticoid copepods were the second most common group, with a mean value of 6.8% at station A, and 5.6% at station B. At station A, other groups of some importance were Polychaeta (1.7%), Kinorhyncha (1.4%), Oligochaeta (1%), Nauplii

larvae (0.9 %), Ostracoda (0.5%), Turbellaria (0.4%), Bivalvia (0.3%) and Amphipoda (0.15%). Groups found infrequently in low density were Gastropoda, Ciliophora, Gastrotricha, Halacaroidea, Cnidaria, Insecta and Acari (less then 0.03%). At station B, groups of some importance were Kinorhyncha (4.3%), Polychaeta (1.0%), Oligochaeta (0.3%), Nauplii larvae (0.25%), Ostracoda (0.13%), Turbellaria (0.12%), Bivalvia (0.1%), Amphipoda (0.02%) and Gastropoda (0.02%). Groups found infrequently in low density were Halacaroidea, Ciliophora, Cnidaria, Tardigrada, Insecta and Acari (less then 0.02%) (Fig. 4.2).

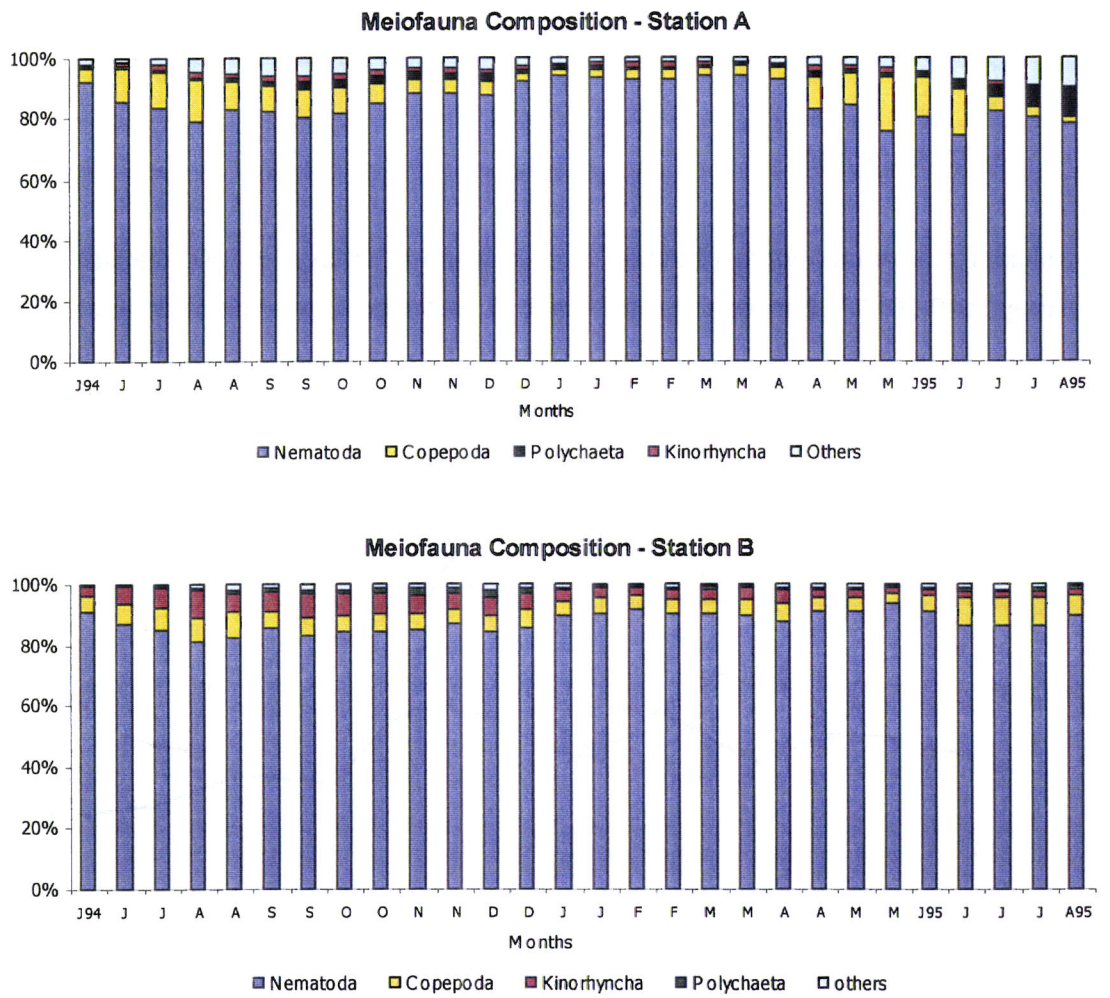


Figure 4.2- Fortnightly variation of relative composition of the meiofauna taxa (0-10 cm sediment depth), from June 94 until August 95, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

Significant differences between station A and station B concerning density temporal variations of the several taxa recorded were detected by the Mann–Whitney test: Nematoda ($Z=-5.2$; $p<0.001$***); Copepoda ($Z=-3.6$; $p<0.001$***); Oligochaeta (Z=-

4.3.9; p<0.001***); Ostrocoda (Z=-2.8; p<0.01**); Kinorhyncha (Z=6.2; p<0.001***); Amphipoda (Z=-4.3; p<0.001***); Gastropoda (Z=-2.0; p<0.05*); Cnidaria (Z=4.7; p<0.001***) and Halacaroidea (Z=-5.8; p<0.001***). However, regarding Polychaeta, Turbellaria, Nauplii larvae and Bivalvia, no significant differences were detected between stations.

Data relating to meiofauna composition and densities between 0 and 10 cm sediment depth are reported in tables 4.1 and 4.2. Nematoda taxon was least abundant at station A, and the minimum density was registered in July 95, while at station B, it was observed in August 94. At both stations, the highest densities were in winter, followed by subsequent decline, at station A, and there remained a constant decrease until summer 95, though at station B, despite the downward tendency, a rise in spring and in summer 95 was observed. At both stations a decrease in November was observed (Fig.4.3).

Table 4.1 – Statistical parameters (95% confidence interval for mean) of the meiofauna taxa densities, at station A. Units are number of individuals per 10 cm^{-2}.

Meiofauna	Mean	95% Confidence interval for mean	Minimum - Maximum
Nematoda	2002	1715.6 – 2289.0	745.6 – 3213.3
Copepoda	156	118.7 – 192.7	21.9 – 400.5
Polychaeta	38	29.1 – 47.4	12.1 – 87.9
Kinorhyncha	33	25.4 – 39.6	4.4 – 68.5
Oligochaeta	24	19.9 – 27.6	6.9 – 41.9
Nauplii larvae	21	10.6 – 31.4	0.0 – 87.5
Ostracoda	11	7.6 – 15.2	0.4 – 31.7
Turbellaria	8	2.9 – 13.9	0.0 – 56.1
Bivalvia	7	4.0 – 9.3	0.6 – 24.0
Amphipoda	3	2.4 – 4.3	0.0 – 8.5
Gastropoda	0.7	0.30 – 1.1	0.0 – 2.7
Ciliophora	0.2	0.04 – 0.4	0.0 – 2.0
Gastrotricha	0.07	0.01 – 0.1	0.0 – 0.4
Halacaroidea	0.05	0.01 – 0.08	0.0 – 0.3
Cnidaria	0.05	0.00 – 0.01	0.0 – 0.4
Insecta	0.02	0.00 – 0.05	0.0 – 0.2
Acari	0.02	0.00 – 0.03	0.0 – 0.1

Harpacticoid copepods such as nematodes were also least abundant at station A. The minimum abundance was reached in July 95 at station A, while at station B it was in December 94. The highest densities were attained in summer 94 at both stations, in

July 94 at station A and in August 94, at station B. The temporal variation of copepods densities was characterized by a very similar pattern between stations during summer 94 and autumn; subsequently a clear opposite trend was observed. In fact, at station A, during winter, the densities were lower, while at station B they were higher (Fig. 4.4).

Table 4.2 – Statistical parameters (95% confidence interval for mean) of the meiofauna taxa densities, at station B. Units are number of individuals per 10 cm^{-2}.

Meiofauna	Mean	95% Confidence interval for mean	Minimum - Maximum
Nematoda	3742	3289.4 – 4194.7	2044.9 – 6528.9
Copepoda	239	216.5 – 261.6	133.6 – 336.9
Kinorhyncha	181	146.4 – 214.6	46.9 – 331.6
Polychaeta	43	37.6 – 48.5	18.7 – 75.3
Oligochaeta	12	9.2 – 15.0	1.0 – 24.6
Nauplii larvae	11	8.5 – 12.9	2.1 – 22.3
Ostracoda	5	2.9 – 7.8	0.4 – 21.7
Turbellaria	5	3.8 – 6.0	1.3 – 12.6
Bivalvia	5	3.5 – 5.5	1.0 – 10.1
Amphipoda	0.9	0.5 – 1.3	0.0 – 4.4
Gastropoda	0.7	0.5 – 0.8	0.0 – 1.3
Halacaroidea	0.7	0.5 – 0.8	0.0 – 1.7
Ciliophora	0.4	0.2 – 0.6	0.0 – 1.9
Cnidaria	0.4	0.3 – 0.5	0.0 – 1.3
Tardigrada	0.1	0.0 – 0.21	0.0 – 0.6
Insecta	0.02	0.0 – 0.05	0.0 – 0.2
Acari	0.02	0.0 – 0.03	0.0 – 0.1

Polychaeta was the third most abundant group at station A and the forth at station B. At both stations the minimum density was observed in summer 94, while the density maxima were reached in August 95 at station A, and in November 94 at station B. An important feature to point out was the similar pattern of the temporal variation of the Polychaeta densities between both stations, the highest values being attained in autumn, followed by a decline during winter, and a rise in early summer 95 (Fig. 4.5).

At station B, Kinorhyncha was the third most abundant taxon, being more abundant than at station A. The minimum abundance obtained was in summer 95 and the higher values were in winter at station A and in summer 95 at station B. Temporal variation exhibited the density maxima in summer 94, while the lowest were obtained in summer 95. At both stations, the density decreased sharply in autumn, followed by a slight

increase during winter. At both stations, an opposite trend occurred in spring and in later summer 95 (Fig. 4.6).

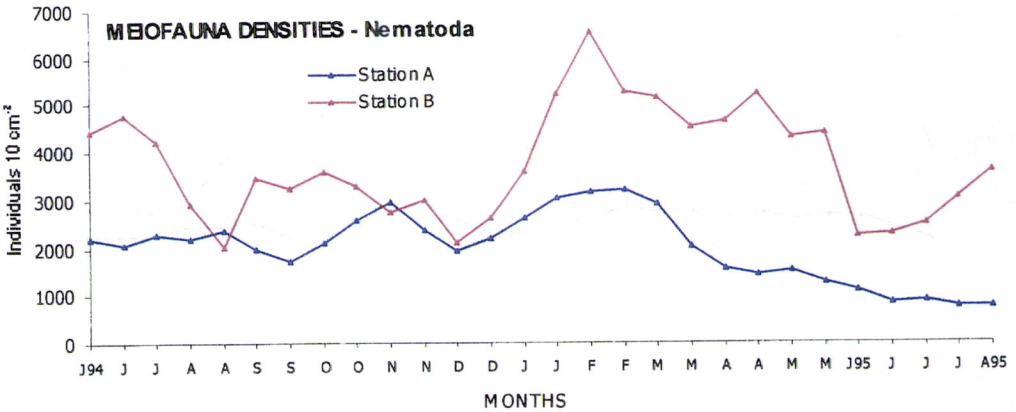


Figure 4.3 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda taxon, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

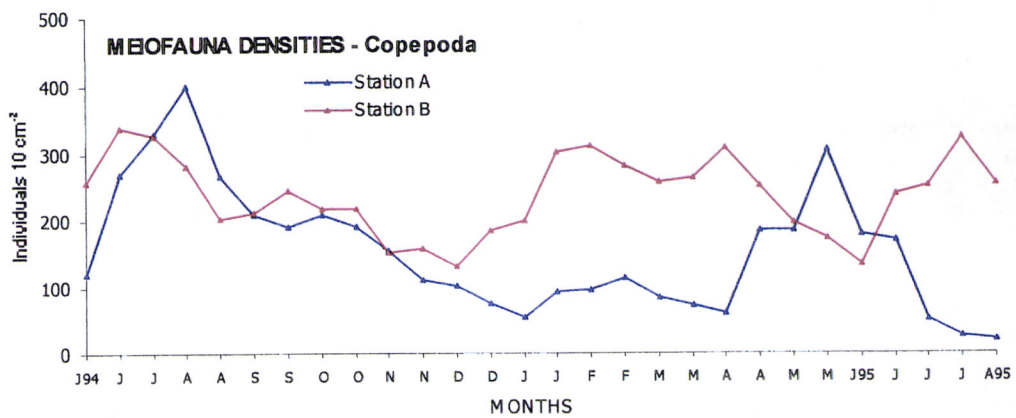


Figure 4.4 - Temporal variation of density (ind. per 10 cm^{-2}) of the Copepoda taxon, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

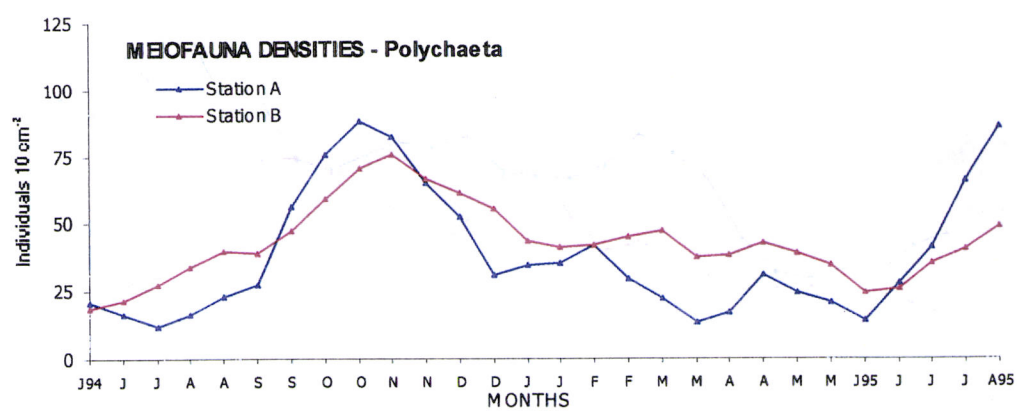


Figure 4.5 - Temporal variation of density (ind. per 10 cm^{-2}) of the Polychaeta taxon, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

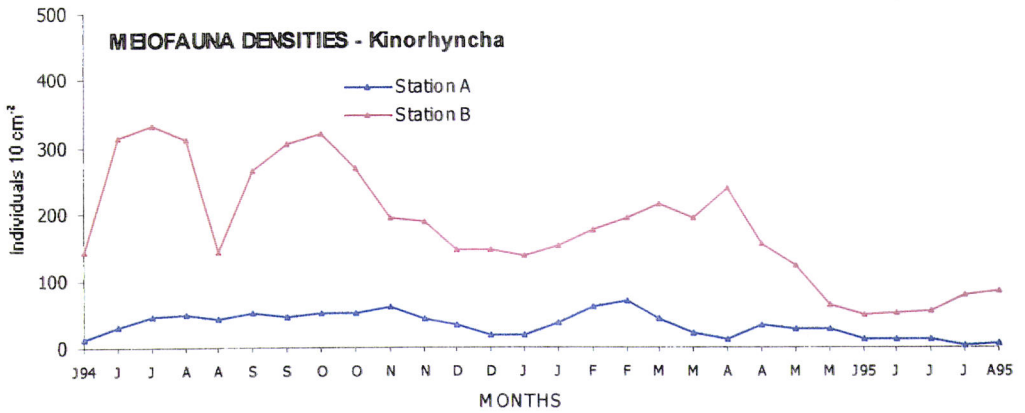


Figure 4.6 - Temporal variation of density (ind. per 10 cm^{-2}) of the Kinorhyncha taxon, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

Oligochaeta was more abundant at station A. At both stations, the minimum density was registered in summer 94, though the highest density at station A was reached in summer 95, and in spring at station B. Temporal patterns differ between stations: at station A, Oligochaeta densities increased throughout the sampling period, while at station B, during winter, there occurred a sharp decline, followed by an increase in spring. In later spring, the densities declined, and both summers became very similar (Fig. 4.7).

Ostracods also were more abundant at station A. The densities and temporal variations at both stations were very similar, the density maxima being attained in early autumn followed by a subsequent decline. However, at station A, a slightly increase in winter and spring was observed (Fig. 4.8).

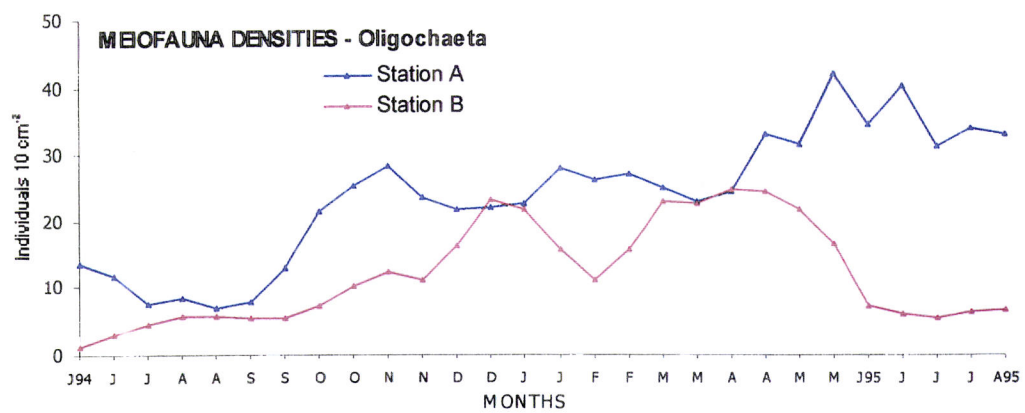


Figure 4.7 - Temporal variation of density (ind. per 10 cm^{-2}) of the Oligochaeta taxon, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

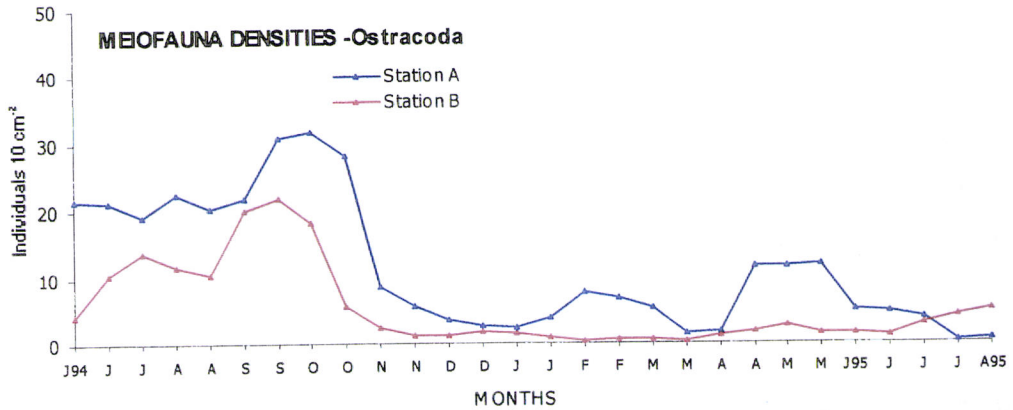


Figure 4.8 - Temporal variation of density (ind. per 10 cm^{-2}) of the Ostracoda taxon, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

Amphipoda, Gastropoda and Halacaroidea represented minor taxa at both stations, always revealing only a few specimens per 10 cm^{-2}. However, the temporal variation of density at both stations differed significantly. Concerning the Amphipoda, at station A the highest densities were attained in autumn, while at station B, the same was observed in summer 95. At station A, Gastropoda taxon showed the highest values in autumn, followed by subsequent decline, until there was a complete disappearence in February. At station B, despite the lower densities, the group was reported throughout the entire study period.

Turbellaria, Nauplii larvae and Bivalvia were also minor taxa. However, the densities between sampling stations were not significantly different. At station A, Turbellaria were absent during winter and spring, but in later spring and in summer 95, they exhibited an accentuated increase. At station B, the group was reported throughout the period of the study. At station A, density maxima of Nauplii larvae occurred in summer 94, followed by a sharp decline, until disappearing in spring. At station B, they were reported throughout the period of the study. At both stations, Bivalvia increased their densities during summer 94, followed by a decline. At station A, during autumn, an important increase was registered, and at both stations a slight increase was also observed during spring.

b) Temporal variation of the vertical densities

The temporal and vertical distribution of meiofauna taxa was studied at three depths of the sediment: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm). As expected, at both sampling stations the vertical distribution of meiofauna taxa exhibited the highest densities at 0-3 cm depth, showing lower densities in deeper sediment layers. There was, therefore, a strong contrast between the upper and deep layers. At station A, and at station B, respectively 85.3% and 82.8 % of the total meiofauna density occurred between 0 and 3 cm depth. A clear reduction of meiofauna taxa was observed at a deeper layer (3-10 cm), with extremely low densities being recorded at both stations: between 3 and 6 cm depth, 9.2 % (station A) and 10.6 % (station B), between 6 and 10 cm depth 5.5% (station A) and 6.6 % (station B) (Fig. 4.9 and Fig 4.10).

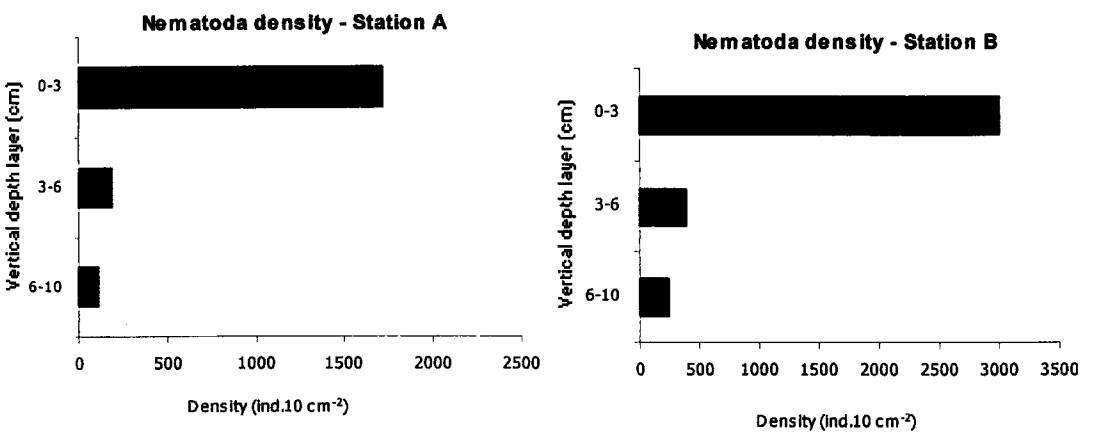


Figure 4.9 - Vertical profile distribution of the average densities of the Nematoda taxon, at the three depths at station A and station B.

Concerning the vertical distribution of meiobenthos taxa densities relative to the total meiofauna density, at both sampling stations, Nematoda taxon was present at a depth of 10 cm, with an average of 88.6%, and the second most abundant group was Copepoda, which reached an average of 6.6%. At station A, Polychaeta and kinorhyncha each represented 2% and 1.5%, respectively, though at station B, kinorhyncha were clearly an important group in relation to abundance at each depth studied.

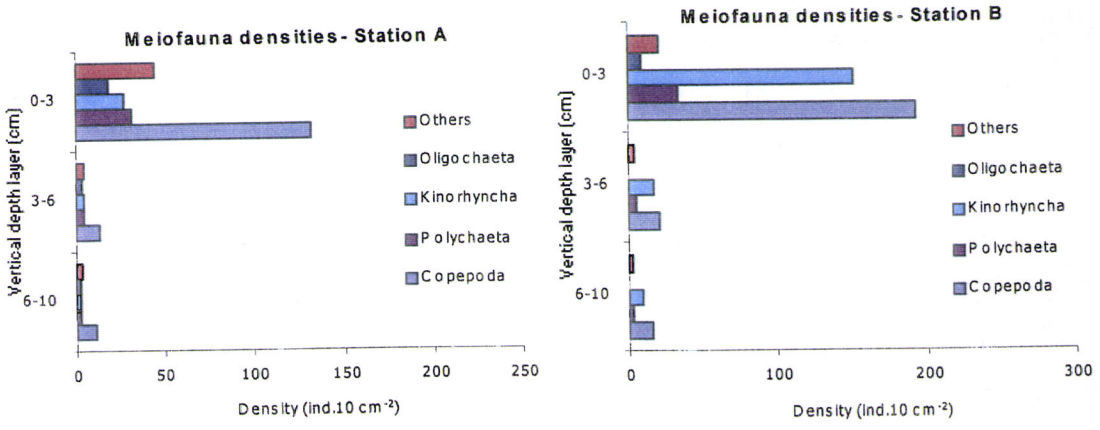


Figure 4.10 - Vertical profile distribution of the average densities of meiofauna taxa (Copepoda, Polychaeta, Oligochaeta, Kinorhyncha and other groups), at the three depths, at station A and station B.

In the top layer of sediment, 0-3 cm depth, at station A, 16 meiofauna groups were observed, and 15 at station B. At station A, nematodes constituted 85.8% of the total meiofauna densities (average density 1712 ind. cm^{-2}), followed by harpaticoids copepods at 7.2% (average density 132 ind.cm^{-2}). Other groups of some importance observed during the entire study period were Polychaeta, Oligochaeta, Kinorhyncha, Ostracoda and Bivalvia. Meiofauna groups found at both stations, infrequently and in low density (less than 1%), were Nauplii larvae, Turbellaria, Amphipoda, Gastropoda, Ciliophora, Halacaroidea, Cnidaria and Insecta). Gastrotricha taxon with very low density (less than 0.02%) was observed only at station A. At station B, nematodes reached 87.7% of the total meiofauna densities (average density 2996 ind. cm^{-2}), followed by harpaticoid copepods 5.8% (average density 192 ind. cm^{-2}) and Kinorhyncha (4.5%) with average density 151 ind. cm^{-2}, which were more abundant than at station A. Groups found during the entire study period, although exhibiting much lower densities, were: Polychaeta, Oligochaeta, Nauplii larvae, Ostracoda and Turbellaria. Groups found infrequently were Bivalvia, Amphipoda, Gastropoda, Cnidaria, Halacaroidea, Ciliophora and Tardigrada, which was observed only in the top layer at station B (less then 0.02 %).

In the middle layer studied, 3-6 cm depth, at both stations, 15 meiofauna groups were registered, Gastrotricha, Ciliophora and Cnidaria were not found and Acari was a new group observed at this depth. Nematodes had the highest mean value of the total meiofauna densities, as in the top layer. This group reached 85.9% at station A

(average density 182 ind. cm^{-2}), and 89.1% (average density 390 ind. cm^{-2}) at station B, followed by harpaticoids copepods, 6.0% (station A) with average density 13 ind. cm^{-2}, and 5.0% (station B) with average density 21 ind. cm^{-2}. In spite of the lower relative densities, several groups were observed during the entire sampling period at station A: Polychaeta, Kinorhyncha, Oligochaeta. Other groups such as Ostracoda, Nauplii larvae, and Bivalvia, Turbellaria, and Amphipoda, Gastropoda, Ciliophora, Halacaroidea, Acari and Insecta were collected infrequently and in low density (>1%). At station B, Acari were also a new group observed in this depth layer. The groups observed during the entire sampling period were: Kinorhyncha, Polychaeta, Turbellaria, Nauplii larvae, Oligochaeta and Ostracoda. Small groups found infrequently in low density were Bivalvia, Halacaroidea, Gastropoda, Cnidaria, Amphipoda, Ciliophora and Acari.

In the bottom layer studied, 6-10 cm depth, 13 groups were obtained at both stations, fewer than in the upper layers. At station A, Halacaroidea, Gastropoda, Cnidaria, Insecta and Tardigrada were not collected. At this depth, Nematoda constituted 81.6% of the total meiofauna (average density 106 ind. cm^{-2}) followed by harpaticoids copepods (9.8% - average density 11 ind. cm^{-2}). Despite very low densities, several groups were registered: Polychaeta, Oligochaeta, Kinorhyncha, Ostracoda, Nauplii larvae, Amphipoda, Turbellaria, Bivalvia, Ciliophora, Gastrotricha and Acari. At station B, Ciliophora and Acari were not found, and Nematoda reached 88.2% of the total meiofauna (average density 238 ind. cm^{-2}) followed by harpaticoids copepods 5.6% (average density 16 ind. cm^{-2}), while Kinorhyncha and Oligochaeta were collected during the entire sampling period. Some small groups were found infrequently in low density: Polychaeta, Nauplii larvae, Ostracoda, Bivalvia, Halacaroidea and Turbellaria, Amphipoda, Gastropoda and Cnidaria.

The temporal variation of the average densities of Nematoda, Copepoda, Polychaeta, Oligochaeta, kinorhyncha and other taxa recorded at the three layers of sediment are shown in tables 4.3 and 4.4. At station A, at the three depths studied, Copepoda was usually the second most abundant group. However, at the last two sampling dates, July 95 and August 95, Polychaeta increased their percentages. At station B, during most of the sampling period, Copepoda was also the second most abundant group. However, in the top sediment layer during the period between July 94 and December 94, the Kinorhyncha sometimes exhibited, the second highest percentages, and

copepods became the third most abundant group. At deeper sediment layers, between October and November, the percentage of Kinorhyncha increased, and it was the second most important group in abundance.

The Mann-Whitney Test, (Z statistic Mann-Whitney; $p<0.001^{***}$) was applied with the aim of analysing the differences in the temporal variation of densities of meiobenthos taxa between layers of the same depth at both stations. In the top layer of sediment (0-3 cm), significant differences between both stations were detected: Nematoda ($Z= -4.57$; $p<0.001^{***}$), Copepoda ($Z=-3.04$; $p<0.01^{**}$), Polychaeta ($Z=-5.74$; $p<0.001^{***}$), Oligochaeta ($Z= -4.70$; $p<0.001^{***}$), Kinorhyncha ($Z= -3.98$; $p<0.001^{***}$), Ostracoda ($Z=-3.13$; $<0.05^{*}$) and Amphipoda ($Z= -4.28$; $p<0.001^{***}$), Ciliophora ($Z= -2.74$; $p<0.01^{**}$), Cnidaria ($Z= -2.52$; $p<0.05^{*}$) and Gastrotricha ($Z= -4.99$; $p<0.001^{***}$). No significant differences were detected in taxa Turbellaria, Nauplii larvae and Gastropoda and Bivalvia. Regarding the sediment layer for 3 and 6 cm depth, significant differences were also detected between both stations: Nematoda ($Z=-5.6$; $p<0.001^{***}$), Copepoda ($Z= -3.00$; $p<0.01^{**}$), Polychaeta ($Z= -4.25$; $p<0.001^{***}$), Kinorhyncha ($Z= -3.05$; $p<0.01^{**}$), Turbellaria ($Z= -3.25$; $p<0.001^{***}$) and Amphipoda ($Z= -3.05$; $p<0.01^{**}$). No significant differences of densities were observed concerning Oligochaeta, Ostracoda, Nauplii larvae, Gastropoda, Bivalvia, Ciliophora and Cnidaria. Finally, at the layer between 6 and 10 cm in depth, significant differences between both stations were found in the following taxa: Nematoda ($Z= -4.73$; $p<0.001^{***}$), Polychaeta ($Z=-4.95$; $p<0.001^{***}$), Oligochaeta ($Z=-2.00$; $p<0.05^{*}$), Ostracoda ($Z= -2.91$; $p<0.01^{**}$), Nauplii larvae ($Z= -2.96$; $p<0.01^{**}$), Amphipoda ($Z= -3.48$; $p<0.001^{***}$) and Gastropoda ($Z= -2.96$; $p<0.01^{**}$). No significant differences were observed concerning the densities of Copepoda, Kinorhyncha, Turbellaria, Ciliophora and Cnidaria.

In the top layer, the patterns of temporal variation in meiobenthos taxa densities were very similar to the pattern obtained in global results for 0-10 cm depth, as a result of their high relative contribution to the total number of meiobenthos. Thus, the density of meiobenthos taxa of the top layer structured the pattern of total density. Statistical data concerning vertical distribution of meiobenthos taxa at three deeper layers of sediment at both sampling sites are shown in tables 4.5 and 4.6.

Table 4.3 – Vertical distribution of the meiofauna densities (number individuals 10 cm^{-2}) of Nematoda, Copepoda, Polychaeta, Kinorhyncha, Oligochaeta and others groups, during sampling period at the three depths studies: 0-3 cm, 3-6 cm and 6-10 cm at station A.

Sampling date	Nematoda	Copepoda	Polychaeta	Kinorhyncha	Oligochaeta	Others
Depth 0-3 cm						
Jun-94 (A1)	1605	83	1	0	13	17
Jul-94 (A2)	2356	84	7	26	6	17
Jul-94 (A3)	1370	514	11	48	7	16
Aug-94 (A4)	2495	287	13	38	3	109
Aug-94 (A5)	1966	246	19	37	10	176
Sept-94 (A6)	2022	162	32	36	4	86
Sept-94 (A7)	1419	133	29	65	4	76
Oct-94 (A8)	1441	258	103	23	23	147
Oct-94 (A9)	2983	222	88	58	30	80
Nov-94 (A10)	2665	72	64	55	10	46
Nov-94 (A11)	2435	134	85	48	33	73
Dec-94 (A12)	1157	95	34	7	15	68
Dec-94 (A13)	1579	57	29	36	11	24
Jan-95 (A14)	3023	59	21	9	27	30
Jan-95 (A15)	2483	42	45	8	19	13
Feb-95 (A16)	2844	161	29	85	24	12
Feb-95 (A17)	2350	36	36	54	8	9
Mar-95 (A18)	2691	89	11	32	22	3
Mar-95 (A19)	1613	46	4	4	15	1
Apr-95 (A20)	813	25	6	13	20	0
Apr-95 (A21)	1244	52	19	9	26	5
May-95 (A22)	1223	293	44	22	35	9
May-95 (A23)	1418	44	1	3	15	4
Jun-95 (A24)	302	365	3	1	20	6
Jun-95 (A25)	768	56	19	20	18	68
Jul-95 (A26)	420	16	27	2	31	23
Jul-95 (A27)	714	48	49	3	28	61
Aug-95 (A28)	529	3	50	4	30	63

Sampling date	Nematoda	Copepoda	Polychaeta	Kinorhyncha	Oligochaeta	Others
Depth 3-6 cm						
Jun-94 (A1)	310	27	13	0	2	4
Jul-94 (A2)	147	15	1	5	1	9
Jul-94 (A3)	132	27	3	6	3	3
Aug-94 (A4)	85	9	1	0	0	2
Aug-94 (A5)	136	37	1	5	0	30
Sept-94 (A6)	91	12	0	3	3	4
Sept-94 (A7)	76	2	0	0	2	1
Oct-94 (A8)	41	0	0	4	4	1
Oct-94 (A9)	113	6	1	1	1	3
Nov-94 (A10)	209	3	4	5	3	4
Nov-94 (A11)	60	5	2	0	0	3
Dec-94 (A12)	267	6	5	0	3	6

Dec-94 (A13)	116	2	1	0	1	1
Jan-95 (A14)	307	6	4	0	6	7
Jan-95 (A15)	103	1	4	1	0	1
Feb-95 (A16)	175	3	0	0	3	1
Feb-95 (A17)	773	20	6	15	4	6
Mar-95 (A18)	84	6	0	1	1	0
Mar-95 (A19)	146	3	2	0	3	0
Apr-95 (A20)	283	15	14	1	3	1
Apr-95 (A21)	135	8	4	1	1	1
May-95 (A22)	363	106	4	48	12	27
May-95 (A23)	54	0	0	0	4	0
Jun-95 (A24)	256	30	6	4	20	1
Jun-95 (A25)	218	6	7	4	4	6
Jul-95 (A26)	241	8	12	0	4	1
Jul-95 (A27)	50	1	2	2	2	0
Aug-95 (A28)	142	0	34	1	3	2

Sampling date	Nematoda	Copepoda	Polychaeta	Kinorhyncha	Oligochaeta	Others
Depth 6-10 cm						
Jun-94 (A1)	61	16	9	0	1	4
Jul-94 (A2)	41	5	0	4	1	3
Jul-94 (A3)	154	37	0	3	1	5
Aug-94 (A4)	83	9	1	2	0	4
Aug-94 (A5)	167	34	0	7	1	27
Sept-94 (A6)	29	4	0	2	0	2
Sept-94 (A7)	36	0	0	0	0	5
Oct-94 (A8)	34	3	3	0	0	6
Oct-94 (A9)	125	9	1	3	0	5
Nov-94 (A10)	106	8	1	2	5	2
Nov-94 (A11)	218	11	1	4	2	3
Dec-94 (A12)	30	1	0	0	0	2
Dec-94 (A13)	18	0	0	0	0	0
Jan-95 (A14)	137	4	0	1	4	0
Jan-95 (A15)	54	1	0	1	1	0
Feb-95 (A16)	32	3	3	0	0	0
Feb-95 (A17)	656	24	4	18	19	4
Mar-95 (A18)	35	3	0	1	0	0
Mar-95 (A19)	320	28	2	4	4	1
Apr-95 (A20)	137	6	1	6	2	2
Apr-95 (A21)	41	1	0	1	0	1
May-95 (A22)	37	56	0	0	0	3
May-95 (A23)	27	2	0	0	0	0
Jun-95 (A24)	99	16	4	0	18	1
Jun-95 (A25)	154	20	3	1	3	5
Jul-95 (A26)	32	1	3	1	1	1
Jul-95 (A27)	28	1	3	0	2	1
Aug-95 (A28)	82	4	19	2	1	3

Table 4.4 – Vertical distribution of the meiofauna densities (number individuals 10 cm^{-2}) of Nematoda, Copepoda, Polychaeta, Kinorhyncha, Oligochaeta and others groups, during sampling period at the three depths studies: 0-3 cm, 3-6 cm and 6-10 cm at station B.

Sampling date	Nematoda	Copepoda	Kinorhyncha	Polychaeta	Oligochaeta	Others
Depth 0-3 cm						
Jun-94 (B1)	2777	177	65	12	1	6
Jul-94 (B2)	6484	270	268	10	1	15
Jul-94 (B3)	3737	428	556	28	3	19
Aug-94 (B4)	948	103	94	34	3	22
Aug-94 (B5	2965	204	214	29	5	15
Sept-94 (B6)	1089	182	53	47	5	28
Sept-94 (B7)	5021	184	458	34	4	84
Oct-94 (B8)	1663	247	287	36	1	24
Oct-94 (B9)	1867	94	110	61	8	17
Nov-94 (B10)	3623	159	161	38	7	7
Nov-94 (B11)	521	106	103	42	8	35
Dec-94 (B12)	2857	136	93	54	6	5
Dec-94 (B13)	2792	118	268	49	24	13
Jan-95 (B14)	1939	262	127	49	30	19
Jan-95 (B15)	4425	146	36	12	2	8
Feb-95 (B16)	6420	381	237	47	11	50
Feb-95 (B17)	273	13	9	4	2	0
Mar-95 (B18)	2127	95	113	26	12	6
Mar-95 (B19)	5910	335	282	47	27	11
Apr-95 (B20)	4082	307	144	26	16	18
Apr-95 (B21)	1921	220	222	28	20	53
May-95 (B22)	7877	162	54	64	32	13
May-95 (B23)	1117	72	24	10	3	11
Jun-95 (B24)	2475	144	47	18	6	8
Jun-95 (B25)	1486	42	6	23	6	6
Jul-95 (B26)	949	330	47	11	0	35
Jul-95 (B27)	3275	202	86	43	3	27
Aug-95 (B28)	3254	263	75	52	7	10

Sampling date	Nematoda	Copepoda	Kinorhyncha	Polychaeta	Oligochaeta	Others
Depth 3-6 cm						
Jun-94 (B1)	153	28	3	11	0	3
Jul-94 (B2)	383	68	16	1	0	7
Jul-94 (B3)	118	10	13	0	0	6
Aug-94 (B4)	275	55	12	0	3	25
Aug-94 (B5	260	13	15	2	1	2
Sept-94 (B6)	202	22	6	1	0	3
Sept-94 (B7)	569	18	27	4	1	3
Oct-94 (B8)	889	65	61	16	4	14
Oct-94 (B9)	468	16	13	16	1	1
Nov-94 (B10)	792	48	160	32	7	20
Nov-94 (B11)	177	4	6	5	1	1
Dec-94 (B12)	276	11	5	0	0	0

Dec-94 (B13)	537	9	5	1	0	1
Jan-95 (B14)	236	7	2	3	2	2
Jan-95 (B15)	440	14	6	1	0	0
Feb-95 (B16)	382	24	8	1	0	6
Feb-95 (B17)	573	49	19	11	1	9
Mar-95 (B18)	185	11	9	4	1	1
Mar-95 (B19)	584	16	32	3	5	1
Apr-95 (B20)	193	7	1	1	0	0
Apr-95 (B21)	694	22	16	5	1	1
May-95 (B22)	280	10	3	2	1	1
May-95 (B23)	275	9	4	3	1	1
Jun-95 (B24)	316	11	11	3	0	1
Jun-95 (B25)	318	9	1	9	0	1
Jul-95 (B26)	299	14	3	3	1	3
Jul-95 (B27)	217	3	3	3	0	1
Aug-95 (B28)	820	11	6	2	3	3

Sampling date	Nematoda	Copepoda	Kinorhyncha	Polychaeta	Oligochaeta	Others
Depth 6-10 cm						
Jun-94 (B1)	94	8	1	0	0	1
Jul-94 (B2)	403	10	7	0	1	4
Jul-94 (B3)	123	11	13	2	3	6
Aug-94 (B4)	208	22	16	6	0	4
Aug-94 (B5	62	1	5	0	0	1
Sept-94 (B6)	127	13	16	1	1	3
Sept-94 (B7)	97	5	4	0	0	1
Oct-94 (B8)	85	4	2	3	1	1
Oct-94 (B9)	151	18	1	0	2	2
Nov-94 (B10)	330	4	15	1	0	1
Nov-94 (B11)	288	9	20	25	3	6
Dec-94 (B12)	73	3	3	3	0	2
Dec-94 (B13)	219	4	2	1	0	0
Jan-95 (B14)	334	7	5	2	1	0
Jan-95 (B15)	940	84	41	13	1	8
Feb-95 (B16)	180	26	6	1	0	1
Feb-95 (B17)	273	13	9	4	2	0
Mar-95 (B18)	72	4	1	1	3	0
Mar-95 (B19)	137	1	1	4	2	0
Apr-95 (B20)	254	11	4	2	2	1
Apr-95 (B21)	185	6	17	1	0	1
May-95 (B22)	183	11	5	1	1	1
May-95 (B23)	382	84	25	6	6	19
Jun-95 (B24)	223	20	19	0	0	0
Jun-95 (B25)	116	17	3	2	0	1
Jul-95 (B26)	639	34	8	3	4	6
Jul-95 (B27)	197	8	1	4	1	1
Aug-95 (B28)	282	3	4	1	0	1

As with the results obtained at 0-10 cm depth, at the three depths studied, the nematodes were least abundant at station A. Despite the minimum and maximum values being obtained in different months, the pattern was similar between the three depths, though, at station B, a sharp increase was observed in the bottom layer during winter (Fig. 4.11 and Fig. 4.12).

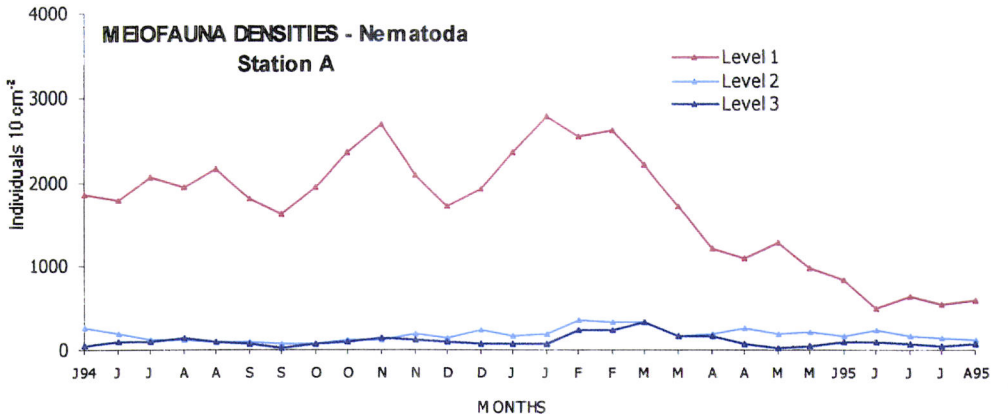


Figure 4.11 - Temporal and vertical variations of density of the Nematoda taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

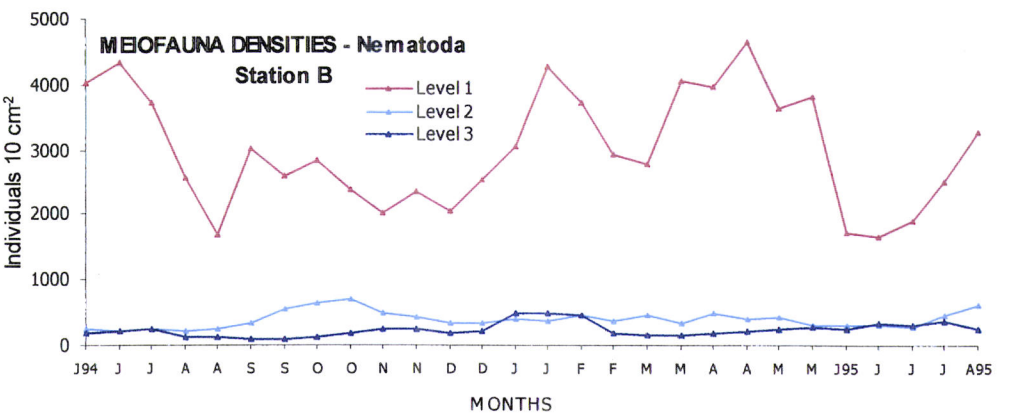


Figure 4.12 - Temporal and vertical variations of density of the Nematoda taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

Harpacticoid copepods such as nematodes were also less abundant at station A in the top layer and middle layer (3-6 cm), although, in the bottom layer, the density of copepods did not differ significantly between stations. At station A, the temporal patterns were similar within the three deeper sediment layers, while at station B, in spring, at 6-10 cm depth, the density increase followed an opposite pattern to that observed in the surface copepods (Fig. 4.13 and Fig. 4.14).

Table 4.5 – Statistical parameters (95% confidence interval for mean) of the vertical distribution of the meiofauna taxa (> 1% of the total meiofauna), at station A. Units are individuals per 10 cm^{-2}.

Meiofauna Taxa	Mean	95% Confidence Interval for Mean	Minimum-Maximum
Nematoda			
(0-3 cm)	1712	1444.9 – 1978.5	496.6 – 2783.3
(3-6 cm)	182	153.0 – 212.0	69.0 – 350.4
(6-10 cm)	106	78.9 – 133.4	33.0 – 337.1
Copepoda			
(0-3 cm)	132	98.9 – 164.2	18.1 – 349.0
(3-6 cm)	13	8.1 – 17.7	0.4 – 45.4
(6-10 cm)	11	8.3 – 13.9	1.7 – 26.7
Polychaeta			
(0-3 cm)	31	22.6 – 40.2	3.3 – 84.6
(3-6 cm)	5	2.8 – 6.6	0.3 – 22.3
(6-10 cm)	2	0.1 – 3.2	0.0 – 13.5
Kinorhyncha			
(0-3 cm)	27	19.9 – 33.2	2.7 – 57.2
(3-6 cm)	4	2.0 – 5.7	0.1 – 17.5
(6-10 cm)	2	1.4 – 2.9	0.0 – 7.4
Oligochaeta			
(0-3 cm)	18	15.3 – 20.9	5.3 – 30.0
(3-6 cm)	3	2.2 – 4.4	0.8 – 12.2
(6-10 cm)	2	1.4 – 3.3	0.0 – 7.8

In the top and in the middle layer, at station B, Kinorhyncha was the third most abundant taxon, while at station A it was the fourth. However, in the bottom layer, the density of Kinorhyncha was not significantly different between stations. The temporal pattern of the top layer was clearly different from that obtained in deeper layers. At station A, in the middle layer in later spring, and at station B in autumn, sharp increases were registered, with an opposite trend in the top layer (Fig. 4.15 and Fig. 4.16).

At station A, Polychaeta taxon was the third most abundant, and at station B the fourth. At both stations, the temporal patterns observed at lower depths differed from the top layer. In deeper layers, at station A in summer 94 and in spring, and at station B in autumn and summer 95, the densities followed a clear opposite trend to the top layer (Fig. 4.17 and Fig 4.18).

Table 4.6 – Statistical parameters (95% confidence interval for mean) of the vertical distribution of the meiofauna taxa (> 1% of the total meiofauna), at station B. Units are individuals per 10 cm^{-2}.

Meiofauna Taxa	Mean	95% Confidence Interval for Mean	Minimum-Maximum
Nematoda			
(0-3 cm)	2996	2650.2 – 3340.9	1636.9 – 4626.4
(3-6 cm)	390	339.4 – 440.0	217.7 – 716.4
(6-10 cm)	238	196.0 – 279.9	95.2 – 497.8
Copepoda			
(0-3 cm)	192	170.8 – 213.6	85.9 – 291.8
(3-6 cm)	21	16.3 – 25.4	8.2 – 44.3
(6-10 cm)	16	11.0 – 20.6	4.7 – 41.0
Kinorhyncha			
(0-3 cm)	151	119.4 – 183.4	26.0 – 306.0
(3-6 cm)	17	9.3 – 24.0	2.6 – 78.0
(6-10 cm)	9	7.0 – 11.0	1.9 – 18.6
Polychaeta			
(0-3 cm)	33	29.2 – 37.6	11.4 – 50.6
(3-6 cm)	5	3.0 – 7.0	0.2 – 21.6
(6-10 cm)	3	2.0 – 4.0	0.0 – 9.5
Oligochaeta			
(0-3 cm)	9	6.4 – 11.8	0.8 – 23.0
(3-6 cm)	1	0.8 – 1.5	0.0 – 3.8
(6-10 cm)	1	0.9 – 1.4	0.2 – 2.2

Oligochaeta taxon was more abundant at station A than at station B. Only a few specimens per 10 cm^{-2} were collected at lower depths, the pattern of temporal variation of densities observed differing from that of the top layer (Fig. 4.19 and Fig. 4.20).

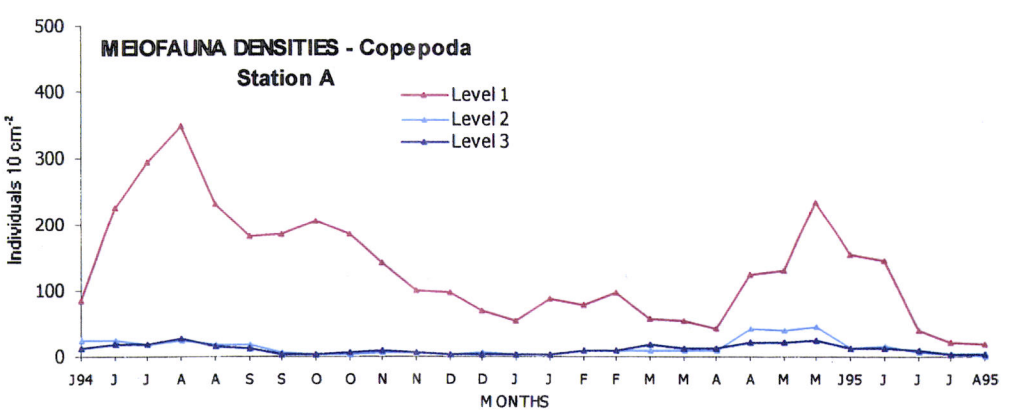


Figure 4.13 - Temporal and vertical variations of density of the Copepoda taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

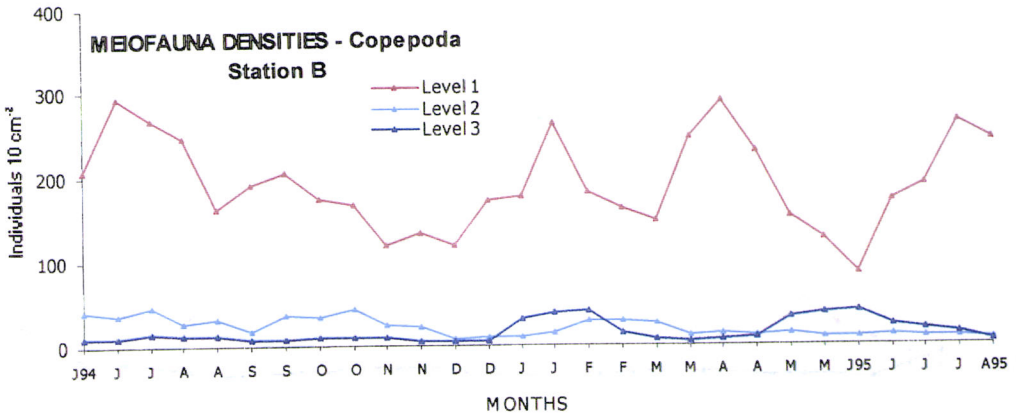


Figure 4.14 - Temporal and vertical variations of density of the Copepoda taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

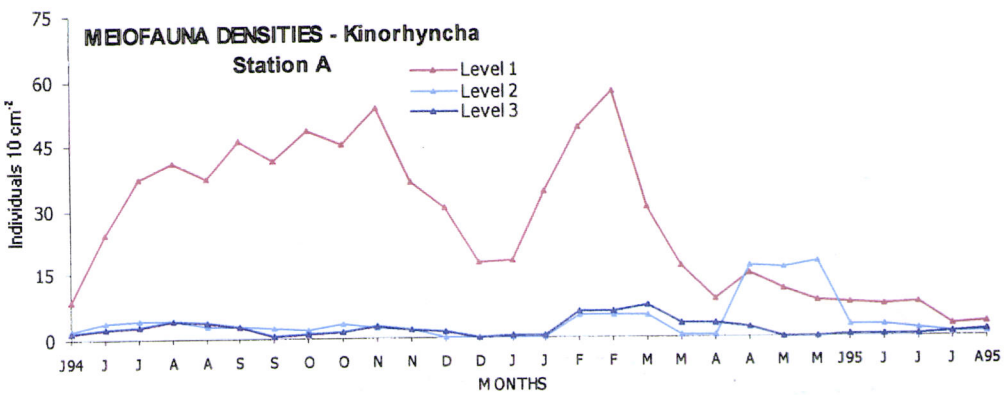


Figure 4.15 - Temporal and vertical variations of density of the kinorhyncha taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

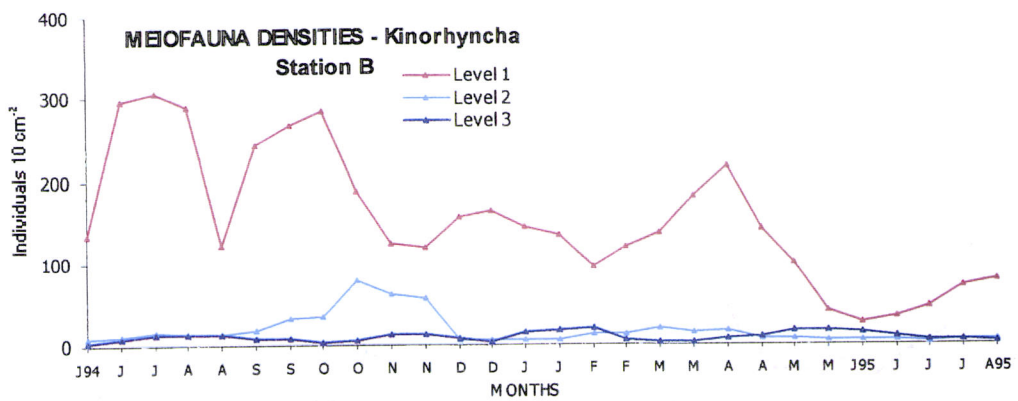


Figure 4.16 - Temporal and vertical variations of density of the kinorhyncha taxon in the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

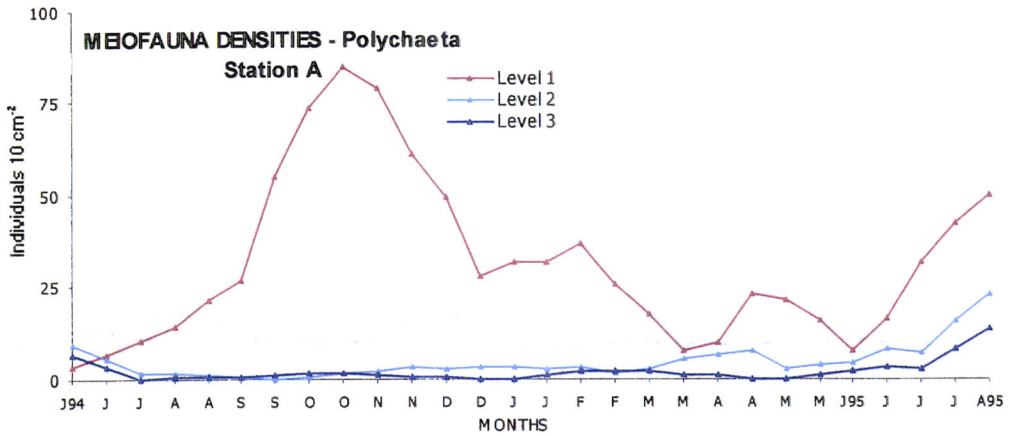


Figure 4.17 - Temporal and vertical variations of density of the Polychaeta taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

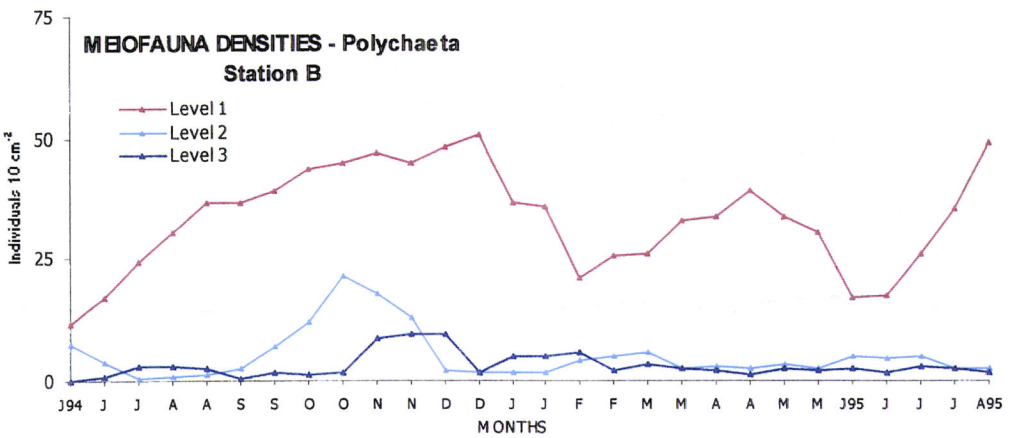


Figure 4.18 - Temporal and vertical variations of density of the Polychaeta taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

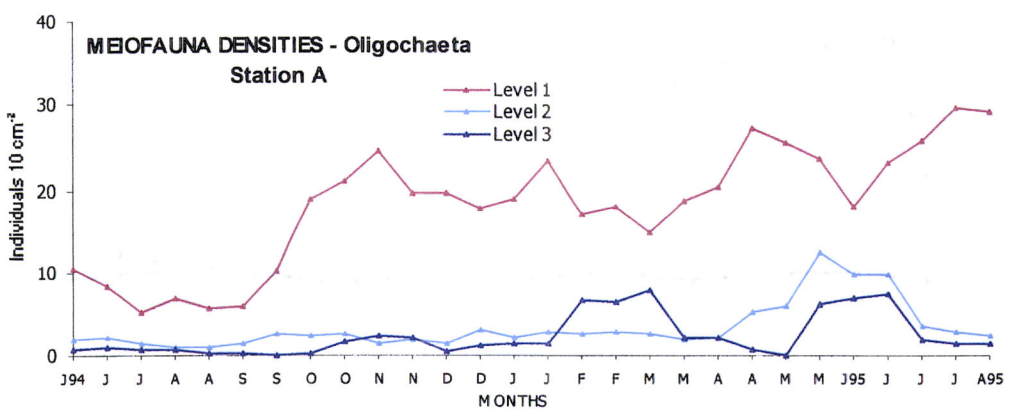


Figure 4.19 - Temporal and vertical variations of density of the Oligochaeta taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

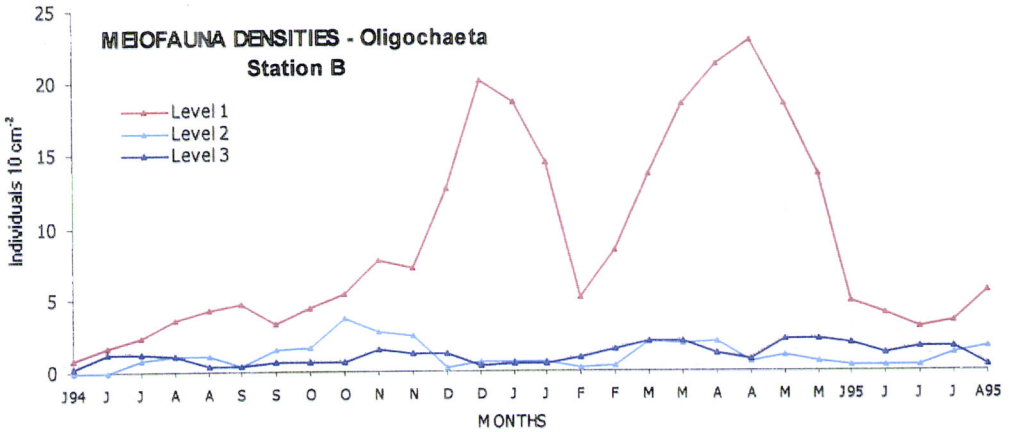


Figure 4.20 - Temporal and vertical variations of density of the Oligochaeta taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

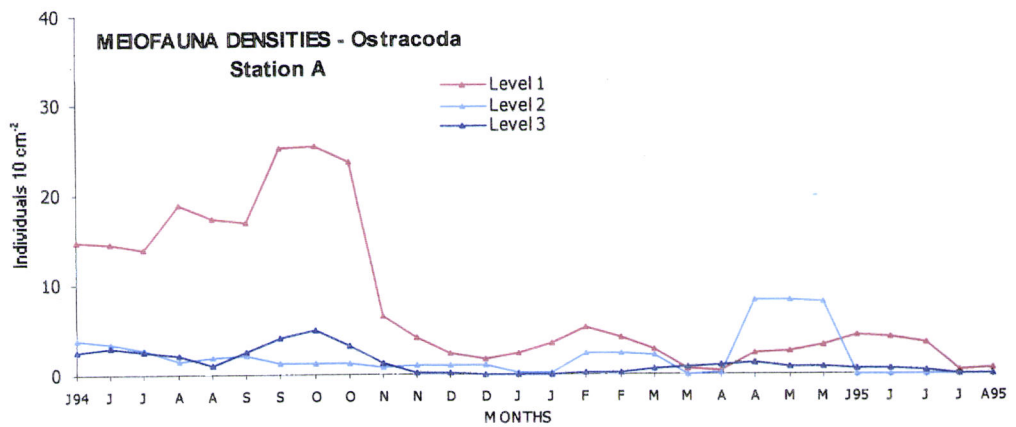


Figure 4.21 - Temporal and vertical variations of density of the Ostracoda taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

Ostracoda also was more abundant at station A than at station B. Only a few specimens per 10 cm^{-2} were collected at the deeper layers, the temporal patterns of the lower depths being very different from the top layer, particularly at station A, where a strong increase in the middle layer was observed in April (Fig. 4.21 and Fig. 4.22).

Amphipoda, Ciliophora and Cnidaria were minor taxa at both stations registering extremely low densities, concentrated in the top layer. The variation patterns differed strongly between both stations.

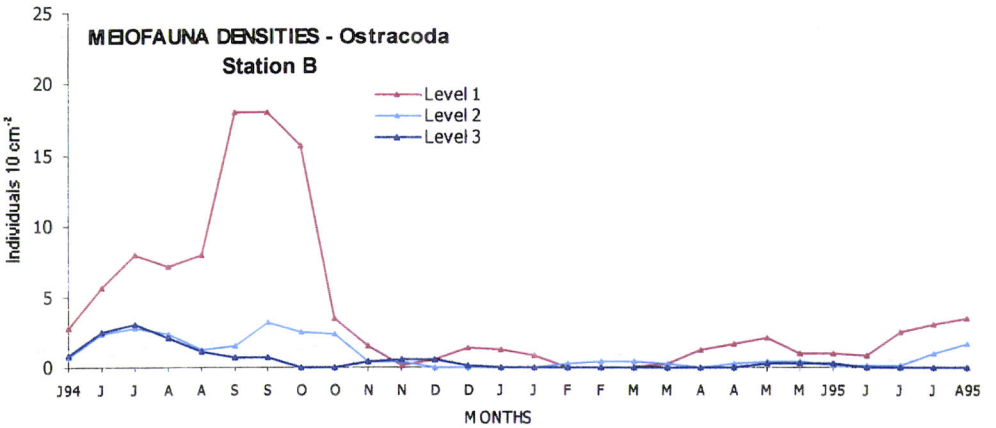


Figure 4.22 - Temporal and vertical variations of density of the Ostracoda taxon at the three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

4.3.2. Seasonal patterns of variation of the meiobenthos communities

a) Global results.

The PCA-ordination of the temporal variation of the meiobenthos taxa densities matrix of each sampling station displayed clear seasonal trends, based on the first three axes, which describe most of the variability (82% station A and 80% at station B) (Fig. 4.23 and 4.24). The decision to study each sampling station separately was only taken after applying the classification and ordination techniques on the matrix of both stations together, which showed that the seasonal trends were very different between stations (Fig. 4.25).

Using the Twinspan-classification and the PCA-ordination based on fortnightly variation of meiofauna percentage, it was possible to define the temporal variation of meiobenthos communities into seasonal groups (Fig. 4.26 and Fig. 4.27). The seasonal groups obtained are described in table 4.7.

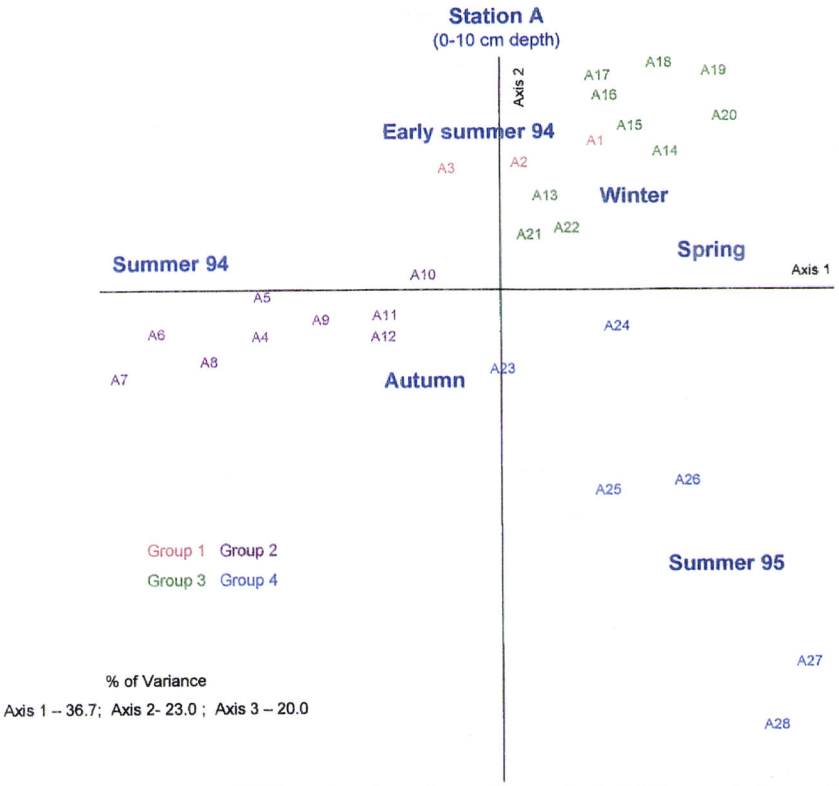


Figure 4.23 - Results of the PCA-ordination based on fortnightly variation of meiofauna percentage (0-10 cm sediment depth) from June 94 (A1) until August (A28) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.See table 4.3 for full sample dates.

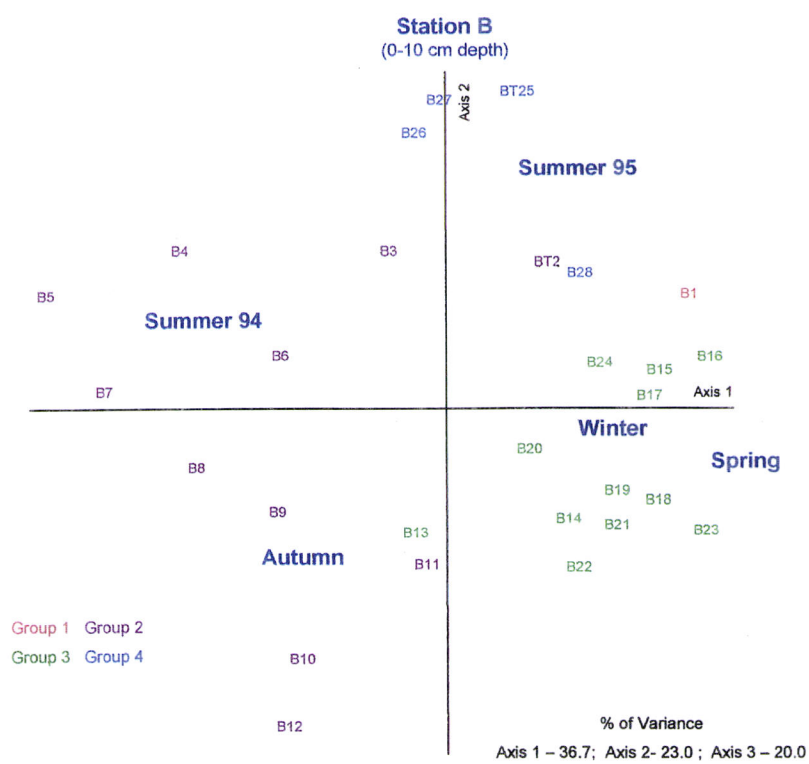


Figure 4.24 -Results of the PCA-ordination based on fortnightly variation of meiofauna percentage (0-10 cm sediment depth) from June 94 (B1) until August (B28) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary. See table 4.4 for full sample dates.

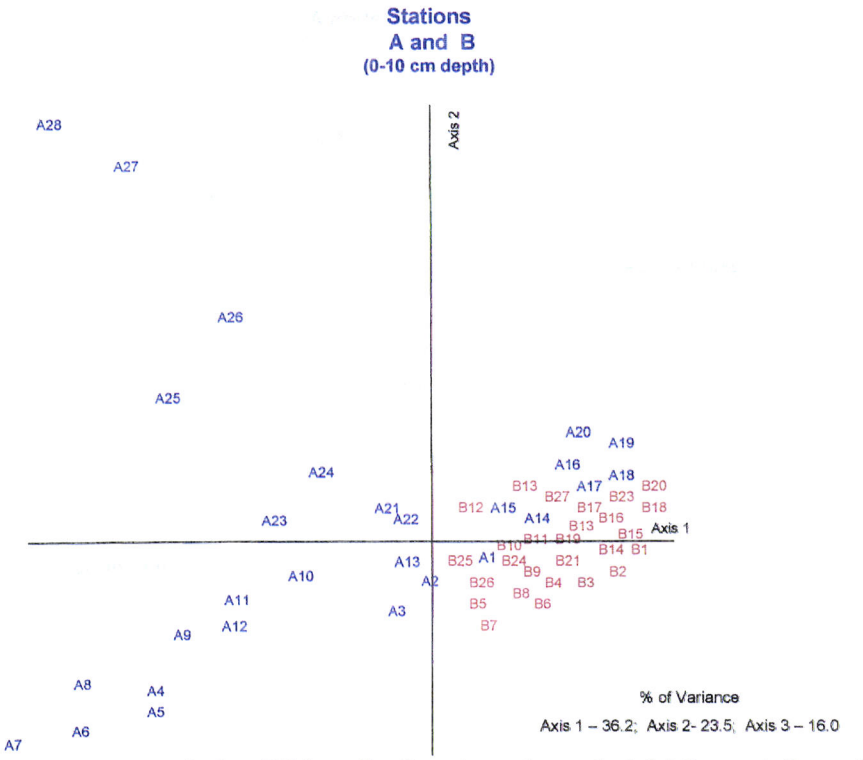


Figure 4.25 - Results of the PCA-ordination based on fortnightly variation of meiofauna percentage (0-10 cm sediment depth) from June 94 (A1;B1) until August (A28;B28) at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary. See table 4.3 and 4.4 for full sample dates.

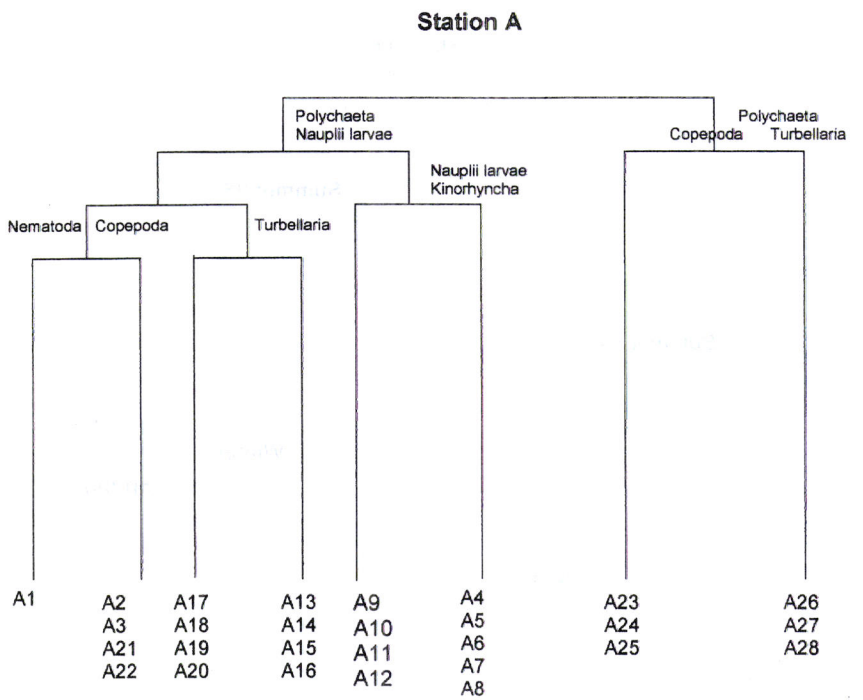


Figure 4.26 – Twinspan analysis of the forthnightly samples from June 94 (A1) to August 95 (A28), at station A. Output of classification based on the meiofauna percentage with the indicator species (taxa) for each division indicated.

Station B

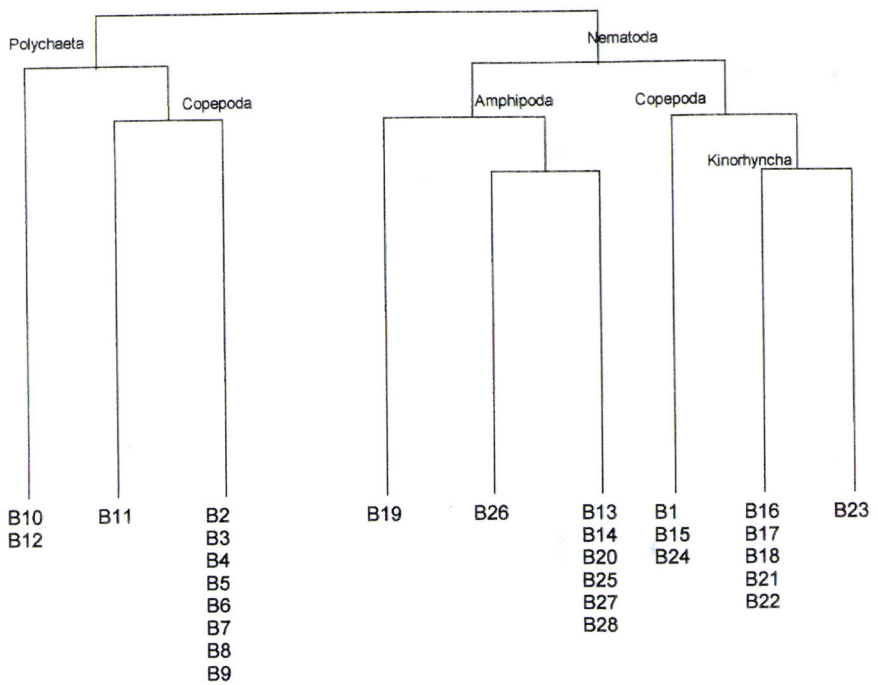


Figure 4.27 – Twinspan analysis of the forthnightly samples from June 94 (B1) to August 95 (B28), at station B. Output of classification based on the meiofauna percentage with the indicator species (taxa) for each division indicated.

At station A, the seasonal groups were clear divided into two major groups according to Nematoda densities, which were highest in "group 1", in June 94 and July 94, and in "group 3" in winter and spring, followed by a tapering off towards "group 4", in summer 95. At station B, the seasonal groups were divided according Kinorhyncha and Nematoda densities. While Kinorhyncha was highest in "group 2", Nematoda densities were highest in "group 3" and "group 4"(Fig. 4.28, 4.29, 4.30).

Table 4.7 – Temporal variation of meiofauna densities and taxa composition in seasonal groups provided from the results of Twinspan-classification and PCA-ordination.

Seasonal groups-station A	Seasonal groups-station B
Group 1 A1 (June 94) - A3 (July 94)	Group 1 B1 (June 94)
Group 2 A4 (August 94) - A12 (December 94)	Group 2: B2 (July 94) - B12 (December 94)
Group 3 A13 (December 94) - A22 (May 95)	Group 3 B13 (December 94) - B24 (June 95)
Group 4 A23 (May 95) - A28 (August 95)	Group 4 B25 (June 94) - B28 (August 95)

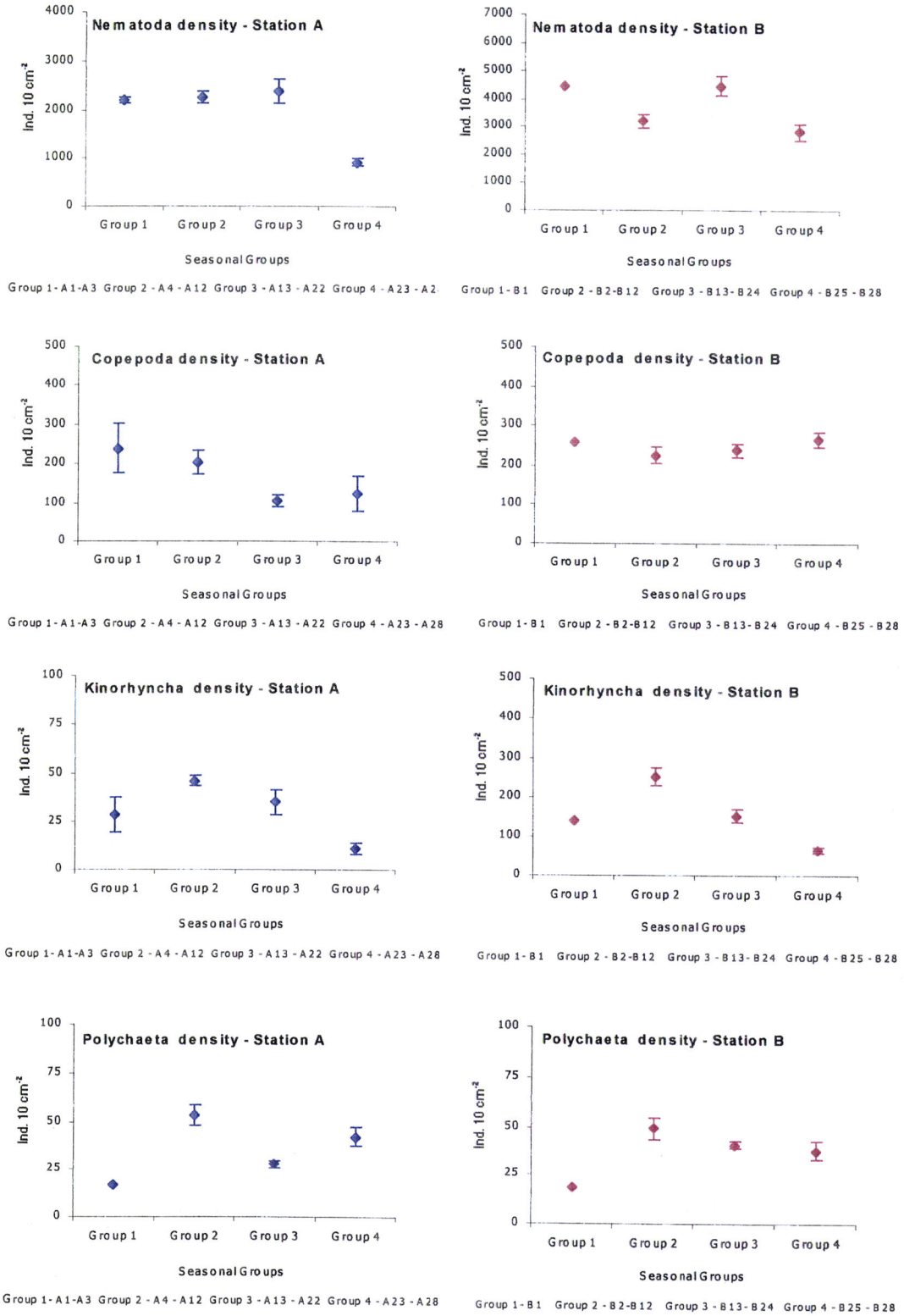
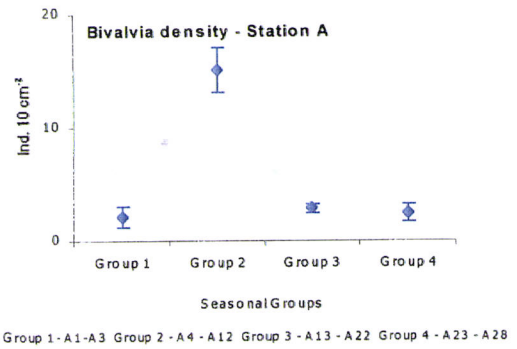
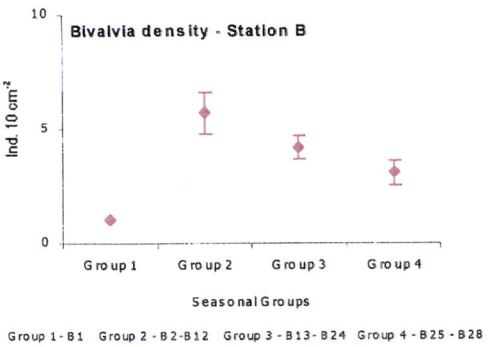


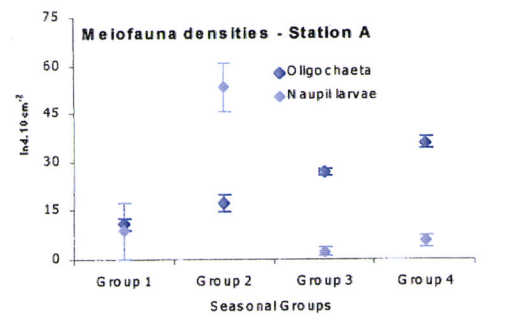
Figure 4.28 – Seasonal variation of the meiofauna taxa densities (0-10 cm sediment depth), at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3 and 4 obtained by the Twinspan–classification and PCA and PCA ordination.



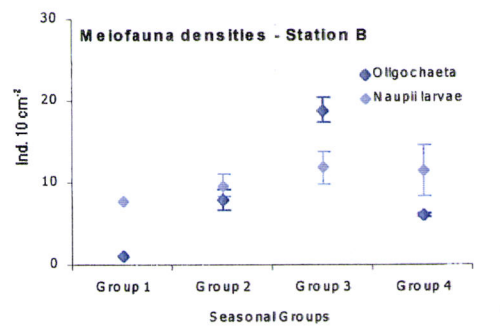
Group 1 - A1-A3 Group 2 - A4 - A12 Group 3 - A13 - A22 Group 4 - A23 - A28



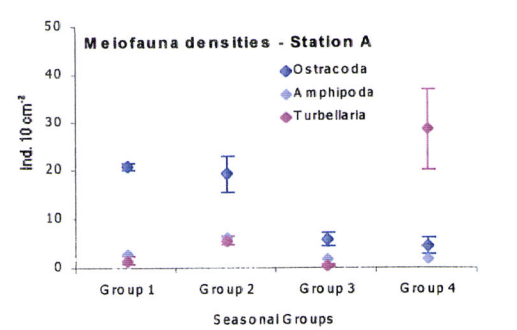
Group 1 - B1 Group 2 - B2-B12 Group 3 - B13 - B24 Group 4 - B25 - B28



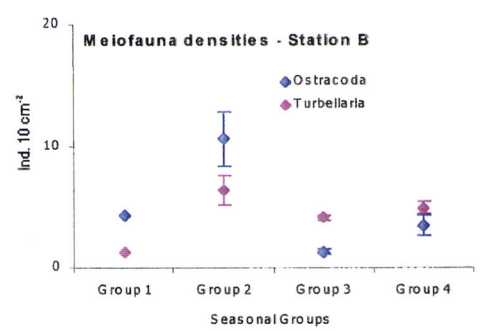
Group 1 - A1-A3 Group 2 - A4 - A12 Group 3 - A13 - A22 Group 4 - A23 - A28



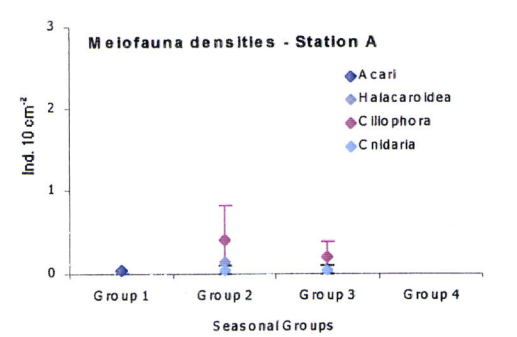
Group 1 - A1-A3 Group 2 - A4 - A12 Group 3 - A13 - A22 Group 4 - A23 - A28



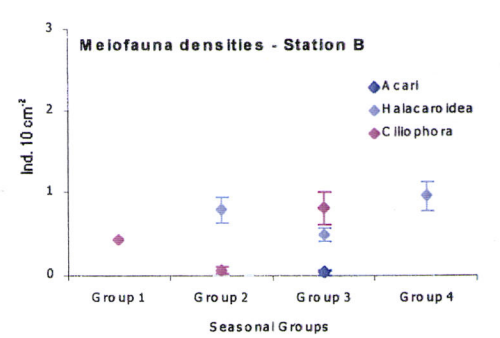
Group 1 - A1-A3 Group 2 - A4 - A12 Group 3 - A13 - A22 Group 4 - A23 - A28



Group 1 - A1-A3 Group 2 - A4 - A12 Group 3 - A13 - A22 Group 4 - A23 - A28



Group 1 - A1-A3 Group 2 - A4 - A12 Group 3 - A13 - A22 Group 4 - A23 - A28



Group 1 - A1-A3 Group 2 - A4 - A12 Group 3 - A13 - A22 Group 4 - A23 - A28

Figure 4.29 – Seasonal variation of the meiofauna taxa densities (0-10 cm sediment depth), at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3 and 4 obtained by the Twinspan–classification and PCA and PCA ordination.

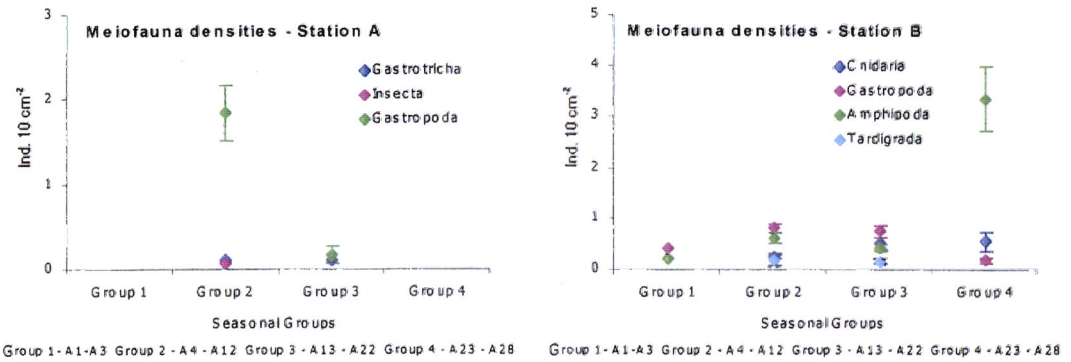


Figure 4.30 – Seasonal variation of the meiofauna taxa densities (0-10 cm sediment depth), at stations A and B, in *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3 and 4 obtained by the Twinspan–classification and PCA and PCA ordination.

The Kruskal-Wallis Test (H statistic Kruskal-Wallis; p<0.001***) was applied with the aim of detecting the differences between seasonal groups defined by Twinspan-classification and the PCA-ordination. At station A, significant differences between seasonal groups were detected: Nematoda (H=13.8; p<0.01**), Copepoda (H=10.2; p<0.05, Oligochaeta (H=18.6; p<0.001***), Ostracoda (H=13.2; p<0.01**), Turbellaria (H=15.7; p<0.01**), Kinorhyncha (H=15.3; p<0.01**), Nauplii larvae ((H=18.0; p<0.001***), Amphipoda (H=16.8; p<0.001***), Gastropoda (H=19.8; p<0.001***), Bivalvia (H=18.3; p<0.001***), and Halacaroidea (H=15.3; p<0.01**). No significant differences were detected in Polychaeta, Gastrotricha, Cnidaria, Insecta, Acari, Ciliophora and Tardigrada. At station B, significant differences were detected: Nematoda (H=9.0; p<0.05*), Oligochaeta (H=17.8; p<0.001***), Kinorhyncha (H=14.4; p<0.01**), Amphipoda (H=12.6; 0.01**), Gastropoda (H=11.1;p<0.01**) and Ciliophora (H=13.2; p<0.01**). No significant differences were detected in Copepoda, Polychaeta, Turbellaria, Nauplii Larvae, Bivalvia, Cnidaria, Halacaroidea, Insecta, Acari and Tardigrada.

The Mann- Whitney Test, (Z statistic Mann-Whitney; p<0.001***) results applied with the aim of analysing the differences between two seasonal groups defined by Twinspan-classification and the PCA-ordination are shown in tables 4.8 and 4.9.

At both stations, Nematoda showed the highest abundances during winter and spring (group 3). At station A, the densities were higher from June 94 until July 94 (early summer 94) and in later autumn (group 2: A10, A11, A12), the highest values,

however, being attained in winter and early spring (group 3), followed by a decline from later spring (group 4). At station B, Nematoda densities showed the highest abundance in June 94 (group1: B1), followed by a decline during the period between summer 94 and autumn, defined by "group 2". The highest densities were attained during winter and spring (group 3) followed by a decline in summer 95 (group 4).

Table 4.8 – Statistical significance the Mann-Whitney Test, (Z statistic Mann-Whitney; $p<0.001$***- very highly significant; $p<0.01$**- highly significant; $p<0.05$*- significant) applied to seasonal groups, at station A.

Meiofauna Taxa	Seasonal groups	Z statistic Mann-Whitney; p<0.001***
Nematoda	group 1 - group 3	Z=-2.2; p<0.05*
	group 1 – group 4	Z=-2.3; p<0.05*
	group 2 – group 4	Z=-3.2; p<0.001***
Copepoda	group 1 - group 3	Z=-3.0; p<0.001***
Polychaeta	group 1 - group 2	Z=-2.1; p<0.05*
	group 1 - group 3	Z=-2.0; p<0.05*
Kinorhyncha	group 1 - group 4	Z=-2.0; p<0.05*
	group 2 - group 4	Z=-3.1; p<0.001***
	group 1 - group 4	Z=-2.3; p<0.05*
	group 2 - group 3	Z=-2.3; p<0.05*
Nauplii larvae	group 1 - group 2	Z=-2.3; p<0.05*
	group 1 - group 3	Z=-2.5; p<0.01**
	group 2 - group 3	Z=-3.6; p<0.001***
	group 2 - group 4	Z=-3.1; p<0.001***
Ostracoda	group 1 - group 3	Z=-2.5; p<0.01**
	group 1 - group 4	Z=-2.3; p<0.05*
	group 2 - group 3	Z=-2.6; p<0.01**
	group 2 - group 3	Z=-2.4; p<0.05*
Turbellaria	group 1 - group 2	Z=-2.5; p<0.01**
	group 2 - group 3	Z=-3.4; p<0.001***
	group 2 - group 4	Z=-2.1; p<0.05*
	group 3 - group 4	Z=-2.6; p<0.01**
Amphipoda	group 1 - group 2	Z=-2.5; p<0.01**
	group 2 - group 3	Z=-3.2; p<0.001****
	group 2 - group 4	Z=-3.1; p<0.001**

Copepoda densities, at station A, presented a constant decrease from "group 1" to "group 3", the highest values having been observed during summer 94 (group 1) and an important decline was observed during autumn and winter (group 2 and group 3). In later spring, an increase in densities was observed (group 4), although an accentuated decline occurred in summer 95. At station B, the temporal pattern of Copepoda densities observed was more constant than station A. The lowest values observed in autumn, winter, spring (group 2 and group 3), the highest densities being recorded in summer 94 (group 1 and group 2), and in summer 95 (group 4).

Table 4.9 – Statistical significance the Mann-Whitney Test, (Z statistic Mann-Whitney; $p<0.001^{***}$- very highly significant; $p<0.01^{**}$- highly significant; $p<0.05^{*}$- significant), applied to seasonal groups, at station B.

Meiofauna Taxa	Seasonal groups	Z statistic Mann-Whitney; $p<0.001^{***}$
Nematoda	group 2 - group 3	$Z=-2.5$; $p<0.05^{*}$
	group 3 – group 4	$Z=-2.0$; $p<0.05^{*}$
Kinorhyncha	group 2 - group 4	$Z=-2.8$; $p<0.001^{***}$
	group 2 – group 3	$Z=-2.6$; $p<0.01^{**}$
	group 3 - group 4	$Z=-2.6$; $p<0.05^{*}$
Oligochaeta	group 2 - group 3	$Z=-3.5$; $p<0.001^{***}$
	group 3 - group 4	$Z=-2.9$; $p<0.001^{***}$
Ostracoda		
	group 1 - group 3	$Z=-2.5$; $p<0.01^{**}$
	group 1 - group 4	$Z=-2.3$; $p<0.05^{*}$
	group 2 - group 3	$Z=-2.6$; $p<0.01^{**}$
	group 2 - group 3	$Z=-2.4$; $p<0.05^{*}$
Turbellaria	group 2 - group 3	$Z=-3.2$; $p<0.001^{***}$
	group 3 - group 4	$Z=2.1$; $p<0.05^{*}$
Amphipoda	group 2 - group 4	$Z=-2.8$; $p<0.001^{***}$
	group 3 - group 4	$Z=-2.9$; $p<0.001^{***}$
Gastropoda	group 2 - group 4	$Z=-2.9$; $p<0.001^{***}$
	group 3 - group 4	$Z=-2.9$; $p<0.001^{***}$
Ciliophora	group 2 - group 3	$Z=-3.0$; $p<0.01^{**}$
	group 3 - group 4	$Z=-2.9$; $p<0.05^{*}$

At both stations, Polychaeta increased their densities from summer 94 until the early autumn (group 2), the decline in densities occurring during later autumn, and winter (group 3). At station A, an accentuated increase was observed in summer 95 (group 4), though at station B, a gentler increase was observed in autumn (group 2).

The temporal pattern of Kinorhyncha was very similar at both stations, the remaining decrease being registered from winter until summer 95. The highest values were recorded in summer 94 and autumn (group 2), and the lowest densities were observed in summer 95 (group 4).

Bivalvia, at both stations, registered the lowest values in early summer (group 1) and reached the highest values in summer 94 and autumn (group 2), following a constant densities decline until summer 95 (group 4).

At station A, Oligochaeta registered a slight increase throughout the study period, from summer 94 until summer 95. At station B, the highest densities were registered in winter and spring (group 3), followed by an accentuated decrease in summer 95 (group 4). The temporal pattern of the Nauplii larvae densities were very different between both stations, at station A, Nauplii larvae densities were highest in summer 94 and autumn (group 2) followed by a sharp decline and disappearing in autumn and winter and spring (group 3), though at station B, this group attained highest densities in winter and and summer 95 (group 3 and group 4).

At station A, Amphipoda attained the highest densities in summer 94 and autumn (group 2), while at station B, the highest values were observed in summer 95 (group 4). Turbellaria registered the highest densities in both summer samplings, at station A; after their disappearance in winter and spring, they increased in summer 95 (group 4). At station B, their highest values were registered in summer 94 (group 2). Ostracoda, at both stations, showed the highest densities in summer 94 and autumn (group 2), at station A showing a permanent decrease, in contrast, to station B, where the densities increased in summer 95.

At station A, meiofauna taxa, which registered higher densities in summer 94,showed an opposite trend in summer 95, declining in their densities, particularly Nematoda, Copepoda, Kinorhyncha, Bivalvia, Ostracoda, Nauplii larvae and Amphipoda.

b) Seasonal patterns of vertical variations

The PCA-ordination of the temporal variation of the meiobenthos taxa densities matrix at the top layer sediment (0-3 cm depth) of each sampling station displayed clear seasonal trends based on the first three axes, which describe most of the variability (total variability 84% at station A and 73.4 % at station B). The result obtained showed a seasonal pattern very similar to that obtained in the sediment layer with 0-10 cm depth (Fig. 4.31 and Fig. 4.32).

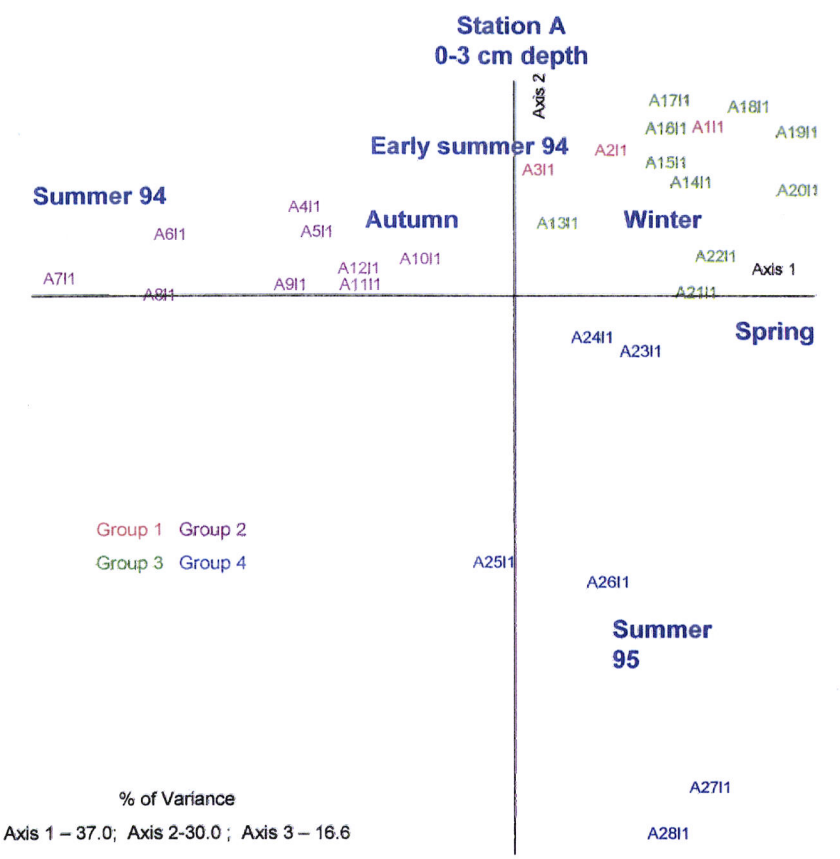


Figure 4.31- Results of the PCA-ordination based on fortnightly variation of meiofauna percentage at Level 1 (0-3 cm depth) from June 94 (A1l1) until August (A28l1) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary. See table 4.3 for full sample.

Based on seasonal groups determined from the Twinspan–classification and PCA-ordination applied to the 0-10 cm sediment layer (table 4.7), temporal variation of meiobenthos densities was also defined into seasonal groups, for each sediment layer studied (Fig. 4.33, 4.34, 4.35, 4.36, 4.37, 4.38 and 4.39).

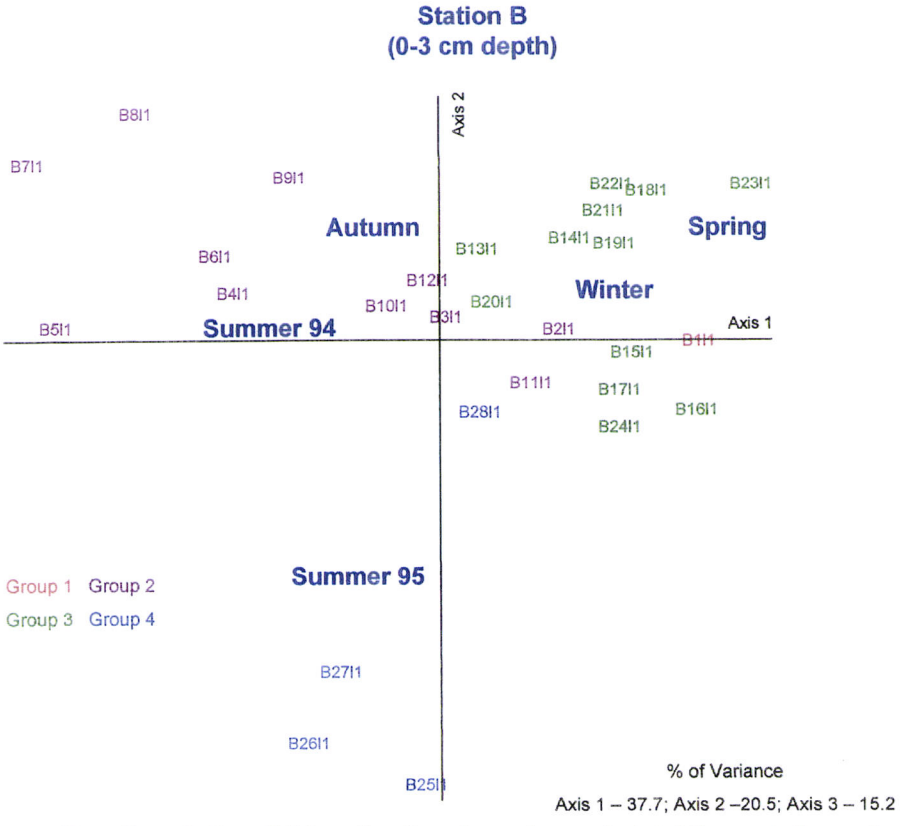


Figure 4.32- Results of the PCA-ordination based on fortnightly variation of meiofauna percentage at Level 1 (0-3 cm depth) from June 94 (B1I1) until August (B28I1) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary. See table 4.3 for full sample.

The Kruskal-Wallis Test (H statistic Kruskal-Wallis; p<0.001***) was applied with the aim of detecting the differences between seasonal groups of the each sediment layer:

- At station A, level 1 (0-3 cm depth), significant differences between seasonal groups were detected: Nematoda (H=13.8; p<0.01**), Copepoda (H=10.8; p<0.05*), Polychaeta (H=11.2; p<0.01**), Oligochaeta (H=11.1; p<0.01**), Ostracoda (H=15.1; p<0.01**), Turbellaria (H=15.3; p<0.01**), Kinorhyncha (H=17.6; p<0.001***), Nauplii larvae (H=18.5; p<0.001***), Amphipoda (H=15.7; p<0.001***), Gastropoda (H=19.8; p<0.001***) and Bivalvia (H=18.5; p<0.001***). No significant differences were detected in Halacaroidea, Gastrotricha, Cnidaria, Insecta, Acari and Ciliophora.

- At station A, in level 2 (3-6 cm depth), significant differences between seasonal groups were detected: Nematoda (H=14.8; p<0.01**), Polychaeta (H=16.0; p<0.001***), Oligochaeta (H=15.1; p<0.01**), Ostracoda (H=8. 9; p<0.05*), Turbellaria (H=17.3; p<0.001***), Kinorhyncha (H=17.6; p<0.001***), Nauplii Larvae ((H=7.9; p<0.05*), Amphipoda (H=8.1; p<0.05*) and Bivalvia (H=9.1; p<0.05*). No significant differences were detected in Copepoda, Kinorhyncha, Gastropoda, Cnidaria, Insecta and Acari.

- At station A, in level 3 (6-10 cm depth), significant differences between seasonal groups were detected: Polychaeta (H=10.8; p<0.05*), Oligochaeta (H=8.0; p<0.05*), Ostracoda (H=13.1; p<0.01**), Turbellaria (H=14.1; p<0.01), Nauplii larvae (H=17.2; p<0.001***) and Halacaroidea (H=11.8; p<0.05*). No significant differences were detected in Copepoda, Kinorhyncha, Gastropoda, Amphipoda, Cnidaria and Bivalvia.

- At station B, in level 1, significant differences between seasonal groups were detected: Nematoda (H=7.8; p<0.05*), Oligochaeta (H=16.8; p<0.001***), Kinorhyncha (H=12.4; p<0.01**), Ostracoda (H=11.2; p<0.05*), Amphipoda (H=17.8; 0.001***), Ciliophora (H=11.2; p<0.05*) and Gastropoda (H=11.1;p<0.01**). No significant differences were detected in Copepoda, Polychaeta, Turbellaria, Nauplii Larvae, Gastropoda, Bivalvia, Cnidaria, Halacaroidea and Tardigrada.

- At station B, in level 2, significant differences between seasonal groups were detected: Copepoda (H=13.6; p<0.01**), Kinorhyncha (H=11.7; p<0.01**), Ostracoda (H=12.5; p<0.01**), Gastropoda (H=7.8;p<0.05*) and Nauplii larvae (H=9.3;p<0.05*). No significant differences were detected in Nematoda, Polychaeta, Oligochaeta, Turbellaria, Amphipoda, Bivalvia, Ciliophora, Cnidaria and Halacaroidea.

- At station B, in level 3, significant differences between seasonal groups were detected: Nematoda (H=9.4; p<0.05*), Ostracoda (H=14.9; p<0.001**) and Halacaroidea (H=13.7;p<0.01**). No significant differences were detected in Copepoda, Polychaeta, Oligochaeta, Turbellaria, Nauplii larvae, Amphipoda, Gastropoda, Bivalvia and Cnidaria.

Meiofauna densities of the seasonal groups obtained at 0-3 cm depth confirm the seasonality was very similar to that obtained in the global results (0-10 cm depth). The highest densities of Nematoda taxon were obtained in winter and spring (group 3), followed by a strong decrease in summer 95 (group 4). At station A, Copepoda registered the highest values in summer 94 and autumn (group1 and group 2), while at station B the highest values were observed in June 94 (group1) and in summer 95 (group 4). Polychaeta, Kinorhyncha and Bivalvia taxa showed the highest values in summer 94 and autumn (group 2). Kinorhyncha taxon lowest densities were obtained in summer 95 (group 4), though Polychaeta and Bivalvia were registered in summer 94 (group 1). At station A, Oligochaeta recorded a steady increase, though at station B, an accentuated decline was obtained in summer 95 (group 4). At station A, the highest densities of Nauplii larvae were in summer 94 and autumn (group 2), followed by a strong decline, and disappearing in winter and spring (group 3), while at station B the highest densities were observed in autumn and winter (group 3), but the decline observed was slight. At station A, Amphipoda was present in summer 94 and autumn (group 2), while at station B the highest values were observed in summer 95 (group 4).

In deeper sediment layers (level 2; level 3), the seasonal patterns were somewhat different to that obtained in the top layer, and therefore to the global results. At station A, at 3-6 cm depth (level 2), some opposite trends were detected: Nematoda showed the lowest densities in summer 94 and autumn (group 2); Copepoda showed an increase in winter and spring (group 3); Polychaeta exibited the lowest densities in summer 94 and autumn (group 2), and in winter and spring (group 3), they increased their densities; Kinorhyncha densities were lowest in summer 94 and autumn (group 2). Considering the seasonal variation in the top layer, at the 6-10 cm depth (level 3) opposite trends were detected: Copepoda densities, after a decline, remained constant in autumn, winter, spring and summer 95 (group 2, group 3 and group 4); Polychaeta exhibited a similar trend to that obtained in level 2 (3-6 cm depth).

At station B, in the deeper sediment layers (level 2; level 3), as at station A, opposite trends were recorded. At the 3-6 cm depth, Nematoda densities, after an increase in summer 94 and autumn (group 2), remained constant, so the seasonality was not observed at this depth. Copepoda densities showed a constant decrease, Polychaeta densities were constant in summer 94 and autumn (group 1; group 2) while Oligochaeta densities declined during winter, spring and early summer 95 (group 2),

and Nauplii larvae decreased between summer 94 and spring (group 1 and group 2). At 6-10 cm depth, Copepoda densities decreased in summer 95 (group 4), Kinorhyncha showed the highest values in winter, spring and early summer 95 (group 3), while Amphipoda taxon disappeared in both summers studied and Nauplii larvae in summer 94.

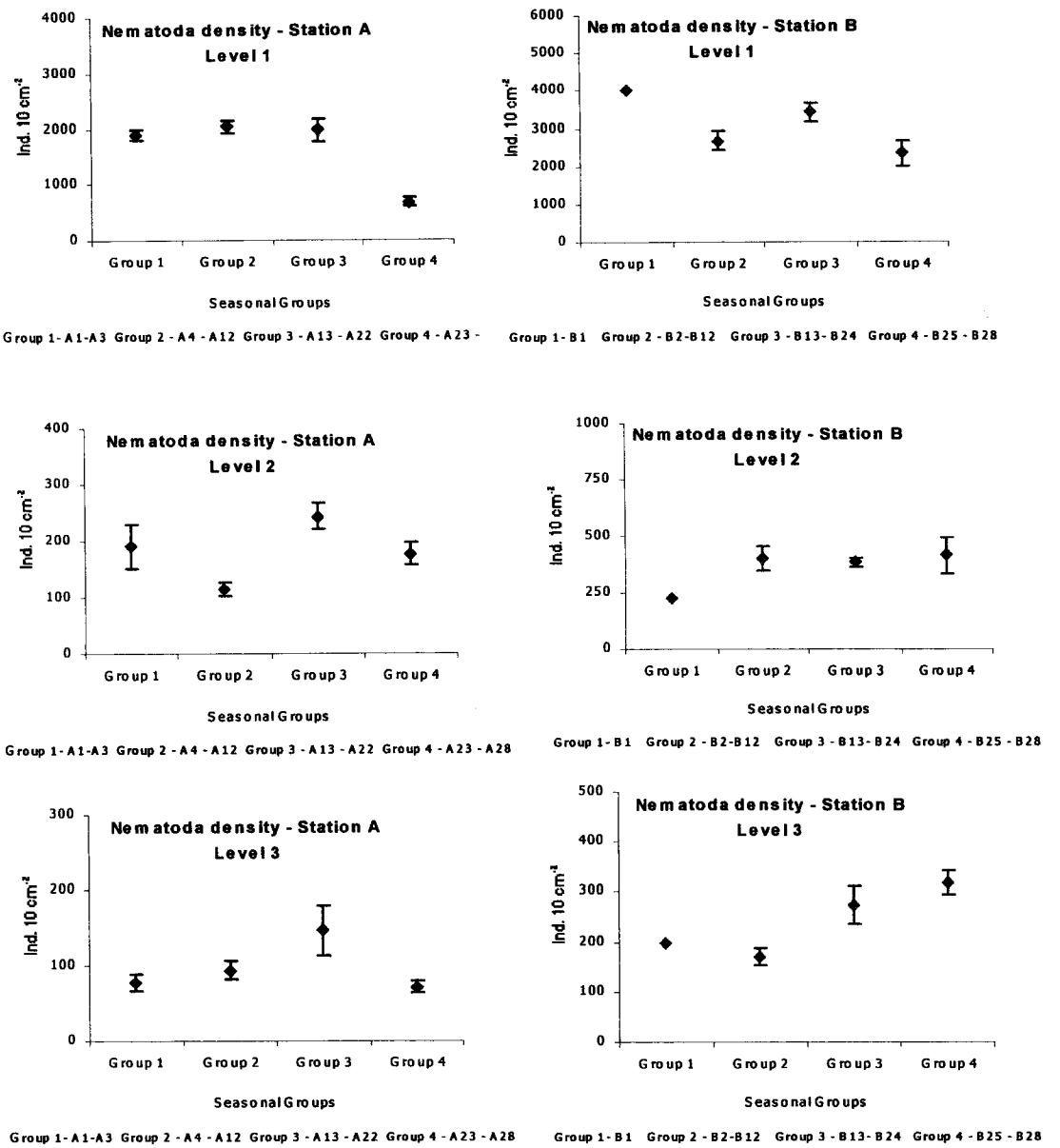


Figure 4.33 – Seasonal variation of the Nematoda taxon densities, at three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (3-10 cm), at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3 and 4 obtained by the Twinspan–classification and PCA-ordination.

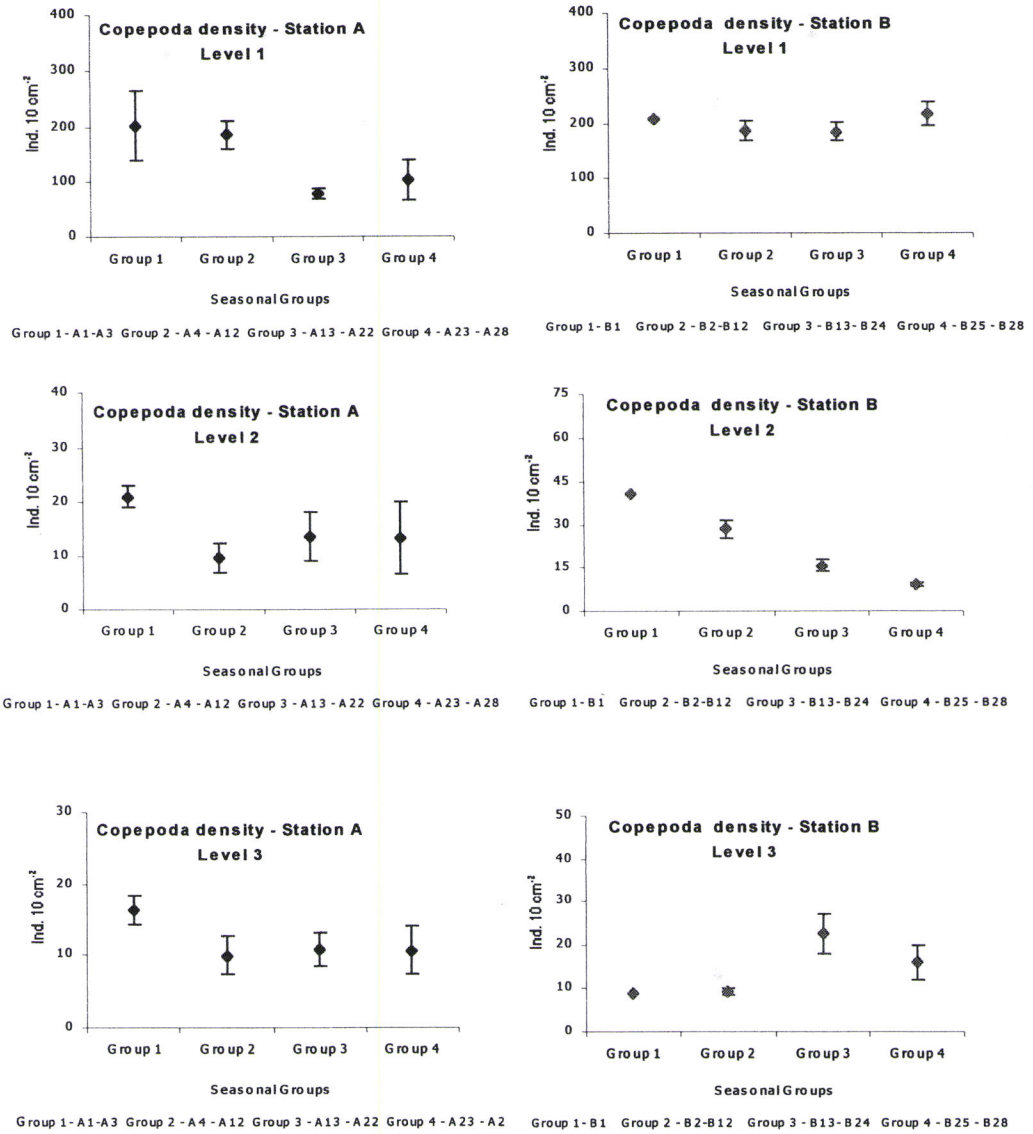


Figure 4.34 – Seasonal variation of the Copepoda taxon densities, at three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (3-10 cm), at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3 and 4 obtained by the Twinspan–classification and PCA - ordination.

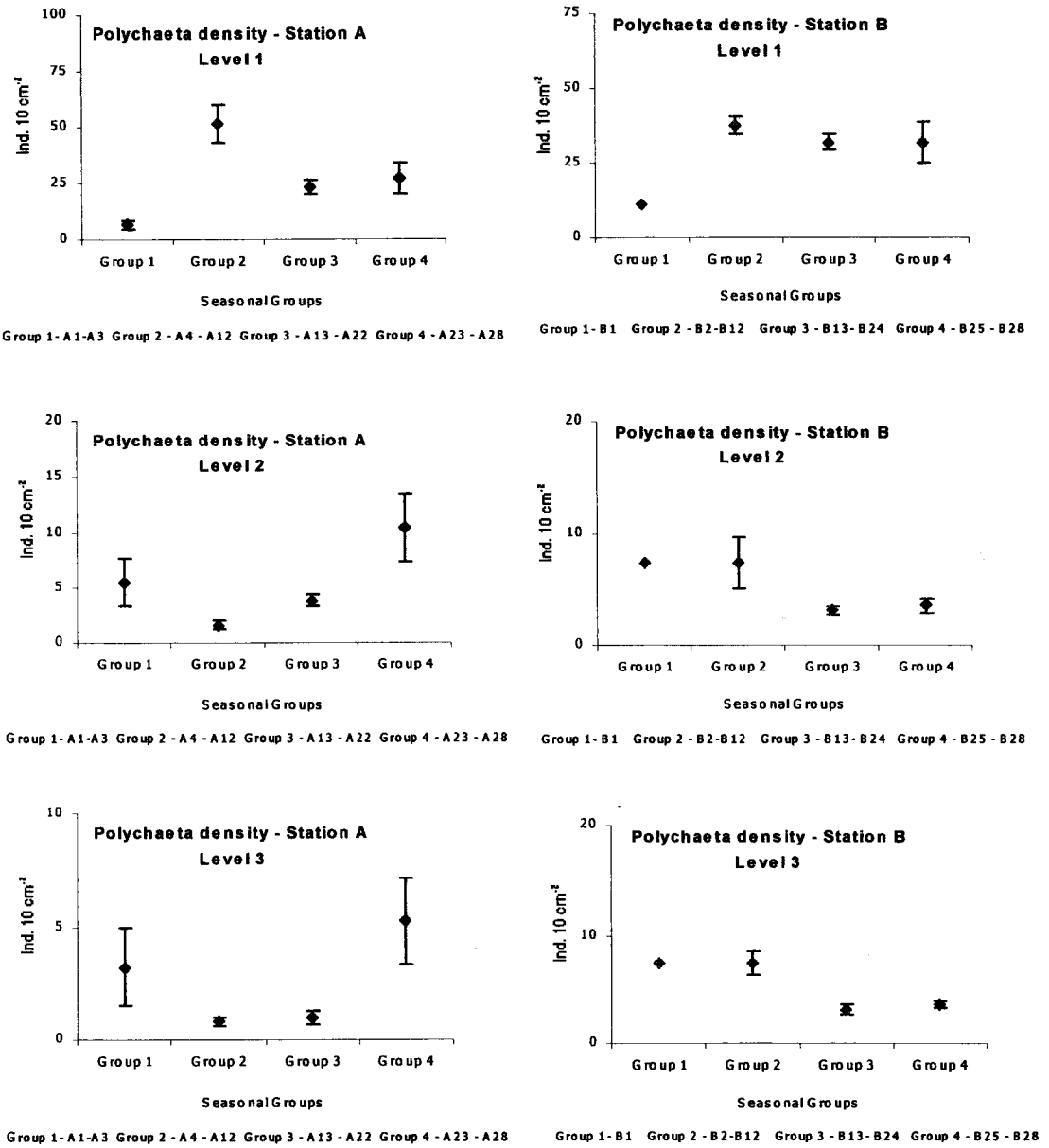
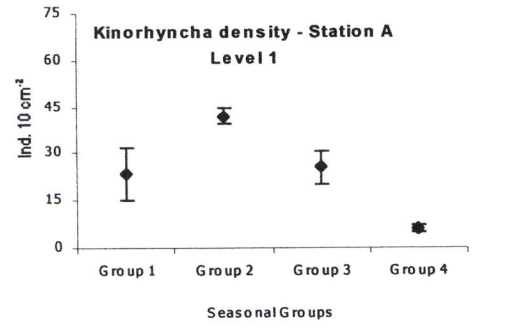
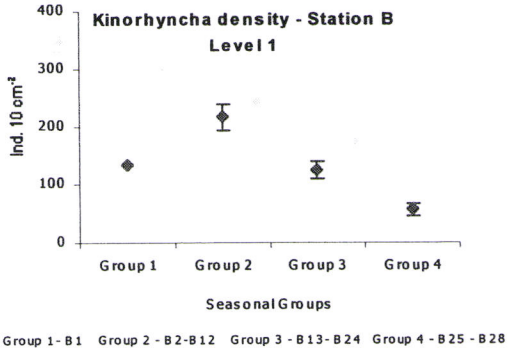
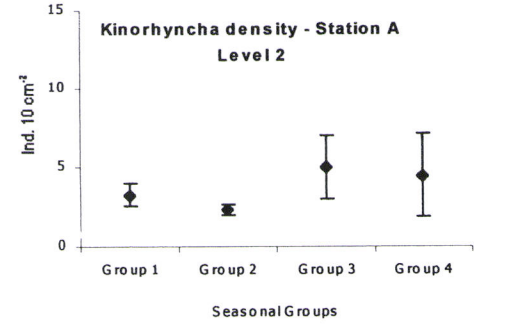
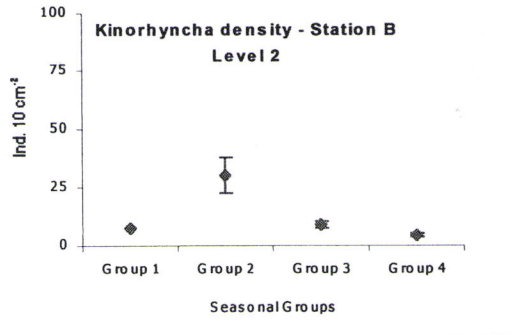


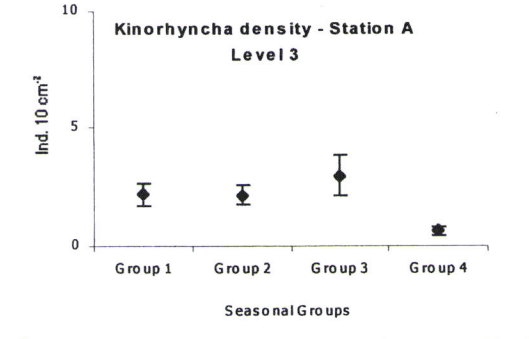
Figure 4.35 – Seasonal variation of the Polychaeta taxon densities, at three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (3-10 cm), at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3 and 4 obtained by the Twinspan–classification and PCA -ordination.











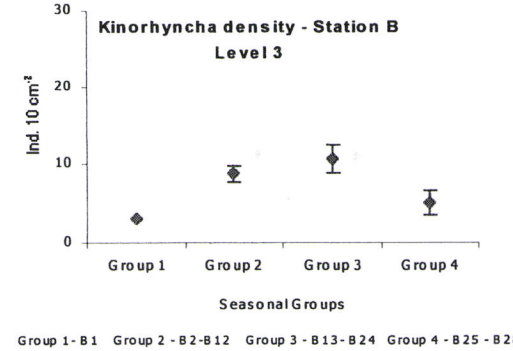


Figure 4.36 – Seasonal variation of the Kinorhyncha taxon densities, at three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (3-10 cm), at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3 and 4 obtained by the Twinspan–classification and PCA – ordination.

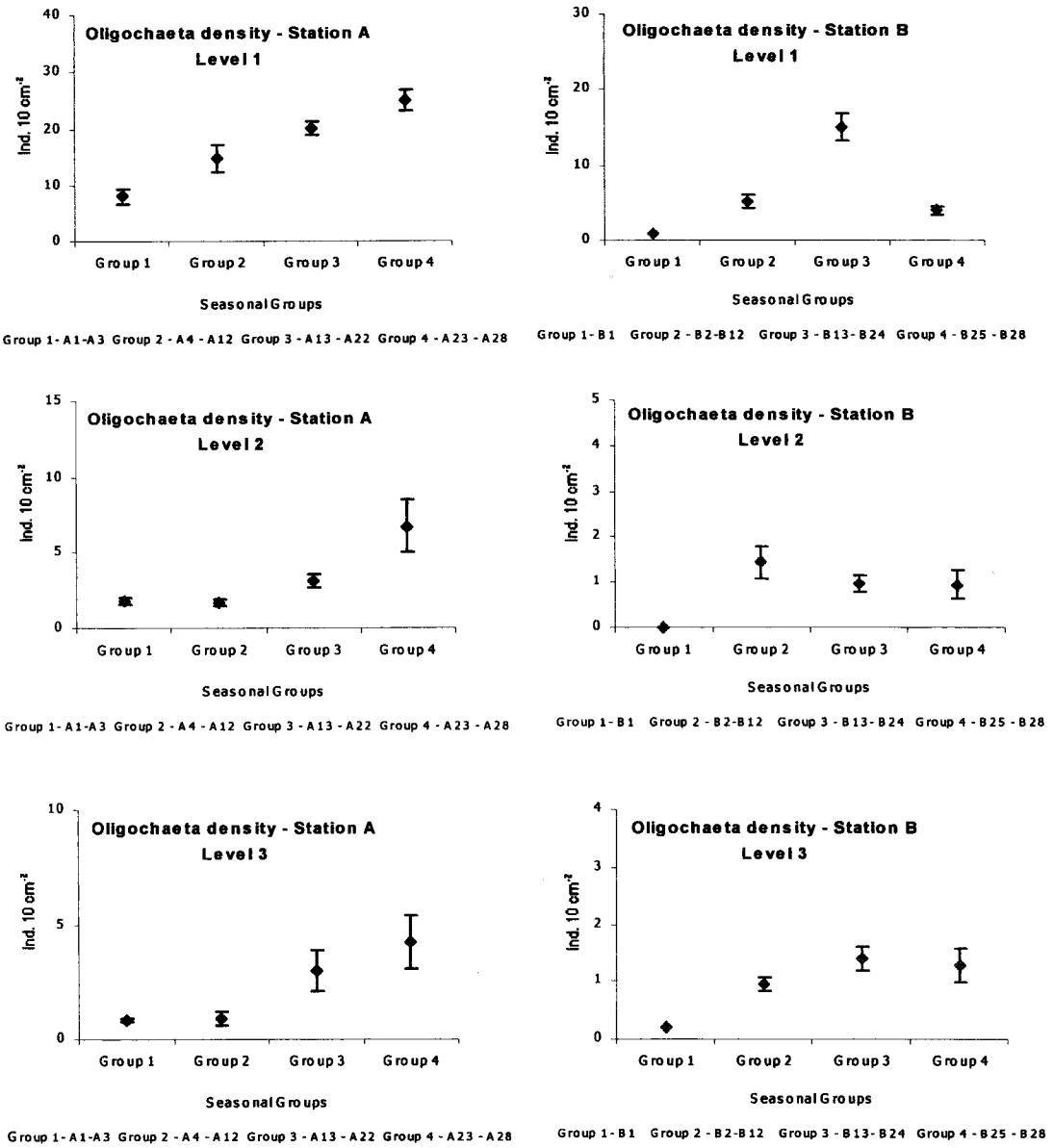


Figure 4.37 – Seasonal variation of the Oligochaeta taxon densities, at three depths: level 1 (0-3 cm), level 2 (3-6 cm), level 3 (3-10 cm), at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3 and 4 obtained by the Twinspan–classification and PCA – ordination.

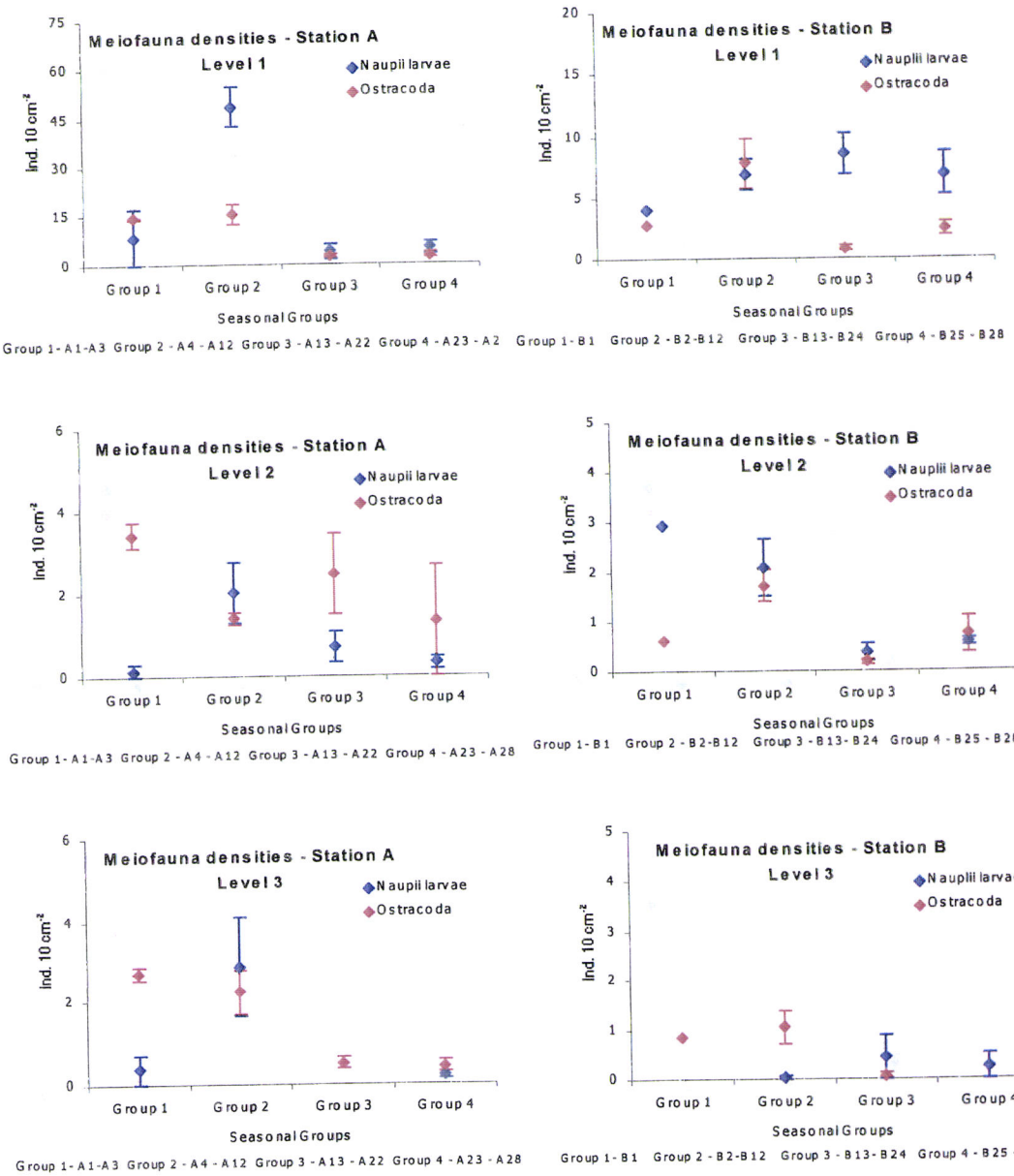


Figure 4.38 – Seasonal variation of the Nauplii larvae and Ostracoda taxon densities, at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (3-10 cm), at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3 and 4 obtained by the Twinspan–classification and PCA – ordination.

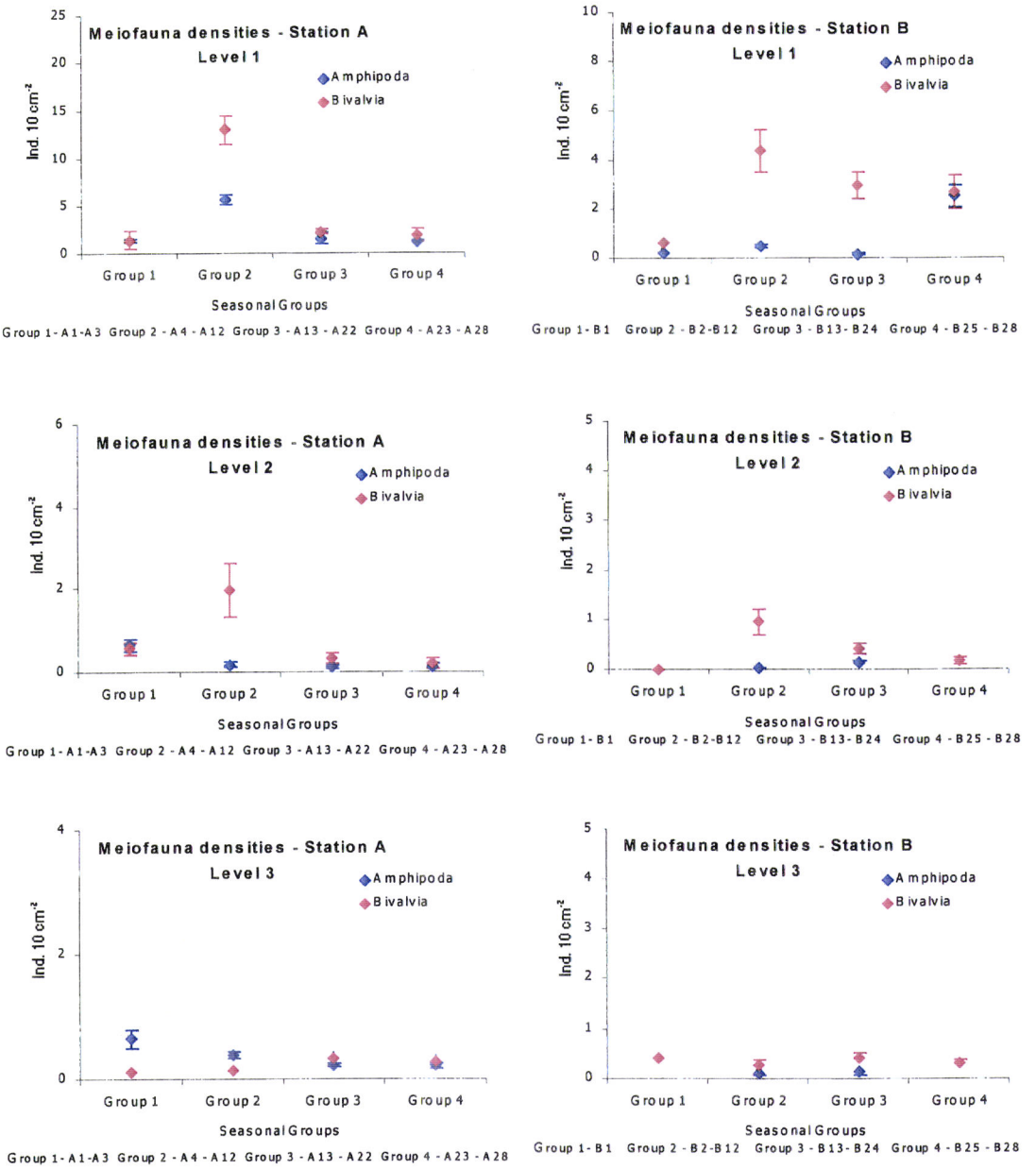


Figure 4.39 – Seasonal variation of the Amphipoda and Bivalvia densities, at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (3-10 cm), at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3 and 4 obtained by the Twinspan–classification and PCA – ordination.

4.3.3. Temporal variation and structuring factors of meiofauna communities

a) Global results.

CCA was performed to relate the temporal variation in abundance of the meiofauna composition with temporal variation in the environmental and biological factors studied, throughout the studied period, at both sampling sites (see chapter 3). At station A, the taxa-environment relations of the first three axes explain 88% of the total variance in the data. Spring and summer 95 were separated from the other periods along the first axis, and summer 94, autumn and summer 94 were separated from the early summer 94, winter and spring autumn by the second axis (Fig.4.40).

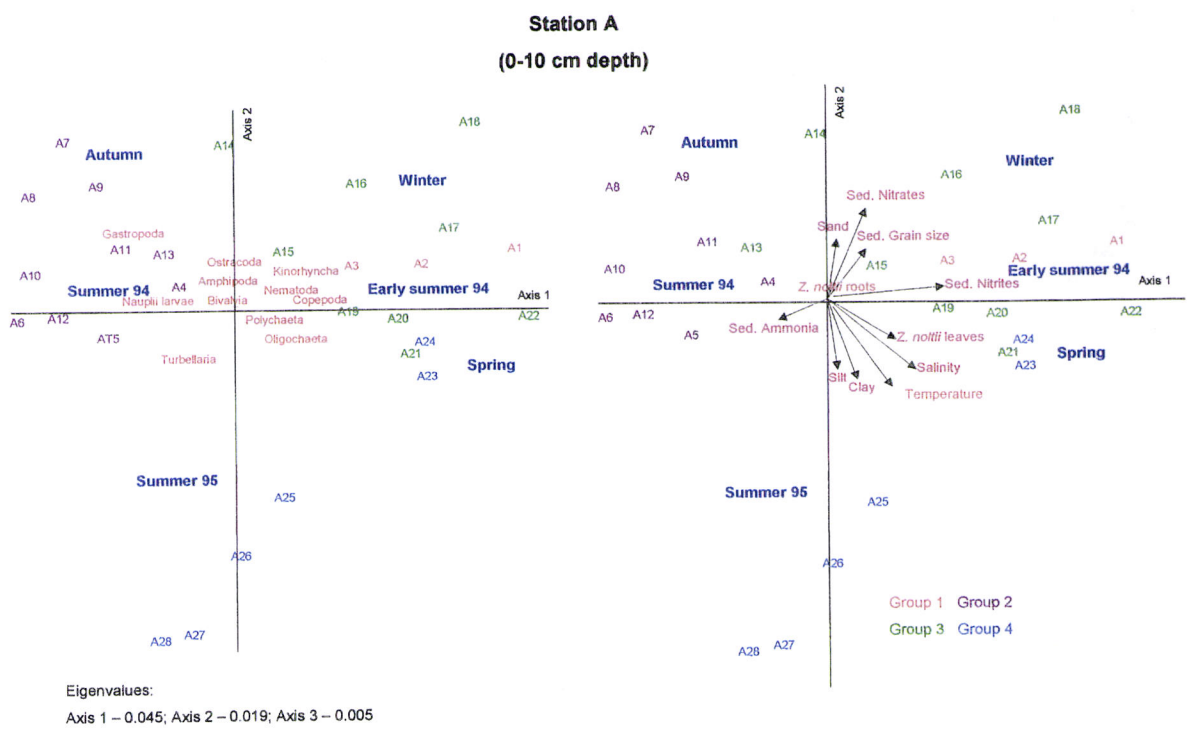


Figure 4.40 – Canonical correspondence analysis (CCA-ordination) (axis 1 vs. axis 2) based on fortnightly variation of meiofauna densities (0-10 cm sediment depth) and on the environmental variables, from June 94 (A1) until August (A28) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary. See table 4.3 for full sample dates.

The CCA results illustrate the seasonal changes in abundances and taxa composition in the meiofauna communities. These seasonal changes can be explained by several environmental factors that were measured. Early summer 94 (group1) and summer 94-autumn (group 2) were separated on the first axis, the high values of sediment nitrites

concentration and water temperature associated with meiofauna communities of the early summer 94 differing from that of the summer 94. Summer 94 and autumn were plotted along the planes with the highest values of sediment ammonia and nitrates concentration, median grain size sediments, *Zostera noltii* biomass roots and sand percentage, while the temperature and salinity had the lowest values. The relevant environmental factors relating to winter meiofauna communities were the highest values of the sediment nitrates and nitrites concentration, and the sediment consisting mainly of a higher percentage of sand. The early spring (A19, A20) samples, like the winter ones, presented the lower values of *Zostera noltii* leaves biomass and higher values of median grain size. Spring (group 3) and summer 95 (group 4) were plotted along the planes with the highest values of water temperature, pH, salinity and *Zostera noltii* leaves biomass, therefore being in contrast to autumn samples (group 2).

The plot of meiofauna scores showed the taxa very close to the middle of the graph, which indicated that the temporal pattern obtained was mainly a consequence of the temporal variation in the environmental factors. However, it was possible to detect that Nematoda, Copepoda, Kinorhyncha, and Ostracoda densities were highest in autumn, winter and spring (group 2; group 3), Polychaeta in winter and summer 95, while Oligochaeta taxon was plotted in winter, spring and summer 95. Amphipoda and Bivalvia were highest in autumn. Furthermore, the plot of meiofauna scores also reflects the periods of maximal densities of the less abundant taxa. Turbellaria was highest in summer 95, Gastropoda and Nauplii larvae were highest in summer 94 and in autumn.

Concerning the results at station B, the taxa-environment relations of the first three axes explain 82% of the variance in the data. Summer 94 and summer 95 were separated from the autumn, winter and spring by the second axis (Fig. 4.41).

At station B, the important environmental variables for the meiofauna communities associated with summer 94 (group1, group 2) were the higher values of sediment silt percentage. The *Zostera noltii* leaves biomass and the sediment clay percentage were clearly related to meiofauna assemblage associated with summer 94 and summer 95. Temperature, salinity and *Zostera noltii* roots biomass were important factors associated mainly with summer 95 (group 4). Autumn, winter and spring (group 3) were plotted in the planes with the lowest values of temperature, sediment clay, silt

percentage and *Zostera noltii* leaves biomass and roots biomass, while, pH, sediment nitrates concentration showed the highest values. Important environmental variables in autumn and spring were sediment ammonia concentrations and sediment organic matter content, principally in early spring. Sediment nitrites concentration was associated with autumn.

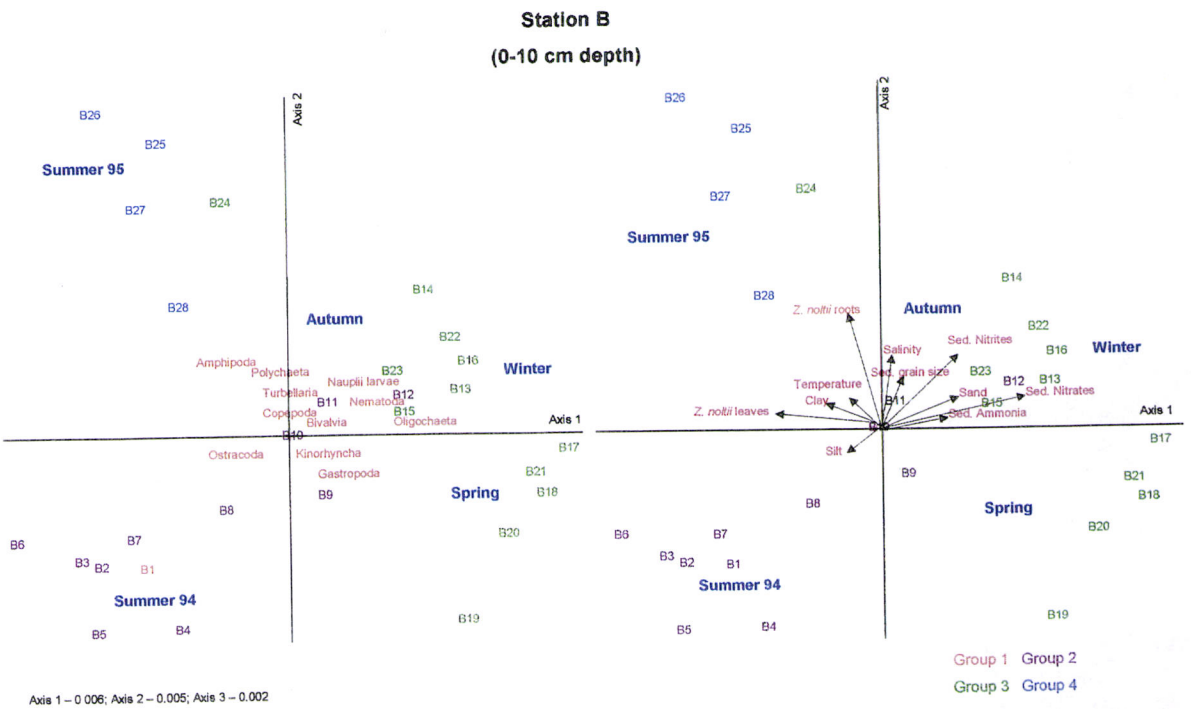


Figure 4.41 – Canonical correspondence analysis (CCA-ordination) (axis 1 vs. axis 2) based on fortnightly variation of meiofauna densities (0-10 cm sediment depth) and on the environmental variables, from June 94 (B1) until August (B28) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary. See table 4.4 for full sample dates.

The plot of meiofauna scores was also very close to the middle of the graph. The pattern obtained is explained mainly by the temporal variation of the environmental factors, as at station A. Nematoda registered the highest abundances in winter, mainly in January and February, (B15, B16 and B17), autumn and spring (group 3). Copepoda, the second most abundant taxon, even though the seasonality was not evident, showed the lowest values in autumn and winter samples. Kinorhyncha densities were highest in summer 94, and very low in summer 95. Polychaeta was highest in autumn, Oligochaeta was clearly plotted in winter and spring, and Bivalvia and Gastropoda were very low in summer 95. The plot of meiofauna scores also reflects the periods of maximal densities of the less abundant taxa: Ostracoda and Amphipoda were mainly higher in summer 94 and lower in spring. Nauplii larvae was highest in autumn and summer 95. The CCA plotted the March sample B19 as

detached from the other samples. This seems to be related to meiofauna densities, particularly the abundance of Nauplii larvae, which was very reduced in those two samples, and Amphipoda, which was absent.

b) Results per sediment layer

CCA was also applied to the three sediment depths studied: 0-3 cm, 3-6 cm, 6-10 cm. It was performed to relate the temporal variation in abundance and meiofauna composition of each depth to the temporal variation in the environmental and biological factors studied throughout the sampling period (see chapter 3).

At both stations, the taxa-environmental relations found the top layer sediment (0-3 cm depth) were very similar to the global results (0-10 cm depth). At station A, the three sediment layers were very similar. Thus, the autumn and winter samples were plotted in the plane with the highest values of median grain size, sediment nitrates and concentrations and percentage of sand. The highest values of temperature, salinity, *Zostera noltii* biomass leaves and high percentage of clay and silt were closely related to spring and summer 95. At station B, 3-6 cm depth, the seasonality was evident, although the autumn samples were more scattered. The autumn and winter samples were plotted in the planes with the highest values of sediment nitrates and nitrites and ammonia concentrations, *Zostera noltii* biomass roots and high percentage of sand. The highest values of temperature, salinity, *Zostera noltii* leaves biomass and high percentage of clay and silt were closely related to summer 94, spring and summer 95. At 6-10 cm depth, the summer 94 and spring samples were detached, although the seasonality of the other samples were not clear.

The plot of meiofauna scores of the three sediment layers studied at station A was also very similar to the global results (0-10 cm depth). At station B, the results obtained in sediment layers 0-3 cm and 3-6 cm depths were very similar to those obtained in the global results (0-10 cm depth), except for Amphipoda taxon, at 3-6 cm depth, which was plotted in the winter plane, while for the top layer, it was associated with summer 95. In sediment layer 6-10 cm depth, the plotted meiofauna scores reflected more clearly the seasonal trend of the minor taxa: Amphipoda was clearly associated with autumn and spring samples, Gastropoda and Turbellaria were with autumn, winter and

spring, Ostracoda with spring and summer 94, and Oligochaeta with spring and both summers.

4.4. DISCUSSION

The study of temporal variations of environmental factors at the *Zostera noltii* beds in the Mira estuary shows that they were mainly influenced by seasonality and by the exchange of water with the adjacent open sea (see chapter 3). Thus, meiofauna abundance, spatial distribution and the temporal variation pattern were mostly controlled by the seasonal variation of physical and biological factors, and by marine intrusion in the system.

Bell *et al.* (1984b) have pointed out that our knowledge of meiofaunal communities in seagrass beds is limited, especially when compared to the information available from other shallow habitats or for seagrass macrofauna communities. However, in recent years, there has been a surge of interest in meiofaunal composition and in the ecology of seagrass beds. In temperate and subtropical regions, most of the studies to date have been conducted within the continental United States (e.g. Bell *et al.*, 1984 a, b; Bell *et al.*, 1988; Decho *et al.*, 1985; Hicks, 1986; Hall & Bell, 1988, 1993; Walters & Bell, 1986, 1994; Bell & Hicks, 1991; Walters, 1991; Peachey & Bell, 1997). There are studies on *Zostera marina* in seagrass beds in Canada and Japan (Webb & Parsons, 1992; Aryuthaka & Kikuchi, 1996). In Europe, few studies have been carried out, these being only in France (Castel *et al.*, 1989; Escaravage *et al.*, 1989), Finland (Boström & Bonsdorff *et al.* 1997), Italy (Novak, 1982; Danovaro, 1996; Guerrini *et al.*, 1998) and Greece (Thiermann *et al.*, 1994). Regarding quantitative meiofauna investigations of intertidal *Zostera noltii* communities, they are very sparse, Castel *et al.* (1989) and Escaravage *et al.*, (1989) having studied the influence of seagrass beds of *Zostera noltii* and oyster parks on the abundance, biomass patterns and distribution of meiofauna in Arcachon Bay, southwest coast of France.

Significantly higher animal abundances have been detected in vegetated as compared to adjacent unvegetated sediments (Stoner, 1980; Summerson & Peterson, 1984; Hicks, 1986; Phil, 1986; Fonseca *et al.*, 1990; Edgar *et al.*, 1994; Edgar & Shaw, 1995). In the present study, the densities found were on average 2304 ind. 10 cm^{-2} at

station A and 4245 ind. 10 cm^{-2} at station B, which is among the highest densities reported from seagrass beds. In fact, maximum densities reported in the literature range between 634 ind. 10 cm^{-2}, in the subtidal seagrass bed (*Thalassia testudinum*) (Decho *et al.*, 1985) and 8478 ind. 10 cm^{-2}, in sediment of the tropical seagrass bed (*Halophila ovalis*) (De Troch *et al.*, 2001). Regarding the seagrass bed *Zostera noltii* sediment in Arcachon Bay, the highest densities found were on an average 7217 ind. 10 cm^{-2} (Castel *et al.*, 1989).

Meiofauna was strongly dominated by nematodes, which represented > 87% of the total average abundance over all the sampling period. They were followed in abundance by Copepods (6%), Kinorhyncha, Oligochaeta, Ostracoda, Turbellaria, Bivalvia and Amphipoda. Other taxa were always observed in low numbers (Gastropoda, Ciliophora, Gastrotricha, Halacaroidea, Cnidaria, Insecta and Acari). In sediments, nematodes were usually the most abundant group, comprising 60-90% of the total meiofauna, while copepods were typically second, varying between 10-40% (Hicks & Coull, 1983; Heip *et al.*, 1985; Hicks, 1986; Coull, 1988; Giere, 1993). Occasionally, a taxon other than nematodes predominated (e.g. Turbellaria, Alongi, 1987c, 1989; Gourbault *et al.*, 1998; Harpaticoida, Santos *et al.*, 1996), or copepods were not second in order of abundance (e.g. Hogue, 1978, Gastrotricha occurrying second to nematodes). In several studies carried out in seagrass beds sediment, Nematoda were always the dominant group and Harpaticoida the second. Other main taxa were: Gastrotricha, Polychaeta, Oligochaeta, Turbellaria, Ostracoda, Bivalvia and Kinorhyncha, which showed very changeable relative abundances (Bell *et al.*, 1984b; Decho *et al.*, 1985; Hall & Bell, 1988, 1993; Castel *et al.*, 1989; Escaravage *et al.*, 1989; Webb & Parsons, 1992; Smol *et al.*, 1994; Thiermann *et al.*, 1994; Danovaro, 1996; De Troch *et al.*, 2001).

Kinorhyncha represented a very important taxon in our study. In fact, they were the third group in abundance at station B and the fourth at station A, which was an unusual result, despite the lower relative abundance, respectively 4.2% and 1.4%. Most Kinorhyncha are found in the upper 0-3 cm of organically enriched mud and some may be found in association with detrital floc on the surface of the plants (Higgins & Thiel, 1988). In studies previously mentioned, in spite of their lower relative densities, Turbellaria, Polychaeta and Oligochaeta were among the highest abundant taxa, whereas Kinorhyncha, when registered, were scarce and always in low numbers.

Kinorhyncha was registered as third abundant group in silty-muddy prodelta located at 26 m depth (northwestern Mediterranean and were related to the amount of fine particles (Guidi-Guilvard & Buscail, 1995). In the case of the Archacon Bay results, the meiofauna was strongly dominated by nematodes (>75%), as in the Mira estuary, followed by Copepods, Turbellarians and Annelids. Other groups observed were: Cnidaria, Ostracoda, Tardigrada, Halacaroidea and Hydrozoa (Castel *et al.*, 1989) while Kinorhyncha was not recorded.

Regarding, the vertical profile distribution of meiofauna densities a decrease in the sediment was observed, from top the layers (>80%) up to 3 cm deep. Vertical distribution of meiofauna has been intensively investigated in a wide variety of habitats, these studies indicating that most meiofauna was restricted to the upper few centimeters in muddy sediments (Huys *et al.*, 1986; Escaravage *et al.*, 1989). In general, the vertical distribution patterns are controlled by a large number of factors and by the sharpest gradients: a) depth oxygen penetration in sediment, resulting in the oxygen/hydrogen sulfide profiles (Wetzel *et al.*, 1995); b) the presence of biogenic structures such as seagrass roots (Castel *et al.*, 1989) and macro-infauna tubes (Peachey & Bell, 1997); c) bioturbation (Fenchel, 1996); d) vertical distribution pattern of food resources (Montagna *et al.*, 1989); and e) increased disturbance near the surface (Carman *et al.*, 1987).

Despite the vertical decrease of meiofauna densities, Nematoda and Copepoda were the most abundant taxa at all the levels considered. The presence of these taxa downwards in the sediment could be explained by the existence of some species very resistant to low oxygen levels, the nematodes constituting the most resistant group. Some species could colonise sulphidic rich sediments because they have strategies for limiting sulphide toxicity and for coping with anoxia, (e.g several internal and peripheral mechanisms for sulphide detoxification and a high anaerobic capacity or obligatory association with ectosymbiotic bacteria) (Vopel *et al.*, 1996; Hentschel *et al.*, 1999). Others species may react to the oxygen deficiency and to H_2S stress by migrating upwards (Hendelberg & Jensen, 1993). Competition for food, species with similar food requirements and feeding behaviour is a possible factor in vertical stratification in allowing species to co-exist in the same locality (Joint *et al.*, 1982).

Furthermore, as previously mentioned, the biogenic structures and bioturbation effects create oxic niches (Nehring *et al.*, 1990; Alkemade *et al.*, 1992b), which allow the penetration of the nematodes and copepods deeper into the sediment.

Twinspan and PCA analysis results showed different seasonal patterns of taxa densities between both sampling stations (apart 2 km), which was determined by differences in several environmental and biological factors. Variation in the physical gradients (km to dm scale) may cause variation in meiofaunal abundance (Montagna, 1991), and community patterns (Soetaert *et al.*, 1994b). The meiofauna of estuarine and marine sediments typically have a strongly heterogeneous distribution, with a very strong horizontal patchiness. Patch sizes are defined on a range from kilometre to subcentimeter scales, (Findlay, 1981; Flindlay & Tenore, 1982; Heip *et al.*, 1985; Fleeger & Decho, 1987; Hodda, 1990; Fleeger *et al.*, 1995a). At larger scales, patchiness is commonly related to abiotic gradients in sediment composition, the physical factors perhaps being more important in generating meso-scale (in order of kilometres) heterogeneity, than in generating micro-scale heterogeneity. Meso-scale variability, due to salinity changes or grain size differences, is more important than a large scale variability of hundreds of kilometres among estuaries (reviews in Hicks & Coull, 1983; Heip *et al*, 1985; Fleeger & Decho, 1987; Fleeger *et al.*, 1995a; Soetaert *et al.*, 1995). At smaller scales, other interactions, many biotic, structure meiofauna spatial distribution. The micro-scale changes in the meiofauna spatial distribution can be related to the aggregation of individuals, e.g. patches, which can be caused by patchy food distribution and by social or reproductive behaviour (Li *et al.*, 1997b). A variety of factors have been documented, including sediment microtopography, biogenic structure (Bell *et al.*, 1978; Chandler & Fleeger, 1984; Sun & Fleeger, 1994; Wetzel *et al*, 1995; Palmer *et al.*, 1995; Fenchel, 1996; Heip, 1975, 1976 in Moens *et al.*, 1999b) intraspecific and interspecific competition, facilitation (Chandler & Fleeger, 1987), and presence and abundance of suspected microbial foods (Decho & Fleeger, 1988; Fleeger *et al*, 1995b; Santos *et al.*, 1996).

In fact, in our study, the temporal variation of the *Zostera noltii* biomass, the sediment clay proportions, and the sediment organic matter content, which determined differences in ammonia and phosphate sediment concentration, were significantly different between stations. This seems to explain the differences in the several taxa densities and seasonality between stations. However, abiotic factors commonly related

to meiofauna composition, such as temperature, salinity, pH, amount of dissolved oxygen (DO), water nutrient concentrations, silt and clay sediment proportions, were not significantly different between both stations, which may explain the similarity of the meiofauna composition at both stations. Moreover, the highest densities of meiofauna taxa observed at station B could be related to its location, farther than station A from the estuary mouth, and thus being more stable and affording highest densities.

The seasonality was evident for meiobenthos community assemblages at both stations, although individual taxonomic groups reached their highest and lowest abundances at different periods of the sampling period. In temperate regions, intertidal and shallow subtidal meiobenthos are known to vary seasonally; moreover, the mud community is distinctly seasonal, whereas at the sand site seasonality is not pronounced (e.g. Hicks & Coull, 1983; Heip *et al.*, 1985; Coull, 1986; Eskin & Coull, 1987; Smol *et al.*, 1994; Santos *et al.*, 1996). One year of study of the seasonal dynamics at two sampling stations must not be over-interpreted, although, at station B, the seasonal patterns of the meiofauna assemblages of both summer samplings were similar, while at station A, they were strongly different. The seasonal patterns can be very different from site to site according to different local environmental conditions and depending on the species composition.

The peak abundance of the total nematodes was observed in winter i.e. December to February, at station A and January to March, at station B, while in the sediment of the *Zostera noltii* seagrass in Arcachon Bay, the nematode densities showed a noticeable temporal stability through the year, showing a slight increase of the densities in spring (Escaravage *et al.*, 1989). However, in our study, the evident seasonal pattern found in the nematodes was consistent with results obtained in other studies carried out in muddy sediments: in sediment of the *Zostera japonica* seagrass bed, the maximum peak was in December (Aryuthaka & Kikuchi, 1996); in the intertidal mud of the Gironde estuary, the peak densities of the nematodes was also observed in autumn and winter (Santos *et al.*, 1996); in the muddy sediments of *Spartina alterniflora* salt marsh of the North Inlet estuary, the high densities of nematodes were also in November and in winter (Bell, 1979, 1980). However, these results contradict the seasonality generally observed in meiobenthic populations, which usually peak in the warmest months; e.g. in intertidal mud of the Oosterschelde estuary, all taxa reached maximum abundance and biomass in the warmer months of the year, where peak

values occurred in spring, summer or autumn and nematodes also fluctuated according to this pattern, the intertidal density sometimes increasing up to 20 times winter values (Smol *et al.*, 1994).

The temporal pattern of the harpaticoid copepods, at station A, showed the highest densities in summer 94, i.e June to autumn, and at station B, the highest densities were in both summer samplings. Despite, the lack of clear seasonal patterns in abundance, the peaks coincide with the warmest months of the year, since reproductive and development rates are know to be positively correlated with temperature (e.g. Feller, 1980; Palmer & Coull, 1980). The slight increase of the densities registered during winter at station B occurred after an increase of the Nauplii larvae densities in November and December. At both stations, it was possible to observe that the temporal patterns of Nauplii larvae were very consistent with the temporal pattern of the Copepoda taxon. The seasonal fluctuations reported in several studies can be very different from site to site, in contrast with the results obtained the density peaks also being observed in the coldest months in several estuaries: Arcachon Bay (France) - *Zostera noltii* - autumn (Escaravage *et al.*, 1989); Gironde estuary (France) - muddy sediment - winter (Santos *et al.*, 1996); Amakusa (Japan) – *Zostera marina* - winter and early spring (Aryutaka & Kikuchi, 1996) d) North Inlet estuary (South Caroline) - *Spartina alterniflora* - winter and spring (Bell, 1979, 1980); Louisiana – *Spartina alterniflora* – spring (Philips & Fleeger, 1985); Roberts bank (Canada) – winter and early spring (Webb & Parsons, 1992).

The different seasonal fluctuations observed in several studies were also related to different species composition in each community studied, corresponding to distinct reproductive cycles. Some species had spring reproductive bursts as a consistent pattern in estuaries, while other species lacked distinct reproductive cycles, and several reproduced sporadically, showing more than one seasonal abundance peak (Philips & Fleeger, 1985). Another possible source of the differences in meiofaunal densities is that interannual variability can be greater than seasonal variability (Coull, 1985b). Other biological interactions must be considered, such as predation and competition. Smith & Coull (1987) have experimentally demonstrated the presence of benthic feeding fish that selectively feed in muddy substrates, which reduced meiofauna abundance (Gee, 1989; Woods & Coull, 1992; Coull *et al.*, 1995). However, some controversy about this issue still exists, because in the field studies, predator

pressure has little impact on meiofauna prey populations (Coull, 1999). Copepoda fluctuations could also be related to the significant proportion of sediment-dwelling copepod assemblages which frequently enter the water column, and this emergence may significantly affect both benthos and pelagic environments (Walters, 1991; Walters & Bell, 1994).

The temporal patterns of the densities of Polychaeta were very similar at both stations, and the densities of Oligochaeta, Turbellaria and Ostracoda were in good agreement with those observed by other studies, carried out in sediment of seagrass beds. However, the relatively high Kinorhyncha densities recorded were an unusual result, as previously mentioned, particulary at station B, where it was the third most abundant taxon; indeed in the sediment of *Zostera noltii* in Arcachon Bay, Kinorhyncha taxon was not even registered (Bell, 1979, 1980; Osenga & Coull, 1983; Decho *et. al*, 1985; Castel *et al.* 1989; Escaravage *et al.*, 1989; Aryuthaka & Kikuchi, 1996; Danovaro, 1996).

The results of the present study indicate that meiofaunal dynamics were not significantly related to temperature or to any other physical factor, but seasonality was evident for the abundant meiofauna assemblages, although with different patterns at both sampling stations. Seasonality was also evident for the environmental factors measured (see Chapter 3). However, it was not possible to distinguish structuring factors regulating the seasonal variations of meiofauna communities, such as was observed in other studies: temperature and salinity (Coull, 1985b; Huys *et al.*, 1986; Ansari & Parulekar, 1993; Smol *et al.*, 1994; Santos *et al.*, 1996) microphytobenthos as chloropyll a, and pheopigment concentrations (Santos *et al.*, 1996), quality of organic matter (Albertelli *et al.*, 1999; Steyaert *et al.*, 1999); phytoplankton sedimentation (Ólafsson & Elmgren,1997); sediment granulometry (Coull & Dudley, 1985; Smol *et al,.*1994; Steyaert, 1999); redoxchemistry (Coull, 1985; Hendelberg & Jensen, 1993); food availability (Danovaro, 1996; Steyaert, 1999; Vanhove *et al.*, 2000); predation (Gee, 1989; Coull *et al.*, 1995); competition (Coull & Vernberg, 1975).

The regulation of meiofauna abundance within a given site results from physical and biological factors, their interactions influencing the community structure and causing the fluctuations. Only through long-term studies of the manipulation and dynamics of species of the meiofauna assemblages will it be possible to identify the fundamental

mechanisms directing community dynamics. However, based on interactions and seasonality of the several environmental factors studied at both sampling stations (see chapter 3), it is possible to suggest the factors structuring the temporal variation of meiofauna communities (taxa-environmental relations) over the time scale of this study.

At station A, the highest densities of Nematoda occurred in autumn, winter and early spring, while Kinorhyncha, Bivalvia, Ostracoda, Polychaeta, Amphipoda, Nauplii larvae, Copepoda and Gastropoda were in summer 94 and autumn. During autumn, winter and early spring periods, the temperature was lowest, while the nitrates and nitrites sediment concentrations registered the highest values, suggesting a period of higher mineralisation rate of the organic matter and, consequently, enough oxidized sediments. The concentrations of the nitrogen compounds as nitrate and nitrite (oxidized) and ammonia (reduced) could be used to evaluate the oxidation status of the sediment. Nitrate reduction requires oxygen to be available; as a result, microbial mineralisation of organic matter often makes vertical profiles of nitrate in sediments a reliable substitute for oxygen profiles (Rheinheimer, 1992). Therefore, the higher nitrates and nitrites concentrations, and a decrease in the ammonia concentration, indicate the occurrence of the nitrification processes that occur only in oxidized sediments. In addition, the increase of the percentage of sand during autumn and winter enhances the oxygen in sediments, because coarser sediments are more permeable to oxygen than fine ones. Thus, highly oxidized sediments could be the likely explanation for the enhancement of meiofauna densities. Meiofauna are diatoms consumers (Montagna *et al.*, 1983; Moens & Vincx, 1997), and indirectly, silica sediment concentrations provide some information about the dynamic of diatoms populations, with the highest concentrations in autumn, winter and spring, suggesting an increase in food supplies.

Oligochaeta showed the highest values in spring and summer 95, and Turbellaria in summer 95; they were related to the highest values of water temperature, pH, dissolved oxygen, salinity, *Zostera noltii* leaves biomass, amount of organic matter, sediment ammonia and phosphates concentration and lower values of sediment nitrates concentration and high percentage of silt and clay. This suggests the existence of most reduced sediment status, and consequently, the oxygen available for decomposition being limited, as demonstrated by higher values of the amount of

organic matter, sediment ammonia concentration and lower values of sediment nitrates concentration. The meiofauna assemblages, which showed higher densities in summer 94, exhibited an opposite trend in summer 95, particularly Nematoda, Copepoda, Kinorhyncha, Bivalvia, Ostracoda, Nauplii larvae and Amphipoda, which declined in densities. Turbellaria, however, showed the highest values which are generally represented in oxygenated substrates.

At station B, Nematoda, Oligochaeta and Nauplii larvae registered the highest abundances in winter and spring. As in station A, autumn, winter and spring seem to be periods of higher mineralisation rate of the organic matter, and to have enough oxidized sediments. Indeed, during winter and spring, we recorded the highest values of nitrates, nitrites and phosphates sediment concentrations, sediment organic matter, dissolved oxygen and pH and a high amount of organic matter. Copepoda remained very constant throughout the study, though the highest values were obtained in both summers 94, corresponding to a period of the highest values of temperature. *Zostera noltii* leaves biomass and high percentage of clay and silt, as at station A, suggest the existence of the reduced status of the sediment. Ostracoda, Turbellaria recorded the highest densities in summer 94 and Kinorhyncha, Polychaeta and Bivalvia in summer 94 and autumn. Amphipoda reached the highest the densities in summer 95.

The temporal patterns of the vertical variations of meiofauna assemblages in general showed a clearly seasonality at both sampling sites. The density patterns of the surface layer structured the seasonality obtained in the global sediment layer (0-10 cm depth) due to most of the meiofauna being concentrated in the uppermost 3 cm (>80%). However, at station A, during winter and spring, was registered an opposite trend in the lowermost sediment layer (6-10 cm depth), with Kinorhyncha and Nauplii larvae increasing their densities, it seemingly the result of migration down, due to the penetration of oxygen or food available.

4.5. CONCLUSIONS

This study of the temporal variation of meiofauna communities at two stations in sediments of *Zostera noltii* seagrass in the Mira estuary leads to the following conclusions:

1-The results obtained throughout the study concerning high abundances and meiofauna composition taxa were in accord with to the results of previous observations carried out in intertidal muddy sediments of several estuaries.

2-The analysis of the temporal variations of the meiofauna assemblages, at both sampling stations, indicated an evident seasonality. The results of the present study indicated that it was not possible to identify any specific environmental factor able to explain the seasonal variation of meiofauna abundance and composition. However, it was possible to recognize that the combined effect of a given set of factors creates the habitat conditions which explain the seasonal variation of meiofauna densities and composition. Consequently, as a result of changes in environmental parameters, it was possible to identify a distinct seasonal pattern year-to-year and between sampling stations.

3-The densities and seasonal patterns of the meiofauna assemblages between sampling stations were different, reflecting the differences in the seasonal fluctuations of several environmental factors, particularly ammonia, biomass of *Zostera noltii* and sediment clay proportions. However, the important factors structuring meiofauna communities, such as temperature, salinity, pH, amount of dissolved oxygen (DO) and concentrations of nutrients in the water and in sediment proportions of silt and clay, were similar between stations, which seems to explain the similarity of meiofauna composition between the stations.

4- Abiotic differences between both sites studied were not the main factors affecting the temporal changes of the meiofauna communities. Biotic factors, i.e. food availability, life cycles, trophic conditions, may play an important role in structuring the seasonal changes of the communities, although these were not considered in this study.

5- Seasonality found for Nematoda at both stations contradicts the seasonality generally observed in meiobenthic populations, which usually peak in the warmest months.

6-The seasonal changes in the vertical distribution and densities of the meiofauna assemblages were also very evident. The seasonality of sediment layer 0-3 cm depth was very consistent with the seasonality obtained at 0-10 cm depth.

7-The higher relative densities of Nematoda taxon (>87%) structured the seasonality of meiofauna community. Therefore, the study of the temporal variation of the species composition of the dominant taxon, with distinct life cycles and different relationships with environmental factors, allows the explanation of the structuring factors of the temporal dynamics of meiofauna communities.

5 - SEASONAL DYNAMICS AND VERTICAL DISTRIBUTION OF FREE-LIVING MARINE NEMATODE COMMUNITIES IN SEDIMENTS: RELATIONSHIP WITH THE ENVIRONMENTAL FACTORS

Abstract

The main aims of this study are to analyse the temporal and vertical variability patterns of the composition, densities and trophic structure of the Nematoda genera assemblages, to investigate the age composition of the dominant Nematoda genera and to relate this to the seasonal variability of the environmental and biological factors studied at the sampling sites (see Chapter 3).

The high abundances of the Nematoda genera observed throughout the study agree with the results of the previous observations carried out in vegetated intertidal muddy sediments of several estuaries. *Terchellingia*, *Paracomesoma*, *Odontophora* and *Linhomoeus* were dominant genera. As expected, sediments were mainly populated by non-selective deposit feeders and epistrate feeders.

The analysis of the temporal variations of the Nematoda assemblages, at both sampling stations, indicated an evident seasonality. It was possible to divide this into seasonal groups: early summer 94, summer 94, autumn, winter-spring, and summer 95. However, the densities and seasonal patterns between sampling stations were different.

Seasonal changes in the vertical distribution and densities of the Nematoda assemblages were evident. The seasonality of the surface sediments was very consistent with the seasonality obtained at 0-10 cm depth.

It was not possible to identify any specific environmental factor to explain the seasonal variation and composition of Nematoda assemblages, but it was possible recognize the combined effect of several environmental parameters related to the seasonality of the Nematoda assemblages.

Biotic factors such as food availability, life cycles and trophic conditions, may play an important role in structuring the seasonal changes obtained. In fact, the temporal variation patterns were closely associated with the seasonality of the populations and the evident changing of the trophic group dominance, suggesting changes in food availability.

5. SEASONAL DYNAMICS AND VERTICAL DISTRIBUTION OF FREE-LIVING MARINE NEMATODE COMMUNITIES IN SEDIMENTS: RELATIONSHIP WITH THE ENVIRONMENTAL FACTORS

5.1. INTRODUCTION

The meiofauna of marine and estuarine sediments is nearly always dominated by nematodes. Densities in fine-grained intertidal and shallow subtidal sediments could attain an average 10^6 ind. m^{-2}, representing a biomass of roughly 0.2 to 2 g C m^{-2} (Heip, *et al.*, 1985). Bouwman (1983) attributed nematode dominance in estuarine sediments to three main factors: (1) their burrowing capacity, in combination with their small and slender shape, allowing the occupation of interstitial spaces in coarse grained sediments as well as the invasion of soft sediments; (2) their tolerance, as a taxon, to a variety of environmental stresses; (3) the diversification in buccal structures, enabling nematodes to exploit a broad range of food items present in the benthos.

A striking feature of nematode assemblages, perhaps the most important in understanding their ecological success, is the large number of species present in any one habitat (Heip, *et al.*, 1985). The marine nematode communities often have high diversity; it is not uncommon to find 50 species in a 10 cm^3 core, and for example, some 800 species have been reported for the North Sea alone (Vincx, 1989). The nematodes tend to increase their density in muddy sediment, while the diversity increases in sandy sediments (Heip *et al.*, 1985).

Zostera beds contribute significantly to biodiversity and their production provides more potential niches than bare sand (Boström & Bonsdorff, 1997). In recent years, there has been a surge of interest in the faunal composition and ecology of invertebrates inhabiting seagrass beds, the impetus for such research effort having largely been based upon a recognition of the role seagrass beds play in the energy or trophic status of estuarine systems, either through their release of dissolved organic carbon directly into the water column, or, after defoliation and fragmentation of leaves, by contributing to the detritus pool. Moreover, the use of seagrass beds as nursery and feeding areas for the young of many commercially important fish species has added to the presumed

importance of vegetated habitats in estuaries. A dense bed of seagrass produces a great quantity of organic matter, but animals that directly consume green seagrass leaves are scarce. Most of them deposit after defoliation and provide a source of detrital and dissolved organic food, being utilized through the detritus food chain. The fauna in seagrass beds can utilize three primary food sources: detritus and microorganisms on plant surfaces; suspended particulate organic matter and plankton; and epiphytic algae. In the benthic ecosystem, meiofauna have been reported to play an integral role as nutrient regenerators or as food higher trophic levels (Hicks & Coull, 1983).

Nematodes occupy a great variety of food niches in sediment due to their diverse feeding types, and consist primarily of organic detritus and diatom feeders (Findlay & Tenore, 1982; Montagna, 1984; Alkemade *et al.*, 1994). They are consumed by other members of the meiobenthos, and by other larger nematodes or by members of the epibenthos (Moens & Vincx, 1997). Thus, nematodes may constitute an important energy pathway, from primary production and detritus to a higher trophic level. For these reasons, this taxon is likely to play a key role in the nutrient cycles and microhabitat ecology of the benthos.

Studies of temporal fluctuations in shallow water meiobenthos in temperate regions have found that abundance and biomass vary seasonally (Warwick & Buchanan, 1971; Bell, 1979; Coull, 1985a, 1986; Rudnick *et al.*, 1985; Eskin & Coull, 1987; Castel *et al.*, 1989; Smol *et al.*, 1994; Guidi-Guilvard & Buscaill, 1995). While there is much literature on the meiofauna as a group, investigations on the natural fluctuations within a particular taxon (e.g. nematodes and copepods) are comparatively scarce and are limited to estuarine (Eskin & Coull, 1987; Ansari & Parulekar, 1993), intertidal (Alongi, 1987b; Bouvy & Soyer 1989; Schizas & Shirley, 1996), or temperate subtidal areas (Rudnick *et al.* 1985; Vincx, 1989; Ólafsson & Elmegren, 1997; Steyaert *et al.*, 1999). Most time series studies of nematodes have a low temporal resolution. Seasonal cycles of nematodes can be very different from site to site according to different local environmental conditions and depending on the species composition. The abundance peak of dominant species can be present in spring, summer, autumn or winter. Great variability from year to year was found for nematode abundance, and sometimes this variability was much larger than seasonal variability. Even in separate species, several irregular seasonal patterns can be found (Li & Vincx, 1993).

The main aims of this study are (1) to assess the Genus composition of the free-living marine nematodes in sediments of *Zostera noltii* seagrass in the Mira estuary, (2) to investigate the temporal variation of the age composition of the dominant Nematoda genera, (3) to analyse the temporal and vertical variability patterns of the Nematoda genera composition and densities, (4) to investigate the temporal and vertical variability of the trophic structure of the assemblages and (5) to relate the seasonal and vertical variability of the Nematoda genera composition and densities with the seasonal variability of the environmental and biological factors studied at the sampling sites (see Chapter 3).

5.2. MATERIAL AND METHODS

5.2.1. Nematoda

5.2.1.1. Sampling strategy

Meiobenthic samples were obtained by forcing a hand core (3.18 cm diameter), to a depth of 10 cm (Higgins & Thiel, 1988). Each sediment sample was cut in three slices according to depth levels: 0-3 cm, 3-6 cm and 6-10 cm. Samples were preserved in 4 % formaldehyde solution in polyethylene bottles. Later, two replicates per station for each date were analysed.

5.2.1.2. Extraction techniques

The extraction of meiofauna from mud sediments is done most efficiently using a density gradient in a centrifugation procedure. The method used was developed in the Marine Biology Section of Gent University (Vincx, 1996) and consists of the slightly modified procedure of Heip *et al.* (1985).

The fixed sample is rinsed over a 1 mm sieve to separate shell detritus from the sediment and the rest is retained in a recipient of 5 litres. This part is suspended vigorously with tap water, then poured through a 38 µm sieve. This rinsing is repeated

10 times. Material from the sieve is collect into tubes for centrifugation, and a colloidal solution of "Ludox HS40 (60% Ludox and 40% water), which is a silicasol with density larger than the density of meiofauna (density 1.18 g cm^{-3}), is added. The fraction remaining on the 38 µm sieve is washed and centrifuged three times.

The supernatant is rinsed with water over a 38 µm sieve for some time, because "Ludox" and formalin react and form a gel which is difficult to wash out. After extraction, 4% neutral formalin is added again to the treated sample. Preserved samples can be stored until analysis.

5.2.1.3. Microscope examination and identification of Nematoda

Using a stereomicroscope and a counting box for nematodes, a random set of 200 nematodes from each of the two cores were mounted on glycerin slides (Seinhorst, 1959); 120 nematodes were picked out from 0-3 cm depth, 60 from 3-6 cm depth and 20 from 6-10 cm depth. After fixation, nematodes must be transferred to anhydrous glycerol. Specimens were transferred from formalin to glycerol through a series of ethanol-glycerol solutions to prevent the animals from collapsing. They were picked out and put into a cavity block (recipient) under a stereoscopic microscope into a solution of 99% formalin (4%) and 1% glycerol. The recipient was then put into a sealed container with 95% (v/v) ethanol at 35°C for about 12 hours.

At 35°C, the ethanol was evaporated into the solution of formalin and glycerol. After 12 hours, the cavity block (with nematodes) was partly covered and put in an oven at 35°C. Every 2 hours, some drops of a solution of ethanol with glycerol (95%: 5%v/v) were added with a pipette. After about 6 hours, some drops of an ethanol and glycerol (50%: 50% v/v) solution were added. The cavity block remained partly open at 35°C until all the ethanol was evaporated and the nematodes remained in pure glycerol.

Animals may be mounted on glass slides when in glycerol. For this, a paraffin ring was put on a slide, within a small droplet of glycerol, and 5-10 nematodes of the same thickness were put into the glycerol drop. A cover glass was put on the droplet and slightly heated at 40°C in order to let the paraffin melt.

Identification to genus level was done using the pictorial keys of Platt & Warwick (1988), where the nematodes were classified according to Lorenzen (1981). The four feeding groups of Wieser (1953), distinguishing selective (1A) and non-selective (1B) deposit feeders, epistratum feeders (2A) and predators/omnivores (2B) were used to investigate the trophic structure of the community assemblages.

5.2.2. Enviromental factors

With regard to the determination of environmental factors see chapter 3

5.2.3. Data Analysis

A variety of multivariate, univariate and graphical methods were employed in the analysis of nematode and environmental data sets (see chapter 4).

5.3. RESULTS

5.3.1. Temporal variation of the Nematoda genera densities and composition

a) Global results

The Mann-Whitney Test, (Z estatistic Mann-Whitney; $p<0.001^{***}$) applied to the temporal variations of the total nematodes densities recorded at both stations showed significant differences between station A and B ($Z= -5.0; p<0.001^{***}$). The densities were highest at station B, and registered more fluctuations over the sampling period (see Fig 4.3).

A total of 70 genera in 23 families were recognized at both sampling stations. They belonged to the orders Enoplida, Monthysterida and Chromadorida, the overall relative abundance of the nematoda families collected being given in table 5.1. Linhomaeidae were dominant at both stations, followed by Comesomatidae at station A (18%) and

Desmodoridae (22%) at station B, whereas Comesomatidae was the third abundant family. At station A, Axonolaimidae was the third abundant family, followed by Chromadoridae, Desmodoridae, Xyalidae, Oncholaimidae, Cyatholaimidae and Leptolaimidae. 10 other families represented the relative abundances lower than 1%. At station B, Xyalidae was the forth abundant family followed by Axonolaimidae, Chromadoridae, Leptolaimidae, Oncholaimidae and Cyatholaimidae. 13 other families represented a relative abundances lower than 1%.

Table 5.1 – Overall relative abundance of the nematoda families collected at stations A and B in sediment of a *Zostera noltii* seagrass bed of the Mira estuary.

Nematoda families Station A	% of Total	Nematoda families Station B	% of Total
Linhomoeidae	24.8	Linhomoeidae	28.3
Comesomatidae	18.4	Desmodoridae	21.9
Axonolaimidae	12.6	Comesomatidae	12.2
Chromadoridae	11.7	Xyalidae	8.8
Desmodoridae	9.2	Axonolaimidae	8.3
Xyalidae	6.2	Chromadoridae	7.5
Oncholaimidae	4.0	Leptolaimidae	2.9
Cyatholaimidae	3.1	Oncholaimidae	2.6
Leptolaimidae	2.1	Cyatholaimidae	2.1
Tripyloididae	1.1	Selachinematidae	0.9
Aegialoalaimidae	1.1	Anticomidae	0.6
Anticomidae	1.0	Ironidae	0.5
Sphaerolaimidae	0.7	Oxystominidae	0.5
Selachinematidae	0.7	Tripyloididae	0.4
Oxystominidae	0.7	Diplopeltidae	0.4
Ironidae	0.7	Aegialoalaimidae	0.4
Diplopeltidae	0.6	Enchelidiidae	0.4
Enchelidiidae	0.6	Microlaimidae	0.4
Microlaimidae	0.4	Sphaerolaimidae	0.3
Phanodermatidae	0.4	Monoposthiidae	0.05
Monoposthiidae	0.05	Desmoscolecidae	0.03

The list of the genera ranked in descending order of dominance, between 0 and 10 cm sediment depth are given in tables 5.2 and 5.3. At station A, 16 genera were higher than 1%, comprising 89% of the total nematode population. *Terschellingia* 17% (average density 430.7 ind.cm^{-2}) and *Paracomesoma* 16.6% (average density 423.7 ind.cm^{-2}) were dominant and followed by *Odontophora* 12.2% (average density 292.3 ind.cm^{-2}), *Spirinia* 10% (average density 176.0 ind.cm^{-2}), *Chromadorella* 5% (average density 123.3 ind.cm^{-2}) and *Linhomoeus* 4.6% (average density 102.8 ind.cm^{-2}). At

station B, 18 genera were higher than 1% and together attained 90% of the entire nematode abundance. As at station A, *Terschellingia* 17.5% (average density 724.0 ind.cm^{-2}) was dominant. However, the second most abundant genus was *Spirinia* 15.9% (average density 677.6 ind.cm^{-2}), which was the fourth abundant genus at station A, followed by *Paracomesoma* 9.5% (average density 451 ind.cm^{-2}), *Linhomoeus* 9.3% (average density 405.2 ind.cm^{-2}), *Odontophora* 8.0% (average density 354.4 ind.cm^{-2}) and *Paramonohystera* 5% (average density 208.8 ind.cm^{-2}). *Chromadorella* was the fifth abundant genus at station A, while at station B it was only the eighteenth abundant, with 49.3 ind.cm^{-2} (1%) (Fig 5.1). There were 24 genera not common to sampling sites, all with low density (table 5.4).

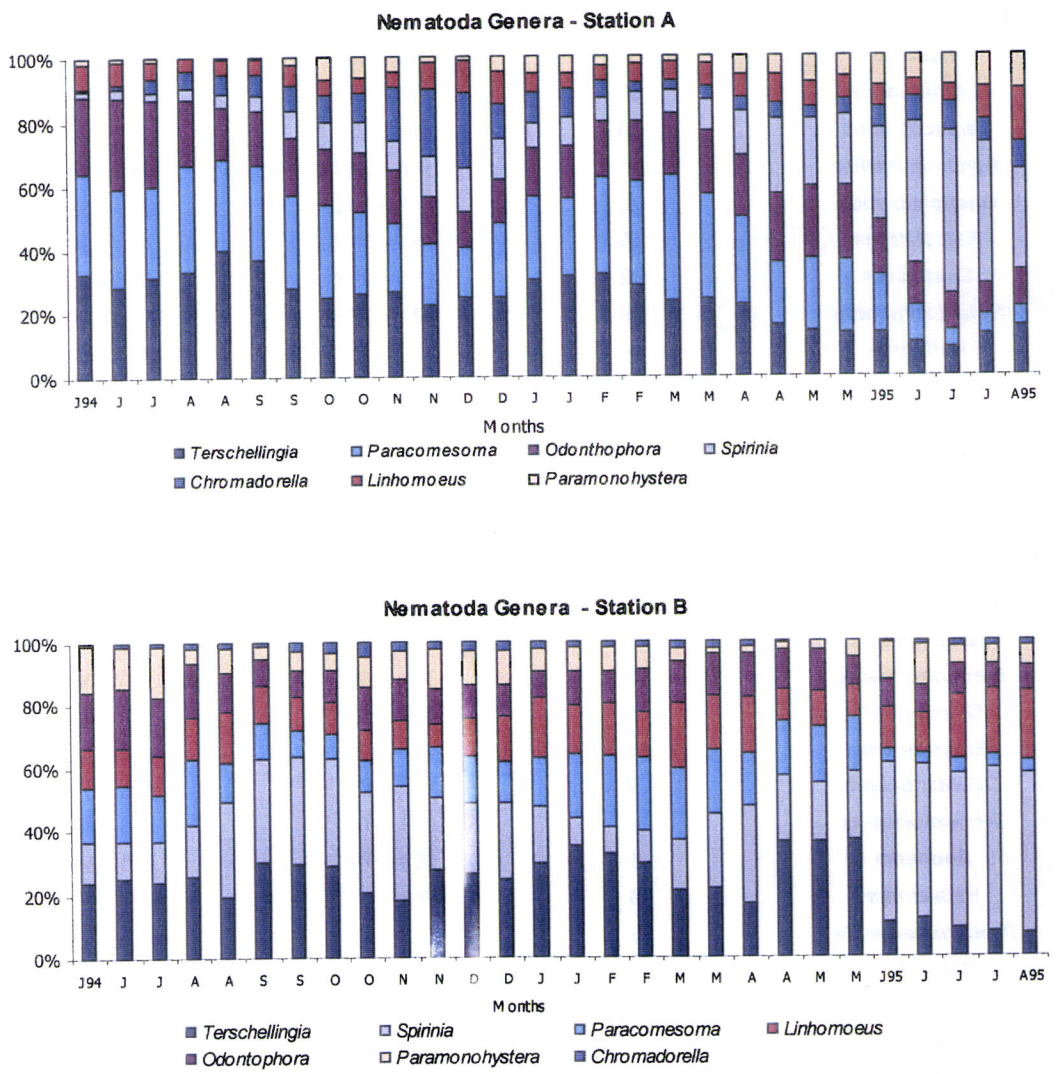


Figure 5.1 - Fortnightly variation of relative composition of the 7 predominant Nematoda genera (0-10 cm sediment depth), from June 94 until August 95, at station A and station B, in *Zostera noltii* seagrass bed sediments of the Mira estuary.

Table 5.2 – Statistical parameters (95% confidence interval for mean) of the Nematoda genera densities at station A. Units are number of individuals per 10 cm^{-2}.

Nematoda	Mean	95% Confidence interval for mean	Minimum - Maximum
Terschellingia	431	335.3 – 526.1	56.3 – 802.8
Paracomesoma	424	332.5 – 514.9	21.6 – 874.2
Odontophora	292	239.9 – 344.7	41.8 – 528.9
Spirinia	176	145.2 – 206.9	39.5 – 318.4
Chromadorella	122	79.2 – 164.4	10.2 – 425.3
Linhomoeus	103	88.2 – 117.4	33.5 – 187.5
Daptonema	84	64.9 – 103.5	16.8 – 180.5
Paramonohystera	60	44.8 – 75.8	2.3 – 183.7
Chromadorina	60	36.2 – 83.0	2.3 – 165.7
Paracyatholaimus	58	38.5. – 76.8	4.8 – 190.2
Viscosia	54	38.8 – 68.8	3.6 – 184.5
Chromadora	51	36.5 – 65.8	3.4 – 136.3
Camacolaimus	40	26.9 – 53.1	5.1 – 143.1
Ptycholaimellus	30	19.6 – 39.8	0.0 – 77.0
Oncholaimellus	28	21.9 – 34.5	0.0 – 56.5
Bathylaimus	25	16.4 – 34.4	0.0 – 67.8
Southernia	22	15.4 – 28.4	3.6 – 68.4
Metachromadora	19	10.6 – 27.9	0.0 – 79.0
Anticoma	18	12.1 – 22.8	0.0 – 44.3
Synonchiella	17	9.2 – 24.6	0.0 – 89.2
Sphaerolaimus	16	8.5 – 24.3	0.0 – 78.7
Megadesmolaimus	16	8.8 – 23.3	0.0 – 70.0
Molgolaimus	16	10.9 – 20.6	0.0 – 46.6-
Thalassironus	15	10.7 – 19.4	0.0 – 41.7
Paracanthonchus	14	7.00 – 20.1	0.0 – 60.5
Metalinhomoeus	13	4.7 – 20.6	0.0 – 78.1
Campylaimus	13	7.8 – 17.0	0.0 – 46.2
Paralinhomoeus	10	7.0 – 20.1	0.0 – 60.5
Oxystomina	8	6.4 – 10.4	0.0 – 20.0
Eurystomina	7	3.5 – 10.1	0.0 – 29.7
Odontanticoma	6	0.72 – 12.0	0.0 – 51.8
Diodontolaimus	6	3.5 – 8.8	0.0 – 24.4
Aponema	6	2.3 – 9.9	0.0 – 34.8
Halalaimus	6	3.8 – 7.5	0.0 - 17.8
Prochromadorella	5	2.3 – 7.0	0.0 – 16.0
Sabatieria	4	2.2 – 5.6	0.0 – 14.3
Eleutherolaimus	4	1.7 – 6.0	0.0 – 13.4
Calyptronema	4	-0.5 – 7.7	0.0 – 33.7
Cyartonema	3	-0.4 – 7.0	0.0 – 29.5
Microlaimus	2	1.0 – 3.7	0.0 – 12.0
Southerniella	2	0.3 – 3.7	0.0 – 13.2
Neochromadora	2	0.5 – 3.3	0.0 – 15.2

Leptolaimus	2	0.3 – 2.8	0.0 – 11.1
Onchium	1	-0.2 – 2.3	0.0 – 15.3
Desmolaimus	1	- 0.2 – 2.3	0.0 – 15.3
Acanthopharynx	1	-0.04 - 1.9	0.0 – 8.5
Desmodora	0.8	0.14 – 1.4	0.0 – 5.1
Wieseria	0.8	0.04 – 0.5	0.0 – 5.8
Chromaspirina	0.7	0.06 – 1.3	0.0 – 6.6
aff Phanodermopsis	0.7	-0.02 – 0.7	0.0 – 6.4
Parasphaerolaimus	0.7	-0.09 – 1.4	0.0 – 6.3
Nemanema	0.6	0.14 – 1.0	0.0 – 3.2
aff Cervonema	0.5	-0.06 – 1.0	0.0 - 4.2
Antomicron	0.4	-0.06 – 0.9	0.0 – 4.0
Paroxystomina	0.4	-0.2 – 1.0	0.0 – 7.6
Atrochromadora	0.4	-0.2 – 1.0	0.0 – 7.6

Table 5.3 – Statistical parameters (95% confidence interval for mean) of the Nematoda genera densities at station B. Units are number of individuals per 10 cm^{-2}.

Nematoda	Mean	95% Confidence interval for mean	Minimum - Maximum
Terschellingia	724	561.2 – 887.0	159.7 – 1567.3
Spirinia	678	577.3 – 777.8	312.3 – 1169.7
Paracomesoma	451	330.9 – 571.0	66.9 – 1123.2
Linhomoeus	405	331.3 – 439.2	132.6 – 50.4
Odontophora	354	287.1 – 421.8	148.5 – 696.o
Paramonohystera	209	162.3 – 255.3	68.3 – 493.8
Daptonema	173	136.3 – 208.6	37.0 – 375.2
Desmodora	118	53.6 – 181.5	11.4 – 579.3
Chromadorina	101	62.3 – 139.9	12.0 – 344.0
Camacolaimus	101	85.3 – 116.0	13.3 – 174.0
Metachromadora	90	42.0 – 138.0	9.8. – 455.4
Viscosia	79	63.4 – 93.6	24.7 – 160.0
Chromadora	74	52.1 – 95.6	6.0 – 189.2
Ptycholaimellus	74	52.0 – 95.2	2.5 – 195.2
Megadesmolaimus	67	51.8 – 81.7	12.3 – 144.8
Paracyatholaimus	56	42.1 – 70.6	8.6 – 149.0
Molgolaimus	50	31.7 – 68.3	0.0 – 148.8
Chromadorella	47	36.7 – 57.9	5.01 – 103.7
Synonchiella	40	28.7 – 45.1	0.0 – 76.2
Paracanthonchus	35	25.0 – 45.3	2.5 – 94.6
Oncholaimellus	34	24.8 – 43.4	3.0 – 98.9
Diodontolaimus	25	20.2 – 30.0	5.0 – 50.2
Comesa	24	8.2 – 39.8	0.0 – 130.4
Setosabatieria	24	1.3 – 46.5	0.0 – 186.4
Sabatieria	23	9.0 – 38.7	0.0 – 122.0
Thalassironus	23	16.3 – 29.0	0.0 – 61.0
Anticoma	21	6.0 – 56.0	6.0 – 56.0

Bathylaimus	19	8.6 – 28.5	0.0 – 78.4
Campylaimus	18	12.8 – 23.3	0.0 – 55.4
Southernia	16	8.5 – 22.5	0.0 – 73.8
Prochromadorella	15	10.1 – 19.5	0.0 – 41.4
Microlaimus	14	6.3 – 20.8	0.0 – 65.1
Eurystomina	13	8.9 – 17.6	0.0 – 33.4
Oxystomina	13	9.4 – 15.8	0.0 – 26.0
Sphaerolaimus	12	7.4 – 15.6	0.0 – 32.8
Paralinhomoeus	10	4.4 – 15.6	0.0 – 60.8
Paradesmodora	7	-0.1 – 13.0	0.0 – 54.3
Desmolaimus	6	-0.9 – 13.4	0.0 – 58.3
Metalinhomoeus	6	4.0 – 7.8	0.0 – 13.3
Hypodontolaimus	6	-0.2 – 11.8	0.0 – 12.3
Halalaimus	4	2.7 – 5.7	0.0 – 10.9
Odontanticoma	3	0.7 – 5.0	0.0 – 14.8
Nemanema	3	1.0 – 4.5	0.0 – 18.3
Dichocromadora	3	1.0 – 4.0	0.0 – 13.3
Monoposthia	2	0.5 – 4.0	0.0 – 10.7
Thoracostoma	2	0.5 – 3.3	0.0 – 11.4
Aponema	2	0.4 – 2.8	0.0 – 12.6
Descomoslex	1	-0.2 – 2.8	0.0 – 12.3
Aegioloalaimus	1	-0.2 – 2.5	0.0 – 10.9
Eleutherolaimus	1	0.2 –1.7	0.0 – 5.5
Wieseria	0.8	-0.12 – 1.8	0.0 – 7.9
Bathyeurystomina	0.7	-0.3 – 1.7	0.0 – 12.6
Calyptronema	0.7	-0.3 – 1.7	0.0 – 12.6
Aff Cervonema	0.5	-0.07 – 1.2	0.0 – 5.0
Belbolla	0.5	-0.07 – 1.2	0.0 – 4.9
Anticomopsis	0.3	-0.04 – 0.7	0.0 – 3.0
Polygastrophora	0.3	0.04 – 0.6	0.0 – 2.8

Table 5.4 –Nematoda genera not common to sampling stations A and B, all with lows density.

Nematoda genera station A	Nematoda genera station B
Acanthopharynx	***Aegioloalaimus***
Antomicron	***Anticomopsis***
Atrochromadora	***Bathyeurystomina***
Chromaspirina	***Belbolla***
aff Phanodermopsis	***Comesa***
Cyartonema	***Desmoscolex***
Leptolaimus	***Dichromadora***
Neochromadora	***Monoposthia***
Onchium	***Paradesmodora***
Parasphaerolaimus	***Polygastrophora***
Paroxystomina	***Setosabatieria***
Southerniella	***Thoracostoma***

Significant differences between station A and station B, concerning density temporal variations of the several Nematoda genera recorded, were detected by the Mann-Whitney test: *Terschellingia* (Z=-2.8; p<0.01**); *Spirinia* (Z=-6.4; p<0.001***); *Chromadorella* (Z=-3.3; p<0.001***); *Linhomoeus* (Z=-6.3; p<0.001***); *Daptonema* (Z=-3.6; p<0.001***); *Paramonohystera* (Z=-5.7; p<0.001***); *Desmodora* (Z=-6.6; p<0.001***); *Camacolaimus* (Z=-4.7; p<0.001***); *Ptycholaimellus* (Z=-3.4; p<0.001***); *Southernia* (Z=-2.5; p<0.01**); *Metachromadora* (Z=-4.1; p<0.001***); *Synonchiella* (Z=-3.7; p<0.001***); *Megadesmolaimus* (Z=-5.2; p<0.001***); *Molgolaimus* (Z=-2.3; p<0.05*); *Paracanthonchus* (Z=-3.6; p<0.001***); *Eurystomina* (Z=-2.3; p<0.05*); *Diodontolaimus* (Z=-5.3; p<0.001***); *Aponema* (Z=-2.3; p<0.05*); *Prochromadorella* (Z=-3.3; p<0.001***); *Eleutherolaimus* (Z=-2.0; p<0.05*); *Microlaimus* (Z=-3.0; p<0.01**); *Nemanema* (Z=-2.0; p<0.05*). However, no significant differences were detected between stations regarding *Paracomesoma*, *Odontophora*, *Chromadorina*, *Paracyatholaimus*, *Viscosia*, *Chromqdora*, *Oncholaimellus*, *Bathylaimus*, *Anticoma*, *Sphaerolaimus*, *Thalassironus*, *Metalinhomoeus*, *Campylaimus*, *Paralinhomoeus*, *Oxystomina*, *Odontanticoma*, *Halalaimus*, *Sabatieria*, *Cyartonema*, *Calyptronema*, *Desmolaimus*, *Wieseria* and aff *Cervonema*.

Several of the most abundant genera collected, such as *Terschellingia*, *Paracomesoma*, *Odontophora*, *Spirinia* and *Linhomoeus*, increased their densities between January and March.

Terschellingia had similar relative densities at both stations. The density decline was observed towards summer 95, decreasing to minimum densities. Both sampling summers registered very different densities: at station A, the highest values were obtained in August 94, November and in winter (January-February), followed by an even decrease until summer 95; at station B, densities rose in February and May, and an accentuated decrease occurred between February and April, with sharp decline being observed in summer 95 (Fig 5.2).

Spirinia had higher relative density at station B, (18%), than at (10 %) at station A. The density temporal patterns differed clearly between both stations, the highest values being observed in autumn and spring. At station A, the lowest values were observed in summer 94 and 95, and at station B in summer 94 and winter. However, density

increase was obtained in summer 95, with exactly the opposite trend to that at station A (Fig 5.3).

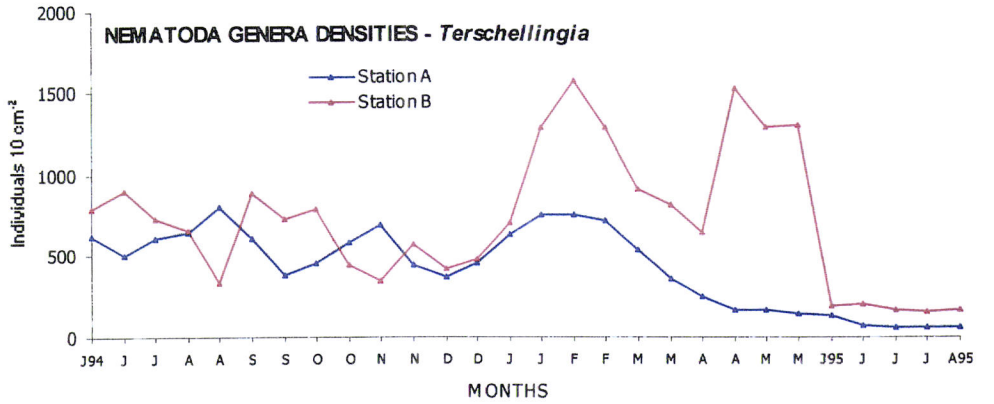


Figure 5.2 - Temporal variation of density (ind.per 10 cm^{-2}) of the Nematoda genus *Terschellingia*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

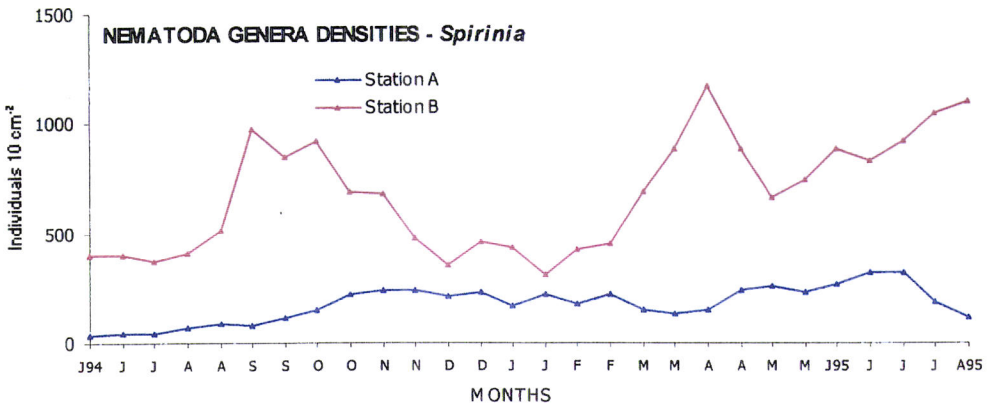


Figure 5.3 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Spirinia*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

Paracomesoma had a higher relative density at station A (17%), while at station B it registered 10%. The temporal pattern at both stations was very similar, the maximum density being attained in late winter and early spring, followed by a subsequent decline until summer 95. This resulted in the summer 94 and summer 95 densities also differing, with the lowest values in summer 95 (Fig 5.4).

Odontophora had higher relative density at station A. At both stations, the temporal patterns were very similar, the highest densities occurring in summer 94 and spring. In summer 95, the densities showed an accentuated decrease, such as that observed in *Terschellingia* and *Paracomesoma* populations. At station A, an important increase was registered in autumn (Fig 5.5).

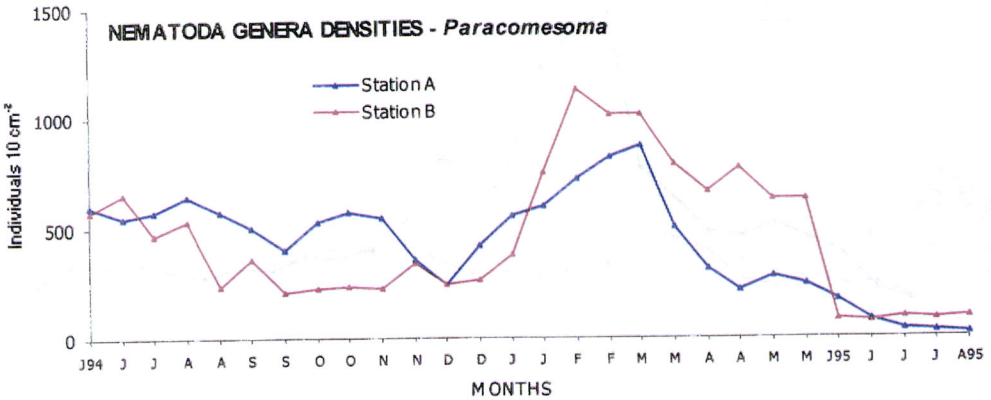


Figure 5.4 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Paracomesoma*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

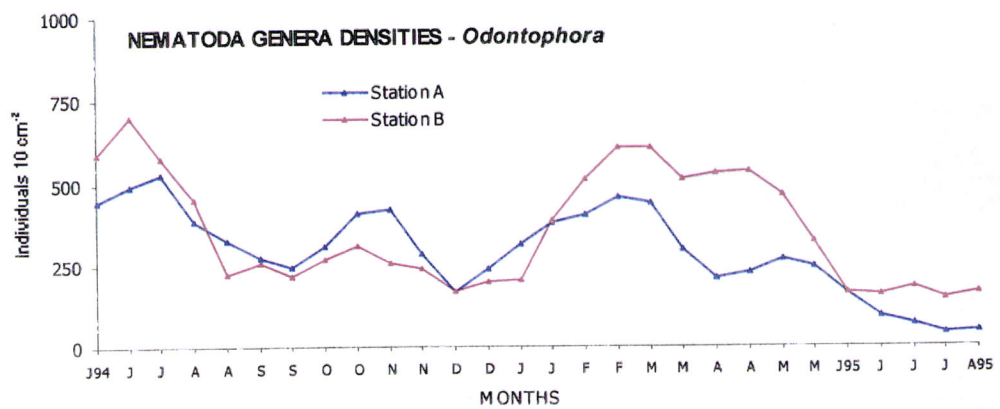


Figure 5.5 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Odontophora*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

Chromadorella duopapillata comprised 96% of the *Chromadorella* genus recorded. At station A, it was the fifth most abundant genus and recorded higher densities than at station B. The temporal patterns clearly differed between sampling stations: at station A, a sharp increase occurred in autumn, peaked in November followed by an accentuated decline towards summer 95, while at station B, an opposite trend was registered, with a slight increase in September and October followed by a decline in November. Both summers registered the lowest values (Fig 5.6).

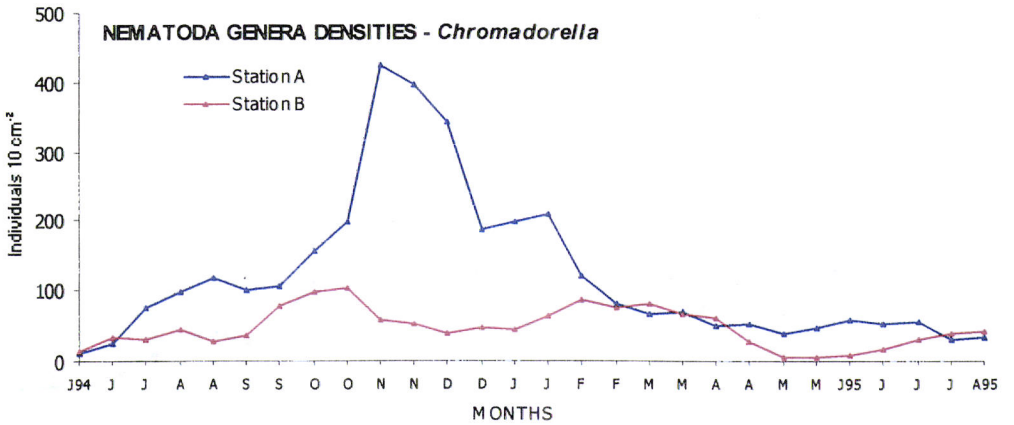


Figure 5.6 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda species *Chromadorella duopapillata*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

At both stations, *Linhomoeus* temporal patterns clearly differed. At station B, the density fluctuations were evident, with an increase in winter, followed by a high decline during spring, while at station A, the densities remained more constant, with a slight decrease in early summer 95 (Fig 5.7).

Paramonohystera had higher relative density at station B. At station A, the lowest values were observed in summer 94, while station B in this period attained maxima densities. At both stations in October and early winter an increase was observed. However, at station A from January until August 95, the densities remained constant, though at station B, strong fluctuations and an increase in late spring were observed (Fig 5.8).

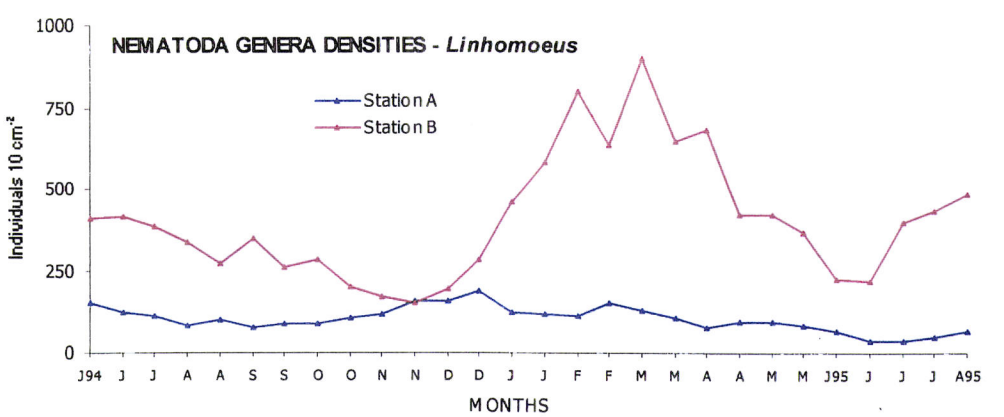


Figure 5.7 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Linhomoeus*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

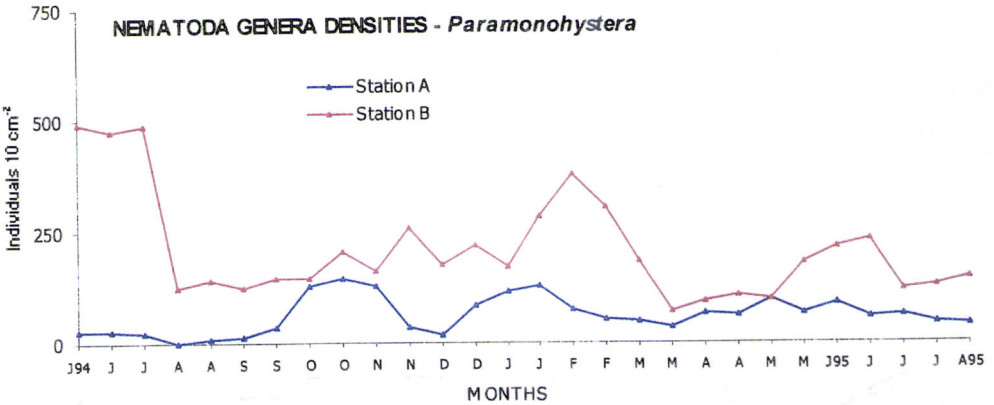


Figure 5.8 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Paramonohystera*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

Daptonema was the seventh genus with high relative densities (4%) at both stations. Temporal patterns differ between stations. At station A, the densities decreased from summer 94 until early autumn (October), while at station B an opposite trend was observed: after a decrease in summer 94, it peaked in October. In winter, both stations presented similar patterns, although, in spring, once again they showed an opposite trend (Fig 5.9).

At station B, *Desmodora* was an important group being registered higher relative density, although at station A it registered a very low density. At station B, densities peaked in early summer 94, tapering off towards August 94, while slight increases were observed in September, October, later winter and early summer 95 (Fig 5.10).

Chromadorina germanica represented 92% of *Chromadorina* genus collected at station A and 96% at station B. At both stations, the temporal patterns of this species were very similar, the highest densities being attained in autumn and winter, followed by a subsequent decline. The lowest values were obtained in summer 94 and summer 95 (Fig 5.11).

Camacolaimus temporal patterns differed between stations. Indeed opposite trends were observed in autumn, early winter, spring and summer 95. At station A, in October a density increase was registered, the maximum being reached in January. However, at station B, densities declined until February. At station A, in early spring, the densities declined, while at station B was registered an increase, followed by a strong

decrease in April and May. In summer 95, once more both stations showed an opposite trend, at station A decreased densities and at station B increased (Fig 5.12).

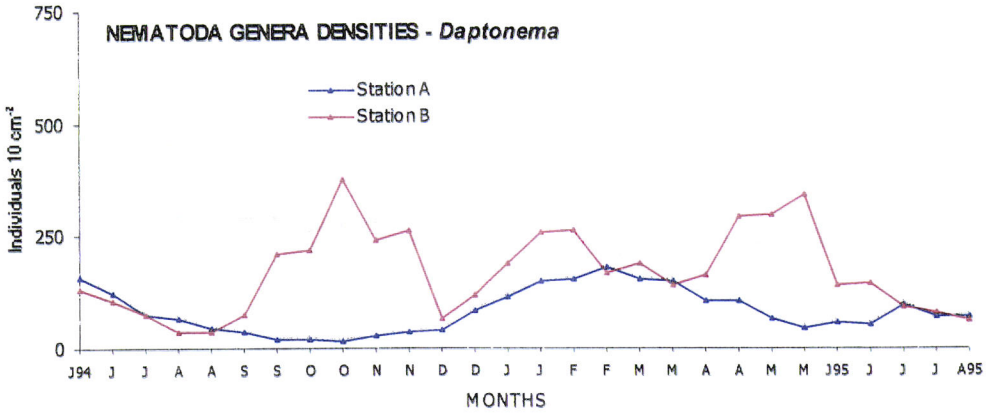


Figure 5.9 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Daptonema*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

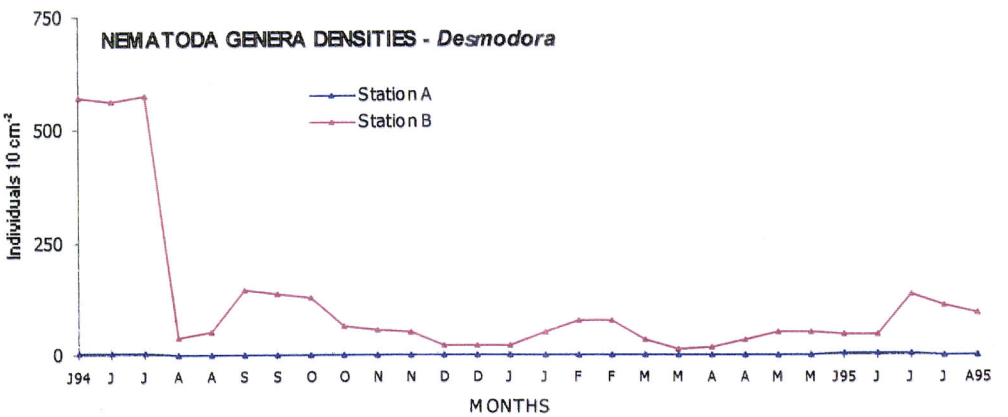


Figure 5.10 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Desmodora*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

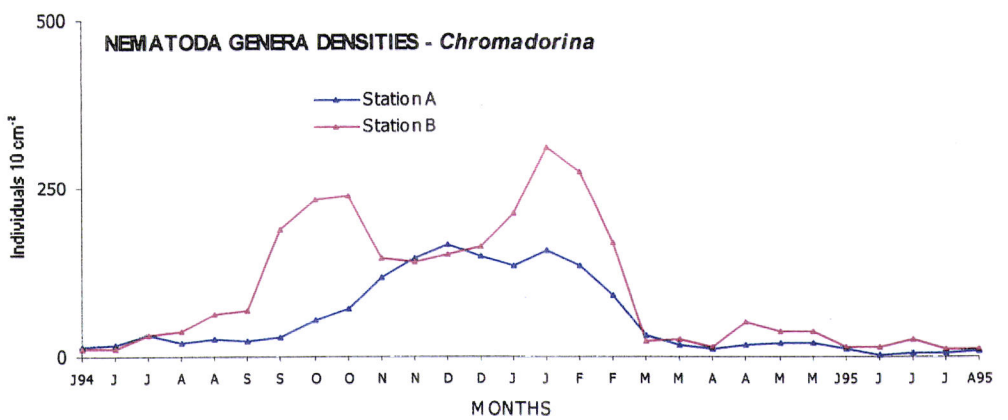


Figure 5.11 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda species *Chromadorina germanica*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

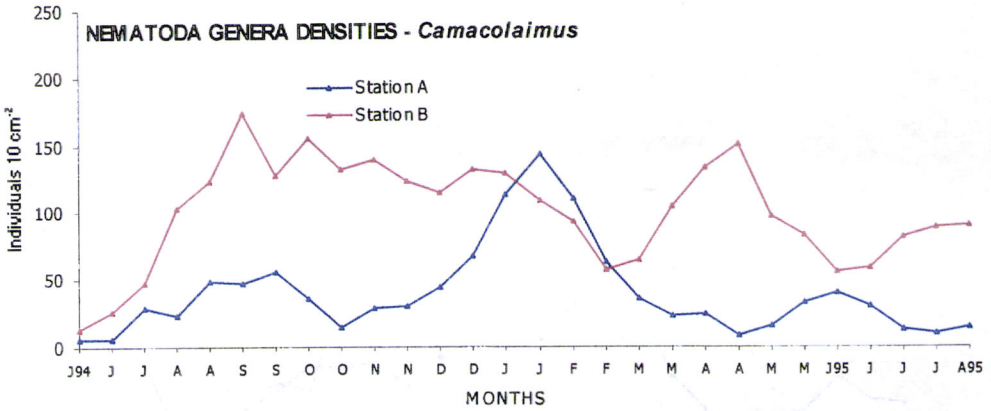


Figure 5.12 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Camacolaimus*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

At both stations, *Viscosia* temporal patterns were very similar, the highest densities being observed in summer 95, after a strong increase in late spring. Densities increased in early autumn, but in November declined until early spring. However, at station B, in late winter, a rise was observed (Fig 5.13).

Chromadora nudicapitata represented 76% of *Chromadora* collected at both stations. At both stations, temporal patterns of this species were very similar, the densities increasing in autumn and the maximum values being attained in winter, followed by a subsequently decline. However, at station B a slight increase in early spring was registered, and at station A in summer 95 (Fig 5.14).

Ptycholaimellus temporal patterns showed opposite trends in both summers. Nevertheless, at both stations, the highest densities were obtained in winter and spring, followed by a strong decline in April (at station B) and in May (at station A) (Fig 5.15).

At both stations, *Oncholaimellus* temporal patterns registered an opposite trend in autumn and winter. At station A, the densities peaked in November, while at station B they declined. In spring, some differences were also registered: at station B the densities declined, though at station A they were constant (Fig 5.16).

Metachromadora was represented by *Metachromadora remanei* species, at both stations. At station B, June 94 and July 94 density values were highest, followed by a deep decline, whereas station A presented lower densities. In winter, both stations had

increased densities, followed by a subsequent decline. However, at station A, in May, there was a complete disappearance of this species (Fig 5.17).

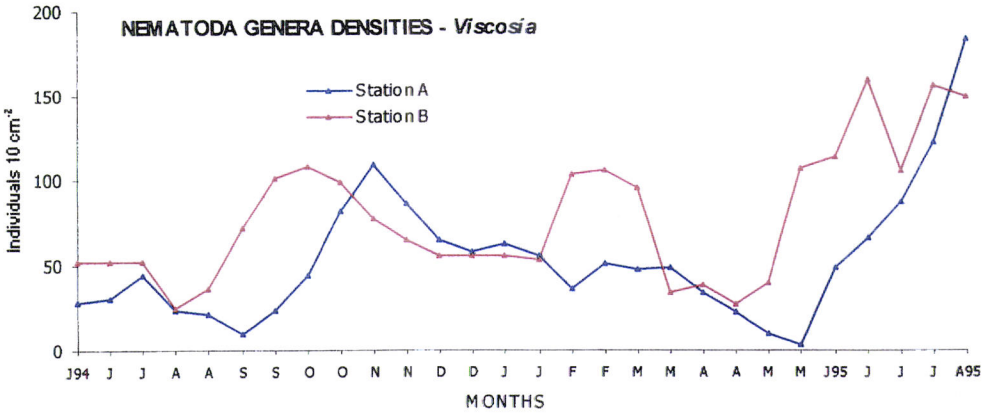


Figure 5.13 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Viscosia*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

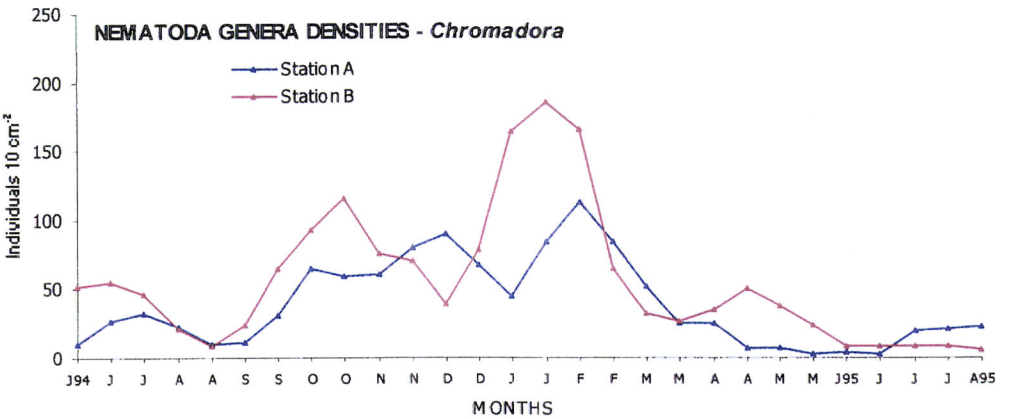


Figure 5.14 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda species *Chromadora nudicapitata*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

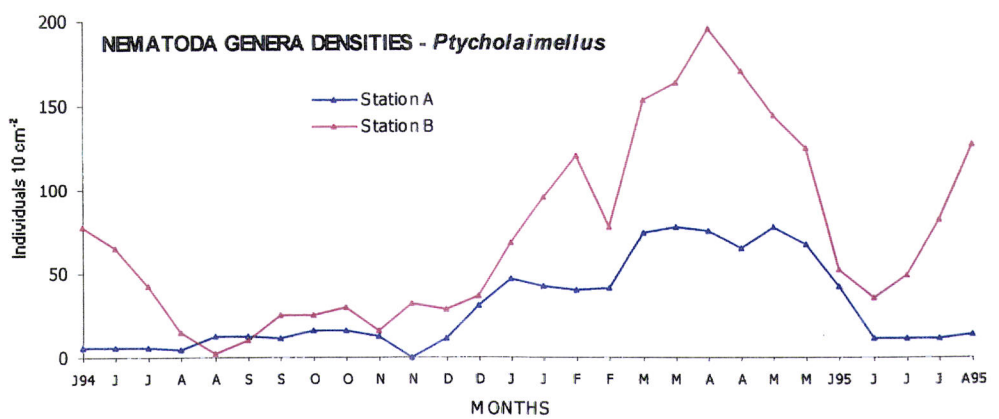


Figure 5.15 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Ptycholaimellus*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

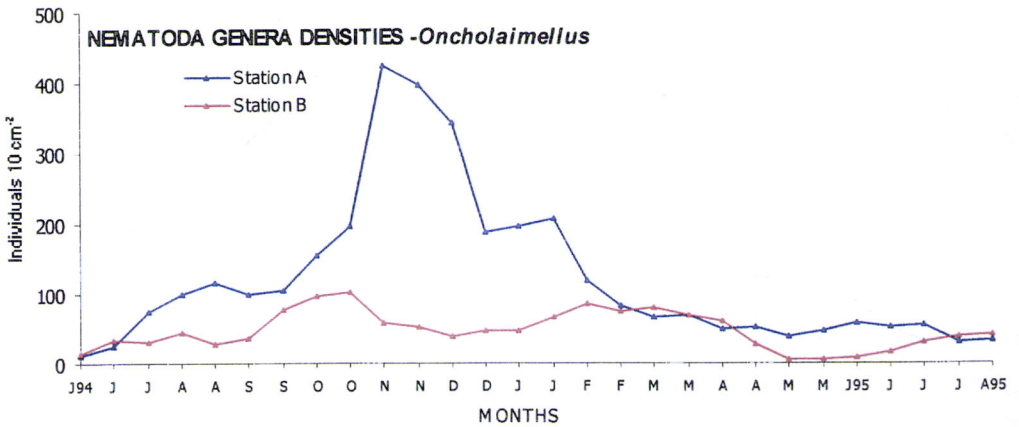


Figure 5.16 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Oncholaimellus*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

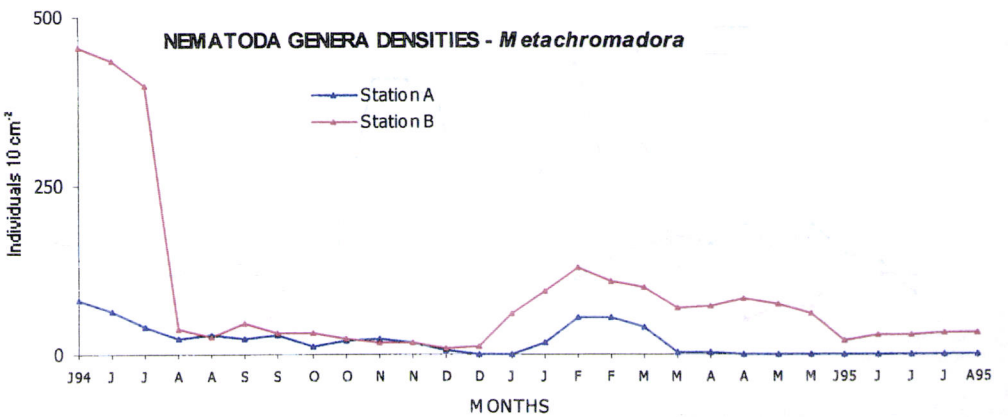


Figure 5.17- Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda species *Metachromadora remanei*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

At both stations, *Megadesmolaimus* temporal patterns were very similar in autumn, winter and spring, while both sampling summers showed an opposite trend: at station A, increased densities in summer 94, at station B, decreased. However, in summer 95, at station A, densities decreased, while at station B they increased (Fig 5.18).

Southernia was more abundant at station A. Density temporal patterns at both stations were very different, and almost the entire sampling period presented opposite trends. At station A, in autumn, lower values were observed, while at station B, it was the opposite. At station A, highest densities were reached in winter, followed by a sharp decline, in contrast to station B, where they disappeared in spring and then increased slightly (Fig 5.19).

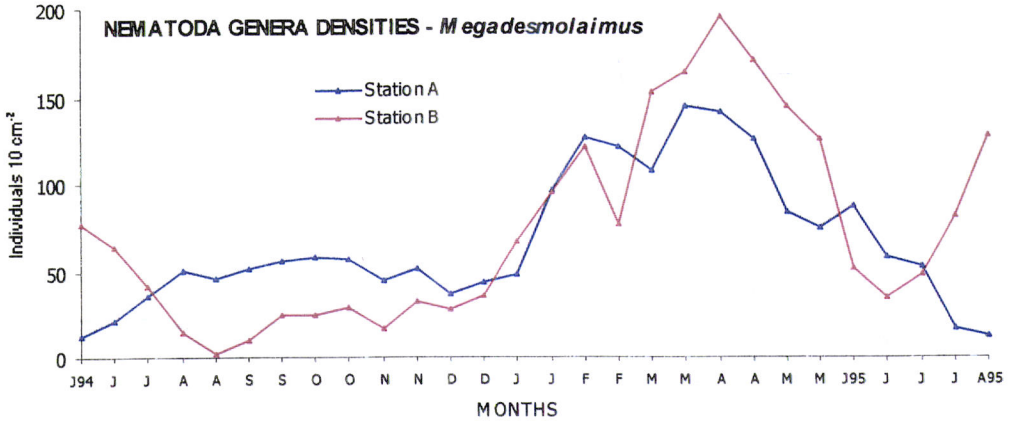


Figure 5.18 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Megadesmolaimus*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

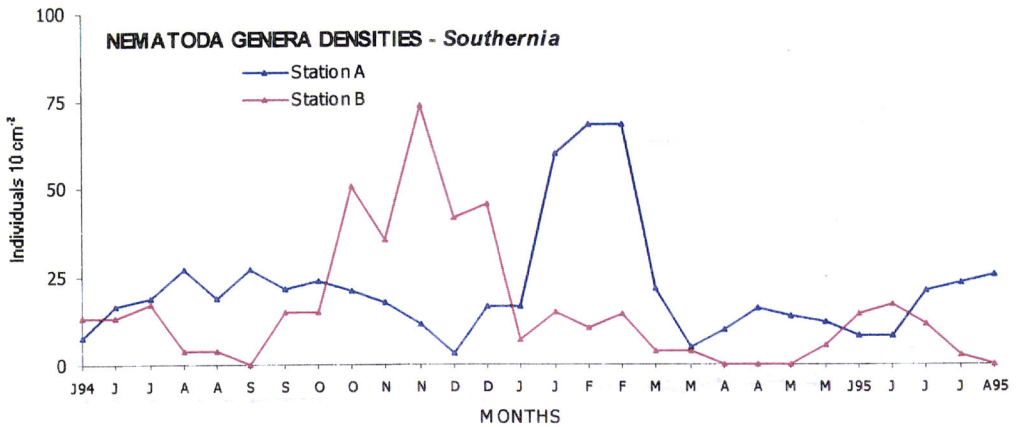


Figure 5.19 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Southernia* from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

The temporal pattern densities of the *Molgolaimus* differ clearly between stations. At station B, the highest densities were registered in June 94 and July 94, and the species disappeared in early autumn. In summer 94, at station A, the densities were lower, and after a slight increase also declined until they disappeared. At both stations, densities increased in late autumn and winter. However, in spring, at station A, densities decreased continuously until summer 95, whereas at station B, an increase was observed before the decline until summer 95 (Fig 5.20).

The other 50 Nematoda genera collected represented lowest densities (<0.1%), their temporal distribution are described in *annex III*.

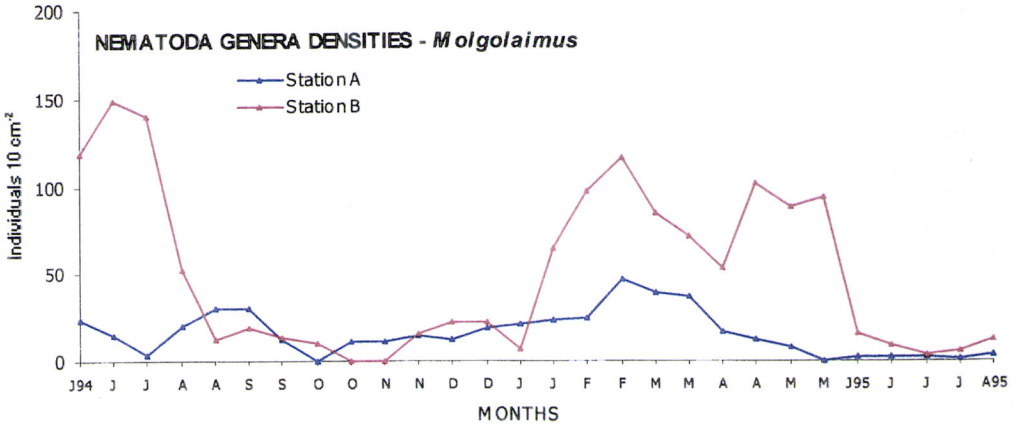


Figure 5.20 - Temporal variation of density (ind. per 10 cm^{-2}) of the Nematoda genus *Molgolaimus*, from June 1994 to August 1995, at station A and station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

b) Temporal variation of the vertical densities of the Nematoda genera

The temporal and vertical distribution of Nematoda genera were studied in three depth sediment layers: level 1 (0-3 cm), level 2 (3-6 cm) and level 3 (6-10 cm). As expected, the vertical distribution of the several genera collected comprised the highest densities in the surface sediment layer (0-3 cm depth), and the lowest in the lowest sediment layer (6-10 cm depth) (Fig 5.21). There was an evident contrast between the Nematoda genera densities of the upper and deep layers: at station A, 83.3%, and at station B, 81.6% of the total Nematoda genera densities occurred in the surface sediment layer. A clear density reduction was observed in the lowest sediment layers (3-10 cm): at 3-6 cm depth, 10.2% (station A) and 10.9% (station B); at 6-10 cm depth 6.5% (station A) and 7.5 % (station B).

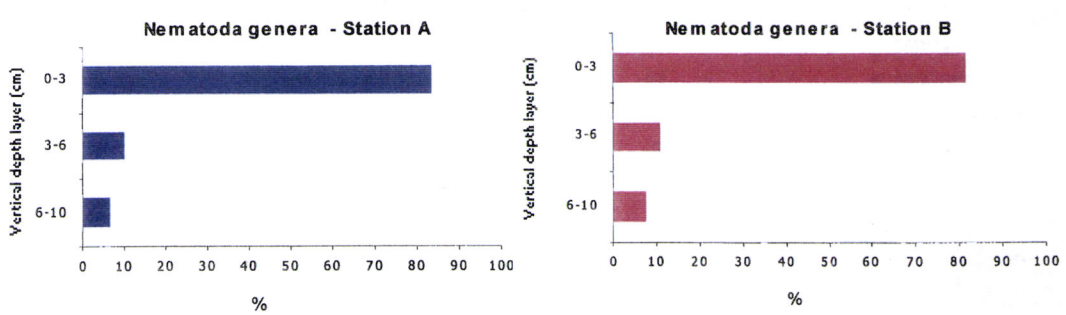


Figure 5.21 – Vertical profile distribution of the percentage of the Nematoda taxon, at the three depths at stations A and B.

Data relating to the vertical temporal variation of Nematoda genera densities in sediment are reported in tables 5.5, 5.6, 5.7, 5.8, 5.9 and 5.10. At both stations *Terschellingia*, *Paracomesoma*, *Odontophora* and *Spirinia* were dominant genera in the three depth sediment levels. At station A, *Paramonohystera* in the intermediate sediment layer and *Viscosia* in the lowermost sediment layer became predominant genera. At station B, in the lowermost sediment layers (3-10 cm depth) *Linhomoeus*, *Paramonohystera* and *Camacolaimus* were also dominant genera (Fig. 5.22 and Fig. 5.23).

Table 5.5 - Statistical parameters (95% confidence interval for mean) of the vertical distribution of the Nematoda genera densities at level 1(0-3 cm depth) at station A. Units are ind. per 10 cm^{-2}.

Nematoda	Mean	95% Confidence interval for mean	Minimum - Maximum
Terschellingia	396	304.9 – 486.3	31.2 – 773.6
Paracomesoma	381	304.5 – 457.2	16.3 – 620.1
Odontophora	267	215.3 – 317.7	41.6 – 500.6
Spirinia	158	129.3 – 187.3	25.0 – 277.7
Chromadorella	81	49.0 – 113.1	0.0 – 320.5
Daptonema	78	59.0 – 96.4	14.0 – 185.3
Linhomoeus	67	53.4 – 80.3	15.6 – 138.6
Paracyatholaimus	44	28.9 – 59.7	0.0 – 155.2
Viscosia	42	30.3 – 53.9	4.7– 154.0
Chromadora	42	26.5 – 57.3	2.6 – 144.3
Chromadorina	39	19.4 – 58.4	0.0 – 146.9
Ptycholaimellus	21	12.9 – 28.3	0.0 – 69.2
Bathylaimus	20	12.0 –28.3	0.0 – 76.6
Sphaerolaimus	20	8.0 – 31.0	0.0 –114.8
Metachromadora	19	11.0 – 26.8	0.0 – 72.2
Oncholaimellus	14	10.0 – 19.0	0.0 – 42.3
Metalinhomoeus	14	4.0 – 23.1	0.0 – 94.0
Molgolaimus	11	6.4 – 16.2	0.0 – 42.8
Campylaimus	11	6.2 – 15.1	0.0 – 38.8
Anticoma	10	5.3 – 15.2	0.0 – 51.9
Camacolaimus	10	3.9 – 16.0	0.0 – 53.4
Megadesmolaimus	8	5.8 – 10.6	0.0 – 17.6
Synonchiella	8	4.6 – 11.0	0.0 – 28.6
Southernia	8	4.3 – 11.2	0.0 – 28.6
Oxystomina	7	7.6 – 10.5	0.0 – 19.4
Paralinhomoeus	7	4.8 – 9.7	0.0 – 27.2
Thalassironus	6	4.6 – 9.5	0.0 – 19.7
Prochromadorella	6	2.7 – 9.3	0.0 – 23.2
Odontanticoma	5	0.8 – 11.2	0.0 – 47.2
Calyptoronema	5	-0.8 – 11.8	0.0 – 51.6

Diodontolaimus	5	2.1 – 8.5	0.0 – 28.5
Paramonohystera	5	1.5 – 9.0	0.0 – 35.0
Cyartonema	5	0.7 – 10.4	0.0 – 45.2
Aponema	4	2.9 – 6.7	0.0 – 16.4
Halalaimus	3	2.4 – 5.6	0.0 – 9.8
Eurystomina	3	1.7 – 8.5	0.0 – 12.8
Paracanthonchus	2	1.2 – 4.5	0.0 – 11.2
Microlaimus	2	0.7 – 4.7	0.0 – 18.5
Leptolaimus	2	0.4 –4.2	0.0 – 17.1
Southerniella	2	-0.3 –4.5	0.0 – 19.6
Sabatieria	2	0.4 – 2.9	0.0 – 8.1
Eleutherolaimus	2	-0.2 –3.5	0.0 – 15.3
Desmolaimus	1	-0.2 –2.7	0.0 – 18.1
Onchium	1	-0.2 – 2.6	0.0 – 18.1
Parasphaerolaimus	1	-0.2 – 2.3	0.0 – 9.9
Neochromadora	1	0.1 – 1.9	0.0 – 9.0
Aff Phanodermopsis	1	-0.03 – 2.0	0.0 – 9.3
Chromaspirina	1	0.09 – 1.5	0.0 – 8.9
Nemanema	0.9	0.2 – 1.6	0.0 – 4.7
Aff Cervonema	0.7	-0.01 – 1.5	0.0 – 6.5
Atrochromadora	0.5	-0.24 – 1.21	0.0 – 9.0
Desmodora	0.5	-0.04 - 0.59	0.0 – 2.6
Wieseria	0.5	-0.02 – 0.3	0.0 – 2.6

Table 5.6- Statistical parameters (95% confidence interval for mean) of the vertical distribution of the Nematoda genera densities at level 2 (3-6 cm depth) at station A. Units are ind. per 10 cm^{-2}.

Nematoda	Mean	95% Confidence interval for mean	Minimum - Maximum
Paracomesoma	39	21.7 – 56.4	1.9 –164.2
Terschellingia	31	25.0 – 36.0	6.8 – 61.3
Odontophora	24	18.1 – 28.8	3.9 – 59.1
Spirinia	18	11.4 – 23.9	3.5 – 63.7
Linhomoeus	17	13.0 – 20.3	4.7 – 37.9
Chromadorella	14	10.3 – 17.0	2.0 – 34.4
Paramonohystera	10	7.4 – 13.0	0.0 – 24.2
Camacolaimus	8	5.3 – 11.0	0.8 – 26.0
Daptonema	8	5.2 – 9.9	0.0 – 20.0
Chromadorina	7	4.8 – 9.3	0.0 – 19.0
Synonchiella	5	0.6 – 9.5	0.0 – 56.9
Thalassironus	4	2.3 – 5.9	0.0 – 14.3
Ptycholaimellus	4	1.8 – 5.8	0.0 – 17.7
Paracyatholaimus	4	1.8 – 5.8	0.0 – 18.2
Viscosia	4	2.0 – 5.0	0.0 – 11.7
Oncholaimellus	4	2.3 – 4.6	0.0 – 11.7
Paracanthonchus	3	1.6 – 5.1	0.0 – 13.8
Anticoma	3	1.3 – 5.4	0.0 – 20.7

Chromadora	3	1.9 –3.8	0.0 – 8.0
Southernia	3	1.6 – 3.5	0.0 – 8.7
Megadesmolaimus	2	0.7 – 3.5	0.0 – 13.3
Bathylaimus	2	1.0 – 2.6	0.0 – 6.7
Paralinhomoeus	2	0.5 – 2.8	0.0 – 1.6
Metachromadora	2	0.5 – 2.6	0.0 – 11.4
Molgolaimus	1	0.8 – 2.0	0.0 – 5.7
Oxystomina	1	0.5 – 1.77	0.0 – 4.9
Sphaerolaimus	1	0.1 – 2.0	0.0 – 11.4
Diodontolaimus	1	0.5 – 1.4	0.0 – 3.6
Campylaimus	1	0.3 – 1.5	0.0 – 5.5
Aponema	0.9	0.1 – 1.6	0.0 – 6.1
Sabatieria	0.8	0.5 – 1.2	0.0 – 2.5
Halalaimus	0.8	0.3 – 1.3	0.0 – 5.7
Eurystomina	0.7	0.3 – 1.1	0.0 – 2.9
Metalinhomoeus	0.5	0.1 – 0.78	0.0 – 2.6
Odontanticoma	0.4	-0.03 – 0.7	0.0 – 3.5
Southerniella	0.3	-0.3 – 0.6	0.0 – 2.7
Acanthopharynx	0.3	0.01 – 0.54	0.0 – 2.4
Eleutherolaimus	0.3	0.05 – 0.4	0.0 – 1.4
Prochromadorella	0.2	-0.02 – 0.3	0.0 – 1.5
Neochromadora	0.2	-0.2 – 0.3	0.0 – 1.3
Antomicron	0.1	-1.5 – 0.2	0.0 – 1.0
Desmodora	0.1	-0.02 – 0.2	0.0 – 1.0
Microlaimus	0.07	-0.01 – 0.2	0.0 – 0.67

Table 5.7- Statistical parameters (95% confidence interval for mean) of the vertical distribution of the Nematoda genera densities at level 3 (6-10 cm depth) at station A. Units are ind. per 10 cm^{-2}.

Nematoda	Mean	95% Confidence interval for mean	Minimum - Maximum
Odontophora	19	11.5 – 27.0	1.5 –84.3
Paracomesoma	19	13.3 – 24.5	0.0 – 61.1
Terschellingia	18	13.7 – 22.7	2.7 –45.9
Spirinia	11	5.0 – 16.0	0.0 –52.5
Viscosia	12	5.4 – 15.0	0.0 –36.4
Paramonohystera	10	5.6 – 14.2	0.0 –41.7
Chromadorella	9	6.0 – 11.9	0.0 – 24.2
Paracyatholaimus	7	3.2 – 10.0	0.0 –29.6
Linhomoeus	7	4.1 – 8.2	0.0 – 17.0
Daptonema	5	2.1 – 7.3	0.0 – 22.7
Camacolaimus	4	2.4 – 5.0	0.0 – 11.7
Paracanthonchus	4	0.2 – 6.8	0.0 – 27.5
Chromadora	4	1.5 – 5.4	0.0 – 15.0
Oncholaimellus	3	1.4 – 4.2	0.0 – 13.0
Chromadorina	3	1.7 – 3.4	0.0 – 7.6
Southernia	2	1.3 – 3.0	0.0 – 8.8

Anticoma	2	1.1 – 2.6	0.0 – 5.7
Metachromadora	2	0.4 – 3.1	0.0 – 11.0
Megadesmolaimus	2	0.3 – 3.1	0.0 – 14.0
Bathylaimus	2	0.3 – 3.1	0.0 – 13.0
Ptycholaimellus	2	0.9 – 2.3	0.0 – 5.2
Campylaimus	1	-0.2 – 2.5	0.0 – 10.9
Molgolaimus	0.8	0.4 – 1.2	0.0 – 2.8
Eleutherolaimus	0.6	0.1 –1.0	0.0 – 3.3
Thalassironus	0.5	0.2 – 0.8	0.0 – 2.7
Synonchiella	0.5	0.2 – 0.8	0.0 – 2.3
Halalaimus	0.4	0.1 – 0.8	0.0 – 2.0
Wieseria	0.2	-0.3 – 0.4	0.0 – 1.9
Oxystomina	0.2	0.4 – 0.3	0.0 – 1.0
Paroxystomina	0.1	-0.6 – 0.3	0.0 – 2.5
Neochromadora	0.1	-0.6 – 0.3	0.0 – 2.5
Diodontolaimus	0.09	-1.3 – 0.2	0.0 – 0.9
Sphaerolaimus	0.09	-0.01 – 0.2	0.0 – 0.86
Eurystomina	0.05	-0.7 – 0.1	0.0 – 0.48
Sabatieria	0.02	-0.003 – 0.03	0.0 – 0.17

Table 5.8 - Statistical parameters (95% confidence interval for mean) of the vertical distribution of the Nematoda genera densities at level 1(0-3 cm depth) at station B. Units are ind. per 10 cm^{-2}.

Nematoda	Mean	95% Confidence interval for mean	Minimum - Maximum
Terschellingia	770	574.0 – 965.4 -	119.2 – 1654.0
Spirinia	633	545.8 – 720.0	256 – 1134.5
Paracomesoma	424	304.6 – 544.3	57.6 – 1148.8
Odontophora	340	261.5 – 417.3	139.5 – 777.0
Linhomoeus	264	198.2 – 329.4	77.2 – 735.6
Daptonema	154	117.6 – 190.2	18.4 – 324.6
Chromadorina	89	48.2 –129.6	0.0 – 358.5
Metachromadora	74	44.5 – 104.0	9 – 234.5
Viscosia	71	55.9 – 86.0	13.3 – 159.3
Chromadora	70	35.8 – 103.8	0.0 – 300.5
Ptycholaimellus	70	41.8 – 97.5	0.0 – 224
Desmodora	61	24.7 – 96.3	0.0 – 284.1
Molgolaimus	59	34.8 –82.3	0.0 – 180.7
Paramonohystera	57	36.0 – 78.4	5.5 – 227.0
Paracanthonchus	50	32.6 – 68.2	0.0 – 169.6
Chromadorella	42	30.5 – 52.4	0.0 – 85.7
Paracyatholaimus	40	29.2 – 50.5	0.0 – 95.8
Oncholaimellus	35	23.7 – 46.6	0.0 – 103.8
Camacolaimus	26	18.7 – 33.9	0.0 – 63.5
Megadesmolaimus	26	17.6 – 34.3	0.0 – 79.3
Synonchiella	22	16.8 – 27.8	0.0 – 44.7
Setosabatieria	18	3.5 – 31.9	0.0 – 108.0

Campylaimus	18	9.4 – 25.7	0.0 – 81.6
Anticoma	17	11.5 – 22.5	0.0 – 48.9
Bathylaimus	17	8.5 – 24.6	0.0 – 67.9
Microlaimus	15	5.2 – 23.9	0.0 – 83.3
Thalassironus	14	7.4 – 19.6	0.0 – 66.7
Sphaerolaimus	13	4.5 – 21.3	0.0 – 78.2
Diodontolaimus	13	9.1 –16.1	0.0 – 33.2
Paralinhomoeus	13	6.0 – 18.5	0.0 – 66.8
Paradesmodora	11	-0.5 – 22.6	0.0 – 95.2
Prochromadorella	11	6.6 – 15.2	0.0 – 39.6
Oxystomina	9	6.6 – 11.7	0.0 – 19.0
Eurystomina	7	2.4 – 12.3	0.0 – 47.0
Comesa	7	2.4 – 11.8	0.0 – 42.7
Hypodontolaimus	6	-0.9 – 13.0	0.0 – 57.1
Odontanticoma	3	0.8 – 6.0	0.0 – 16.6
Nemanema	3	0.8 – 5.7	0.0 – 27.3
Halalaimus	3	0.8 – 5.0	0.0 – 16.3
Southernia	3	-0.04 – 5.2	0.0 – 21.6
Aegioloalaimus	2	-2.0 –4.4	0.0 – 19.0
Descomolex	0.9	-0.1 –1.9	0.0 – 8.4
Dichromadora	0.9	-0.1 – 1.9	0.0 – 8.4
Sabatieria	0.8	-0.1- 1.8	0.0 – 7.6
Aponema	0.8	-0.1 – 1.7	0.0– 7.6
Belbolla	0.6	-0.08 – 1.3	0.0 – 5.5
Metalinhomoeus	0.2	-0.03 – 0.4	0.0 –1.8

Table 5.9 - Statistical parameters (95% confidence interval for mean) of the vertical distribution of the Nematoda genera densities at level 2 (3-6 cm depth) at station B. Units are ind. per 10 cm^{-2}.

Nematoda	Mean	95% Confidence interval for mean	Minimum - Maximum
Spirinia	88	56.8 – 119.0	6 – 394.0
Linhomoeus	57	49.6 – 63.9	23.8 – 81.7
Terschellingia	55	43.2 – 67.2	11.0 – 110.0
Paramonohystera	36	27.8 – 44.0	6.9 – 87.4
Odontophora	34	28.5 – 40.0	10 – 74.6
Paracomesoma	32	23.6 – 39.4	7.3 – 90.6
Camacolaimus	19	13.5 – 24.1	0.00 – 59.0
Daptonema	17	11.6 – 21.9	4.3 – 57.6
Desmodora	16	7.9 – 24.6	0.0 – 74.7
Chromadorina	14	7.4 – 21.3	0.0 - 58.4
Megadesmolaimus	13	11.0 – 15.5	2.1 – 28.2
Sabatieria	9	3.5 – 14.0	0.0 – 36.2
Metachromadora	9	2.0 – 15.3	0.0 – 57.2
Viscosia	9	5.3 – 12.0	0.0 – 31.9
Synonchiella	7	4.5 – 9.7	0.0 – 24.3
Chromadorella	7	4.4 – 9.1	0.0 – 21.8
Ptycholaimellus	14	4.3 – 9.0	0.0 – 58.4

Chromadora	7	4.4 – 9.0	0.0 – 17.0
Paracyatholaimus	6	3.8 – 8.0	0.0 – 16.6
Southernia	6	2.3 – 8.8	0.0 – 29.0
Thalassironus	4	2.1 – 5.0	0.0 – 11.2
Anticoma	3	1.3 – 5.3	0.0 – 16.7
Oncholaimellus	3	2.0 – 4.2	0.0 – 10.7
Diodontolaimus	3	1.9 – 3.7	0.0 – 8.1
Setosabatieria	2	-0.3 – 5.2	0.0 – 22.5
Eurystomina	2	1.3 –3.5	0.0 – 6.8
Prochromadorella	2	0.8 –3.5	0.0 – 10.0
Comesa vitae	2	0.7 – 3.4	0.0 – 10.1
Oxystomina	2	1.0 – 3.0	0.0 – 10.1
Molgolaimus	2	1.1 – 2.8	0.0 – 5.9
Metalinhomoeus	2	1.0 –2.1	0.0 – 4.2
Paracanthonchus	1	0.6 – 2.2	0.0 – 5.9
Microlaimus	1	0.6 – 1.9	0.0 – 6.9
Campylaimus	1	0.6 – 1.7	0.0 – 4.1
Bathylaimus	1	0.6 – 1.8	0.0 – 4.2
Thoracostoma	0.7	0.2 – 1.2	0.0 – 3.4
Sphaerolaimus	0.5	0.04 – 1.0	0.0 – 4.6
Dichromadora	0.4	-0.06 – 0.9	0.0 – 3.7
Halalaimus	0.2	0.05 – 0.4	0.0 – 1.3
Nemanema	0.2	0.03 – 0.4	0.0 – 1.8
Aponema	0.2	-0.03 – 0.4	0.0 – 1.8
Paralinhomeus	0.1	0.02 – 0.3	0.0 – 1.1
Bathyeurystomina	0.1	-0.06 – 0.3	0.0 – 2.1
Desmoscolex	0.09	-0.01 – 0.2	0.0 – 0.8

Table 5.10 - Statistical parameters (95% confidence interval for mean) of the vertical distribution of the Nematoda genera densities at level 3 (6-10 cm depth) at station B. Units are ind. per 10 cm^{-2}.

Nematoda	Mean	95% Confidence interval for mean	Minimum - Maximum
Linhomoeus	45	26.5 – 62.5	12.4 – 176.6
Spirinia	44	31.0 – 56.2	5.0 – 115.2
Terschellingia	35	19.6 – 49.6	10.0 – 143.4
Paracomesoma	31	11.3 – 49.9	1.0 – 181.3
Paramonohystera	30	14.9 – 44.4	4.1 – 149.8
Odontophora	18	13.4 – 23.1	1.6 – 53.2
Camacolaimus	17	13.0 – 21.4	1.0 – 39.4
Daptonema	14	7.7 – 22.0	1.7 – 66.3
Desmolaimus	12	-1.6 – 24.5	0.0 – 107.0
Viscosia	10	4.2 – 15.3	0.0 – 52.6
Desmodora	8	4.0 – 12.4	0.0 – 28.2
Ptycholaimellus	8	2.8 – 12.2	0.0 – 55.0

Megadesmolaimus	6	4.1 – 8.2	0.0 – 16.0
Chromadorina	6	2.4 – 5.0	0.0 – 22.7
Paracyatholaimus	5	3.3 – 7.1	0.0 – 14.7
Oncholaimellus	5	1.9 – 7.7	0.0 – 25.3
Paracanthonchus	5	1.1 – 8.3	0.0 – 29.3
Chromadora	4	2.4 – 5.0	0.0 – 13.5
Synonchiella	4	2.5 – 5.9	0.0 – 14.8
Anticoma	3	0.8 – 6.0	0.0 – 22.5
Metachromadora	3	1.8 – 4.5	0.0 – 10.3
Chromadorella	3	1.6 – 4.3	0.0 – 13.2
Comesa	3	-0.4 – 6.0	0.0 – 24.6
Thalassironus	3	1.3 – 3.7	0.0 – 9.8
Diodontolaimus	2	1.6 – 2.9	0.0 – 6.5
Campylaimus	2	0.6 – 3.4	0.0 – 11.6
Sabatieria	2	0.2 – 3.1	0.0 – 13.8
Eurystomina	2	0.2 – 3.0	0.0 – 11.6
Molgolaimus	1	0.7 – 2.0	0.0 – 6.0
Halalaimus	1	-0.08 – 2.7	0.0 – 11.6
Bathylaimus	1	0.4 – 2.1	0.0 – 6.1
Sphaerolaimus	1	0.06 – 2.5	0.0 – 9.9
Wieseria	1	-0.2 – 2.8	0.0 – 11.6
Dichromadora	1	-1.4 – 2.4	0.0 – 9.9
Paralinhomeus	1	0.2 – 2.0	0.0 – 8.1
Southernia	1	0.4 – 1.5	0.0 – 5.7
Metalinhomoeus	0.6	-0.08 – 1.3	0.0 – 5.6
Anticomopsis	0.6	-0.08 – 1.3	0.0 – 5.6
Polygastrophora	0.5	-0.07 –1.1	0.0 – 5.0
Thoracostoma	0.5	-0.07 – 1.1	0.0 – 5.0
Oxystomina	0.5	0.06 – 0.8	0.0 – 3.0
Prochromadorella	0.4	0.1 – 0.7	0.0 – 2.0
Eleutherolaimus	0.4	0.04 – 0.7	0.0 –2.7
Monoposthia	0.3	0.08 –.0.6	0.0 –1.7
Setosabatieria	0.3	-0.05 – 0.7	0.0 –3.0
Hypodontolaimus	0.3	-0.04 – 0.7	0.0 – 3.0
Aff Cervonema	0.2	-0.03 – 0.4	0.0 – 2.0
Calyptoronema	0.2	-0.08 – 0.4	0.0 – 3.0
Aponema	0.2	-0.08 – 0.4	0.0 – 3.0
Microlaimus	0.08	-0.01 – 0.2	0.0 – 0.78

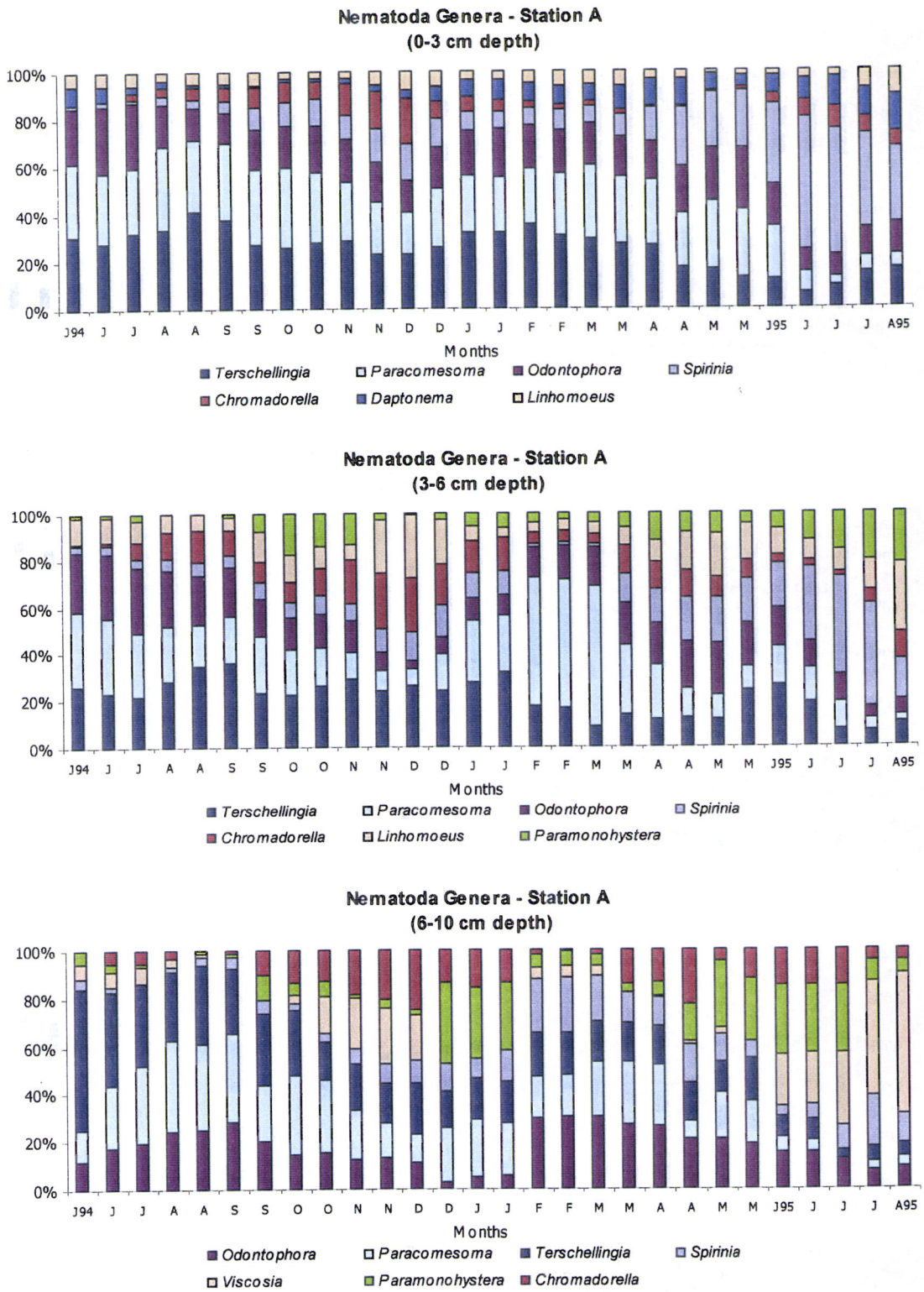


Figure 5.22 - Fortnightly variation of relative composition of the 7 predominant Nematoda genera, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 94 until August 95, at station A, in *Zostera noltii* seagrass bed sediments of the Mira estuary.

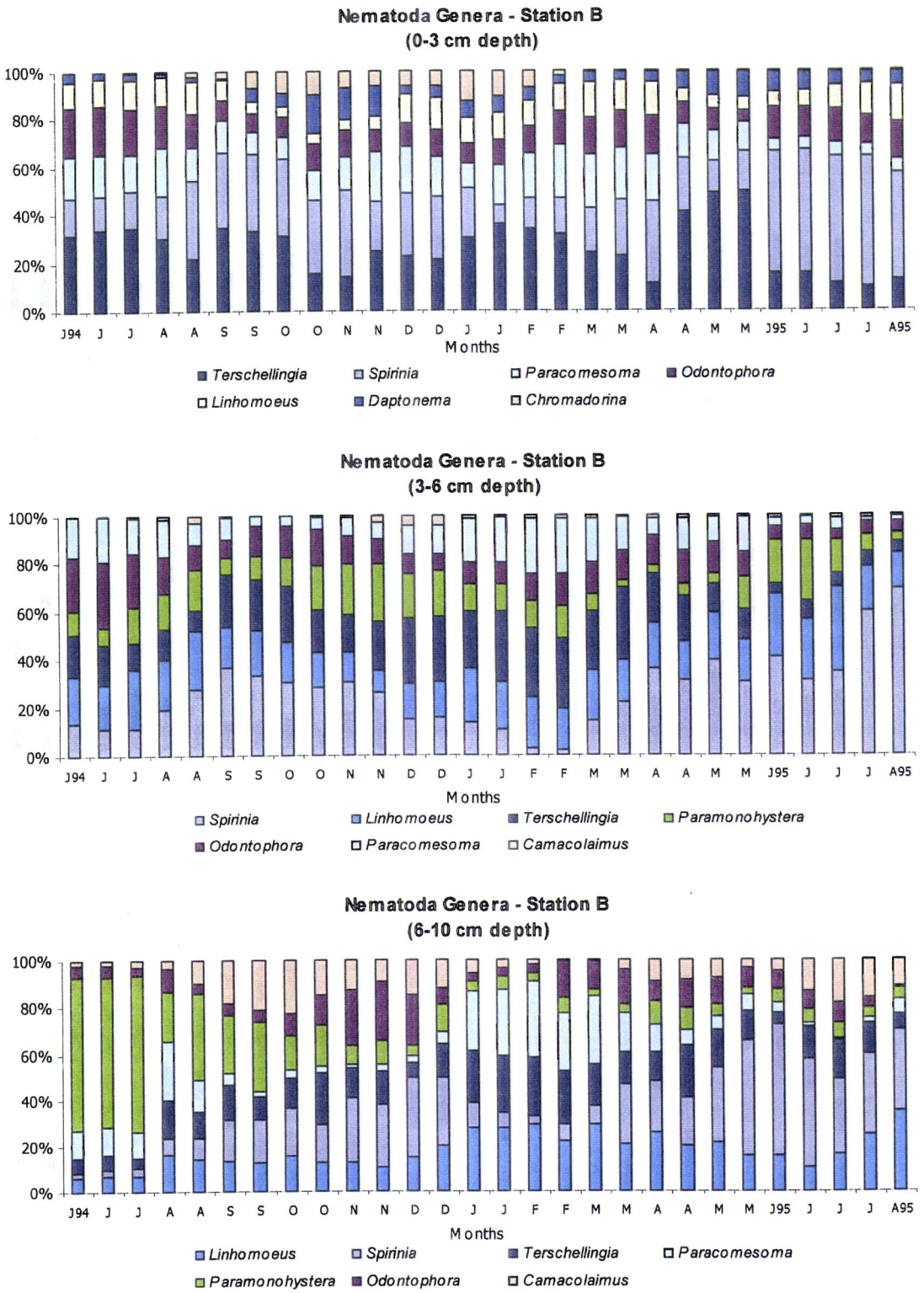


Figure 5.23 - Fortnightly variation of relative composition of the 7 predominant Nematoda genera, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 94 until August 95, at station B, in *Zostera noltii* seagrass bed sediments of the Mira estuary.

Despite vertical density reduction with depth, the number of genera exhibited a small reduction and at station B, even an increase of genera number was obtained. At station A, the relative contribution of each dominant genera per sediment layer was similar, but at station B, *Camacolaimus*, *Paramonohystera* and *Linhomoeus* in the lowermost sediment layer became important genera.

At station A, in the surface sediment layer, a total of 53 genera in 19 families were identified. Only 12 genera proved to be higher than 1% and together comprised 85% of the total nematode population: *Terschellingia*, (average density 395.6 ind.cm^{-2}) and *Paracomesoma* (average density 380.8 ind.cm^{-2}) were dominant, followed by Odontophora (average density 266.5 ind.cm^{-2}), *Spirinia* (average density 158.3 ind. cm^{-2}), *Chromadorella* (average density 81.0 ind.cm^{-2}), *Daptonema*, *Linhomoeus, Paracyatholaimus*, *Viscosia*, *Chromadora*, *Chromadorina* and *Ptycholaimellus*.

At station B, in the surface sediment layer, a total of 47 genera in 20 families were identified. Eighteen genera were higher than 1% and together comprised 91% of the entire nematode abundance. *Terschellingia* (average density 769.7 ind.cm^{-2}) was dominant, as at station A; however, the second most abundant was *Spirinia* (average density 632.9 ind.cm^{-2}), while at station A it was the fourth most abundant genus. *Paracomesoma* (average density 424.4 ind.cm^{-2}) was the third most abundant genus followed by *Odontophora* (average density 339.4 ind.cm^{-2}), *Linhomoeus* (average density 263.8 ind.cm^{-2}), *Daptonema* (average density 153.9 ind.cm^{-2}), *Chromadorina* (average density 88.9 ind.cm^{-2}), *Metachromadora*, *Viscosia*, *Chromadora*, *Ptycholaimellus*, *Desmodora, Molgolaimus*, *Paramonohystera* and *Paracanthonchus*, which registered higher densities than at station A, *Chromadorella*, *Paracyatholaimus* and *Oncholaimellus*.

18 genera were not common at both sampling sites; they registered very low densities (<0.1%): *Cyartonema*, *Southerniella*, *Neochromadora*, *Paradesmodora*, *Onchium*, *Acanthopharynx*, *Chromaspirina, aff Phanodermopsis*, *Parasphaerolaimus, Atrochromadora*, *Aegialoalaimus*, *Leptolaimus*, *Comesa*, *Setosabatieria*, *Paradesmodora*, *Dichromadora*, *Desmoscolex* and *Belbolla*.

At station A, in the intermediate sediment layer, a total of 43 genera in 17 families were identified. 21 genera proved to be higher than 1% and together comprised 89% of the

total Nematoda communities. In contrast to the top layer, *Paracomesoma* (average density 39.0 ind.cm^{-2}) was higher than *Terschellingia* (average density 30.5 ind.cm^{-2}), followed by *Odontophora* (average density 23.5 ind.cm^{-2}), *Spirinia* (average density 17.6 ind.cm^{-2}), *Linhomoeus* (average density 16.7 ind.cm^{-2}), *Paramonohystera* (average density 10.2 ind.cm^{-2}), *Chromadorella* (13.7 ind.cm^{-2}), *Camacolaimus*, *Daptonema*, *Chromadorina*, *Synonchiella*, *Thalassironus*, *Ptycholaimellus*, *Paracyatholaimus*, *Viscosia*, *Oncholaimellus*, *Paracanthonchus*, *Anticoma*, *Chromadora*, *Southernia* and *Bathylaimus*.

At station B, in the intermediate layer studied, a total of 46 genera in 19 families were identified. 20 genera proved to be higher than 1% and together comprised 93% of the total Nematoda communities. *Spirinia* (average density 88.0 ind.cm^{-2}) was dominant and the second most abundant group was *Linhomoeus* (average density 57.0 ind. cm^{-2}); in fact it was an important group at station B. The third most abundant genus was *Terschellingia* (average density average density 55.2 ind.cm^{-2}), followed by *Paramonohystera* (average density 35.9 ind.cm^{-2}), *Odontophora* (average density 34.2 ind.cm^{-2}), *Paracomesoma* (average density 31.5 ind.cm^{-2}), *Camacolaimus* (average density 18.8 ind.cm^{-2}), *Daptonema* (average density 16.8 ind.cm^{-2}), *Desmodora* (average density 16.2 ind.cm^{-2}), *Chromadorina*, *Megadesmolaimus*, Sabatieria, *Metachromadora*, Viscosia, *Synonchiella*, *Chromadorella*, *Ptycholaimellus*, *Chromadora*, *Paracyatholaimus* and *Southernia*.

At station A, in the lowest sediment layer studied, a total of 36 genera in 19 families were identified. 18 genera proved to be higher than 1% and together comprised 93% of the total nematode population. *Odontophora* was the dominant genus, whereas in the upper sediment layer, it was the third most abundant. In the lower layer it registered lowest density values, average density being 19.3 ind.cm^{-2}, followed by *Paracomesoma* (average density 18.9 ind.cm^{-2}) and *Terschellingia* (average density 18.2 ind.cm^{-2}), *Spirinia* (average density 10.5 ind.cm^{-2}), *Viscosia* (average density 10.0ind.cm^{-2}), *Paramonohystera* (average density 9.9 ind.cm^{-2}), *Chromadorella*, *Paracyatholaimus*, *Linhomoeus*, *Daptonema*, *Camacolaimus*, *Paracanthonchus*, *Chromadora*, *Oncholaimellus*, *Chromadorina*, *Southernia*, *Anticoma*, *Metachromadora*, *Megadesmolaimus*, *Bathylaimus*, *Ptycholaimellus* and *Campylaimus*.

At station B, in the lowermost layer studied, a total of 51 genera in 17 families were identified. 19 genera proved to be higher than 1% and together comprised 89% of the total nematode population. *Linhomoeus* (average density 44.5 ind.cm^{-2}) and *Spirinia* (average density 43.6 ind.cm^{-2}) were the dominant genera, as in the intermediate sediment layer, followed by *Terschellingia* (average density 34.6 ind.cm^{-2}), *Paracomesoma* (average density 30.6 ind.cm^{-2}), *Paramonohystera* (average density 30.6 ind.cm^{-2}) *Odontophora* (average density 18.2.ind.cm^{-2}), *Camacolaimus*, *Daptonema*, *Desmolaimus*, *Viscosia*, *Desmodora*, *Ptycholaimellus*, *Megadesmolaimus*, *Chromadorina*, *Paracyatholaimus*, *Chromadora*, *Synonchiella*, *Anticoma*, *Metachromadora* and *Thalassironus*.

The Mann-Whitney Test (Z statistic Mann-Whitney; p<0.001***) was applied to analyse the differences of the Nematoda density temporal variations at similar depths at both stations. At surface sediment layers (0-3 cm depth) significant differences between both stations were detected: *Terschellingia* (Z=-2.7; p<0.01**); *Spirinia* (Z=-6.4; p<0.001***); *Daptonema* (Z=-3.2; p<0.01**); *Linhomoeus* (Z=-5.9; p<0.001***); *Viscosia* (Z=-3.0; p<0.01**), *Chromadorina* (Z=-2.6; p<0.01**); *Ptycholaimellus* (Z=-2.9; p<0.01**); *Metachromadora* (Z=-3.2; p<0.01**); *Oncholaimellus* (Z=-2.9; p<0.01**); *Metalinhomoeus* (Z=-4.5; p<0.001***); *Molgolaimus* (Z=-2.9; p<0.01**); *Anticoma* (Z=-2.4; p<0.05*); *Camacolaimus* (Z=-3.6; p<0.001***); *Megadesmolaimus* (Z=-3.8; p<0.001***); *Synonchiella* (Z=-3.7; p<0.001***); *Southernia* (Z=-3.2; p<0.001***); *Prochromadorella* (Z=-2.0; p<0.05*); *Diodontolaimus* (Z=-3.1; p<0.01**); *Paramonohystera* (Z=-5.7; p<0.001***); *Aponema* (Z=-2.3; p<0.001***); *Paracanthonchus* (Z=-5.5; p<0.001***); *Microlaimus* (Z=-2.0; p<0.05*); *Desmodora* (Z=-5.1; p<0.001***). However, regarding *Paracomesoma*, *Odontophora*, *Chromadorella*, *Paracyatholaimus*, *Chromadora*, *Bathylaimus*, *Sphaerolaimus*, *Campylaimus*, *Oxystomina*, *Paralinhomoeus*, *Thalassironus*, *Odontanticoma*, *Calyptoronema*, *Cyartonema*, *Halalaimus*, *Eurystomina*, *Southerniella*, *Sabatieria*, *Eleutherolaimus* and *Nemanema*, no significant differences were detected between stations.

Regarding the sediment layer 3-6 cm depth, significant differences were also detected between both stations: *Terschellingia* (Z=-2.7; p<0.01**); *Odontophora* (Z=-2.8; p<0.001); *Spirinia* (Z=-5.0; p<0.001***); *Linhomoeus* (Z=-6.1; p<0.001***); *Chromadorella* Z=-3.3; p<0.001***); *Paramonohystera* (Z=-5.3; p<0.001***),

Camacolaimus (Z=-3.5; p<0.001***); *Daptonema* (Z=-3.2; p<0.01**); *Synonchiella* (Z=-2.5; p<0.01**); *Ptycholaimellus* (Z=-2.0; p<0.05*), *Viscosia* (Z=-2.7; p<0.01**); *Chromadora* (Z=-2.5; p<0.05*); *Megadesmolaimus* (Z=-5.8; p<0.001***); *Paralinhomoeus* (Z=-2.8; p<0.01**), *Metachromadora* (Z=-2.0; p<0.05*); *Diodontolaimus* (Z=-3.4; p<0.001***); *Metalinhomoeus* (Z=-3.4; p<0.001***); *Prochromadorella* (Z=-3.3; p<0.001***); *Desmodora* (Z=-5.8; p<0.001***); *Microlaimus* (Z=-3.0; p<0.01**). Concerning *Paracomesoma*, *Chromadorina*, *Thalassironus*, *Paracyatholaimus*, *Oncholaimellus*, *Paracanthonchus*, *Anticoma*, *Southernia*, *Bathylaimus*, *Molgolaimus*, *Oxystomina*, *Sphaerolaimus*, *Campylaimus*, *Aponema*, *Sabatieria*, *Halalaimus*, *Eurystomina*, *Neochromadora*, and *Antomicron*, no significant differences were detected between stations.

At sediment layer 6-10 cm depth, significant differences were also detected between both stations: *Terschellingia* (Z=-2.0; p<0.05*); *Spirinia* (Z=-4.8; p<0.001***); *Paramonohystera* (Z=-3.6; p<0.001***), *Chromadorella* (Z=-3.4; p<0.001***); *Linhomoeus* (Z=-6.2; p<0.001***); *Daptonema* (Z=-3.8; p<0.001***); *Camacolaimus* (Z=-5.0; p<0.001***); *Southernia* (Z=-2.6; p<0.01**); *Metachromadora* (Z=-2.6; p<0.01**); *Megadesmolaimus* (Z=-4.0; p<0.001***); *Thalassironus*, (Z=-2.1; p<0.05*); *Synonchiella* (Z=-3.7; p<0.001***); *Diodontolaimus* (Z=-5.6; p<0.001***); *Eurystomina* (Z=-2.2; p<0.05*); *Sabatieria* (Z=-2.7; p<0.01**). However, regarding *Odontophora, Paracomesoma*, *Viscosia*, *Paracyatholaimus*, *Paracanthonchus Chromadora*, *Oncholaimellus*, *Chromadorina*, *Anticoma*, *Ptycholaimellus*, *Molgolaimus*, *Eleutherolaimus*, *Halalaimus*, *Bathylaimus*, *Oxystomina*, *Paroxystomina*, *Neochromadora*, *Sphaerolaimus*, no significant differences were detected between stations.

However, at the similar depths at both stations, no significant differences were detected for genera: *Paracomesoma*, *Paracyatholaimellus Bathylaimus*, *Chromadora*, *Sphaerolaimus*, *Oxystomina*, *Halalaimus*. *Odontophora*. *Chromadora* was not significantly different in surface and low sediment layers, and in the uppermost sediment layers, *Campylaimus, Thalassironus*, *Eurystomina*, *Sabatieria*, *Eleutherolaimus* were also not significantly different.

The densities registered in the surface sediment layer structured the pattern of total density as a result of their high relative contribution to the total number of each genera

collected and, consequently, the patterns of the density temporal variations of the Nematoda genera in the surface sediment layer were very similar to the patterns obtained in global results (0-10 cm depth).

At station A, in sediment layer 0-3 cm depth, nematode density variation patterns peaked in October and November, followed by a decline in December, as was observed in sediment layer 0-10 cm depth. The densities peaked once more in January and February followed by a tapering off towards July 95. Therefore, summer 94 attained higher densities than summer 95. Within the depth layers, densities were more constant, although an increase was registered in February and March, showing an opposite trend to that in the top layer (Fig. 5.24). At station B, in the surface sediment layer (0-3 cm depth), the densities declined in summer 94, a slightly increase was recorded in September, followed by a strong increase between February and March and a constant decrease until June 95. The summer 95 densities were lower than in summer 94, as was observed at station A. Within the depth layers, the densities were more constant, although at the lowest depth (6-10 cm) an increase was registered in January and February (Fig. 5.25).

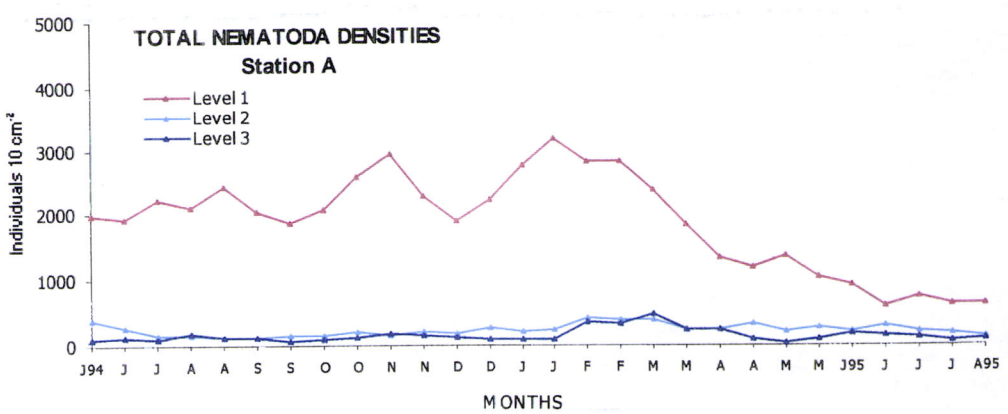


Figure 5.24 - Temporal and vertical variations of density of the total nematodes, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

Density temporal variation patterns within the deeper layers of the *Terschellingia*, *Paracomesoma* and *Odontophora* genera were regularly distributed over the study period. However, at both stations, in January, February and March, an increase was obtained (except for *Odontophora* genera at station B) and in summer 95 the densities were very low (Fig. 5.26, Fig. 5.27, Fig.5.28, Fig 5.29, Fig.5.30 and Fig 5.31).

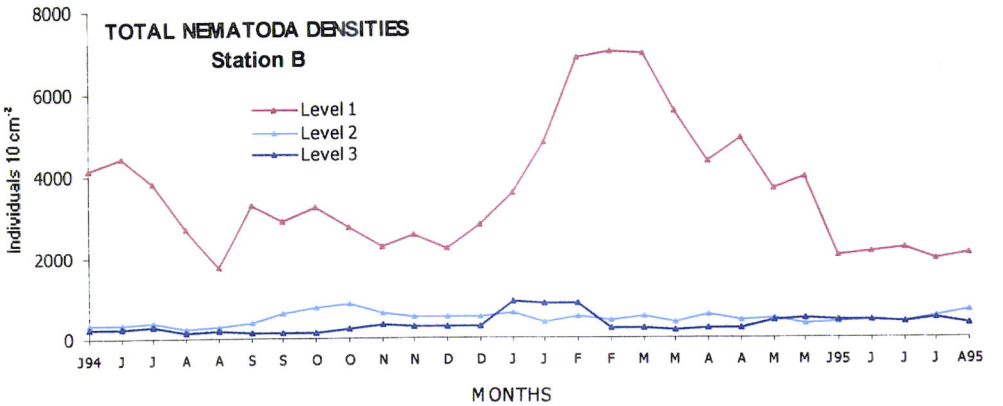


Figure 5.25 - Temporal and vertical variations of density of the total nematodes, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

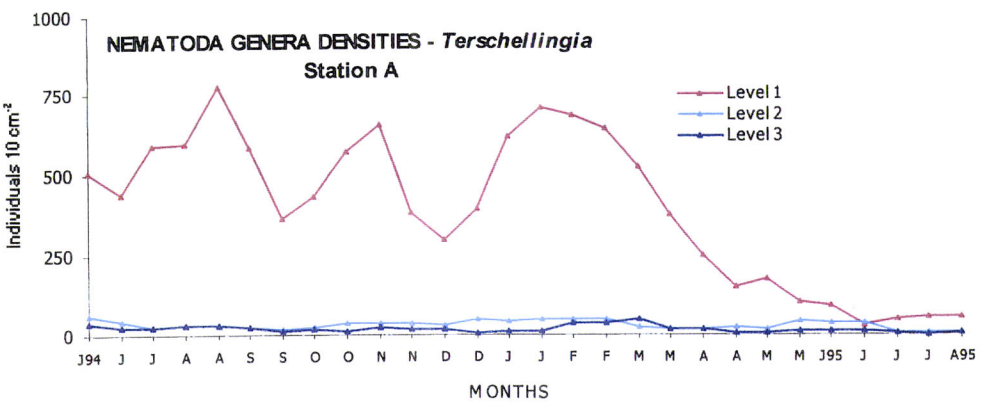


Figure 5.26 - Temporal and vertical variations of density of the Nematoda genus *Terschellingia*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

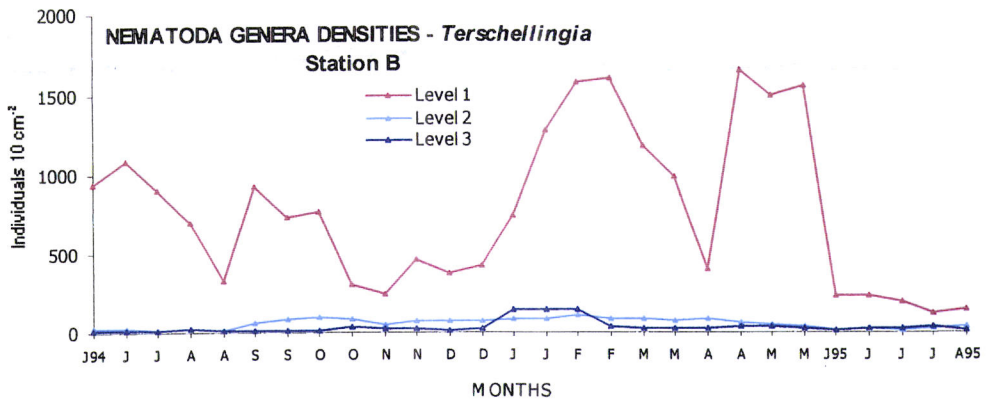


Figure 5.27 - Temporal and vertical variations of density of the Nematoda genus *Terschellingia*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

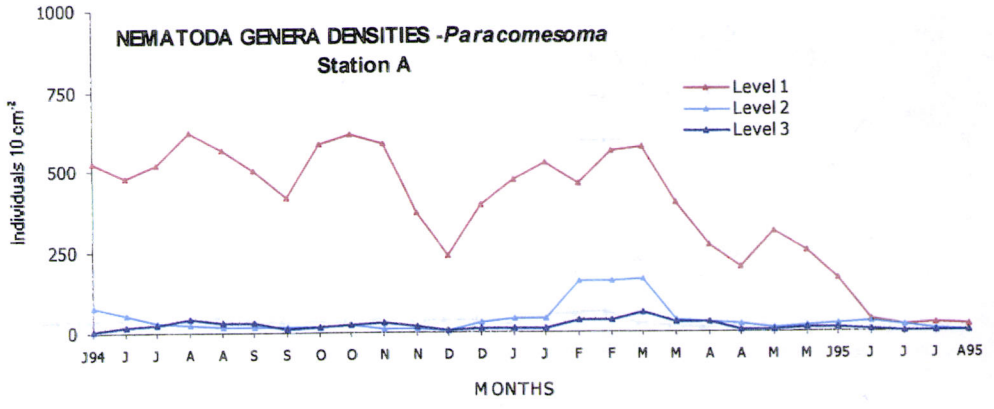


Figure 5.28 - Temporal and vertical variations of density of the Nematoda genus *Paracomesoma* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

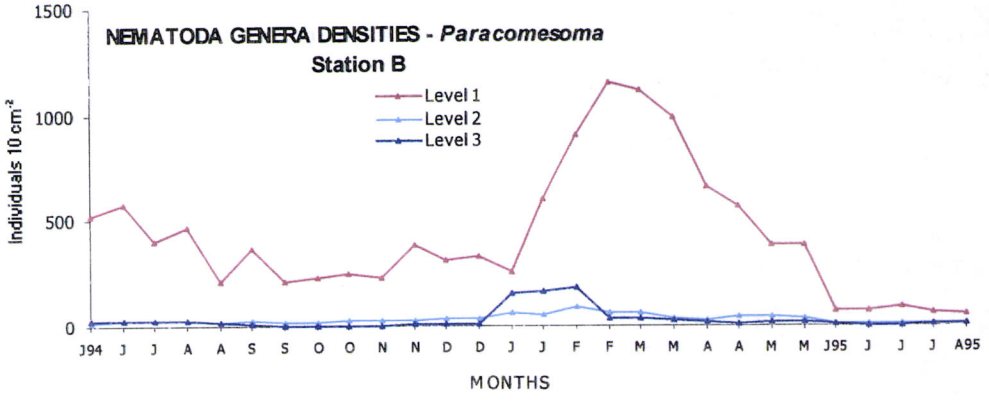


Figure 5.29 - Temporal and vertical variations of density of the Nematoda genus *Paracomesoma* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

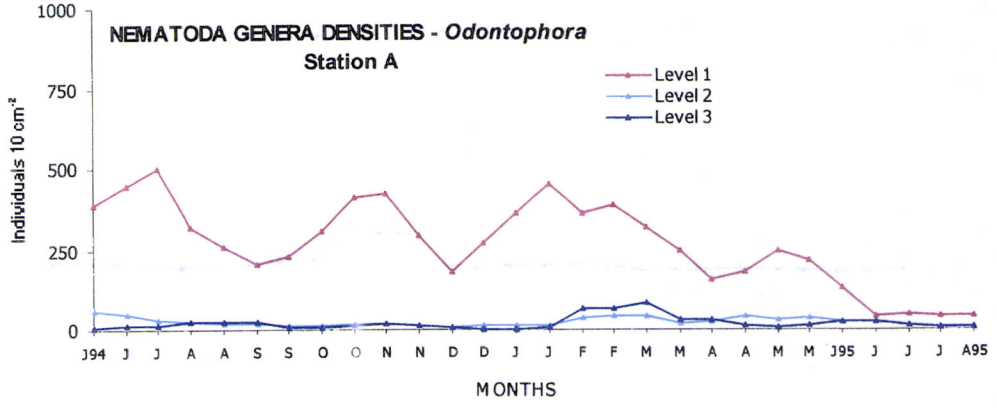


Figure 5.30 - Temporal and vertical variations of density of the Nematoda genus *Odontophora* in at three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

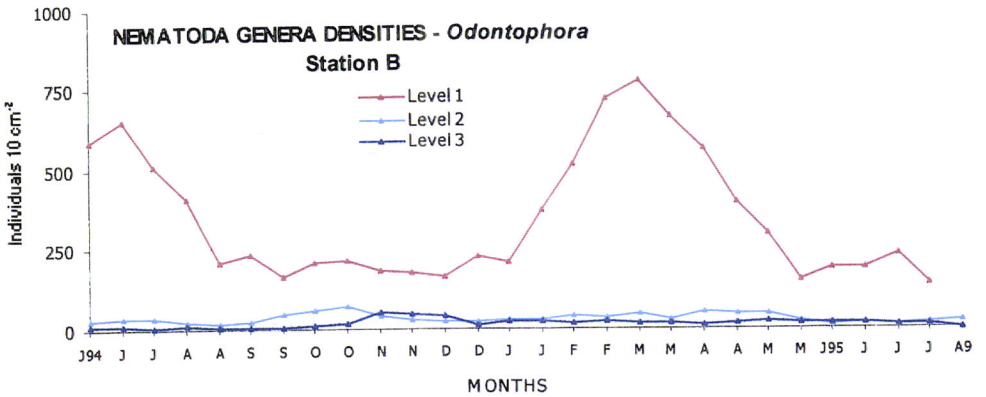


Figure 5.31 - Temporal and vertical variations of density of the Nematoda genus *Odontophora*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

At station B, in the intermediate layer, *Spirinia* densities increased between August 94 and November 94, and after July 95 a continuous increase was also registered. At station A, in the lowermost sediment layer in February and March, an increase was observed, while station B showed exactly an opposite trend (Fig.5.32 and Fig 5.33).

Chromadorella duopapillata species in uppermost sediment layers had different patterns at both stations. Although after March an accentuated decrease was observed at both stations, in April and May the densities were much lower. In the case of station A, in April, the intermediate layer recorded highest densities (Fig 5.34 and Fig 5.35).

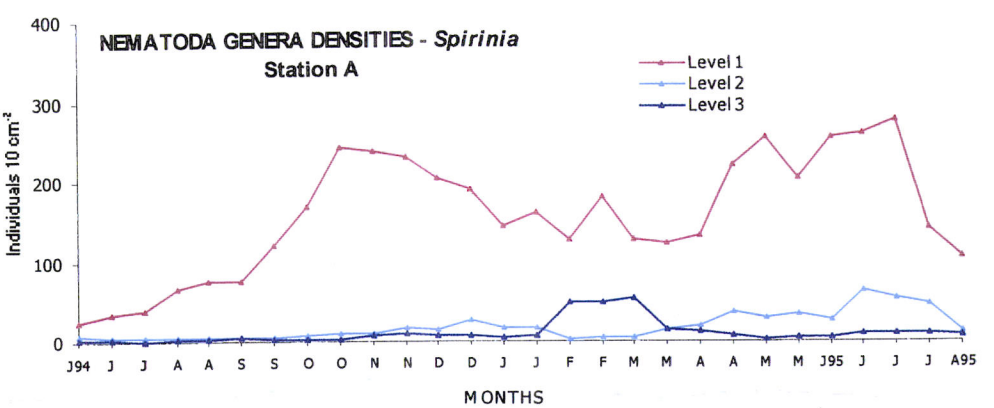


Figure 5.32 - Temporal and vertical variations of density of the Nematoda genus *Spirinia* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

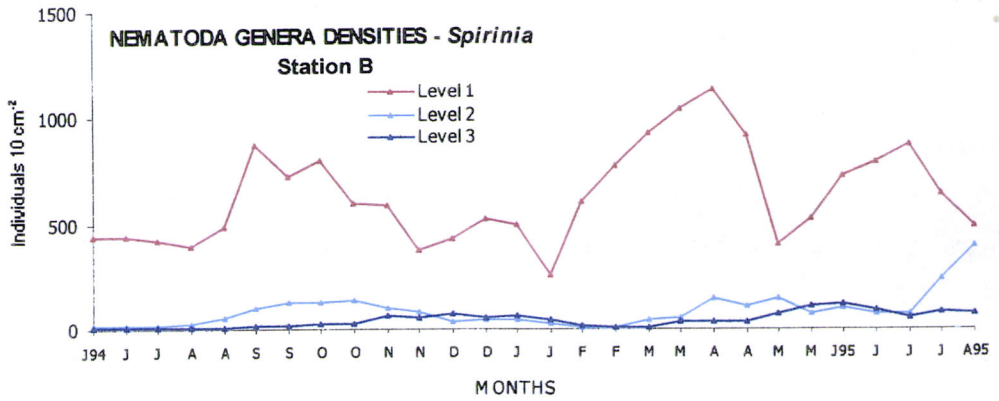


Figure 5.33 - Temporal and vertical variations of density of the Nematoda genus *Spirinia* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

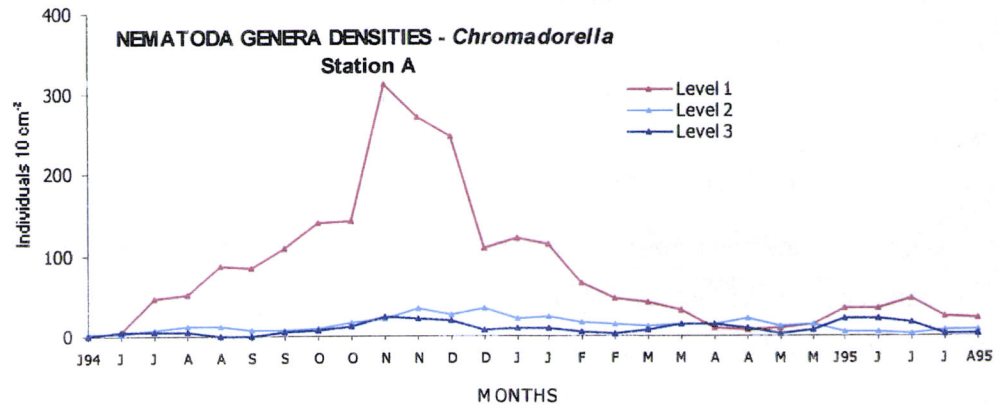


Figure 5.34 - Temporal and vertical variations of density of the Nematoda species *Chromadorella duopapillata* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

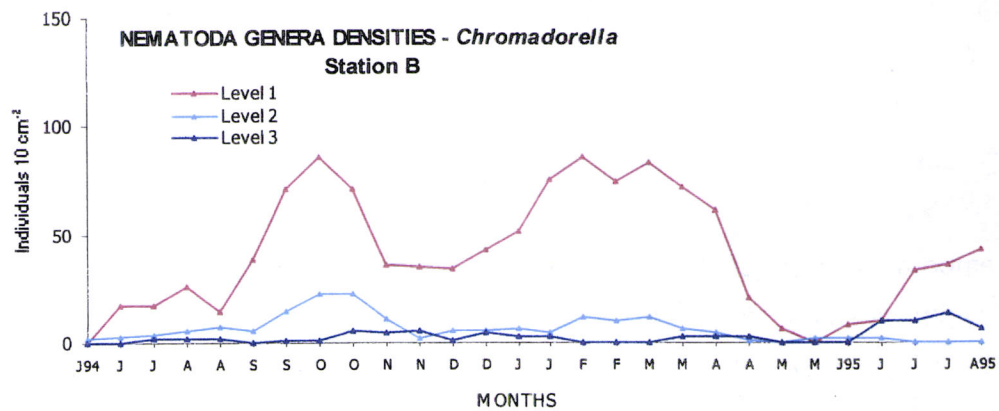


Figure 5.35 - Temporal and vertical variations of density of the Nematoda species *Chromadorella duopapillata* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

At station A, in the surface layer, *Linhomoeus* provided the highest values in late February, whereas the global results presented the highest values in December, because the densities increased in the intermediate sediment layer. In the lowermost sediment layer, after May, the genera disappeared. At station B, in January and February, an increase in the intermediate sediment layer was also observed (Fig.5.36 and Fig 5.37).

Contrary to most genera collected at surface sediment layers, *Paramonohystera* temporal variation patterns differ clearly from those obtained in global results (0-10 cm depth) due the high densities at depth. At both stations, the top sediment layer exhibited higher densities between December and March, followed by a disappearance between March and June 95 at station A; thus, in the lowermost sediment layers, the densities were higher (Fig.5.38). However, at station B, densities decreased but did not disappear, and in May an increase was even registered, thereby presenting an opposite trend to that obtained at station A (Fig.5.39).

At both stations, in the lowermost sediment layers (6-10 cm depth), *Daptonema* had very low densities. However, during February and March (station A), January and February (station B) an increase in the densities was registered, as observed in several genera collected (Fig.5.40 and Fig.5.41).

Density temporal variation patterns of the *Viscosia* of the surface sediment layer were similar to the global results. At depth, the densities were very low, although, at station A, in June 95 and July 95, they were higher than in the top sediment layers. At station B, in the intermediate sediment layer, the densities increased in September and October, while in the lowermost sediment layer they increased in June 95 and July 95, as observed at station A (Fig.5.42 and Fig.5.43).

The temporal patterns of the *Chromadorina germanica* species were similar at the three depth sediment layers. At station A, however, the low densities at depth, in summer 94 and May 95, were higher than in the top sediment layer, and likewise at station B in June 95 (Fig.5.44 and Fig.5.45).

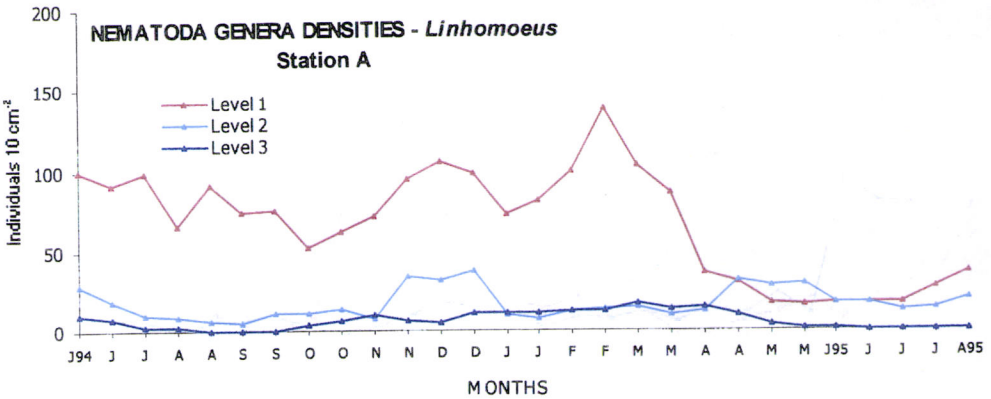


Figure 5.36 - Temporal and vertical variations of density of the Nematoda genus *Linhomoeus* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

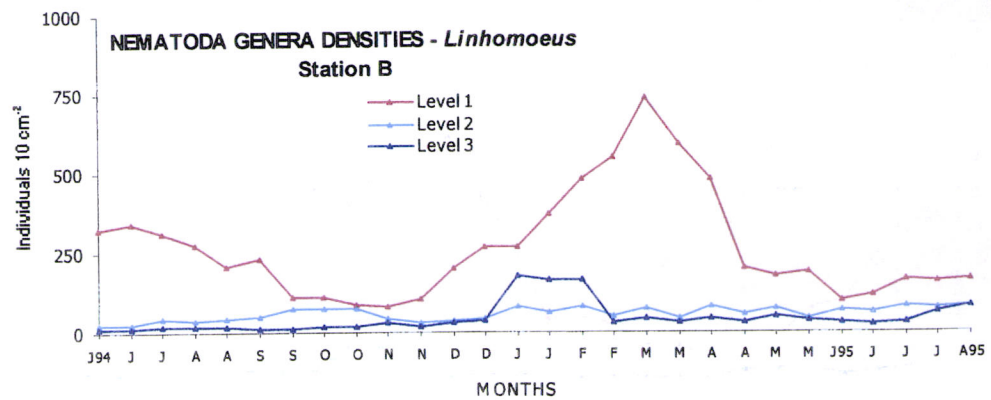


Figure 5.37 - Temporal and vertical variations of density of the Nematoda genus *Linhomoeus*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

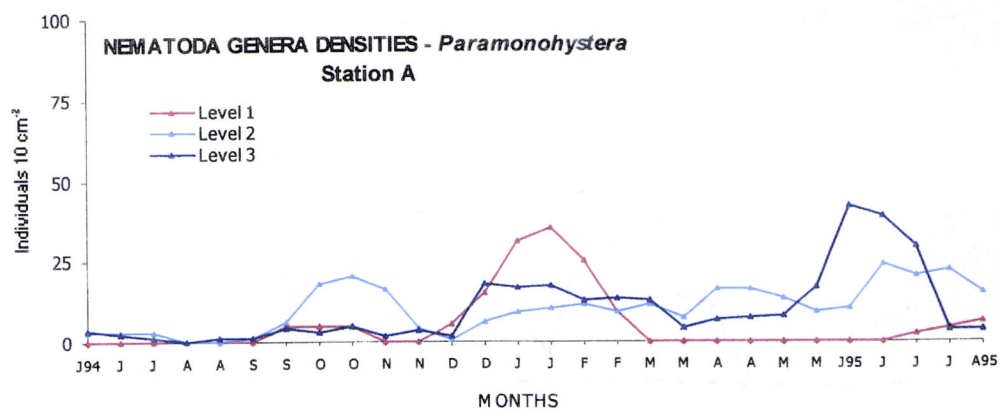


Figure 5.38 - Temporal and vertical variations of density of the Nematoda genus *Paramonohystera* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

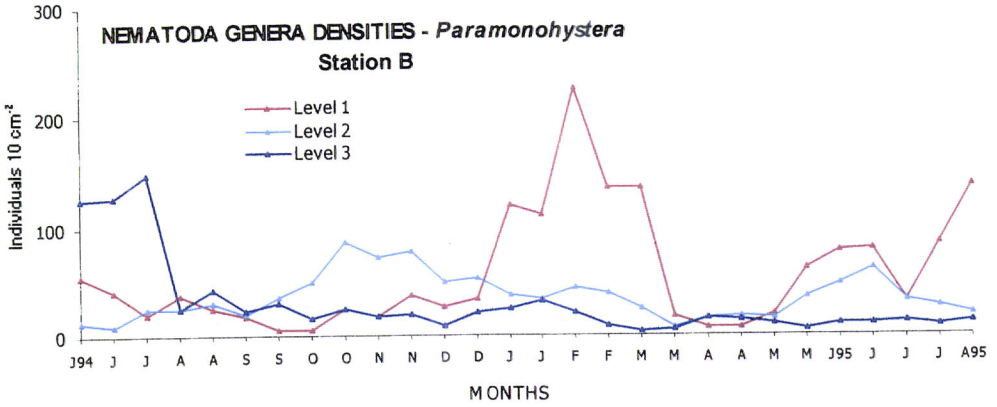


Figure 5.39 - Temporal and vertical variations of density of the Nematoda genus *Paramonohystera* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

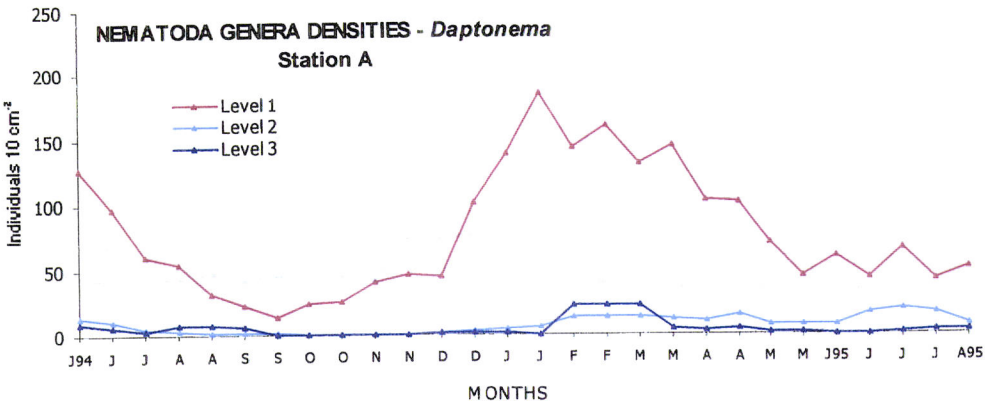


Figure 5.40 - Temporal and vertical variations of density of the Nematoda genus *Daptonema*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

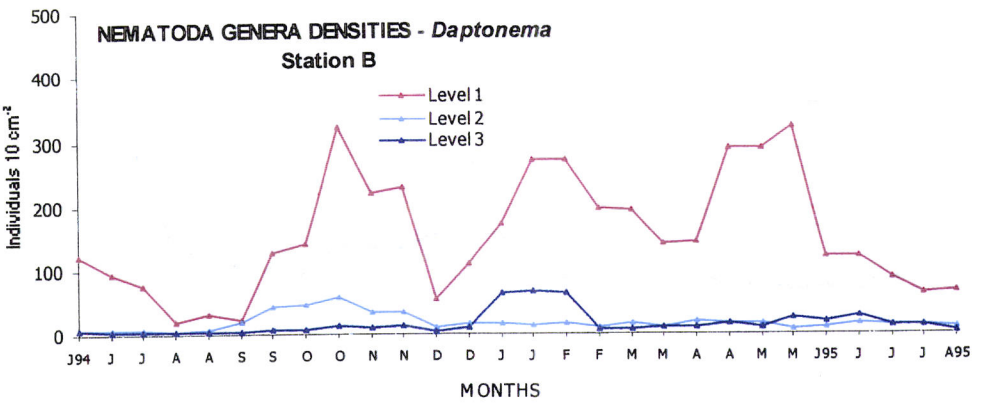


Figure 5.41 - Temporal and vertical variations of density of the Nematoda genus *Daptonema* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

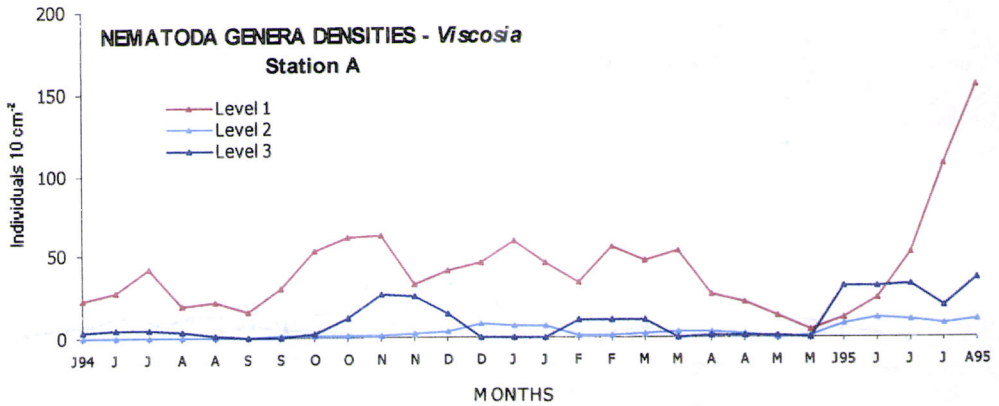


Figure 5.42 - Temporal and vertical variations of density of the Nematoda genus *Viscosia* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

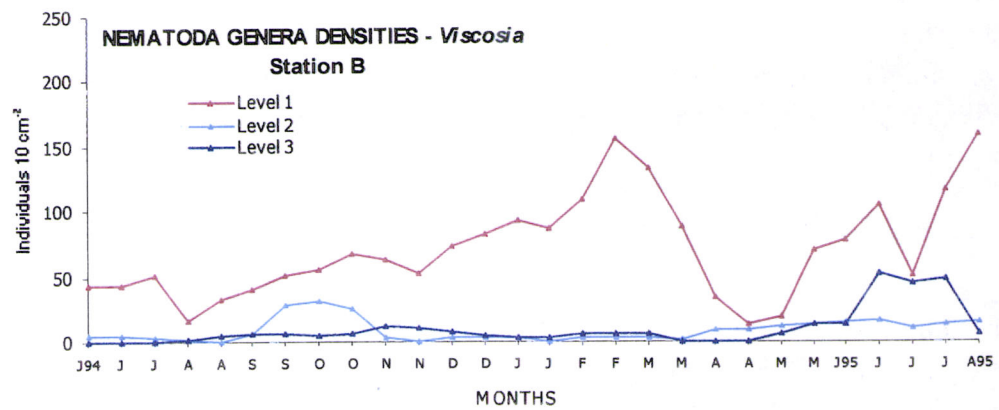


Figure 5.43 - Temporal and vertical variations of density of the Nematoda genus *Viscosia* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

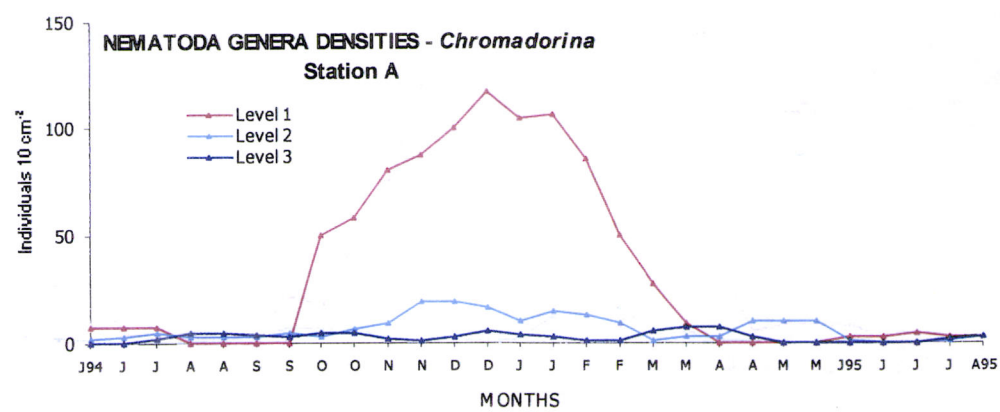


Figure 5.44 - Temporal and vertical variations of density of the Nematoda species *Chromadorina germanica* at the three depths: Level1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

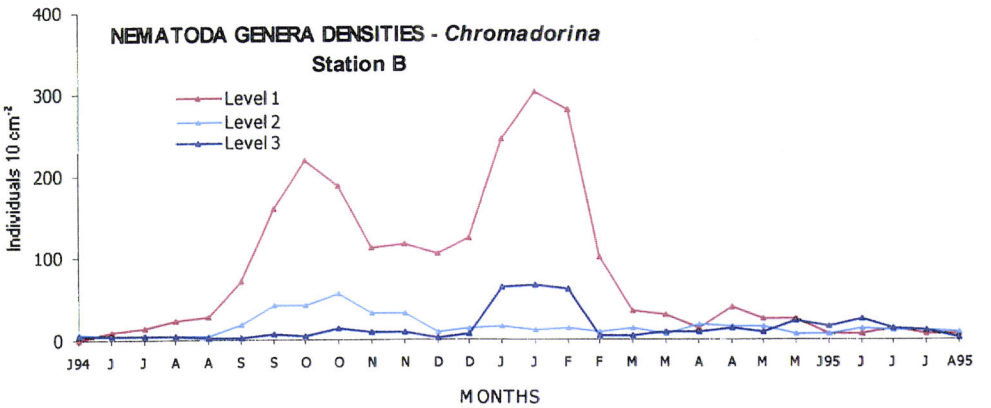


Figure 5.45 - Temporal and vertical variations of density of the Nematoda species *Chromadorina germanica* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

Chromadora nudicapitata species at both stations registered very low densities at depth, although, at station A, a slight increase was registered in November, and densities were higher than in top sediment layers, which showed a noticeable decrease (Fig.5.46 and Fig.5.47).

Density temporal variation patterns of the *Paracyatholaimus* were similar within the three depth sediment layers. However, at station B, in the top layer, a sharp decline was observed between February and March, although at depth the densities showed an opposite trend (Fig.5.48 and Fig.5.49).

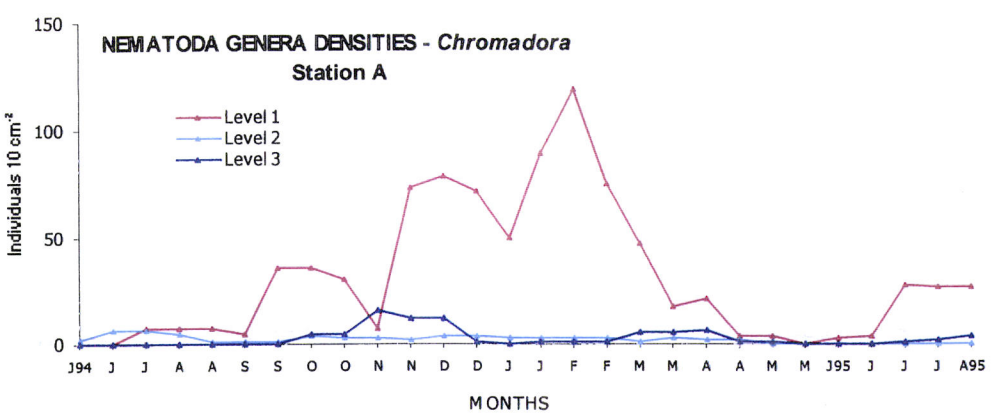


Figure 5.46 - Temporal and vertical variations of density of the Nematoda species *Chromadora nudicapitata*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

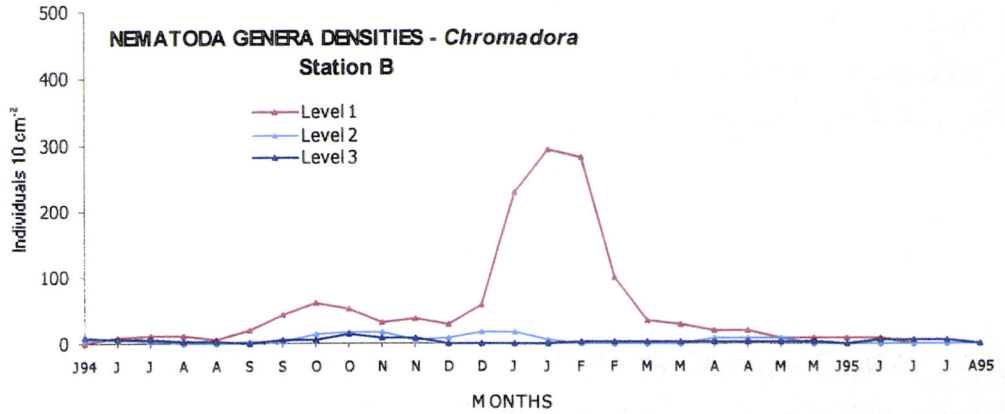


Figure 5.47 - Temporal and vertical variations of density of the Nematoda species *Chromadora nudicapitata*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

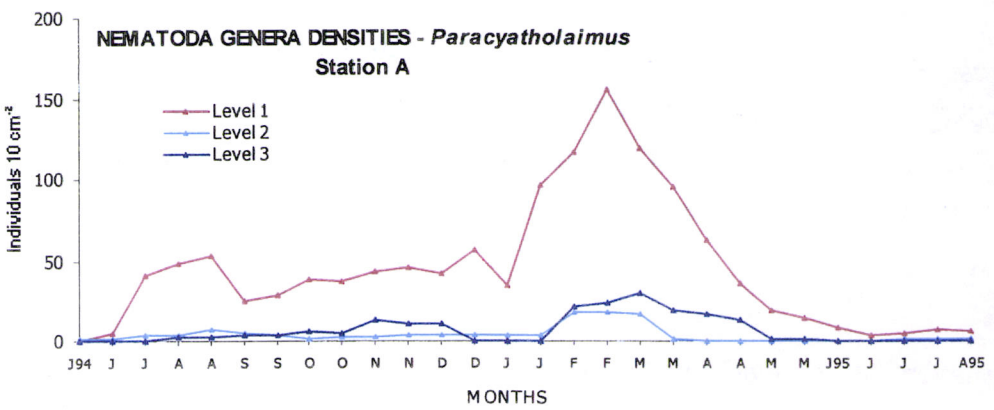


Figure 5.48 - Temporal and vertical variations of density of the Nematoda genus *Paracyatholaimus* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

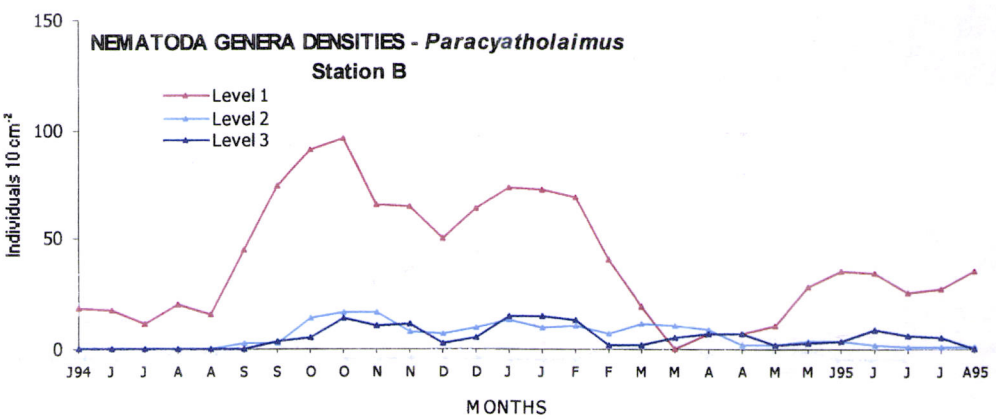


Figure 5.49 - Temporal and vertical variations of density of the Nematoda genus *Paracyatholaimus*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

The density temporal variation patterns of *Ptycholaimellus* in depth sediment layers were different at both stations: at station A, in sediment layer 3-6 cm depth, from July 94 until December, this genus was not recorded, followed by an increase until April, while at station B, a quite similar pattern was recorded, but in the sediment layer 6-10 cm. In summer 95, the densities increased in the lowermost sediment layer, higher values being attained than in the top layer (Fig.5.50 and Fig.5.51).

Desmodora was an important genus at station B. In most of the sampling period, the uppermost sediment layer exhibited a similar pattern to that obtained in global results. Nevertheless, in the surface sediment layer, this genus disappeared in August 94 and December. In depth sediment layers, after April 95, slightly density increases were observed (Fig.5.52).

Camacolaimus showed high densities at depth. At station B, from August 94 until November, the intermediate sediment layer presented the highest densities and the bottom sediment layer after June 95 registered the highest values, while, at station A, the deepest layers presented the highest densities after February (Fig.5.53 and Fig 5.54).

At station A, *Paracanthonchus* showed high densities in depth sediment layers, particularly in May and April, with the bottom layer showing a large density increase. However, at station B, over the sampling period, the top layer had the highest densities, as in the global results (Fig.5.55 and Fig 5.56).

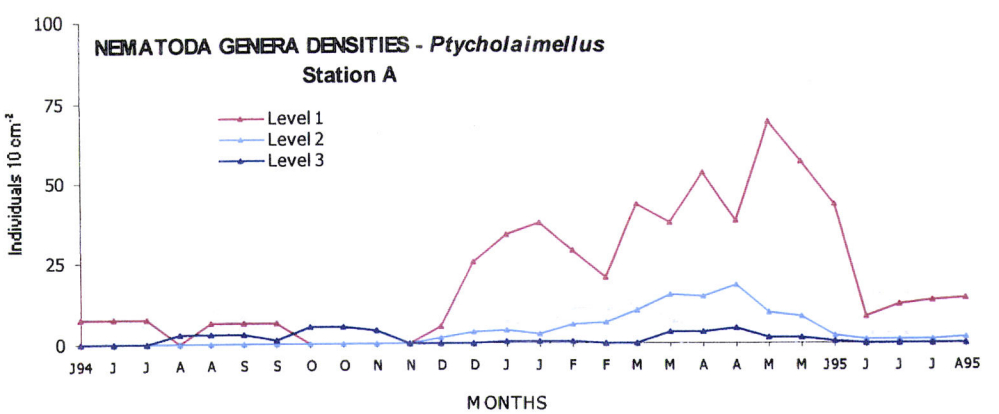


Figure 5.50 - Temporal and vertical variations of density of the Nematoda genus *Ptycholaimellus*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

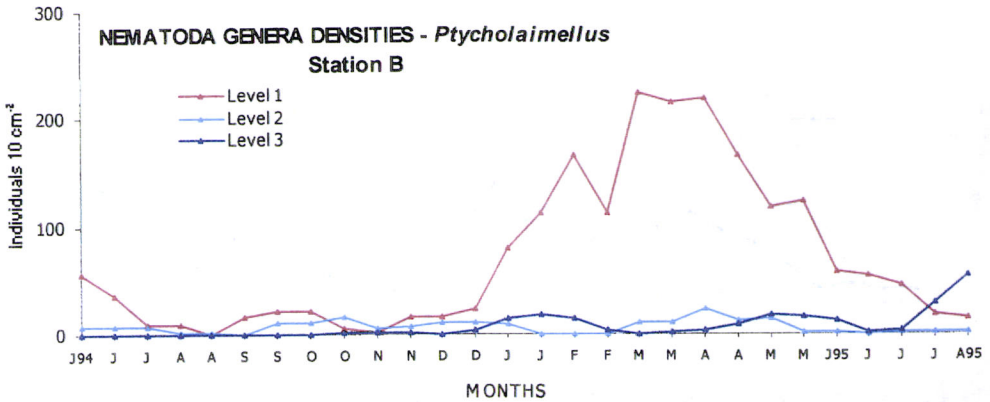


Figure 5.51 - Temporal and vertical variations of density of the Nematoda genus *Ptycholaimellus,* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B in a *Zostera noltii* seagrass bed of the Mira estuary.

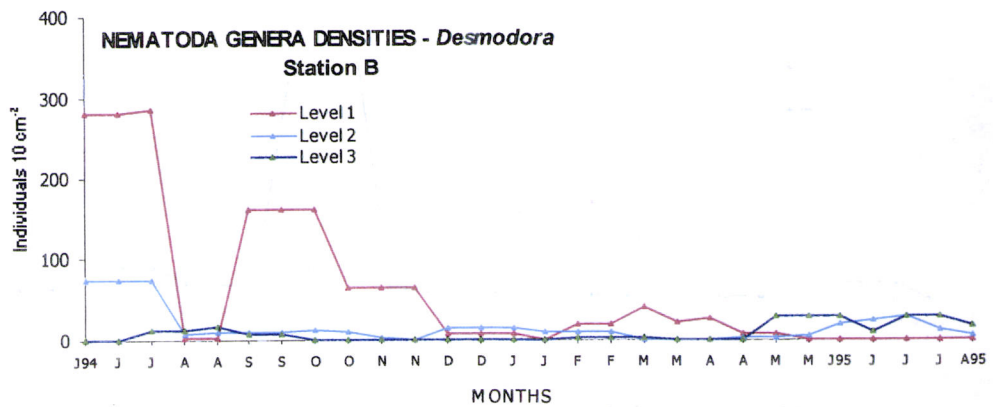


Figure 5.52 - Temporal and vertical variations of density of the Nematoda genus *Desmodora*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

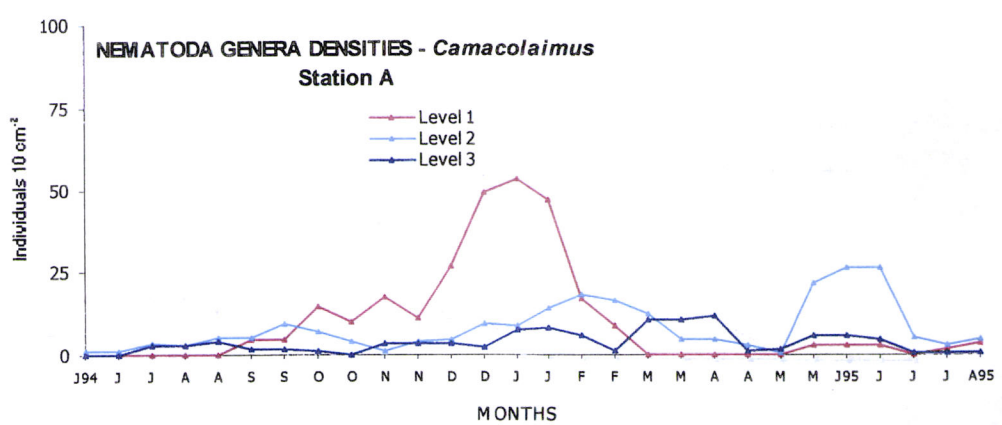


Figure 5.53 - Temporal and vertical variations of density of the Nematoda genus *Camacolaimus* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

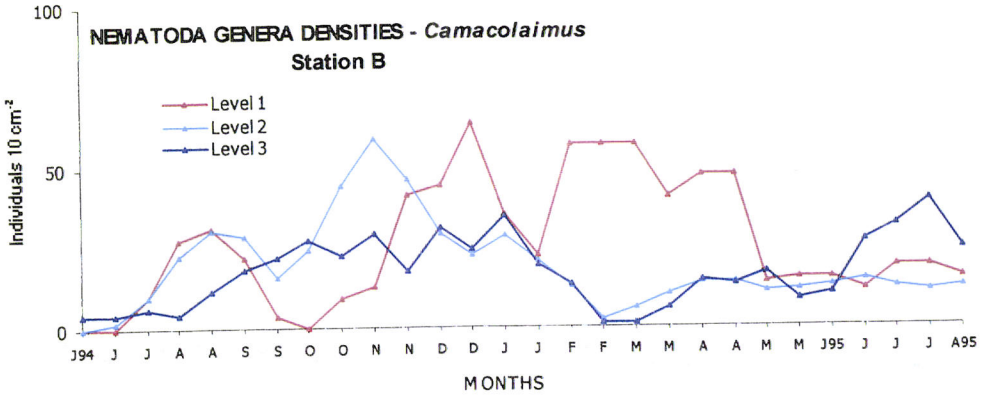


Figure 5.54 - Temporal and vertical variations of density of the Nematoda genus *Camacolaimus* at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

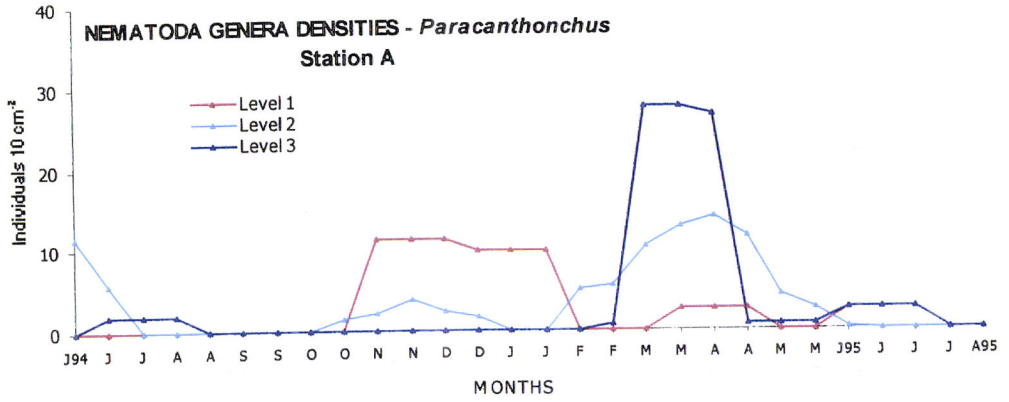


Figure 5.55 - Temporal and vertical variations of density of the Nematoda genus *Paracanthonchus*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

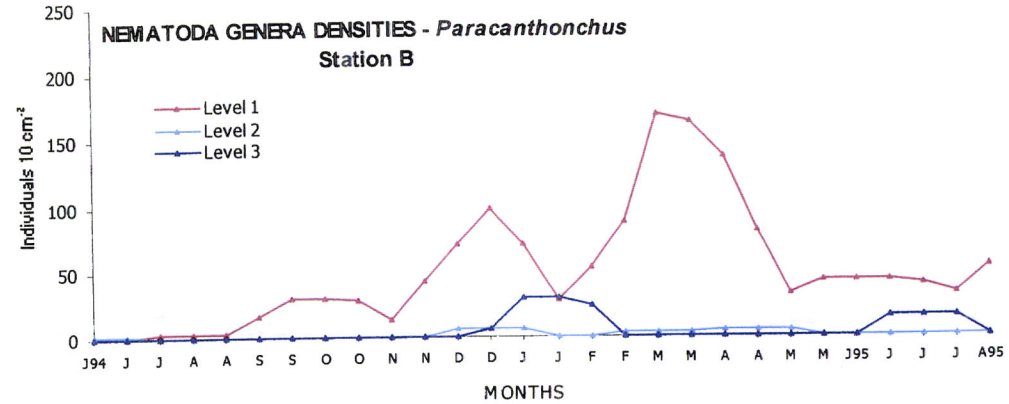


Figure 5.56 - Temporal and vertical variations of density of the Nematoda genus *Paracanthonchus*, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at sampling station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

Data relating to the vertical temporal variations of Nematoda genera in sediment with the lowest densities are describe in the annex *III*.

5.3.2. Seasonal patterns of variation of the Nematoda communities

a) Global results

The PCA-ordination of the temporal variation of the Nematoda genera density matrix of each sampling station displayed seasonal trends, based on the first three axes, which describe most of the variability (Fig 5.57 and Fig. 5.58). The decision to study each sampling station separately was only taken after applying the classification and ordination techniques on the joint matrix of the both stations, which showed clearly different seasonal trends at both sampling stations (Fig. 5.59).

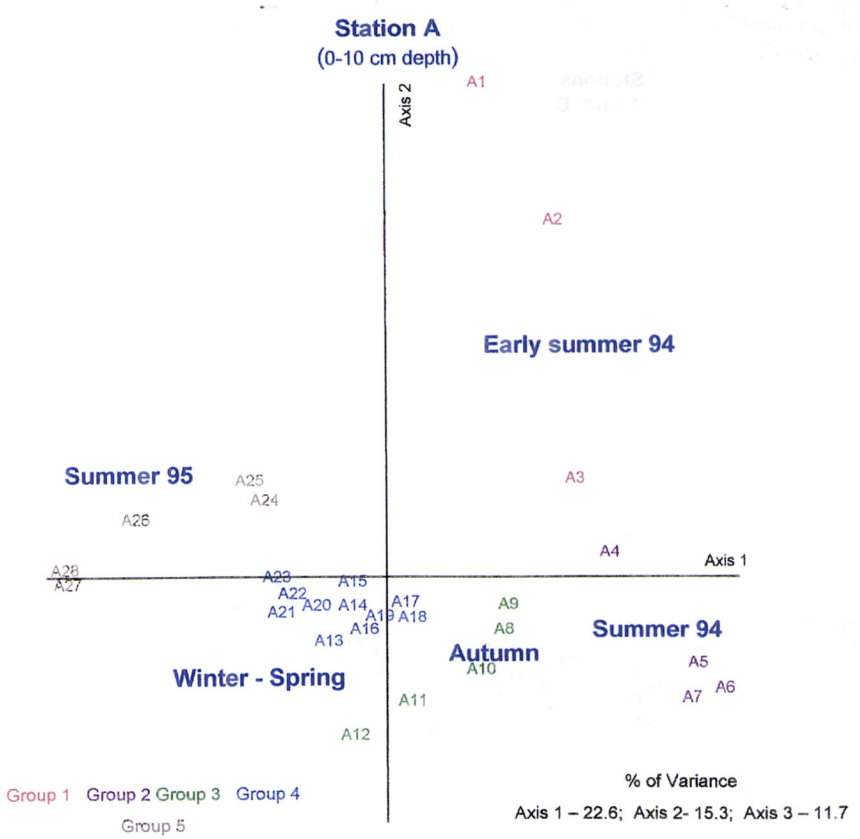


Figure 5.57 - Results of the PCA-ordination based on fortnightly variation of Nematoda genera percentage (0-10 cm sediment depth) from June 94 (A1) until August (A28) at station A, in a *Zostera noltii* seagrass bed of t he Mira estuary. See table 4.3 for full samples dates.

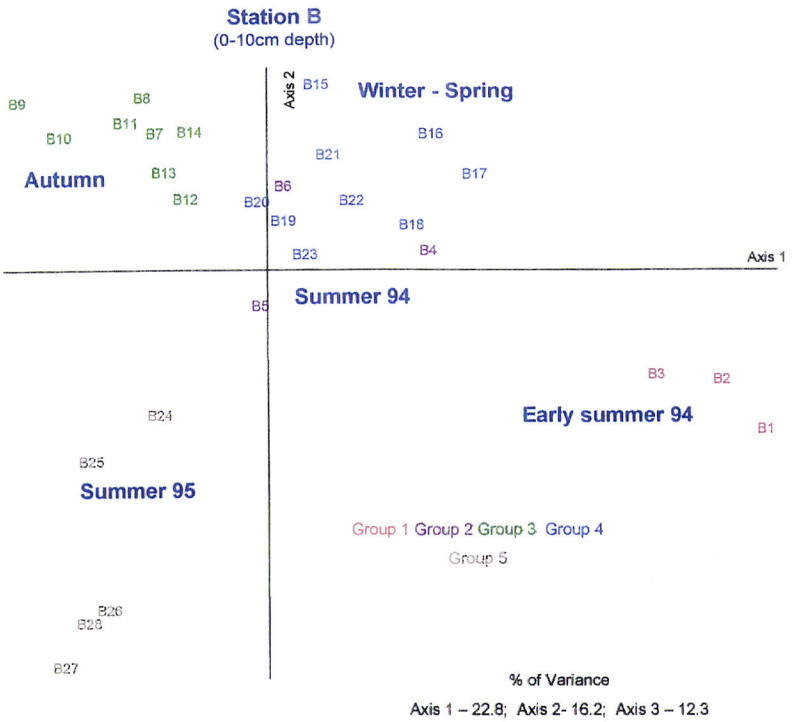


Figure 5.58 - Results of the PCA-ordination based on fortnightly variation of Nematoda genera percentage (0-10 cm sediment depth) from June 94 (B1) until August (B28) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.See table 4.3 for full samples dates.

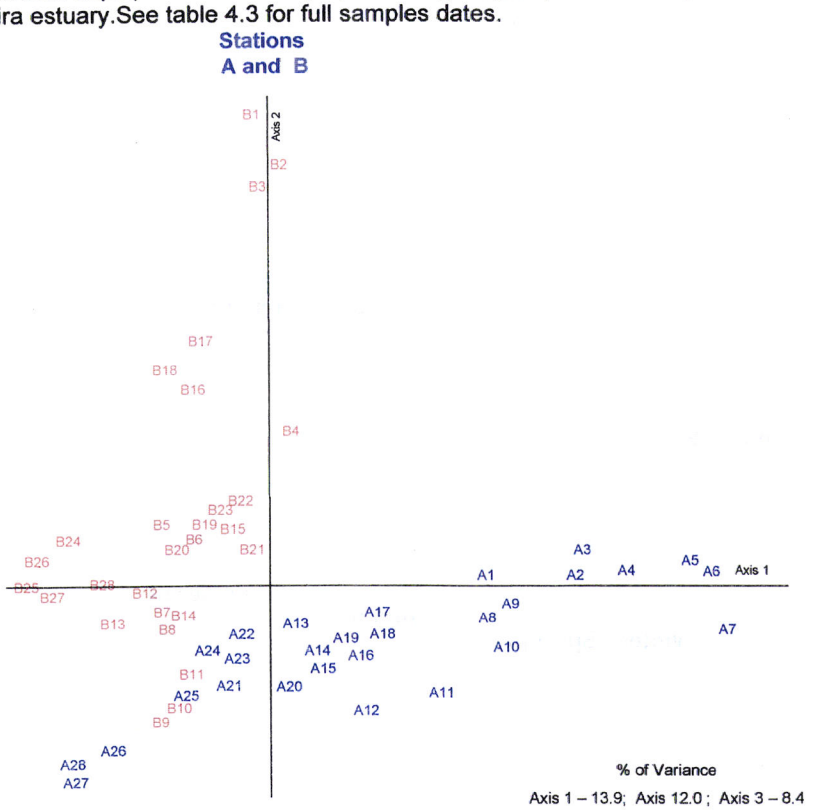


Figure 5.59 -Results of the PCA-ordination based on fortnightly variation of Nematoda Genera (0-10 cm sediment depth) from June 94 (A1;B1) until August (A28;B28) at stations A and B, in a *Zostera noltii* seagrass bed of the Mira estuary. See table 4.3 and 4.4 for full sample dates.

Using the PCA-ordination and Twinspan-classification based on fortnightly variation of Nematoda genera percentage, it was possible to divide the temporal variation of Nematoda communities into seasonal groups (Fig. 5.60 and Fig. 5.61).

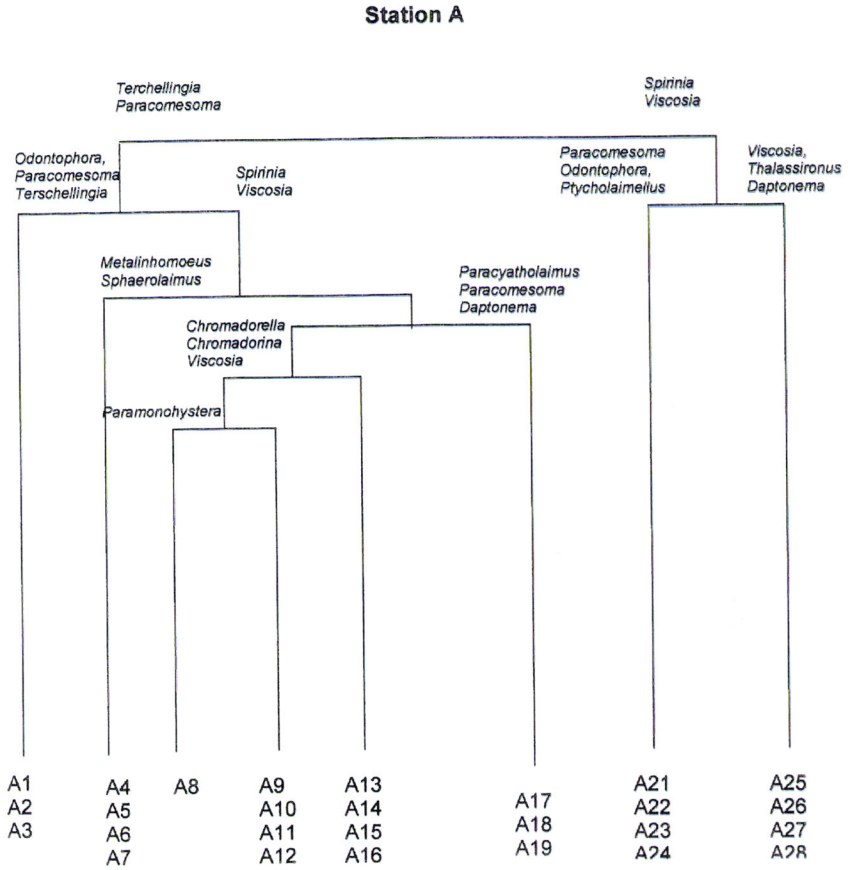


Figure 5.60 – Twinspan analysis of the fortnightly samples from June 94 (A1) to August 95 (A28), at station A. Output of classification based on the Nematoda genera percentage with the indicator species for each division indicated.

The seasonal groups of the both stations are shown in table 5.11. At station A, the seasonal groups were clearly divided into two major groups, one including the samples between summer 94 and early spring 95 (seasonal groups 1, 2, 3 and 4) and the other between late spring until summer 95 (seasonal group 5). This division is according to the temporal variation densities of *Terschellingia*, *Paracomesoma*, *Spirinia* and *Viscosia* : *Terschellingia* and *Paramesoma* registered highest densities from "early summer 94" (seasonal group 1) until "early spring" (seasonal group 4), followed by a tapering off towards in "summer 95" (seasonal group 5). *Spirinia* and *Viscosia* followed the opposite pattern the lowest densities being observed from "early summer 94" (seasonal group 1) until "early spring" (seasonal group 4) followed by an increase in summer 95.

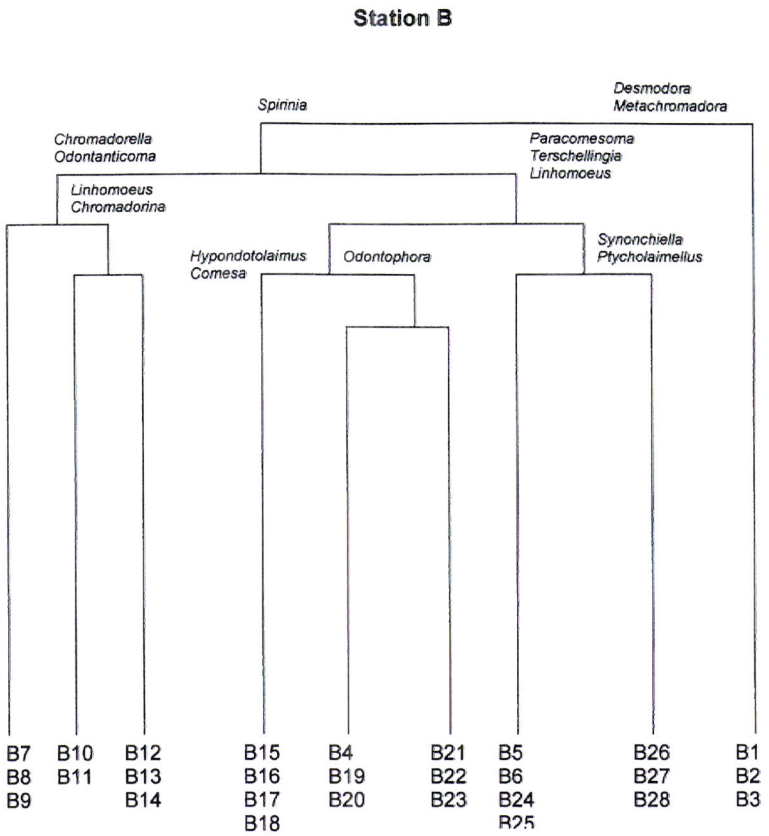


Fig 5.61 – Twinspan analysis of the fortnightly samples from June 94 (B1) to August 95 (B28), at station B. Output of classification based on the Nematoda genera densities with the indicator species for each division indicated.

Table 5.11 – Temporal variation of Nematoda communities and genera composition in seasonal groups provided from the results of Twinspan-classification and PCA-ordination.

Seasonal groups-station A	Seasonal groups-station B
Group 1 A1 (June 94) - A3 (July 94)	Group 1 B1 (June 94) - B3 (July 94)
Group 2 A4 (August 94) - A7 (September t94)	Group 2 B4 (August 94) – B6 (September 94)
Group 3 A8 (October 94) - A12 (December 94)	Group 3 B7 (September 94) - B14 (January 95)
Group 4: A13 (December 94) – A23 (May 95)	Group 4: B15 (January 94) – B23 (May 95)
Group 5 A24 (May 95) - A28 (August 95)	Group 5 B24 (May 95) - B28 (August 95)

At station B, although the seasonal groups were clearly divided into two major groups, one is very small, including only the samples of "early summer 94" (seasonal group 1), which resulted from the presence of *Desmodora* and *Metachromadora* genera in the Nematoda community. The other major group included all samples between "late

summer 94" until "summer 95" (seasonal groups 2, 3, 4 and 5), in which *Spirinia* exhibited highest densities. This major group was also clearly divided into two groups, one including autumn and early winter samples (seasonal group 3) with the highest densities of *Chromadorella*. The other group included the seasonal groups 2, 4, 5 of which *Paracomesoma*, *Terschellingia* and *Linhomoeus* were highest in "summer 94" (seasonal group 2) and "winter-spring" samples (seasonal group 4). Regarding "summer 95" samples (seasonal group 5), *Linhomoeus*, *Synonchiella* and *Ptycholaimellus* were important genera in this period, with their densities increasing.

The Kruskal-Wallis Test (H statistic Kruskal-Wallis; $p<0.001^{***}$) was applied with the aim of detecting significant differences between Nematoda communities of the seasonal groups defined from Twinspan-classification and the PCA-ordination within each sampling station:

- At station A, significant differences between Nematoda genera were obtained: *Terschellingia* (H=13.2; $p<0.01^{**}$), *Paracomesoma* (H=13.0; $p<0.01^{**}$), *Odontophora* (H=16.7; $p<0.01^{**}$), *Spirinia* (H=16.4; $p<0.01^{**}$), *Chromadorella* (H=17.2; $p<0.01^{**}$), *Linhomoeus* (H=15.9; $p<0.01^{**}$), *Daptonema* (H=19.4; $p<0.001^{***}$), *Paramonohystera* (H=13.9; $p<0.01^{**}$), *Chromadorina* (H=16.5; $p<0.01^{**}$), *Paracyatholaimus* (H=15.2; $p<0.01^{**}$), *Viscosia* (H=16.7; $p<0.01^{**}$), *Chromadora* (H=14.6; $p<0.01^{**}$), *Ptycholaimellus* (H=19.8; $p<0.001^{***}$), *Oncholaimellus* (H=16.9; $p<0.01^{**}$), *Bathylaimus* (H=14.8; $p<0.01^{**}$), *Metachromadora remanei* (H=15.4; $p<0.01^{**}$), *Anticoma* (H=15.1; $p<0.01^{**}$), *Sphaerolaimus* (H=21.0; $p<0.001^{***}$), *Megadesmolaimus* (H=19.0; $p<0.001^{***}$), *Molgolaimus* (H=13.0; $p<0.01^{**}$), *Paracanthonchus* (H=14.4; $p<0.01^{**}$), *Metalinhomoeus* (H=17.2; $p<0.01^{**}$), *Campylaimus* (H=10.4; $p<0.05^{*}$), *Eurystomina* (H=20.0; $p<0.001^{***}$), *Odontanticoma* (H=17.5; $p<0.01^{**}$), *Aponema* (H=9.5; $p<0.05^{*}$), *Halalaimus* (H=16.0; $p<0.01^{**}$), *Sabatieria* (H=13.8; $p<0.001^{***}$), *Eleutherolaimus* (H=23.1; $p<0.001^{***}$), *Calyptronema* (H=19.4; $p<0.001^{***}$), *Cyartonema* (H=19.4; $p<0.001^{***}$), *Microlaimus* (H=13.0; $p<0.01^{**}$), *Southerniella* (H=9.5; $p<0.05^{*}$), Neochromadora (H=9.9; $p<0.05^{*}$), *Desmodora* (H=21.6; $p<0.001^{***}$), *Onchium* (H=9.8; $p<0.05^{*}$), *Desmolaimus* (H=14.9; $p<0.01^{**}$), *Acanthopharynx* (H=11.2; $p<0.05^{*}$), *Atrochromadora* (H=17.3; $p<0.01^{**}$), *Wieseria* (H=13.3; $p<0.01^{**}$), *aff Phanodermopsis* (H=9.6; $p<0.05^{*}$), *Parasphaerolaimus* (H=15.0; $p<0.01^{**}$), *aff Cervonema* (H=19.4; $p<0.001^{***}$). Concerning some genera densities, no significant

differences between seasonal groups were obtained: *Camacolaimus*, *Synonchiella*, *Paralinhomoeus*, *Southernia*, *Thalassironus*, *Oxystomina*, *Diodontolaimus* and *Chromaspirina*.

- At station B, significant differences between Nematoda genera were obtained: *Terschellingia* (H=20.6; p<0.001***), *Spirinia* (H=10.6; p<0.05*), *Paracomesoma* (H=24.0; p<0.001***), *Linhomoeus* (H=16.0; p<0.01**), *Odontophora* (H=23.3; p<0.001***), *Paramonohystera* (H=10.0; p<0.05*), *Daptonema* (H=16.2; p<0.01**), *Desmodora* (H=10.0; p<0.05*), *Chromadorina* (H=17.4; p<0.01**), *Camacolaimus* (H=17.8; p<0.001***), *Metachromadora remanei* (H=21.9; p<0.001***), *Viscosia* (H=14.4; p<0.01**), *Chromadora* (H=18.0; p<0.001***), *Ptycholaimellus* (H=19.8; p<0.001***), *Megadesmolaimus* (H=19.0; p<0.001***), *Paracyatholaimus* (H=19.8; p<0.001***), *Molgolaimus* (H=22.2; p<0.001***), *Chromadorella* (H=10.0; p<0.05*), *Paracanthonchus* (H=16.7; p<0.01**), *Oncholaimellus* (H= 18.8; p<0.001***), *Diodontolaimus* (H=16.5; p<0.01**), *Comesa* (H=11.3; p<0.05*), *Setosabatieria* (H=14.5; p<0.01**), *Thalassironus* (H=14.3; p<0.01**), *Southernia* (H=14.9; p<0.01**), *Prochromadorella* (H=12.7; p<0.01**), *Microlaimus* (H=17.1; p<0.01**), *Eurystomina* (H=14.4; p<0.01**), *Oxystomina* (H=10.5; p<0.05*), *Sphaerolaimus* (H=13.5; p<0.01**), *Paralinhomoeus* (H=10.6; p<0.05*), *Metalinhomoeus* (H=13.5; p<0.01**), *Hypodontolaimus* (H=10.5; p<0.05*), *Nemanema* (H=13.8; p<0.01**), *Aponema* (H=18.6; p<0.001***), *Desmoscolex* (H=13.6; p<0.01**), *Calyptronema* (H=17.3; p<0.01**). Concerning some genera densities, no significant differences between seasonal groups were obtained: *Chromadorella*, *Bathylaimus*, *Campylaimus*, *Desmolaimus*, *aff. Cervonema*, *Halalaimus*, *Odontanticoma*, *Hypodontolaimus*, *Dichromadora*, *Eleutherolaimus*, *Wieseria*, *Aegioloalaimus* and *Belbolla*.

Considering genera abundance >1% collected at station A, the Mann-Whitney Test (Z statistic Mann-Whitney; p<0.001***) was applied with the aim of detecting the differences between Nematoda communities of the seasonal groups:

> "Early summer 94 - Summer 94" (seasonal group 1 - seasonal group 2): no significant differences were detected.

"Early summer 94 - Autumn" (seasonal group1 – seasonal group3): *Odontophora*, *Spirinia*, *Daptonema*, *Chromadorina*, *Paracyatholaimus*, *Chromadora*, *Metachromadora remanei* and *Anticoma* (Z=2.2; p<0.05*).

"Early Summer 94 - Winter-Spring" (seasonal group 1 – seasonal group 4): *Odontophora*, *Spirinia*, *Prochromadorella*, *Paramonohystera*, *Ptycholaimellus*, *Metachromadora remanei*, *Anticoma*, *Sphaerolaimus* and *Megadesmolaimus* (Z=2.3; p<0.05*),

"Early summer 94 - Summer 95" (seasonal group 1 – seasonal group 5): *Terschellingia*, *Odontophora Paracomesoma*, *Spirinia*, *Prochromadorella*, *Linhomoeus*, *Paramonohystera*, *Chromadorina*, *Paracyatholaimus*, *Anticoma* and *Molgolaimus* (Z=2.2; p<0.05*).

"Early summer 94 - Autumn" (seasonal group 2 – seasonal group 3): *Spirinia*, *Chromadorina*, *Paracyatholaimus* (Z=2.4; p<0.05*), *Metachromadora remanei* (Z=2.2; p<0.05*), *Anticoma* (Z=2.4; p<0.05*).

"Summer 94 – Winter - Spring" (seasonal group 2 – seasonal group 4): *Spirinia* (Z=2.9; p<0.001***), *Daptonema* (Z=2.7; p<0.01**), *Paramonohystera*, *Ptycholaimellus*, *Megadesmolaimus* (Z=2.9; p<0.001***) and *Anticoma* (Z=2.2; p<0.05*).

"Summer 94 - Summer 95" (seasonal group 2 - seasonal group 5): *Terschellingia*, *Paracomesoma*, *Odontophora*, *Spirinia*, *Linhomoeus*, *Viscosia*, *Paramonohystera*, *Paracyatholaimus*, *Chromadorina*, *Metachromadora remanei* and *Anticoma* (Z=2.5; p<0.05*).

"Autumn–Winter - Spring" (seasonal group 3 - seasonal group 4): *Daptonema*, *Viscosia*, *Ptycholaimellus* (Z=3.1; p<0.001***), *Megadesmolaimus* (Z=2.8; p<0.01**) and *Molgolaimus* (Z=2.0; p<0.05*).

"Autumn - Summer 95" (seasonal group 3 - seasonal group 5): *Terschellingia*, *Paracomesoma*, *Odontophora* (Z=2.1; p<0.05*), *Linhomoeus* (Z=2.6;

p<0.01**), *Daptonema* (Z=2.1; p<0.05*), *Chromadorina*, *Paracyatholaimus*, *Chromadora*, *Oncholaimellus* (Z=2.6; p<0.01**).

"Winter - Spring" (seasonal group 4 - seasonal group 5): *Terschellingia*, *Paracomesoma*, *Odontophora*, *Linhomoeus* (Z=3.1; p<0.001***), *Daptonema* (Z=2.3; p<0.05*), *Viscosia* (Z=2.6; p<0.01**), *Paracyatholaimus*, *Chromadorina* (Z=3.1; p<0.001***), *Chromadora*, *Ptycholaimellus* (Z=2.7; p<0.05*) and *Oncholaimellus* (Z=3.1; p<0.001***).

Considering genera abundance >1% collected at station B, the Mann-Whitney Test (Z statistic Mann-Whitney; p<0.001***) was applied with the aim of detecting the differences between Nematoda communities of the seasonal groups:

"Early summer 94 - Summer 94" (seasonal group 1 – seasonal group 2): no significant differences were detected.

"Early summer 94 - Autumn" (seasonal group 1 – seasonal group 3): *Paracomesoma*, *Odontophora*, *Paramonohystera*, *Chromadorina*, *Camacolaimus*, *Metachromadora remanei*, *Viscosia*, *Ptycholaimellus* (Z=2.0; p<0.05*), *Megadesmolaimus*, *Paracyatholaimus*, *Molgolaimus* (Z=2.5; p<0.05*).

"Early summer 94 - Winter-Spring" (seasonal group 1 – seasonal group 4): *Paracomesoma* (Z=2.1; p<0.05*), *Paramonohystera*, *Daptonema*, *Camacolaimus*, *Metachromadora remanei*, *Ptycholaimellus*, *Megadesmolaimus*, *Paracyatholaimus* and *Molgolaimus* (Z=2.5; p<0.01**).

"Early summer 94 - Summer 95" (seasonal group 1 – seasonal group 5): *Terschellingia*, *Spirinia*, *Paracomesoma*, *Odontophora*, *Paramonohystera*, *Camacolaimus*, *Metachromadora remanei*, *Viscosia*, *Chromadora*, *Paracyatholaimus*, *Molgolaimus* and *Bathylaimus* (Z=2.2; p<0.05*).

"Summer 94 - Autumn" (seasonal group 2 – seasonal group 3): *Paramonohystera*, *Chromadorina* *Chromadora*, *Ptycholaimellus* and *Paracyatholaimus* (Z=2.4; p<0.01**).

"Summer 94 – Winter-Spring" (seasonal group 2 – seasonal group 4): *Paracomesoma*, *Linhomoeus*, *Daptonema*, *Metachromadora remanei* *Chromadora*, *Ptycholaimellus*, *Megadesmolaimus* and *Molgolaimus* (Z=2.4; p<0.01**).

"Summer 94 – Summer 95" (seasonal group 2 – seasonal group 5): *Terschellingia*, *Paracomesoma* *Odontophora*, *Chromadorina*, *Camacolaimus*, *Viscosia* and *Ptycholaimellus* (Z=2.2; p<0.05*).

"Autumn – Winter-Spring" (seasonal group 3 – seasonal group 4): *Terschellingia* (Z=-3.2; p<0.001***), *Paracomesoma* (Z=3.5; p<0.001*), *Linhomoeus* (Z=-3.2; p<0.001***), *Odontophora* (Z=-3.5; p<0.001***), *Camacolaimus* (Z=2.2; p<0.05*), *Metachromadora remanei*, *Ptycholaimellus*, *Megadesmolaimus* (Z=-3.5; p<0.001***), *Paracyatholaimus* (Z=-2.3; p<0.05*) and *Molgolaimus*.

"Autumn – Summer 95" (seasonal group 3 – seasonal group 5): *Terschellingia* (Z=-2.9; p<0.01**) *Spirinia* (Z=-2.5; p<0.01**), *Paracomesoma* (Z=-2.9; p<0.01**), *Odontophora* (Z=-2.8; p<0.01**), *Daptonema* (Z=-2.0; p<0.05*), *Chromadorina* (Z=-2.9; p<0.01**), *Camacolaimus* (Z=-2.9; p<0.01**), *Viscosia* (Z=-2.8 p<0.01**), *Chromadora*, *Ptycholaimellus* (Z=-2.3 p<0.01**), *Paracyatholaimus* (Z=-2.9; p<0.01**).

"Winter – Spring" (seasonal group 4 – seasonal group 5): *Terschellingia*, *Paracomesoma* (Z=-3.0; p<0.001***), *Linhomoeus* (Z=-2.0; p<0.05*), *Odontophora* (Z=-3.0; p<0.001***), *Daptonema* (Z=-2.9; p<0.01**), *Chromadorina* (Z=-2.7; p<0.01**), *Metachromadora remanei* (Z=-3.0; p<0.001***), *Viscosia* (Z=-2.7; p<0.01**), *Chromadora* (Z=-3.0; p<0.001***), *Megadesmolaimus* (Z=-2.7; p<0.01**), *Ptycholaimellus* (Z=-2.3; p<0.01**), *Molgolaimus* (Z=-3.0; p<0.001***).

The seasonal patterns of *Terschellingia*, *Paracomesoma* and *Odontophora* genera registered the lowest abundances in "summer 95" (group 5). However, the seasonal patterns differ between both stations, at station A, *Terschellingia* density declining

continuously after "summer 94" (group 2), with the lowest abundances found in "summer 95" (group 5). At station B, a slight decline was observed between "early summer 94" (group 1) and autumn, followed by an increase, the highest values being attained in "winter-spring" (group 4). *Paracomesoma* presented the same seasonal pattern at both stations. The densities declined from "early summer 94" (group 1) until "autumn" (group 3), the highest values being attained in winter-spring (group 4). However, at station B, the "winter-spring" densities increase was more accentuated. At both stations, *Odontophora* declined between "early summer" 94 (group 1) until "summer 94" (group 2). At station A, the densities were constant from "summer 94" (group 2) until "winter-spring" (group 4), though at station B a decline was registered between "summer 94" (group 2) and "autumn" (group 3), followed by an increase until "winter-spring" (group 4) (Fig. 5.62).

The *Spirinia* seasonal pattern showed an opposite trend to the dominant genera described above (*Terschellingia*, *Paracomesoma* and *Odontophora*). At both stations, densities increased continuously from "early summer" 94 (group 1) until "summer 95" (group 5), and exhibited the highest abundances in "summer 95" (group 5). At both stations, *Chromadorella* and *Chromadorina* had the same seasonal patterns, with the highest densities in autumn (group 3) followed slightly decline (Fig. 5.63).

Linhomoeus, *Daptonema* and *Paramonohystera* registered some differences between stations: *Linhomoeus* densities presented a clear opposite trend between "summer 94" (group 2) and "autumn" (group 3), at station A densities being enhanced, while at station B, the lowest values were obtained; at station A, *Daptonema* densities declined until "autumn" (group 3) when the lowest values were attained, and at station B, an accentuated increase was observed in the same period; at station A *Paramonohystera* exhibited the highest values in autumn, whereas at station B, this was attained in "early summer 94" (Fig. 5.64).

At station B, *Desmodora* were highest in "early summer 94" (group1), followed by lower densities. At both stations, *Paracyatholaimus* showed the lowest densities in "early summer" (group 1) and in "summer 95" (group 5), while at station A the highest values were in "winter-spring" (group 4), and at station B they were in "autumn" (group 3). *Viscosia* seasonal patterns were similar between both stations lowest densities

being registered in summer 94 (group 1 and group 2) and highest in summer 95 (group 5) (Fig. 5.65).

Chromadora seasonal patterns also were similar between stations, the highest densities being obtained in "winter-spring" (group 4), followed by an accentuated decline, with lower values obtained in "summer 95" (group 5). *Camacolaimus* seasonal pattern was different; at station A, the highest densities were obtained in "winter-spring" (group 4), while at station B, after "summer 94" they declined continuously. However, at both sampling stations, lowest densities were in "early summer 94" and an important increase occurred during "summer 95" (group 5). *Ptycholaimellus* displayed the same seasonal trends, lowest densities being registered in summer 94 (station A - group 1; station B - group 2) and the highest densities being in "winter-spring" (group 4) (Fig. 5.66).

Oncholaimellus seasonality differed between stations, station A presenting the highest densities in "summer 94" (group 2) and in "autumn" (group 3), while in "summer 95" (group 5) the lowest values were obtained. At station B, highest values were in "autumn" (group 3) followed by a decline, although "summer 95" (group 5) densities were higher than in summer 94 (group 1; group 2). At both stations, *Metachromadora remanei* registered similar seasonal patterns, with the highest values in "early summer 94" (group 1) and the lowest in "summer 95" (group 5); indeed at station A they disappeared. *Southernia* seasonal variation presented an opposite trend at both stations: at station A, the highest densities were obtained in "winter-spring" (group 4), at station B in "autumn" (group 3) (Fig. 5.67).

At both stations, *Megadesmolaimus*, registered similar seasonal patterns with the highest values in "winter-spring" (group 4) and the lowest in "early summer 94" (group 1) and "summer 94" (group 2). *Paracyatholaimus* registered similar trends at both stations, at station A the highest values being obtained between "summer 94" (group 2) and "winter-spring" (group 4), while at station B they were between "autumn" and "winter-spring" (group 4). At both stations, in "early summer 94" (group 1) and "summer 94" (group 2) *Molgolaimus* presented different trends, although in the remaining sampling period they were very similar (Fig. 5.68).

The Nematoda community seasonal distribution of the genera with lower densities (<1%) is described in annex *III*.

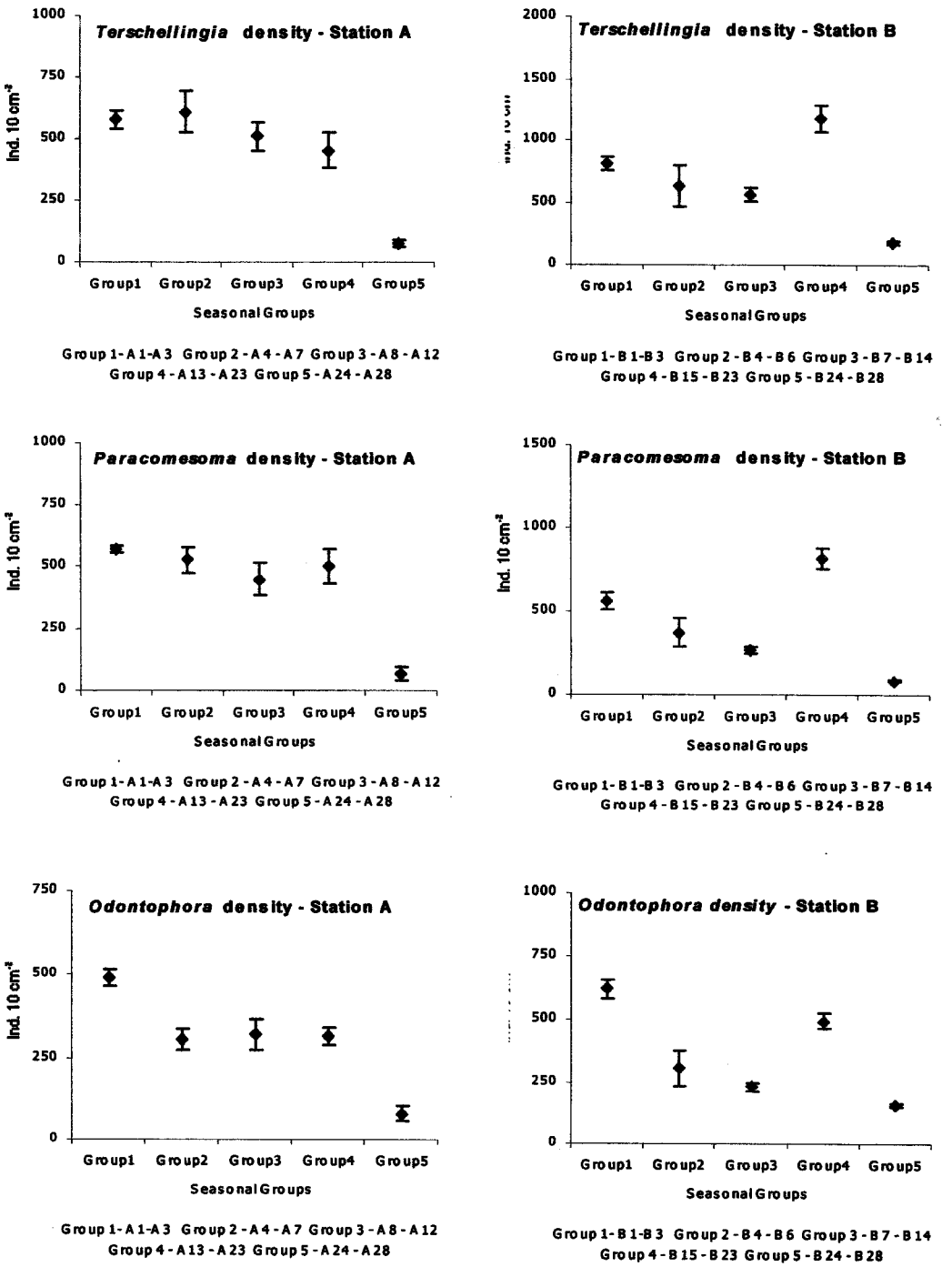
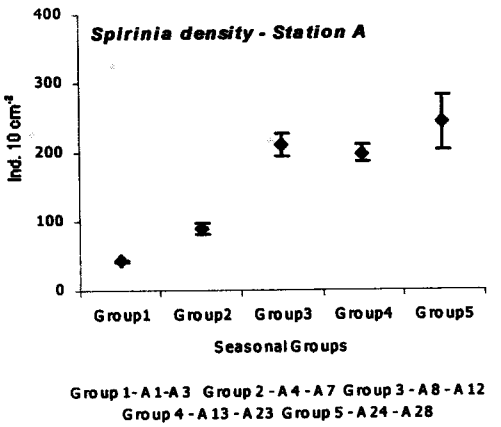
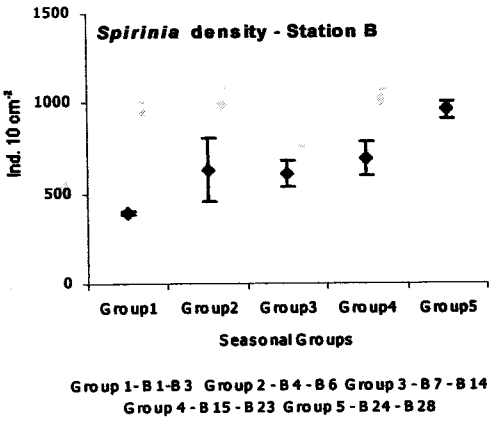
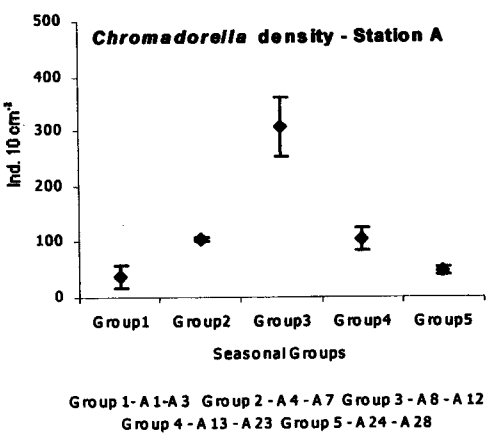
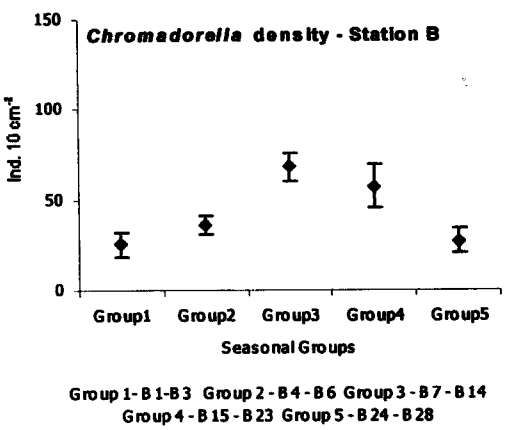


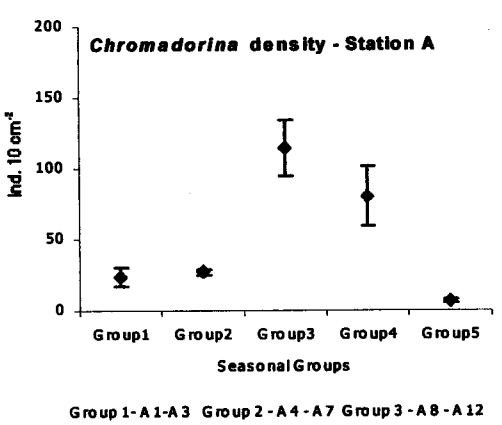
Figure 5.62 – Seasonal variation of the Nematoda genera densities (>1%), at stations A and B, in sediment of a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.











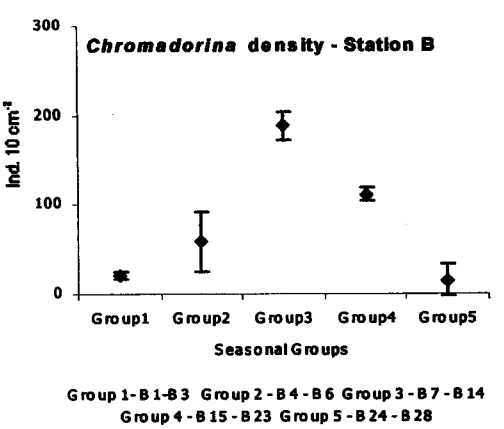
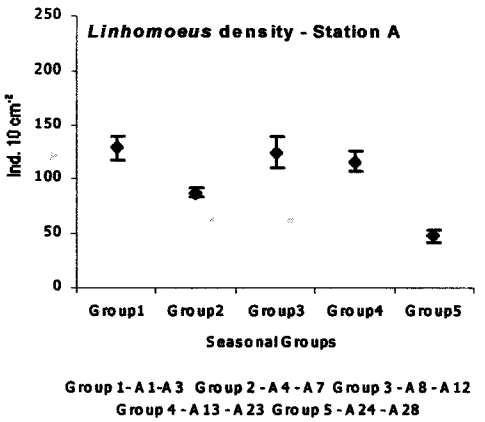
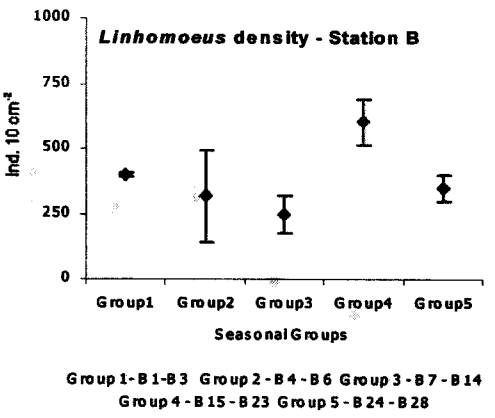
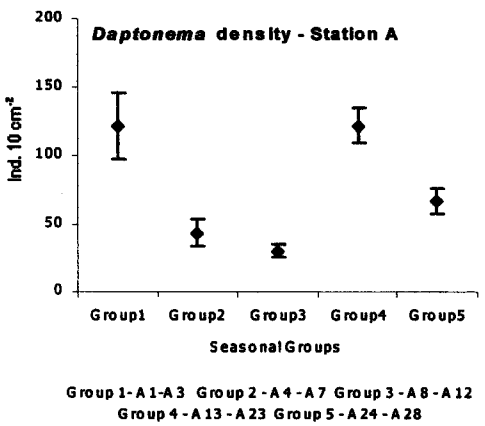
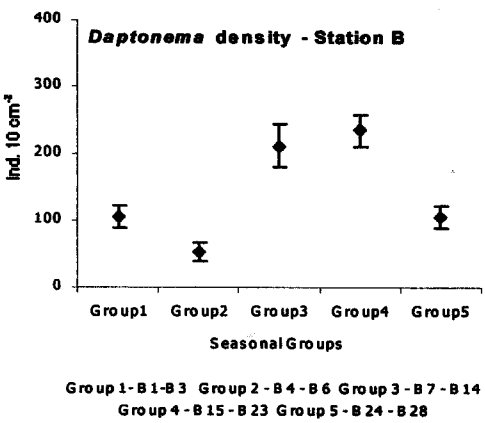


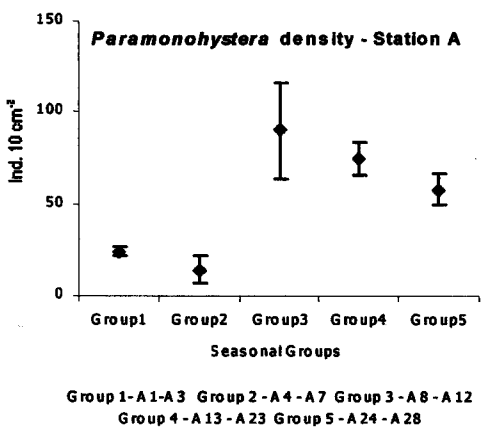
Figure 5.63 – Seasonal variation of the Nematoda genera densities (>1%), at stations A and B, in sediment of a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.











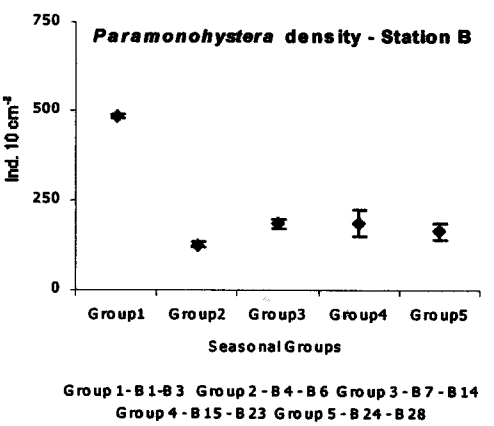


Figure 5.64 – Seasonal variation of the Nematoda genera densities (>1%), at stations A and B, in sediment of a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

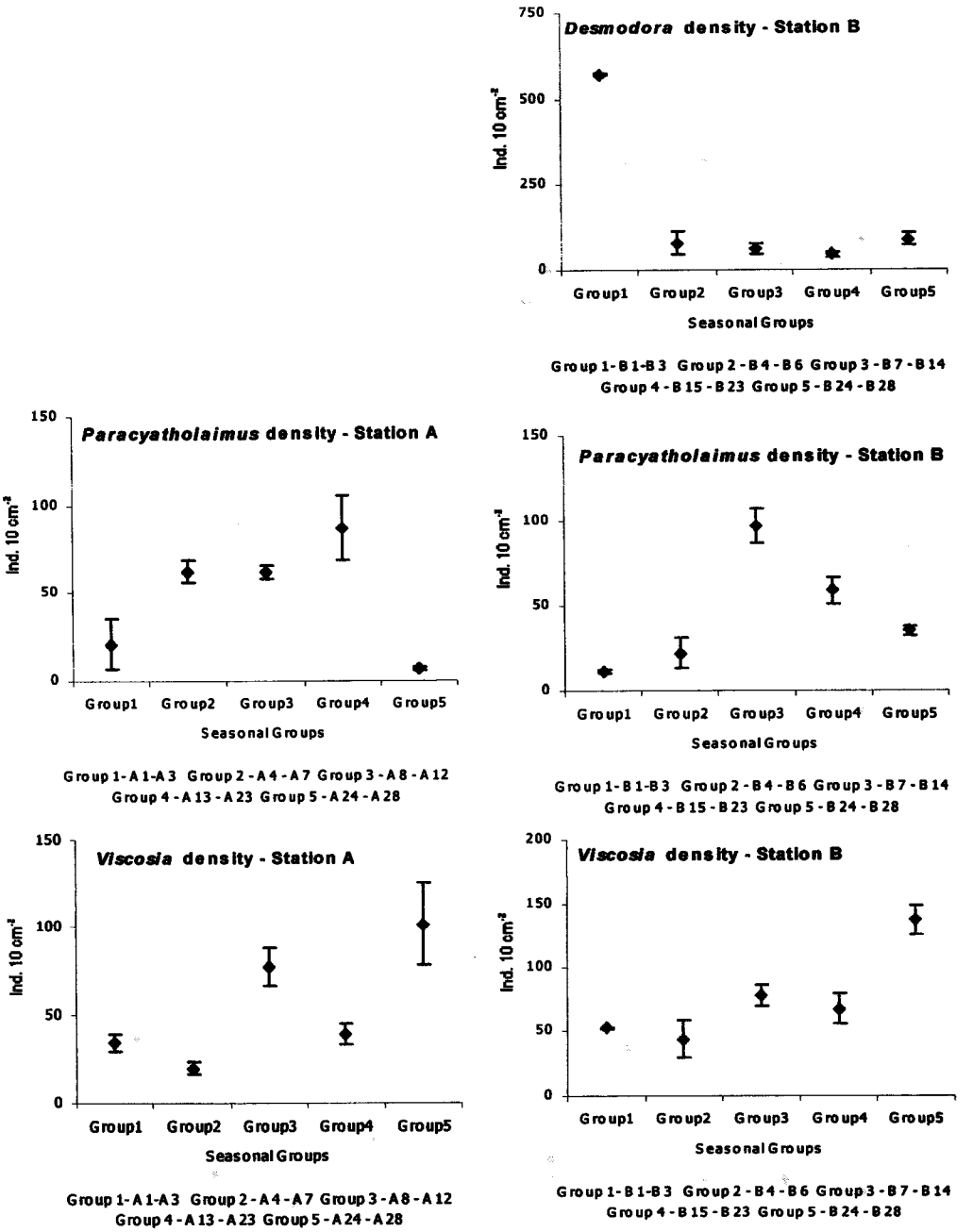


Figure 5.65 – Seasonal variation of the Nematoda genera densities (>1%), at stations A and B, in sediment of a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

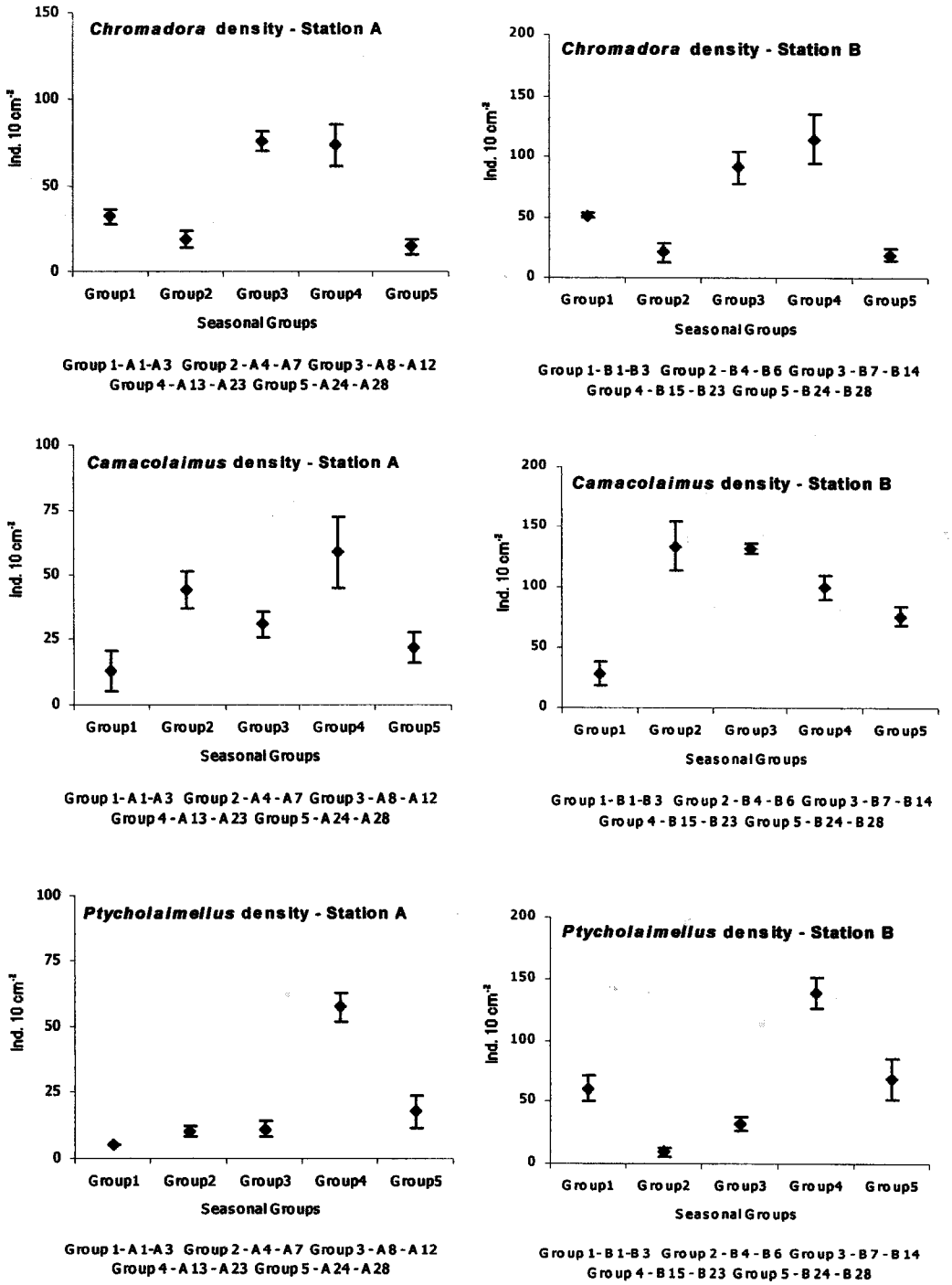


Figure 5.66 – Seasonal variation of the Nematoda genera densities (>1%), at stations A and B, in sediment of a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

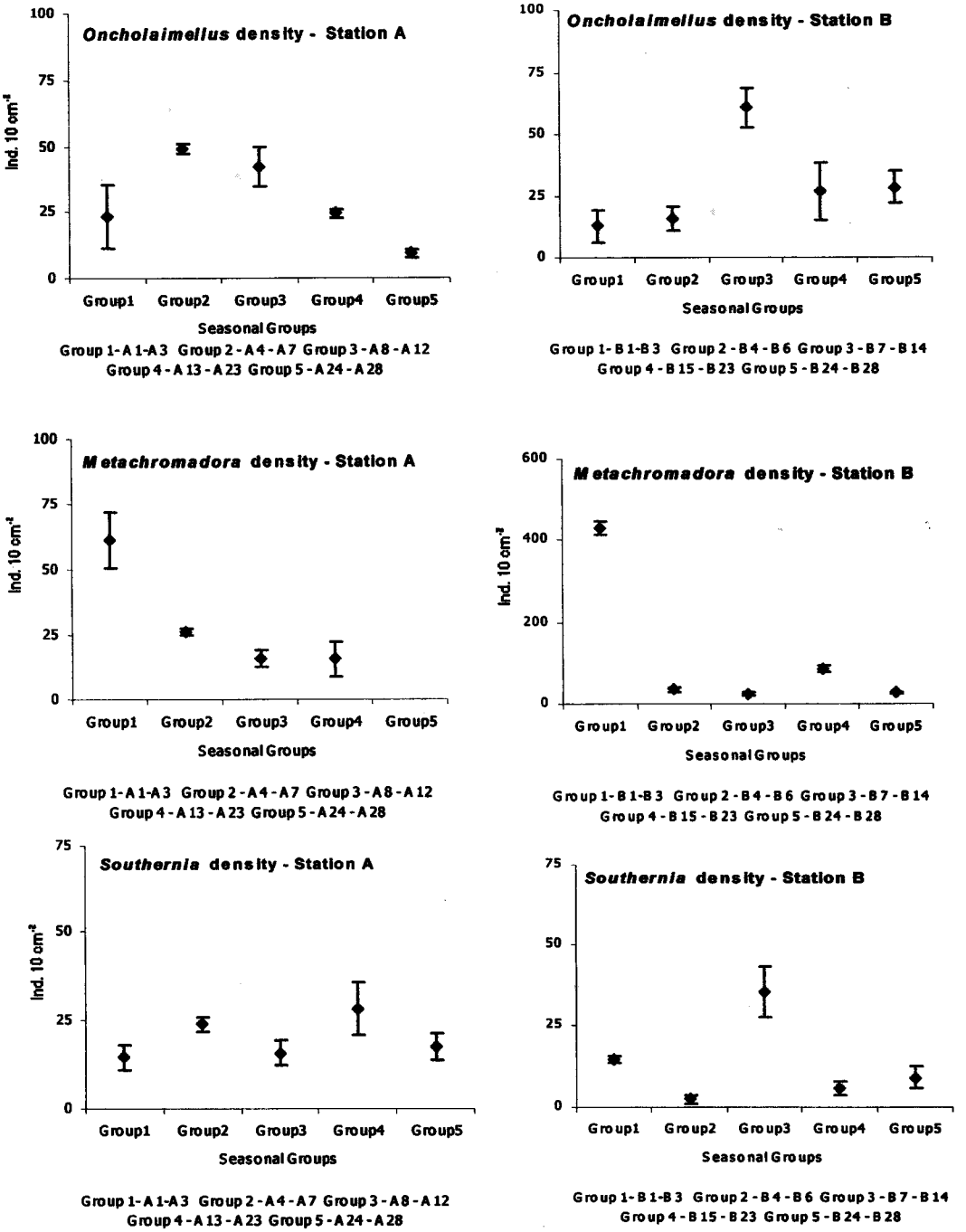


Figure 5.67 – Seasonal variation of the Nematoda genera densities (>1%), at stations A and B, in sediment of a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

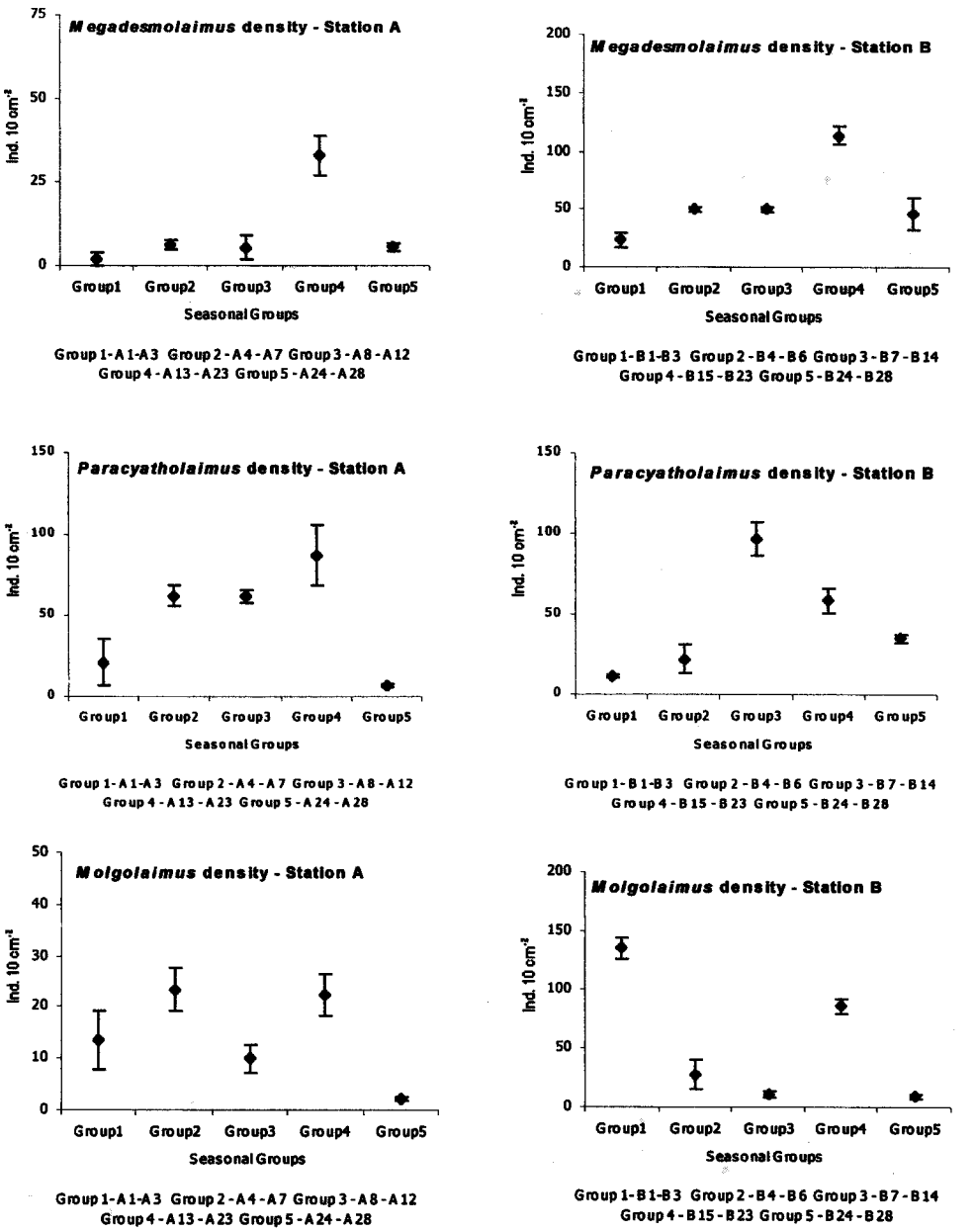


Figure 5.68 – Seasonal variation of the Nematoda genera densities (>1%), at stations A and B, in sediment of a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1; B1) to August 95 (A28; B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

b) Seasonal patterns of the vertical variations

The densities of the most abundant Nematoda genera collected in the surface sediment layer (0-3 cm depth) structured the pattern of total density, as a result of their high relative contribution to the total number. Therefore, based on seasonal groups determined from the Twinspan-classification and PCA-ordination applied to the 0-10cm sediment layer, there was also defined the temporal variation of Nematoda densities into seasonal groups, for each sediment layer studied: level1 (0-3 cm), level2 (3-6 cm) and level 3 (6-10 cm) (Fig 5.57 and Fig. 5.58).

The Kruskal-Wallis Test (H statistic Kruskal-Wallis; $p<0.001^{***}$) was applied with the aim of detecting significant differences between the seasonal groups of each sediment layer:

- At station A, level 1 (0-3 cm depth), significant differences were obtained: *Terschellingia* (H=12.8; $p<0.05^{*}$), *Paracomesoma* (H=14.6; $p<0.01^{**}$), *Odontophora* (H=16.3; $p<0.01^{**}$), *Spirinia* (H=17.2; $p<0.01^{**}$), *Chromadorella* (H=17.2; $p<0.01^{**}$), *Linhomoeus* (H=10.0; $p<0.05^{*}$), *Daptonema* (H=19.3; $p<0.001^{***}$), *Paracyatholaimus* (H=14.5; $p<0.01^{**}$), *Chromadora* (H=13.9; $p<0.01^{**}$), *Ptycholaimellus* (H=23.2; $p<0.001^{***}$), *Oncholaimellus* (H=12.9; $p<0.01^{**}$), *Bathylaimus* (H=14.9; $p<0.01^{**}$), *Metachromadora remanei* (H=14.9; $p<0.01^{**}$), *Anticoma* (H=14.2; $p<0.01^{**}$), *Sphaerolaimus* (H=18.9; $p<0.001^{***}$), *Megadesmolaimus* (H=19.4; $p<0.001^{***}$), *Oxystomina* (H=10.0; $p<0.05^{*}$), *Southernia* (H=22.0; $p<0.001^{***}$), *Molgolaimus* (H=11.2; $p<0.05^{*}$), *Metalinhomoeus* (H=17.4; $p<0.01^{**}$), *Campylaimus* (H=10.3; $p<0.05^{*}$), *Eurystomina* (H=13.8; $p<0.01^{**}$), *Prochromadorella* (H=14.9; $p<0.01^{**}$), *Odontanticoma* (H=17.5; $p<0.01^{**}$), *Aponema* (H=11.0; $p<0.05^{*}$), *Eleutherolaimus* (H=27.0; $p<0.001^{***}$), *Calyptronema* (H=19.4; $p<0.001^{***}$), *Cyartonema* (H=19.4; $p<0.001^{***}$), *Microlaimus* (H=13.6; $p<0.01^{**}$), *Desmodora* (H=14.9; $p<0.01^{**}$), *Onchium* (H=9.8; $p<0.05^{*}$), *Desmolaimus* (H=14.9; $p<0.01^{**}$), *Atrochromadora* (H=17.3; $p<0.01^{**}$), *Wieseria* (H=14.9 ; $p<0.01^{**}$), *aff Phanodermopsis* (H=9.7; $p<0.05^{*}$), *Parasphaerolaimus* (H=14.9; $p<0.01^{**}$), *aff Cervonema* (H=19.4; $p<0.001^{***}$). No significant differences were detected in *Chromaspirina*, *Chromadorina*, *Camacolaimus*, *Halalaimus*, *Leptolaimus*, *Nemanema*, *Neochromadora*, *Paracanthonchus*, *Paralinhomoeus*, *Paramonohystera*, *Sabatieria*, *Southerniella*, *Synonchiella*, *Thalassironus* and *Viscosia*.

- At station A, level 2 (3-6 cm depth), significant differences were obtained: *Paracomesoma* (H=14.0; p<0.01**), *Odontophora* (H=12.7; p<0.05*), *Spirinia* (H=12.1; p<0.05*), *Chromadorella* (H=20.6; p<0.001***), *Paramonohystera* (H=16.1; p<0.01**), *Daptonema* (H=19.4; p<0.001***), *Chromadorina* (H=15.9; p<0.01**), *Chromadora* (H=12.2; p<0.05*), *Southernia* (H=11.2; p<0.05*), *Ptycholaimellus* (H=24.0; p<0.001***), *Oncholaimellus* (H=12.4; p<0.05*), *Paracanthonchus* (H=12.6; p<0.05*), *Bathylaimus* (H=17.0; p<0.01**), *Paralinhomoeus* (H=9.6; p<0.05*) *Metachromadora remanei* (H=10.3; p<0.05*), *Anticoma* (H=15.7; p<0.01**), *Sphaerolaimus* (H=13.1; p<0.01**), *Megadesmolaimus* (H=16.9; p<0.01**), *Molgolaimus* (H=13.7; p<0.01**), *Metalinhomoeus* (H=10.1; p<0.05*), *Eurystomina* (H=22.6; p<0.001***), *Odontanticoma* (H=20.6; p<0.001***), *Eleutherolaimus* (H=12.3.; p<0.05*), *Microlaimus* (H=19.4; p<0.001***), *Desmodora* (H=27.0; p<0.001***), *Acantopharynx* (H=10.6; p<0.05*) *Neochromadora* (H=14.9; p<0.01***) and *Prochromadorella* (H=14.9; p<0.01**) *Viscosia* (H=19.2; p<0.001***). No significant differences were detected in *Terschellingia*, *Linhomoeus*, *Camacolaimus*, *Synonchiella*, *Thalassironus*, *Paracyatholaimus*, *Oxystomina*, *Diodontolaimus*, *Campylaimus*, *Acanthopharynx*, *Aponema*, *Sabatieria*, *Halalaimus*, *Southerniella* and *Antomicron*.

- At station A, level 3 (6-10 cm depth) significant differences between were obtained: *Paracomesoma* (H=11.1; p<0.05*), *Spirinia* (H=14.6; p<0.01**), *Viscosia* (H=18.0; p<0.001***), *Paramonohystera* (H=16.9; p<0.01**), *Chromadorella* (H=12.7; p<0.05*), *Paracyatholaimus* (H=11.8; p<0.05*), *Linhomoeus* (H=20.2; p<0.001***), *Daptonema* (H=9.8; p<0.05*), *Chromadora* (H=15.1; p<0.01**), *Southernia* (H=13.4; p<0.01**), *Paroxystomina* (H=17.2; p<0.01**), *Wieseria* (H=14.9; p<0.01**) and *Ptycholaimellus* (H=10.3; p<0.05*). No significant differences were detected in *Odontophora*, *Terschellingia*, *Camacolaimus*, *Paracanthonchus*, *Oncholaimellus*, *Chromadorina*, *Bathylaimus*, *Campylaimus*, *Molgolaimus*, *Thalassironus*. *Synonchiella*, *Oxystomina*, *Diodontolaimus*, *Sphaerolaimus*, and *Sabatieria*.

- At station B, level 1 (0-3 cm depth), significant differences between Nematoda genera were obtained: *Terschellingia* (H=21.1; p<0.001***), *Paracomesoma* (H=22.3; p<0.001***), *Odontophora* (H=15.2; p<0.01**), *Linhomoeus* (H=16.2; p<0.01**), *Daptonema* (H=18.5; p<0.001***), *Chromadorina* (H=19.4; p<0.001***),

Metachromadora remanei (H=19.9; p<0.001***), *Viscosia* (H=9.7; p<0.05*), *Chromadora* (H=21.2; p<0.001***), *Ptycholaimellus* (H=19.8; p<0.001***), *Desmodora* (H=18.0; p<0.001***), *Paracanthonchus* (H=15.8; p<0.01**), *Paracyatholaimus* (H=14.8; p<0.01**), *Oncholaimellus* (H=13.5; p<0.01**), *Camacolaimus* (H=11.0; p<0.05*), *Synonchiella* (H=15.2; p<0.05*), *Setosabatieria* (H=18.0; p<0.001***), *Campylaimus* (H=9.8; p<0.05*), *Anticoma* (H=13.6; p<0.05*), *Microlaimus* (H=16.0; p<0.01**), *Thalassironus* (H=11.7; p<0.05*), *Diodontolaimus* (H=10.2; p<0.05*), *Prochromadorella* (H=12.4; p<0.05*), *Eurystomina* (H=15.1; p<0.01**), *Comesa* (H=18.3; p<0.001***), *Nemanema* (H=15.0; p<0.01**), *Halalaimus* (H=17.7; p<0.001***), *Southernia* (H=21.6; p<0.001***), *Sabatieria* (H=14.9; p<0.01**), Descolomex (H=13.6; p<0.01**), *Dichocromadora* (H=13.6; p<0.01**) and *Aponema* (H=14.9 p<0.01**). No significant differences were detected in *Chromadorella*, *Metalinhomoeus* and *Belbolla*.

- At station B, level 2 (3-6 cm cm depth), significant differences were obtained: *Linhomoeus* (H=11.7; p<0.05*), *Terschellingia* (H=18.3; p<0.001***), *Paramonohystera* (H=15.8; p<0.01**), *Odontophora* (H=15.0; p<0.01**), *Paracomesoma* (H=20.4; p<0.001***), *Camacolaimus* (H=21.2; p<0.001***), *Daptonema* (H=14.1; p<0.01**), *Desmodora* (H=16.3; p<0.01**), *Chromadorina* (H=19.5; p<0.001***), *Megadesmolaimus* (H=20.0; p<0.001***), *Metachromadora remanei* (H=15.6; p<0.01**), *Synonchiella* (H=16.4; p<0.01**), *Chromadorella* (H=13.7; p<0.01**), *Ptycholaimellus* (H=9.9; p<0.05*), *Chromadora* (H=12.9; p<0.05*), *Paracyatholaimus* (H=18.7; p<0.01**), *Southernia* (H=19.4; p<0.001***), *Anticoma* (H=11.7; p<0.05*), *Oncholaimellus* (H=19.4; p<0.001***), *Diodontolaimus* (H=14.9; p<0.01**), *Setosabatieria* (H=27.0; p<0.001***), *Comesa* (H=16.2; p<0.01**), *Molgolaimus* (H=11.0; p<0.05*), *Sphaerolaimus* (H=22.7; p<0.001***), *Dichromadora* (H=14.9; p<0.01**), *Nemanema* (H=13.6; p<0.01**), *Aponema* (H=13.6; p<0.01**), *Paralinhomoeus* (H=14.9; p<0.001***), *Bathyeurystomina* (H=17.3; p<0.01**) and *Desmoscolex* (H=13.6; p<0.01**). No significant difference was detected in *Viscosia*.

- At station B, level 3 (6-10 cm depth) significant differences between Nematoda genera were obtained: *Terschellingia* (H=10.8; p<0.05*), *Spirinia* (H=17.6; p<0.001***), *Paracomesoma* (H=14.0; p<0.01**), *Odontophora* (H=13.5; p<0.01**), *Linhomoeus* (H=15.0; p<0.01**), *Daptonema* (H=11.2; p<0.05*), *Metachromadora*

remanei (H=12.4; p<0.05*), *Viscosia* (H=15.9; p<0.01**), *Ptycholaimellus* (H=14.7; p<0.01**), *Desmodora* (H=12.2; p<0.01**), *Molgolaimus* (H=20.1; p<0.001***), *Paramonohystera* (H=15.5; p<0.01**), *Chromadorella* (H=10.5; p<0.05*), *Paracyatholaimus* (H=14.0; p<0.01**), *Oncholaimellus* (H=9.5; p<0.05*), *Camacolaimus* (H=17.2; p<0.01**), *Megadesmolaimus* (H=10.9; p<0.05*), *Campylaimus* (H=16.0; p<0.01**), *Anticoma* (H=12.1; p<0.01**), *Bathylaimus* (H=11.1; p<0.05*), *Thalassironus* (H=9.6; p<0.05*), *Sphaerolaimus* (H=9.6; p<0.05*), *Diodontolaimus* (H=10.2; p<0.05*), *Paralinhomoeus* (H=17.0; p<0.01**), *Prochromadorella* (H=15.3; p<0.01**), *Eurystomina* (H=17.0; p<0.01**), *Dichromadora cephalata* (H=10.3; p<0.05*) and *Aponema* (H=17.2; p<0.01**). No significant differences were detected in *Anticompsis*, *Eleutherolaimus*, *aff. Cervonema*, *Wieseria*, *Oxystomina*, *Paracanthonchus*, *Monoposthia* and *Thoracostoma*.

At both stations, Nematoda densities of the seasonal groups at 0-3 cm depth confirm that seasonality was very similar to that obtained in the global results (0-10 cm depth).

At station A, in the three sediment layers studied, *Terschellingia* seasonal patterns were similar, in that densities decreased continuously until "summer 95" (group 5). However, at station B, the seasonal pattern of the surface sediment layer differed from that of the lower sediment layers, with densities declining from "early summer" (group 1) until autumn (group 3), whereas in deeper layers an opposite trend was registered, with densities increasing from "early summer" (group 1) until "winter-spring" (group 4) (Fig. 5.69). The vertical seasonal patterns within the sediments of the *Paracomesoma* were similar, with densities increasing continuously until "winter-spring" (group 4) followed by accentuated decline in "summer 95" (group 5) (Fig. 5.75).

At station A, *Odontophora* seasonal patterns within sediments were more or less similar, with the highest densities in "winter-spring" (group 4), followed by a sharp decline in "summer 95" (group 5) (Fig. 5.70).

At station B, this accentuated decline was also registered in "summer 95" (group 5). However, the seasonal patterns within sediments differed, in the surface layer the densities declining from "early summer 94"(group 1) until autumn (group 3) followed by

an increase, though in low sediment layers an accentuated increase in "autumn" (group 4) was observed (Fig. 5.76).

Spirinia seasonal patterns showed a density increase between "early summer 94" and "summer 95", in contrast to the most abundant genera describe above (Fig. 5.70 and 5.75).

At station A, in the uppermost sediment layers, *Chromadorella* seasonal patterns were similar, with lowest densities in both sampling summers (group 1, group 2 and group 3). Nevertheless, in summer 95, in the lowest sediment layer, an opposite trend was observed. At the three depths, the highest densities were in "autumn" (group 3). At station A, *Daptonema* seasonal patterns within sediments were similar, in "winter-spring" (group 4) the highest values were obtained, and the lowest in "autumn" (group 3). However, in the intermediate sediment layer, in "summer 95" (group 5), an opposite trend was observed. At station B, surface and bottom sediment layer seasonal patterns were similar, the lowest values being observed in both sampling summers (group 1, group 2 and group 5) and in "winter-spring" (group 4) higher densities being registered as at station A (Fig. 5.71 and Fig. 5.77).

At station A, seasonal patterns of *Linhomoeus* were similar within sediments; the highest densities were in "autumn" (group 3) and "winter-spring" (group 4). Although, at station B, the seasonal patterns at depth were different, the highest values were also observed in "winter-spring" (group 4). At both stations, in the surface sediment layer, the lowest densities were observed in "summer 95" (group 5). At station A, at the three depths studied, *Paracyatholaimus* presented similar seasonal patterns, with lowest densities in both summers (group 1 and group 5) and the highest in "winter-spring" (group 4) (Fig. 5.72 and Fig. 5.77).

At station A, seasonal patterns of *Daptonema* within sediments were similar, in "winter-spring" (group 4) the highest values being obtained and the lowest in "autumn" (group 3). In the intermediate sediment layer, in "summer 95" (group 5), an opposite trend was observed (Fig. 5.71). The seasonal patterns were somewhat different between stations; in spite of the highest densities also being obtained in "winter-spring" (group 4) as at station A, the lowest values were observed in both summers (group 1, group 2 and group 5) (Fig. 5.77).

At station A, the seasonal patterns of *Viscosia* in the top and bottom sediment layers were very similar, with densities increasing in "autumn" (group 3) and decreasing in "winter-spring" (group 4), followed by a sharp increase in "summer 95" (group 5). The intermediate sediment layer recorded continuous density increase. At the three depths, the densities were lower in "summer 94" (group 1 and group 2), the highest values being exhibited in "summer 95". At station B, the seasonal patterns within sediment layers were very similar. At station A, the lowest densities were obtained in "summer 94" (group 1 and group 2) and the highest values in "summer 95". At both stations, seasonal patterns of *Chromadora* differed clearly between the three depths, although, lower densities were registered in "summer 95" (Fig. 5.73 and Fig. 5.78).

At both stations, *Chromadorina* seasonal patterns were very similar within sediments and between stations, the highest densities being obtained in "autumn" (group 3) and the lowest in "winter-spring" (group 4). At station B, *Metachromadora*, at the uppermost sediment layer (0-6 cm) depth, showed the highest densities in "early summer 94" (group 1) followed by an accentuated decline in "summer 94" (group 2). In contrast, in "summer 95" (group 5), the lowest densities were attained. In the low sediment layer seasonal pattern registered an opposite trend; in fact, in "early summer 94" (group 1) this genus was absent, followed by a continuously increase until "summer 95" (group 5) when the highest densities were reached (Fig. 5.74 and Fig. 5.79).

At station B, in the uppermost sediment layer, the highest densities of *Ptycholaimellus* were obtained in "winter-spring" (group 4) followed by a strong decline in "summer 95" (group 5). In the bottom layer, it was absent in summer 94 (group 1 and group 2), followed by an increase from "autumn" (group 3) until summer 95 (group 5). Seasonal patterns of *Desmodora* within sediments were very different; in the surface sediment layer, densities declined continuously, disappearing in "summer 95". In the low sediment layer, (3-10 cm depth), an opposite trend was observed; indeed the highest values were in "summer 95" (group 5) (Fig. 5.80).

At station B, seasonal patterns of *Paramonohystera* within sediments were very different, increasing in surface sediment layer densities from "autumn" (group 3) and attaining the highest values in "summer 95" (group 5). In the intermediate sediment layer, the highest values were in autumn (group 3) and declined in "winter-spring"

(group 4). In the bottom sediment layer a continuous decline until "summer 95" (group 5) was registered. The seasonal pattern of *Camacolaimus* in the surface sediment showed a continuous increase, but at depth the densities declined in "winter-spring" (group 4) and increased in summer 95 (Fig. 5.81).

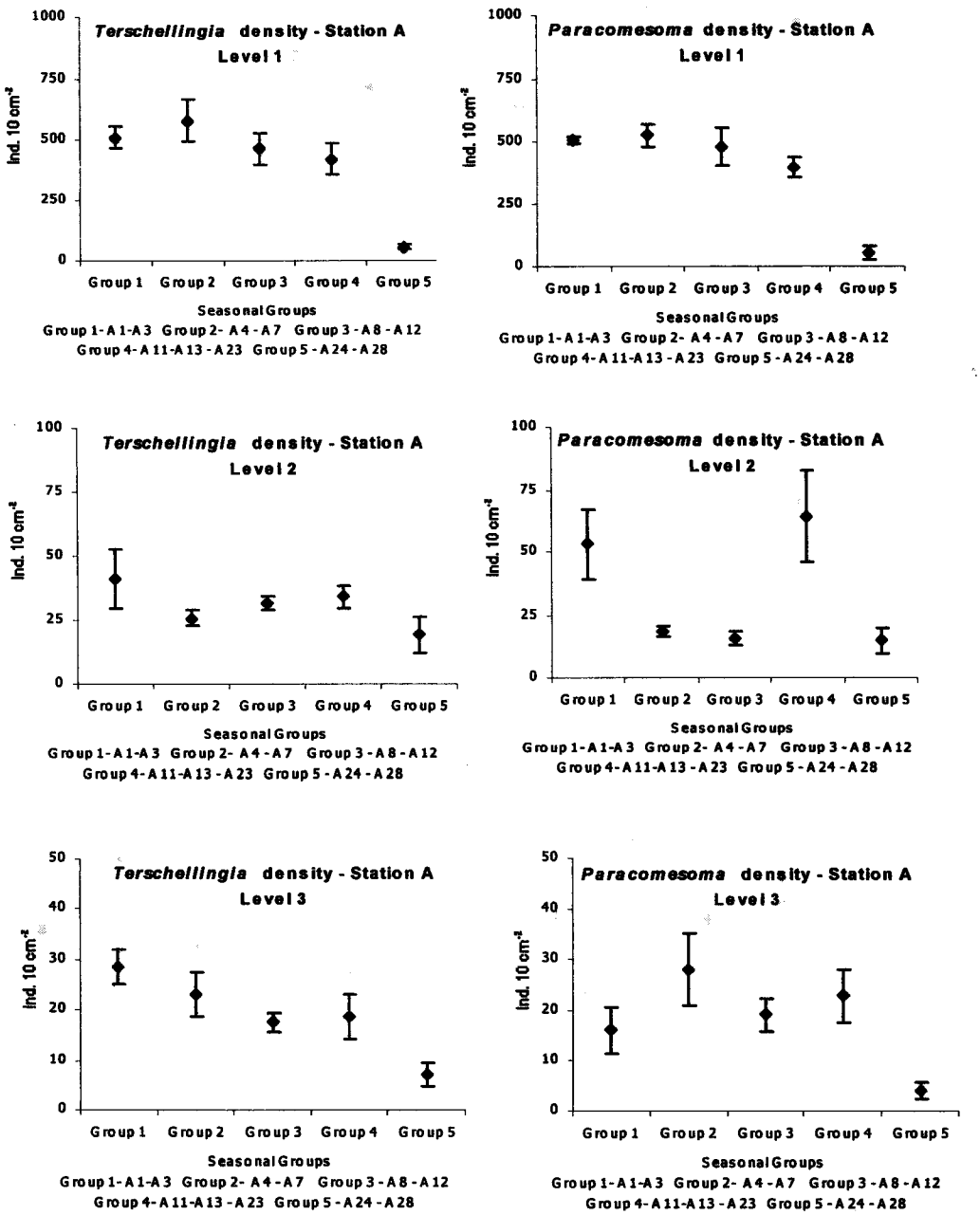


Figure 5.69 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1) to August 95 (A28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

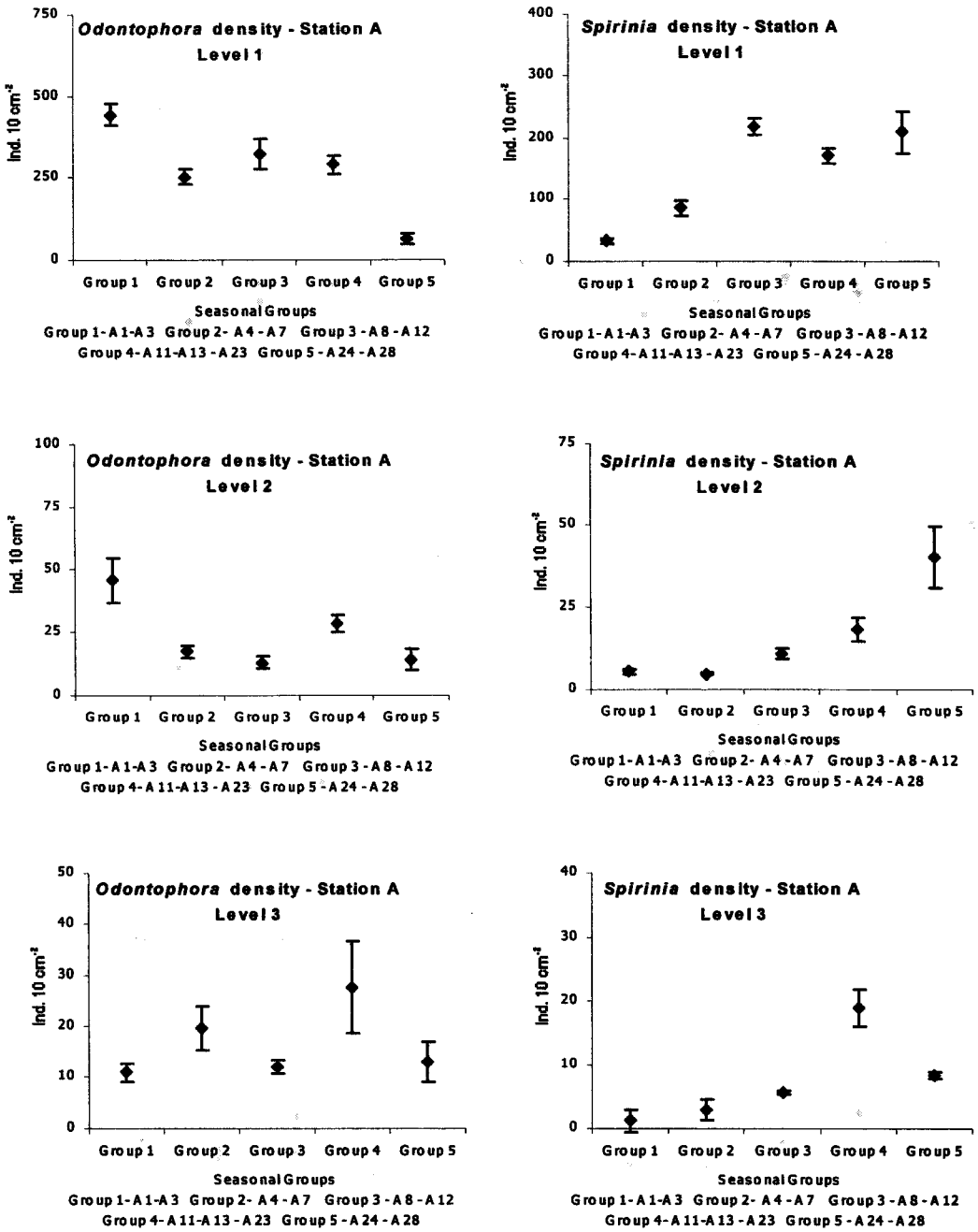


Figure 5.70 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1) to August 95 (A28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

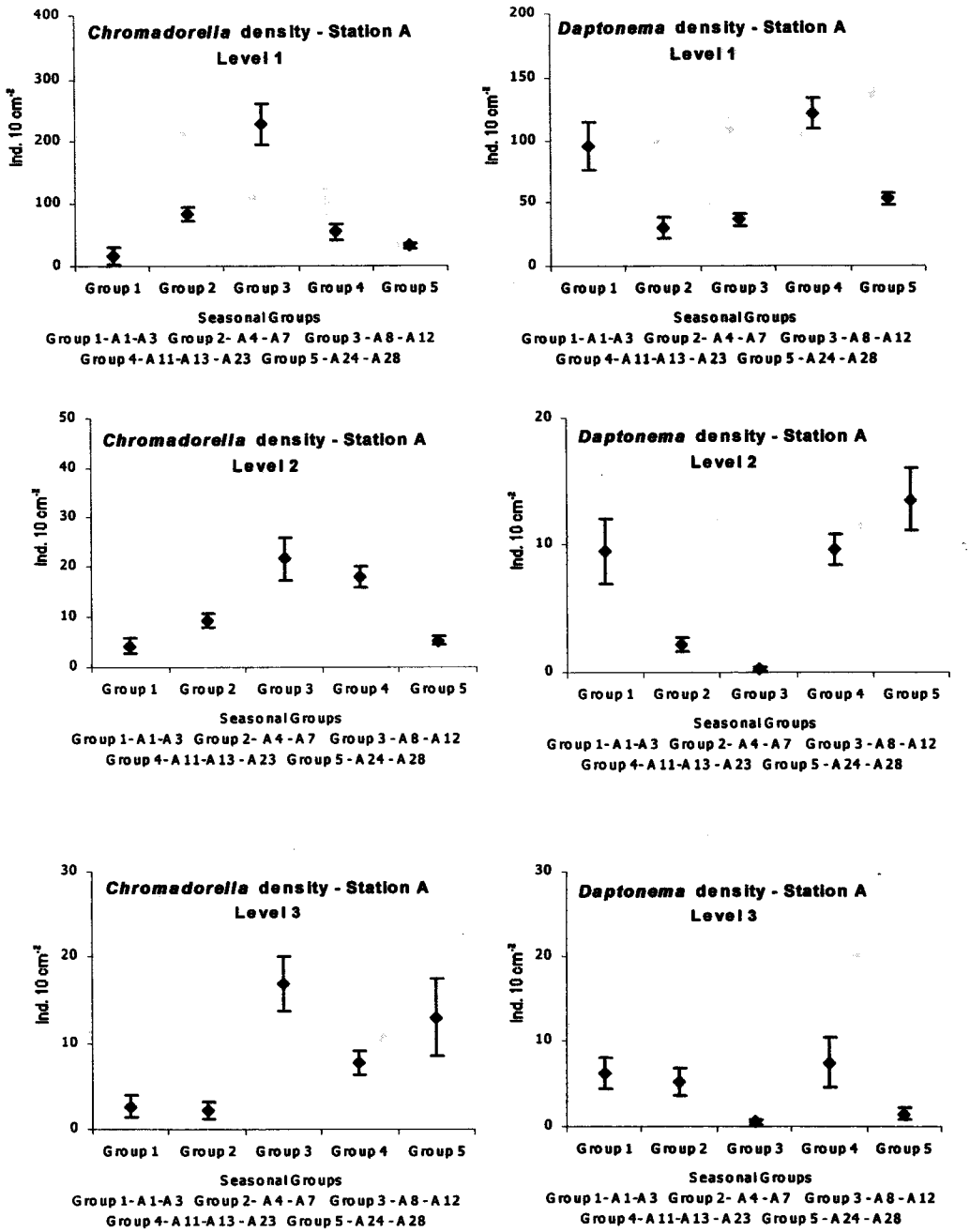


Figure 5.71 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1) to August 95 (A28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

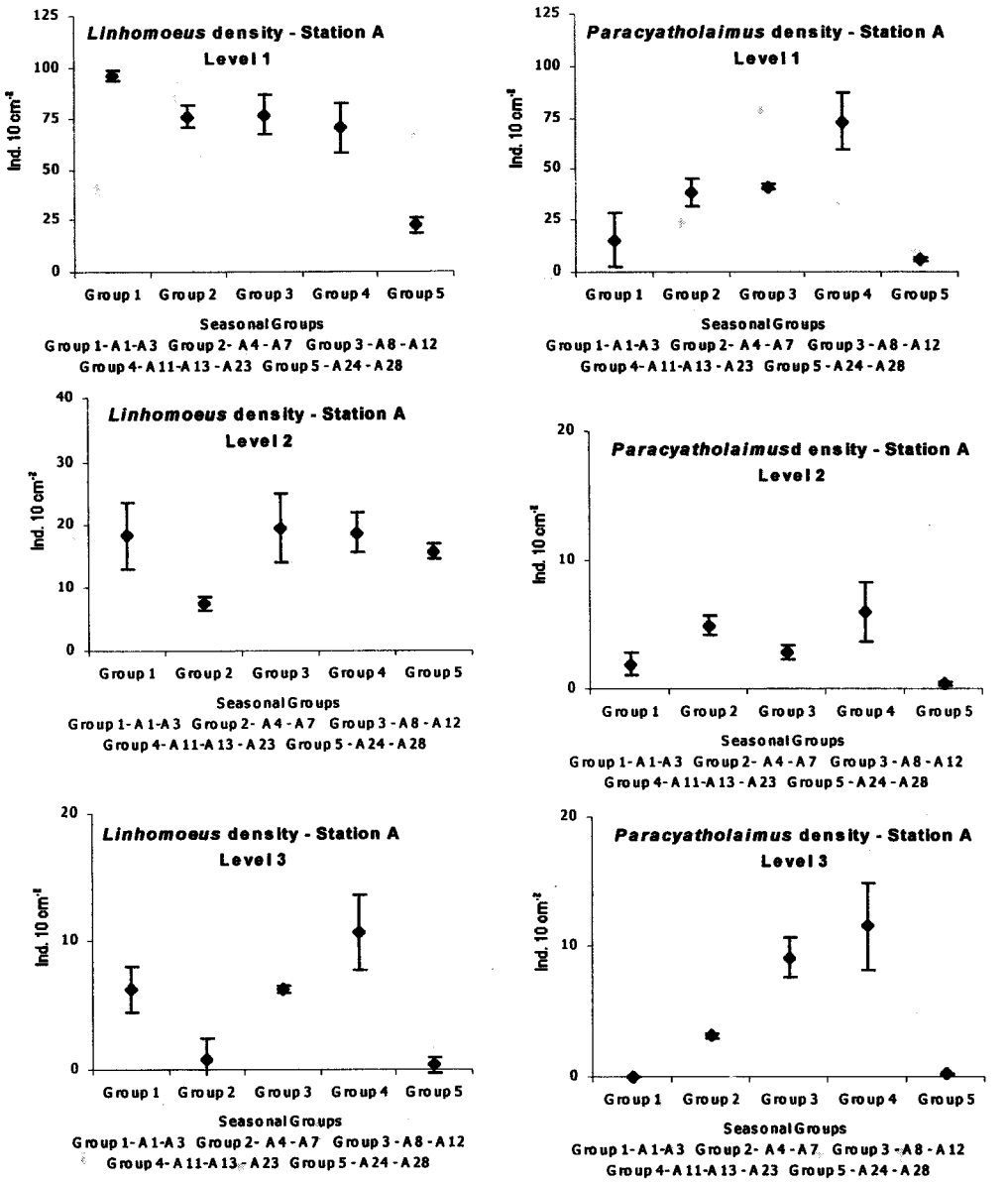


Figure 5.72 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1) to August 95 (A28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

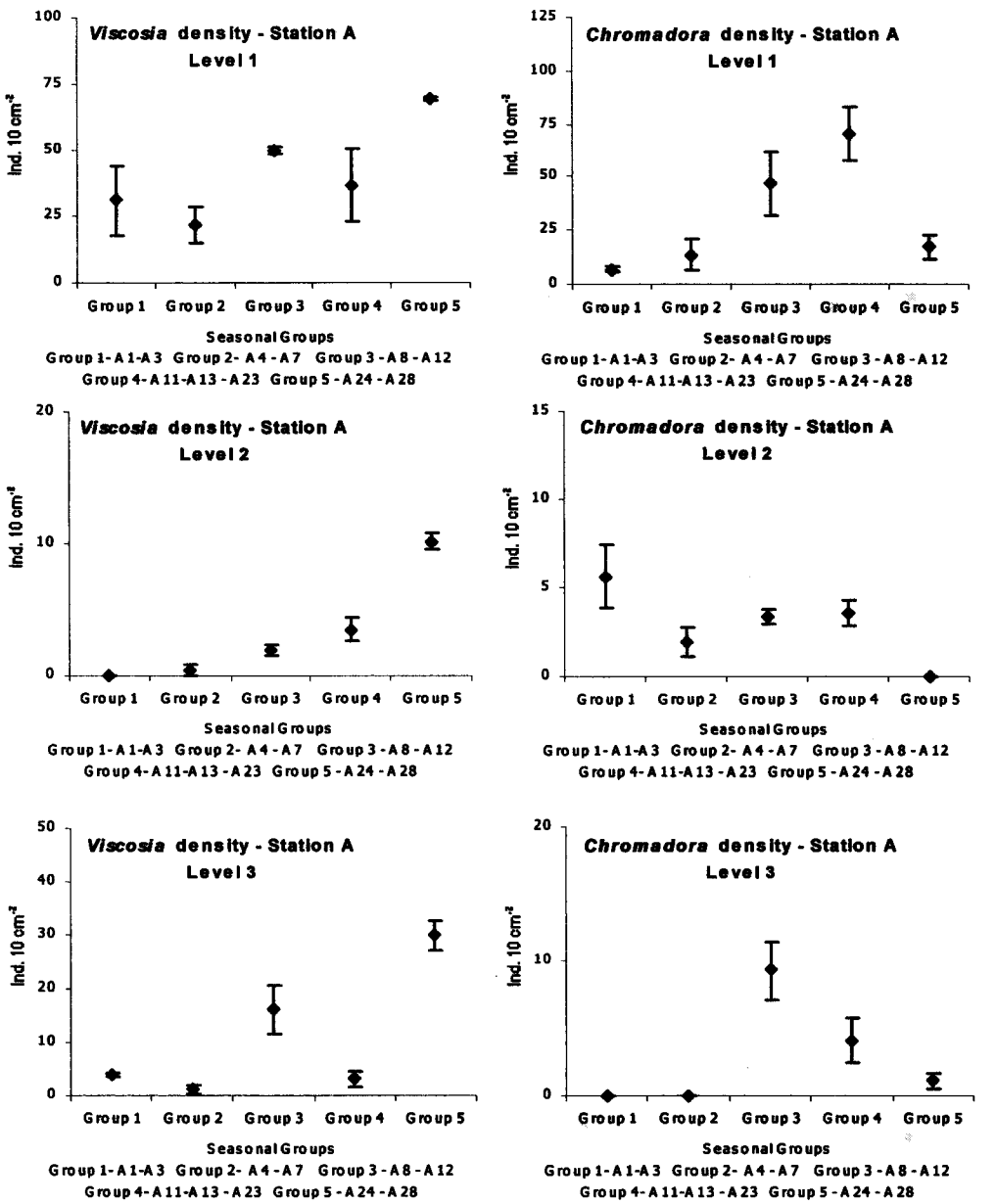


Figure 5.73– Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1) to August 95 (A28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

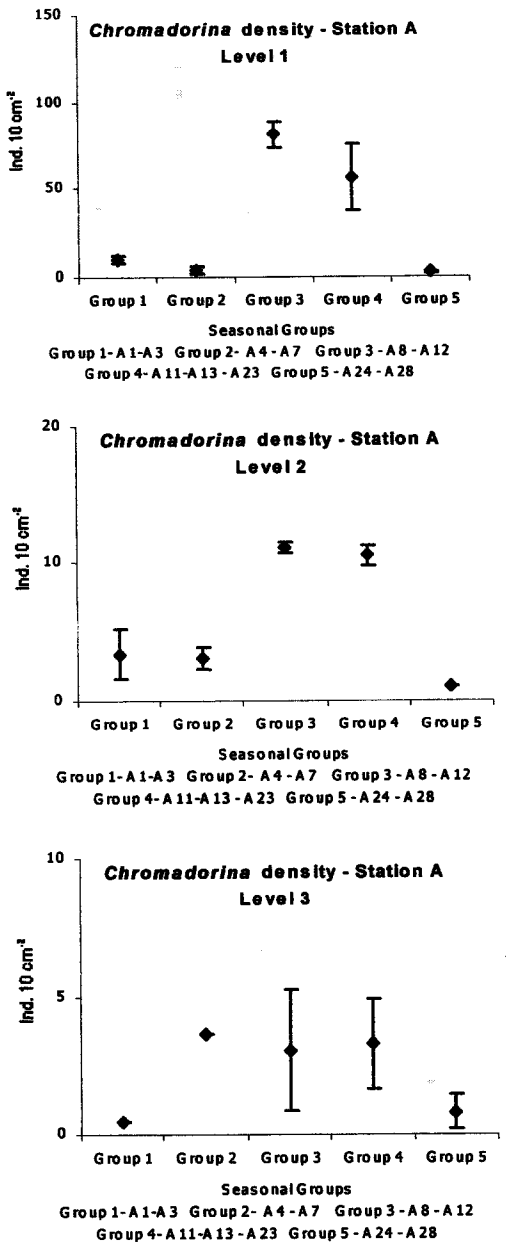


Figure 5.74 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (A1) to August 95 (A28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

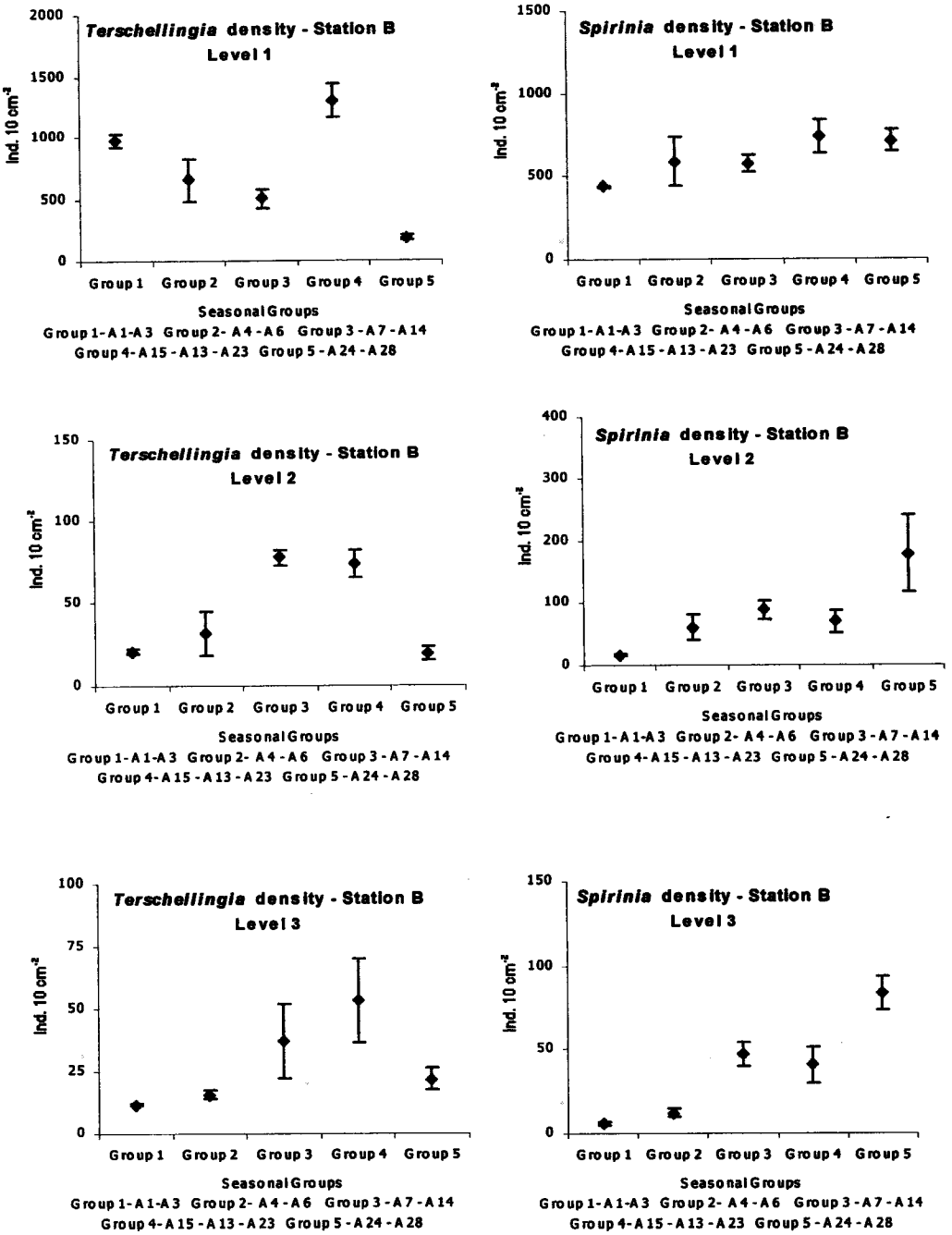


Figure 5.75 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (3-10 cm) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (B1) to August 95 (B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

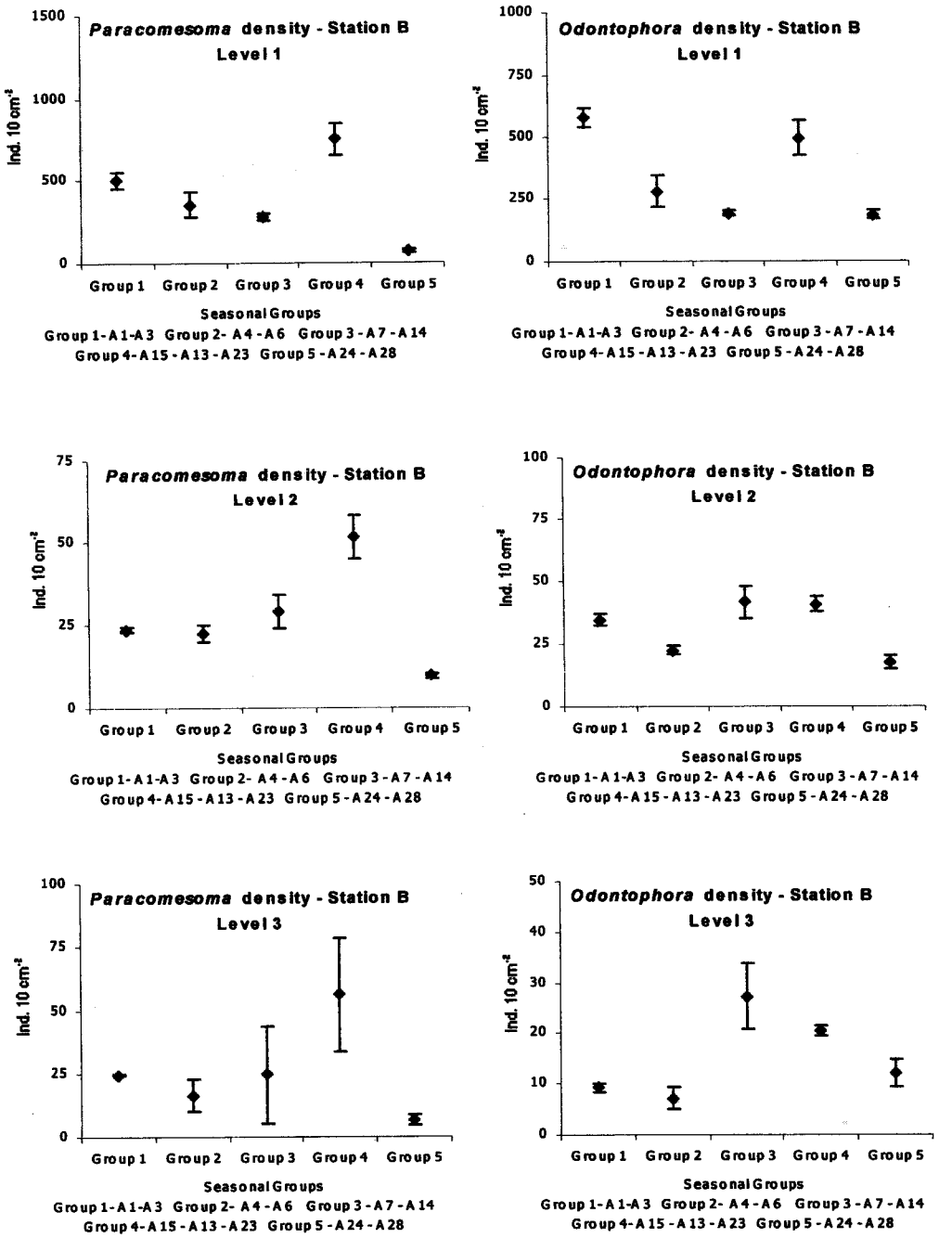


Figure 5.76 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (B1) to August 95 (B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 3 obtained by the Twinspan–classification and PCA-ordination.

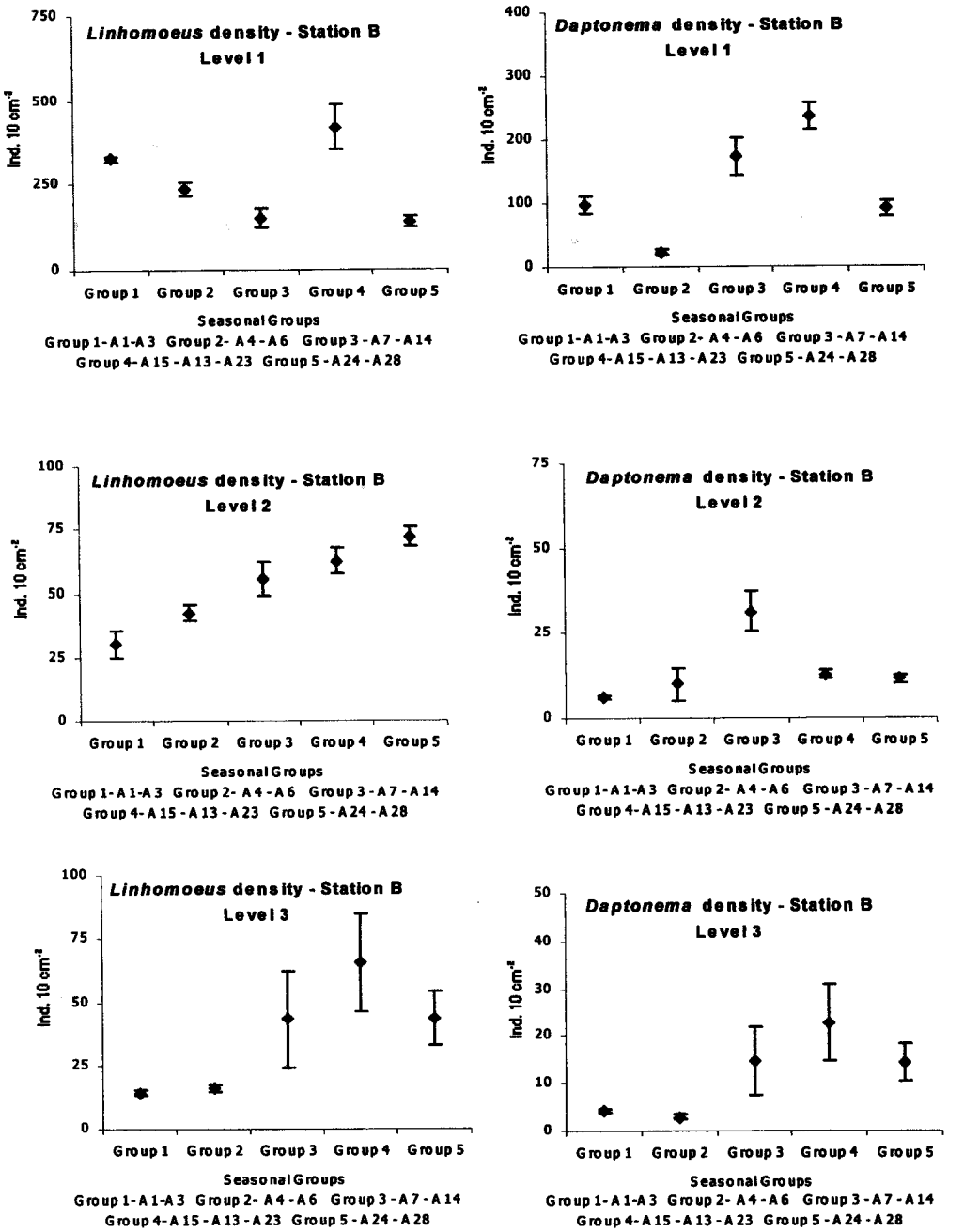


Figure 5.77 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (B1) to August 95 (B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

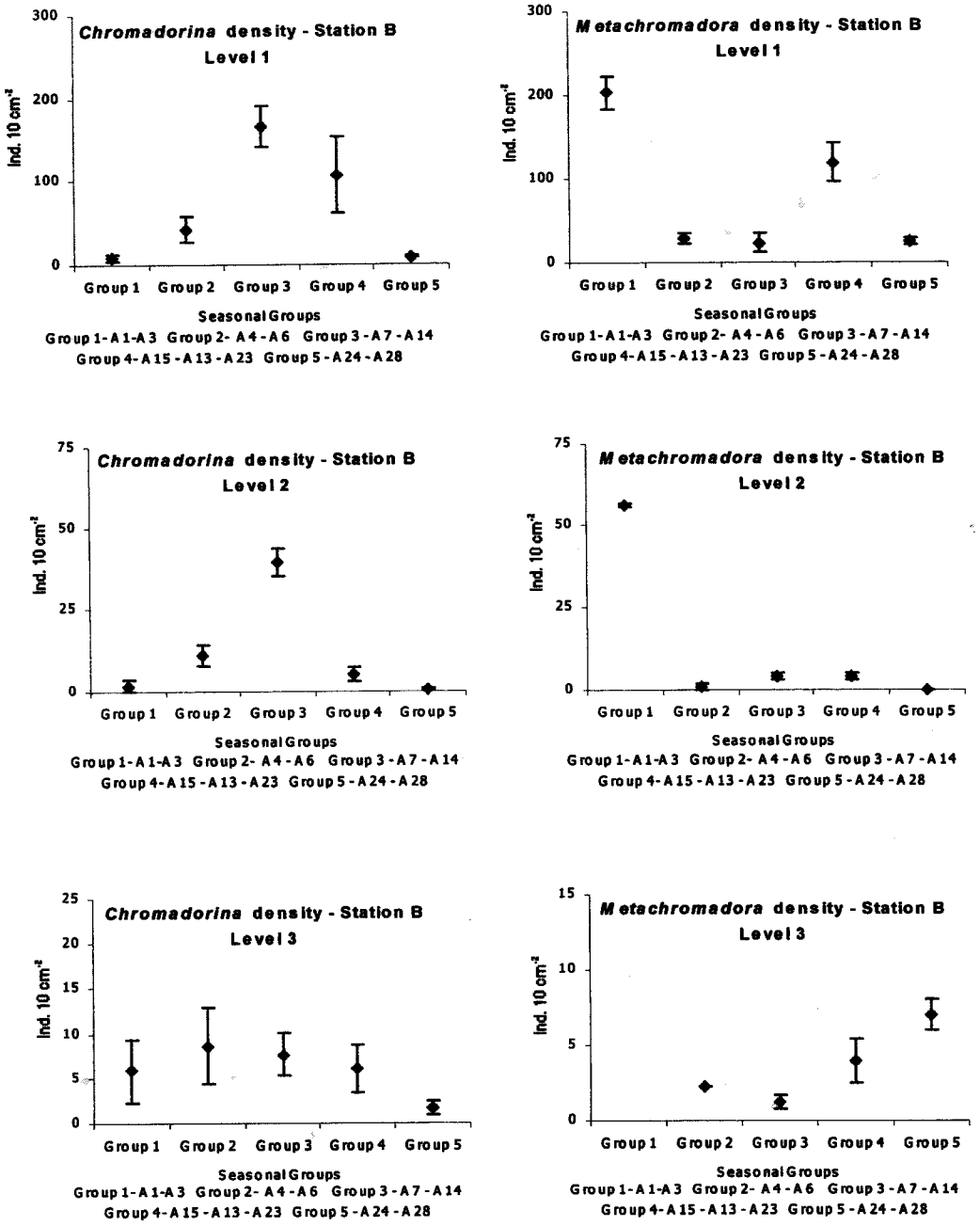


Figure 5.79 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (B1) to August 95 (B28). Average number (± SE) of the sampling dates of the groups 1, 2, 3, 4 and 5 obtained by the Twinspan–classification and PCA-ordination.

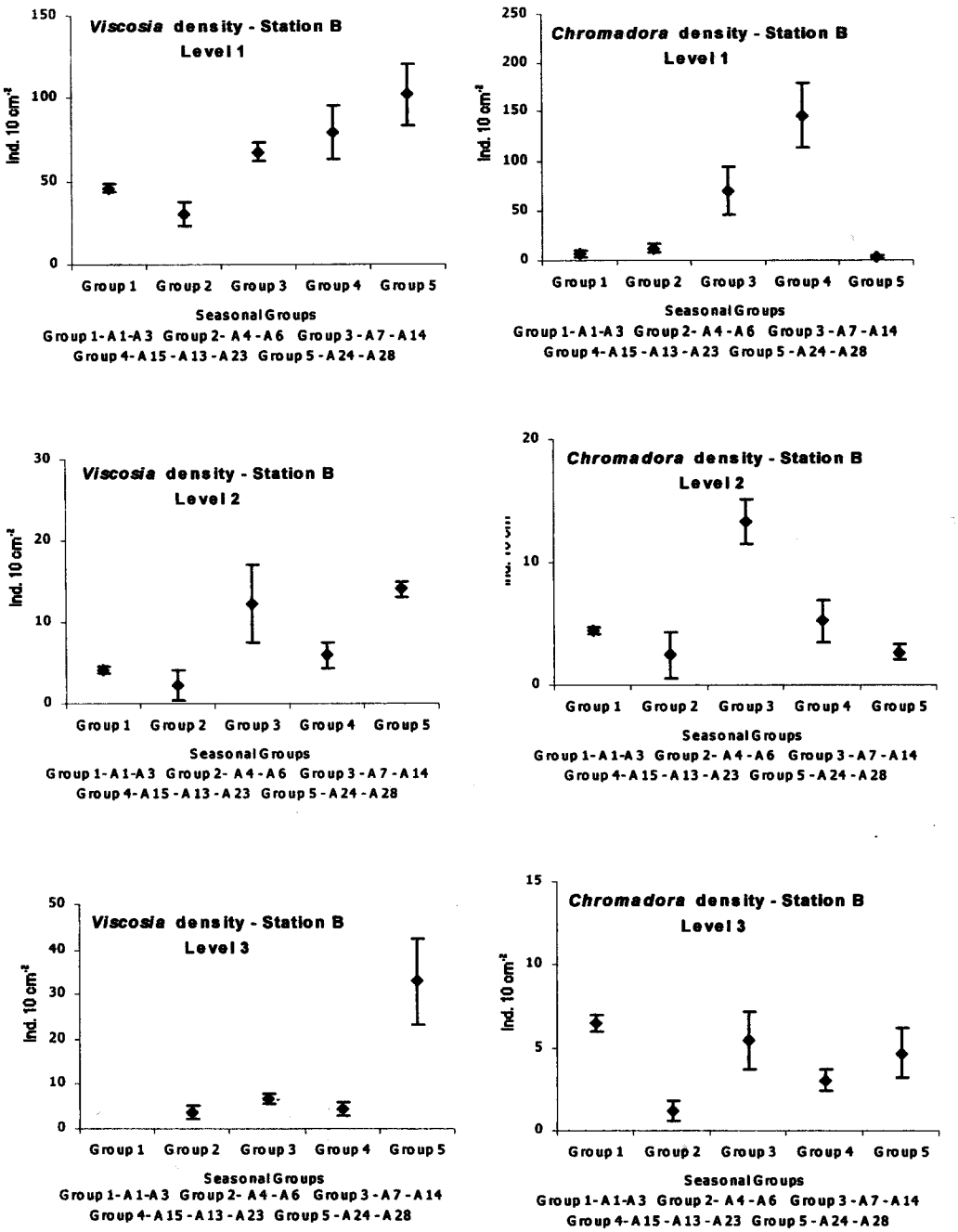


Figure 5.78– Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (B1) to August 95 (B28). Average number (± SE) of the sampling dates of the groups 1, 2 and 3 obtained by the Twinspan–classification and PCA-ordination.

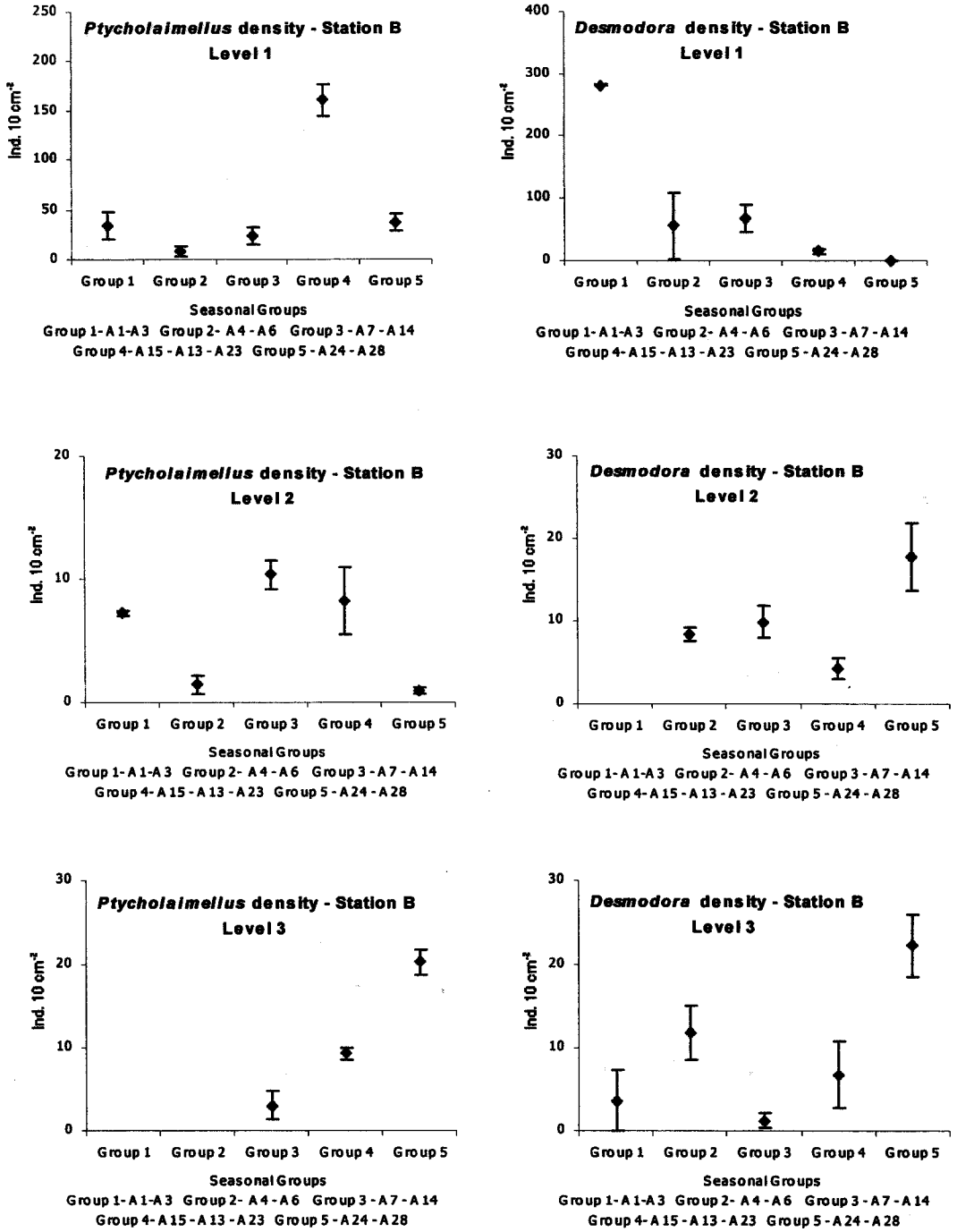


Figure 5.80 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (B1) to August 95 (B28). Average number (± SE) of the sampling dates of the groups 1, 2 and 3 obtained by the Twinspan–classification and PCA-ordination.

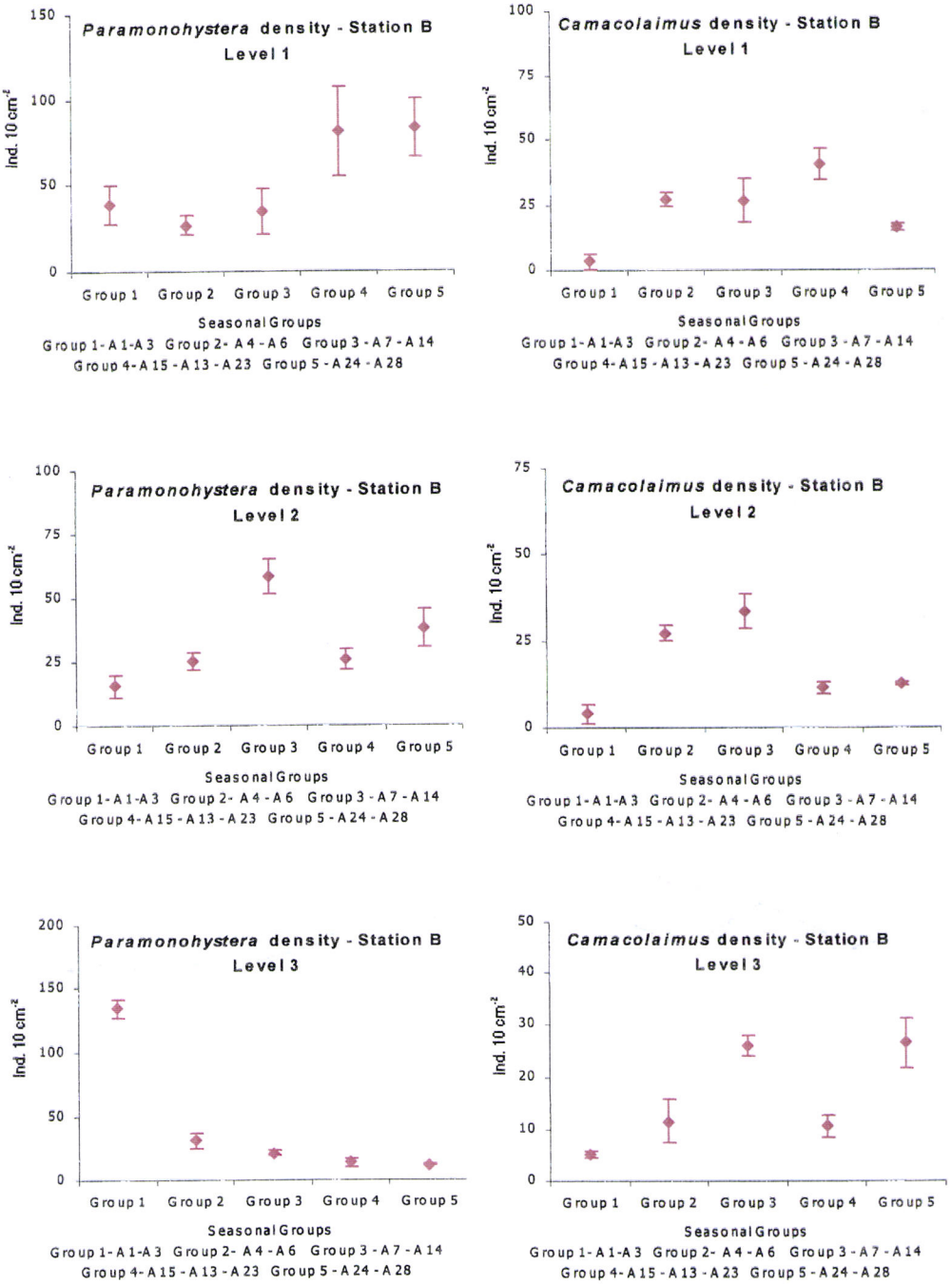


Figure 5.81 – Seasonal variation of the Nematoda genera densities(>1%), at three depths: level 1(0-3 cm), level 2 (3-6 cm), level 3 (6-10 cm) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary, from June 94 (B1) to August 95 (B28). Average number (± SE) of the sampling dates of the groups 1, 2 and 3 obtained by the Twinspan–classification and PCA-ordination.

5.3.3. Temporal variation of the structure population of the dominant Nematoda genera

Analysis of the females, males and juveniles of the predominant genera at both stations showed higher densities of juveniles during most of the sampling period; this is the case with *Paracomesoma*, *Linhomoeus*, *Odontophora*, *Paramonohystera*, *Daptonema*. Although, at station A, *Terschellingia* juveniles were highest in all sampling periods, station B exhibited exactly the opposite result, the adults being highest (Fig.5.82 – Fig.5.101).

Nematode reproduction is continuous, the juveniles being almost evenly present through the sampling period. Moreover, the distinct recruitment periods were clearly identified, following closely the genera densities' peak. Juvenile density increase was almost always closely linked to female density increase.

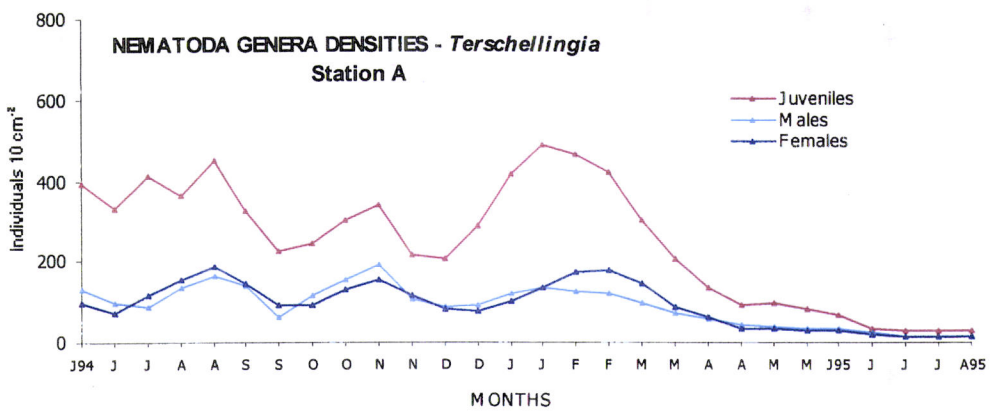


Figure 5.82 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Terschellingia* juveniles, males and females, from June 1994 to August 1995, at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

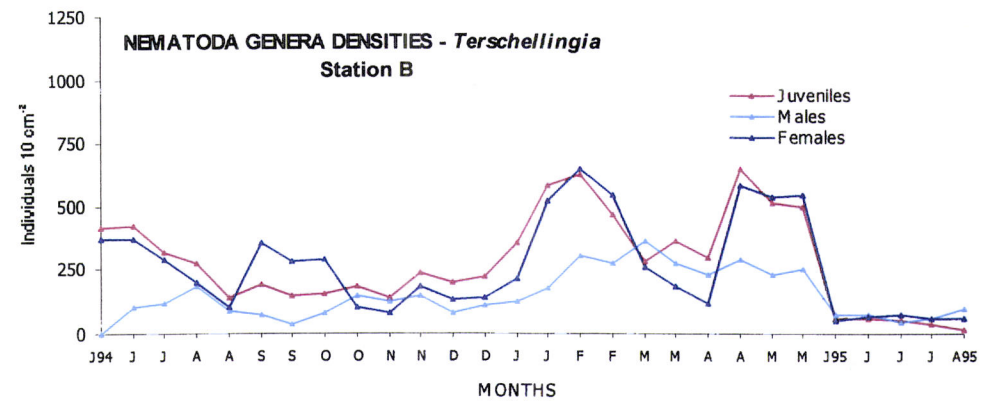


Figure 5.83 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Terschellingia* juveniles, males and females, from June 1994 to August 1995, at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

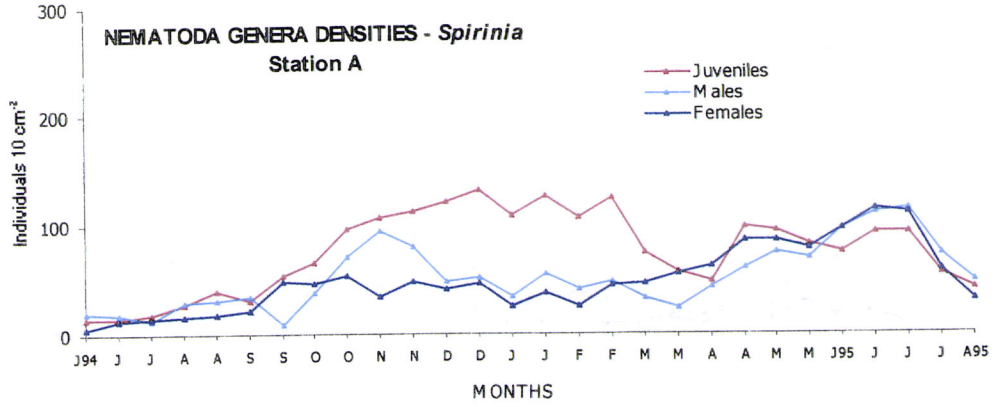


Figure 5.84 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Spirinia* juveniles, males and females, from June 1994 to August 1995, at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

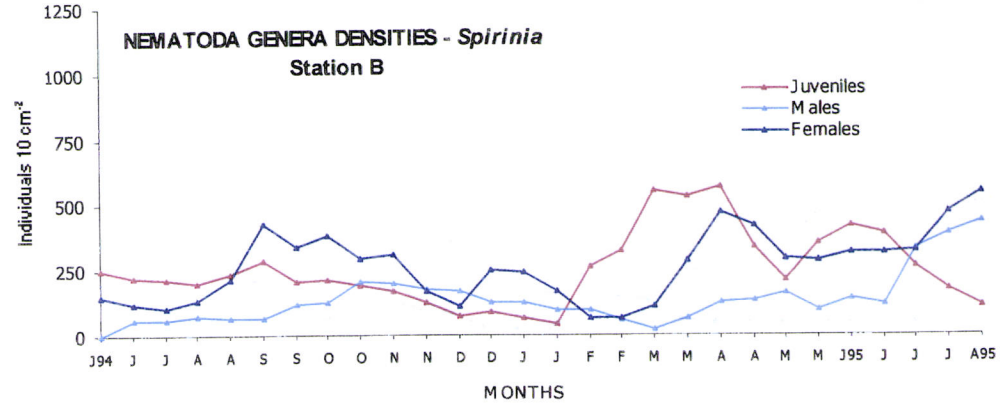


Figure 5.85 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Spirinia* juveniles, males and females, from June 1994 to August 1995, at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

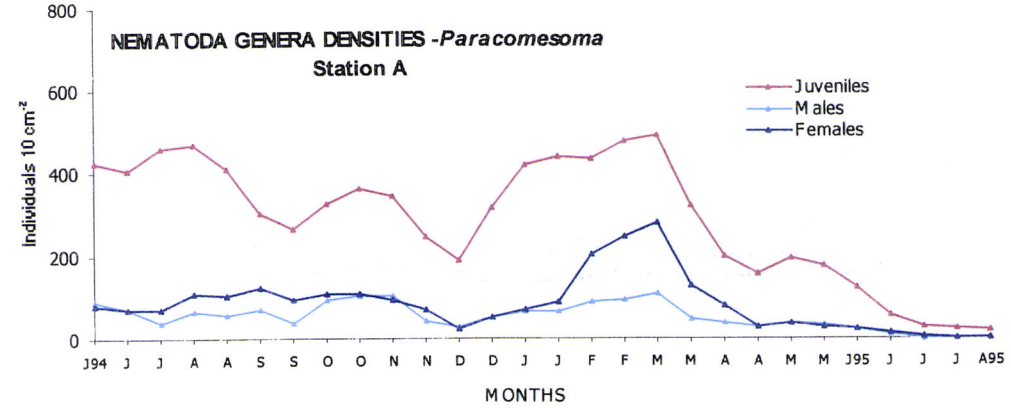


Figure 5.86- Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Paracomesoma* juveniles, males and females, from June 1994 to August 1995, at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

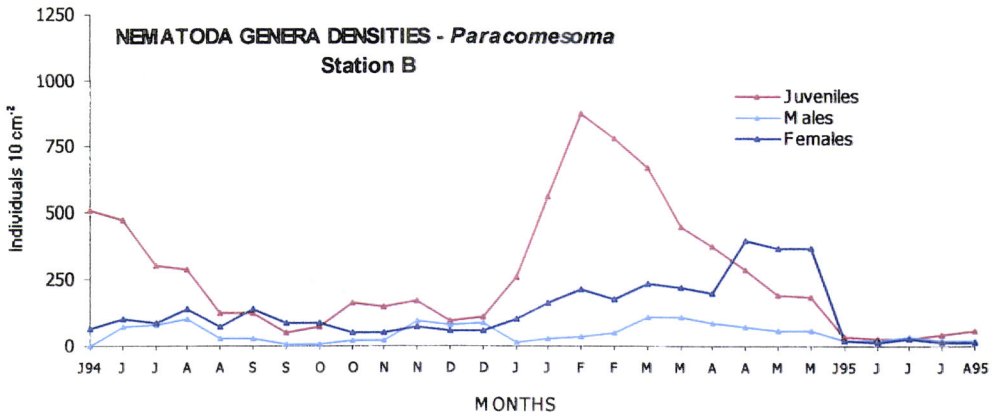


Figure 5.87 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Paracomesoma* juveniles, males and females, from June 1994 to August 1995, at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

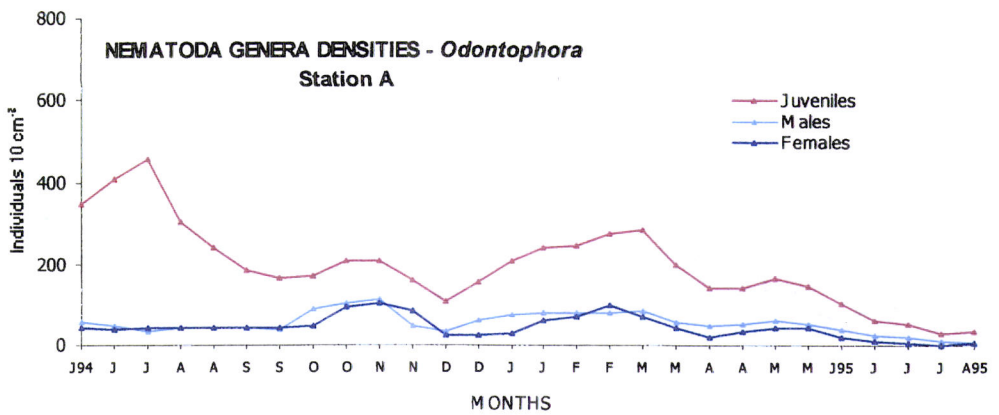


Figure 5.88 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Odontophora* juveniles, males and females, from June 1994 to August 1995, at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

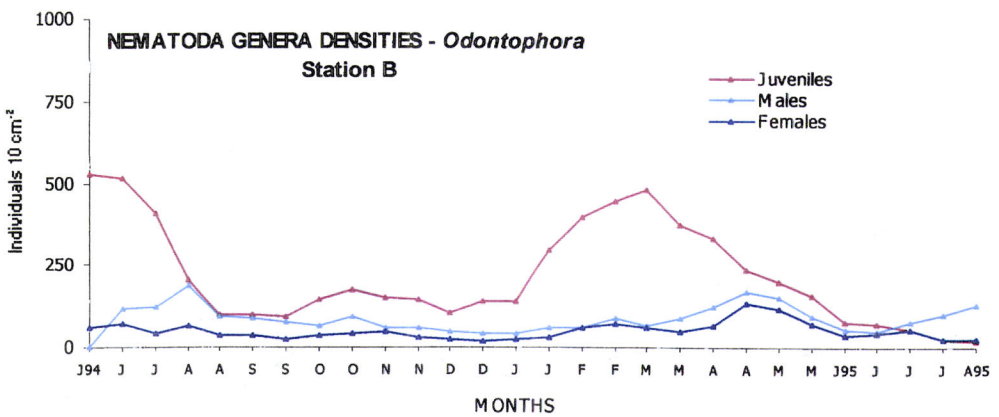


Figure 5.89 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Odontophora* juveniles, males and females, from June 1994 to August 1995, at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

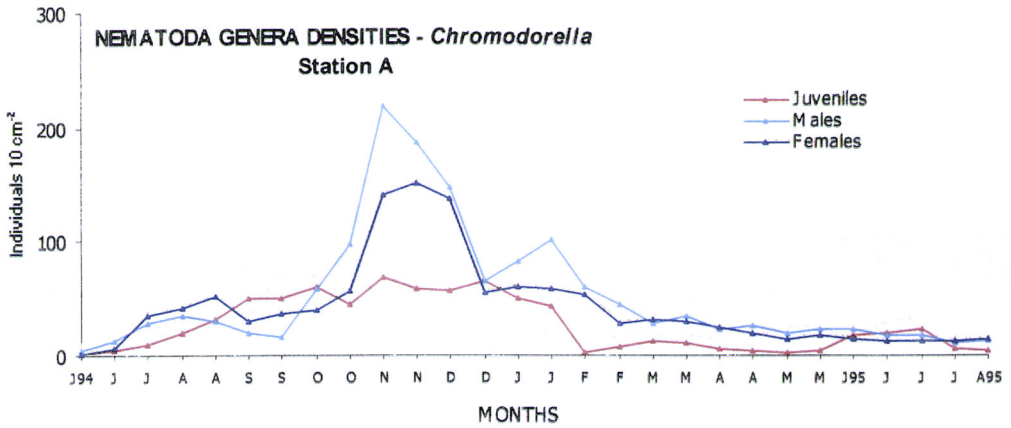


Figure 5.90 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Odontophora* juveniles, males and females, from June 1994 to August 1995, at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

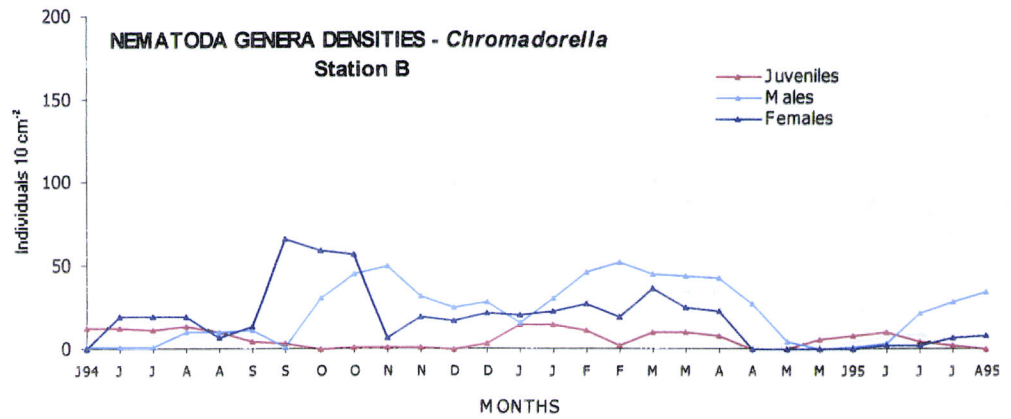


Figure 5.91 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Chromadorella* juveniles, males and females, from June 1994 to August 1995, at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

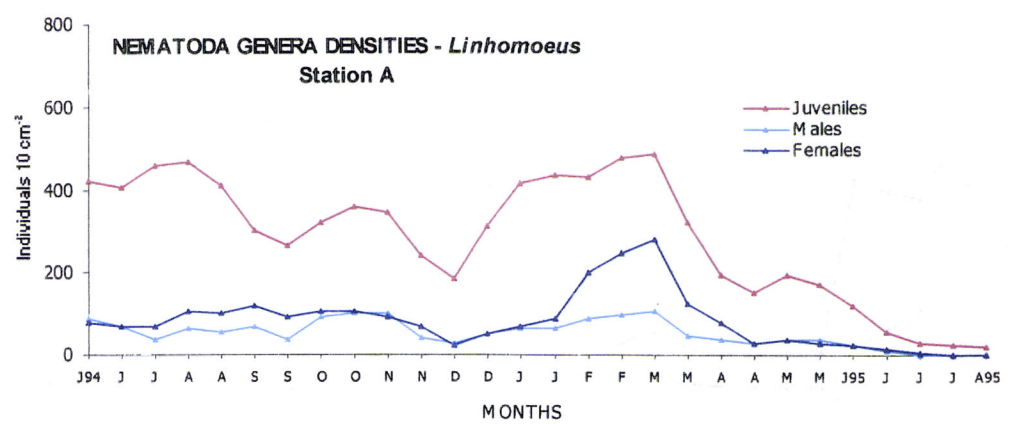


Figure 5.92 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Linhomoeus* juveniles, males and females, from June 1994 to August 1995, at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

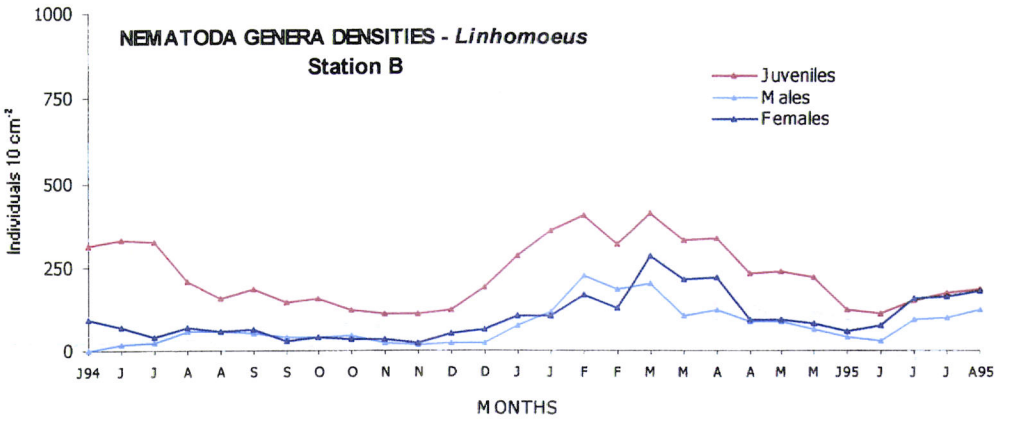


Figure 5.93- Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Linhomoeus* juveniles, males and females, from June 1994 to August 1995, at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

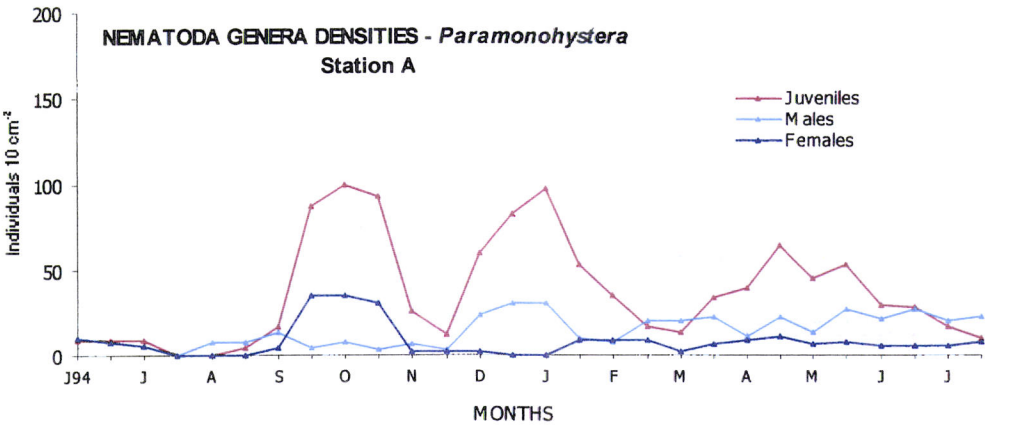


Figure 5.94 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Paramonohystera* juveniles, males and females, from June 1994 to August 1995, at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

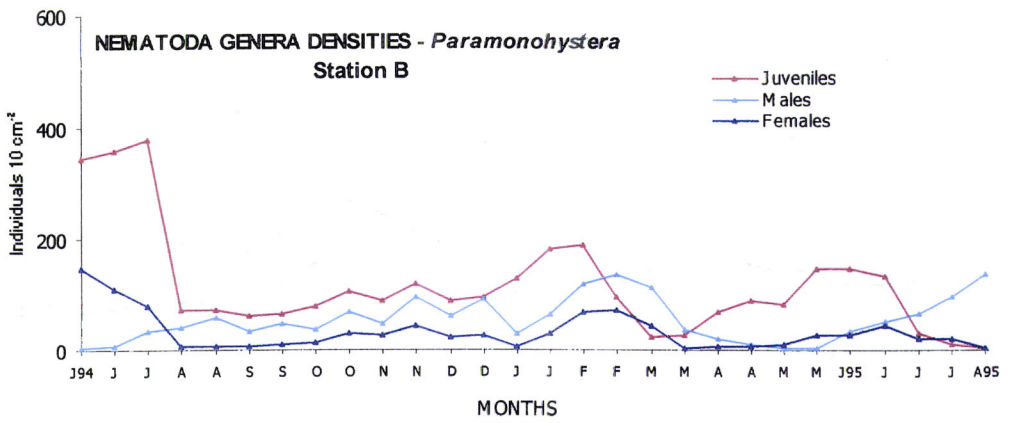


Figure 5.95 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Paramonohystera* juveniles, males and females, from June 1994 to August 1995, at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

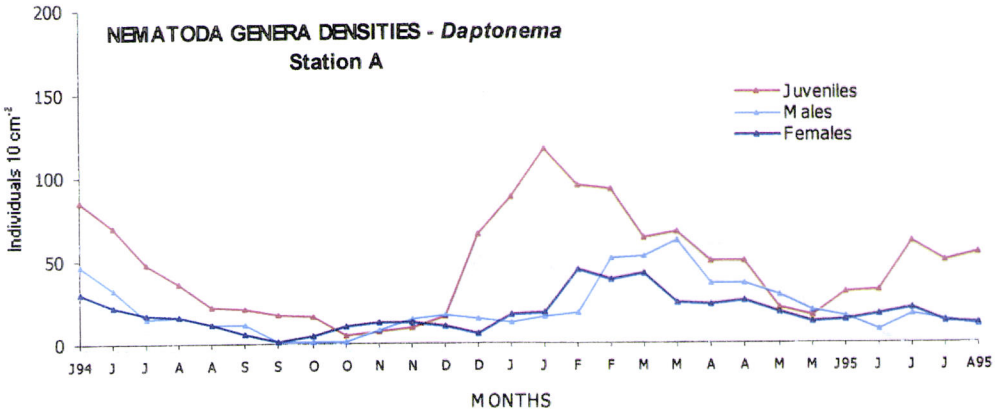


Figure 5.96 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Daptonema* juveniles, males and females, from June 1994 to August 1995, at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

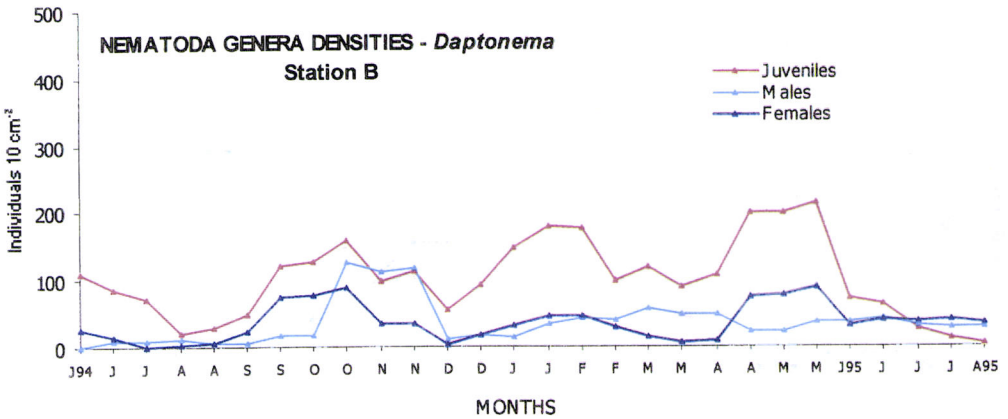


Figure 5.97 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Daptonema* juveniles, males and females , from June 1994 to August 1995, at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

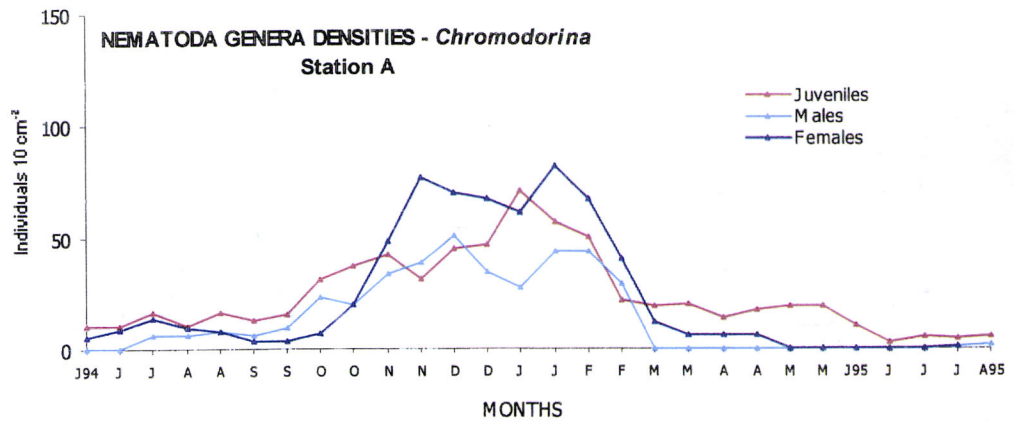


Figure 5.98 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Chromadorina* juveniles, males and females, from June 1994 to August 1995, at station A, in a *Zostera noltii* seagrass bed of the Mira estuary

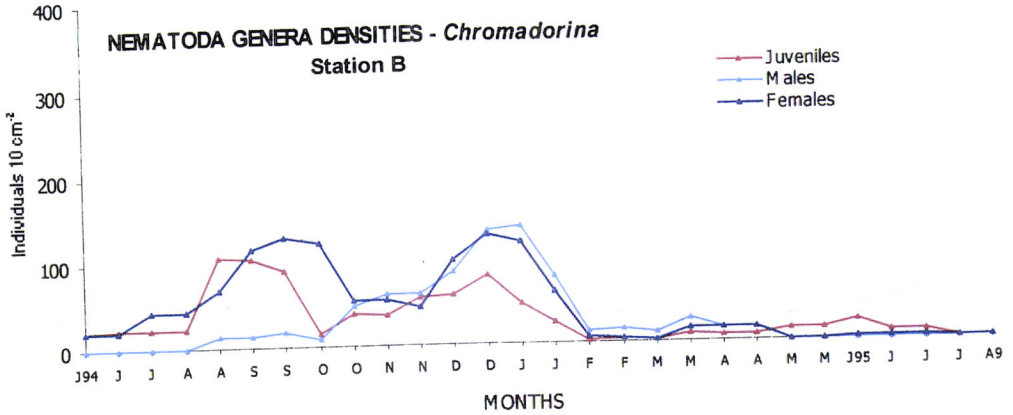


Figure 5.99 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Chromadorina* juveniles, males and females, from June 1994 to August 1995, at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

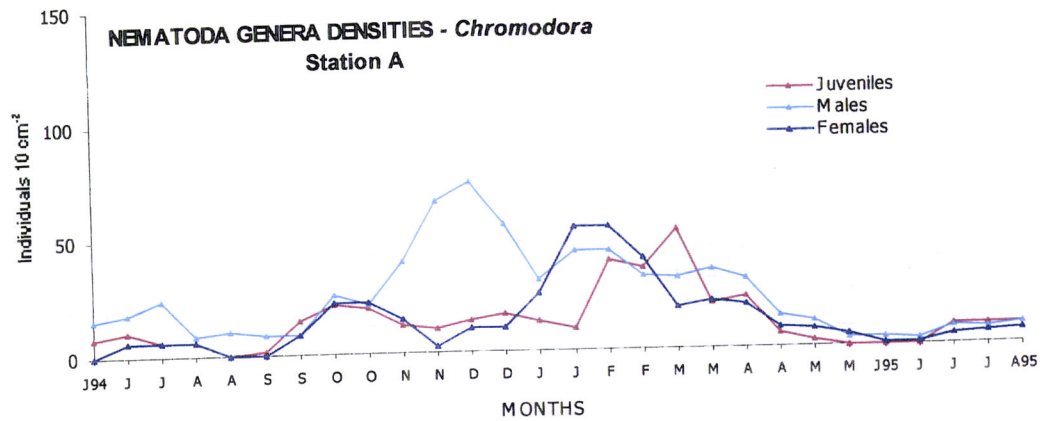


Figure 5.100 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Chromadora* juveniles, males and females, from June 1994 to August 1995, at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

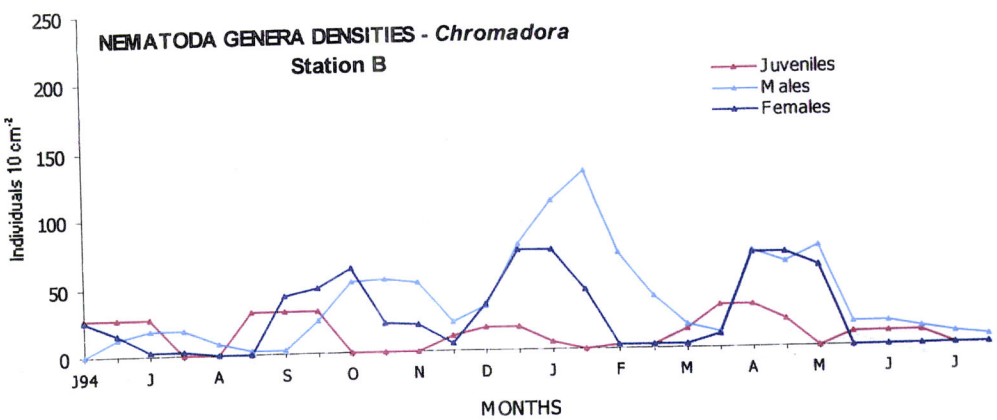


Figure 5.101 - Temporal variation of density (ind. per 10 cm^{-2}) of Nematoda genus *Chromadora* juveniles, males and females, from June 1994 to August 1995, at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

5.3.4. Temporal variation of the trophic composition of the Nematoda communities.

Classification of the entire genera Nematoda community into the feeding types used is as follows: 1A: Selective deposit feeders; 1B: non-selective deposit feeders; 2A: epistrate feeders; 2B: predators/omnivores (Wieser, 1953). At both stations, the sediments were mainly populated by non-selective deposit feeders (1B and 2A) and epistratum.

At station A, non-selective deposit feeders predominated (1B: 41%, 14 genera), followed by epistrate feeders (2A: 30%, 20 genera) and selective deposit feeders (1A: 21%, 12 genera), while the predator/omnivores were much less abundant (2B: 7%, 11 genera. At station B, epistrate feeders predominated (2A: 42%, 19 genera) followed by non-selective deposit feeders (1B: 32%, 15 genera) and selective deposit feeders (1A: 18%, 11 genera), with the predator/omnivores (2B: 7%, 12 genera), as at station A, being much less abundant (Fig. 5.102 and Fig. 5.103).

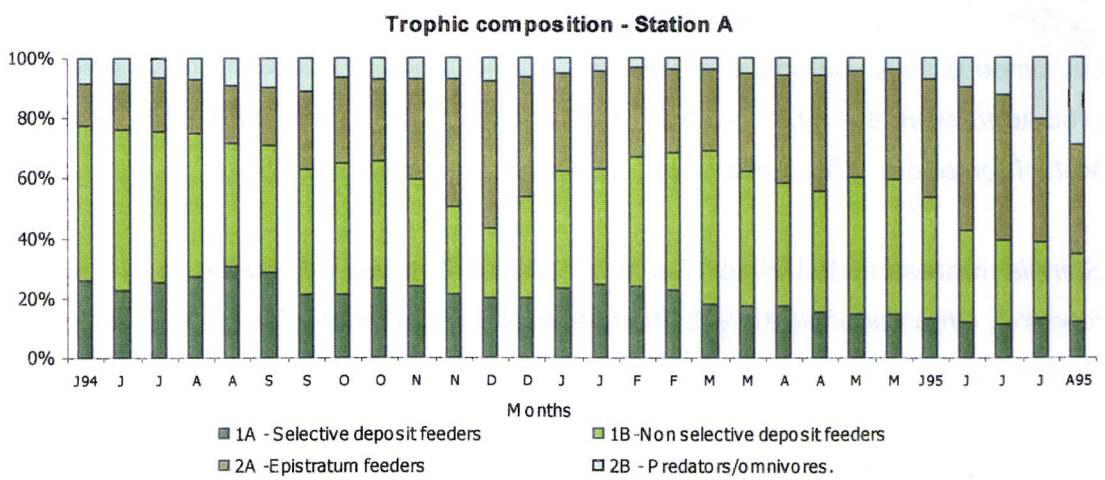


Figure 5.102 – Relative variation in trophic composition of the nematode communities from June 1994 to August 1995, at station A in *Zostera noltii* seagrass bed sediments of the Mira estuary.

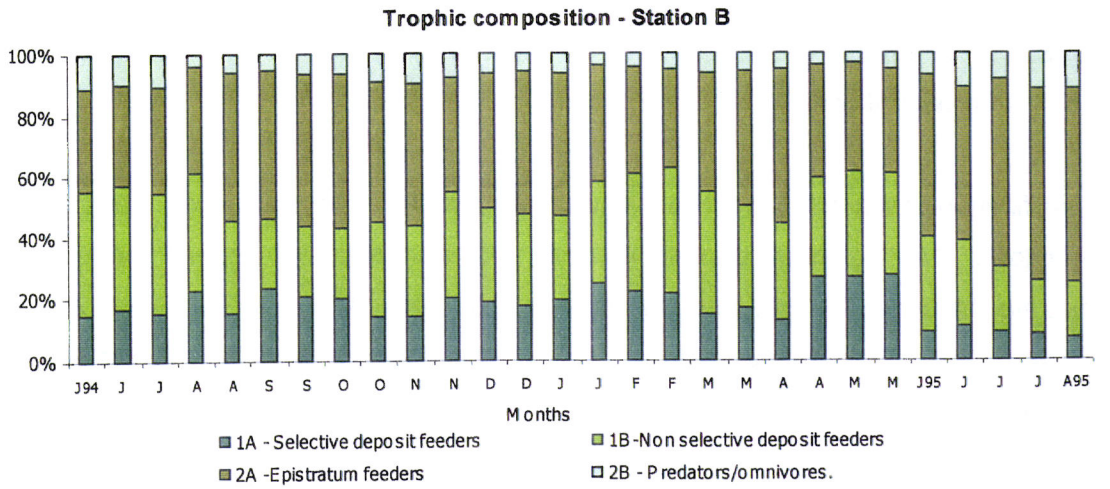


Figure 5.103 – Relative variation in trophic composition of the nematode communities from June 1994 to August 1995, at station A and station B, in *Zostera noltii* seagrass bed sediments of the Mira estuary.

Regarding the relative abundances of the genera of each trophic group, at station A, *Paracomesoma* represented a contribution of 45% of the total dominant trophic group (1B: selective deposit feeders) followed by *Odondophora* 31%, *Daptonema* 9%, and *Paramonohystera* 6%. *Terschellingia* genus comprised 87% of the total selective deposit feeders (group 1A), *Southernia* 5% and *Anticoma* 4%. Concerning epistrate feeders (group 2A), *Spirinia* represented 25%, followed by *Chromadorella* 18%, *Linhomoeus* 15%, *Chromadorina* 9% and *Paracyatholaimus* 8%. In the trophic group, predator/omnivores (2B) *Viscosia* predominated, 33%, with *Oncholaimellus* 17%, *Metachromadora* 12%, *Synonchiella* 10% and *Sphaerolaimus* 10%.

Spirinia represented 37% of the total dominant group at station B (2A:epistrate feeders), *Chromadorella* 18%, *Linhomoeus* 22%, *Desmodora* 7%, *Camacolaimus* 6%. Regarding non-selective deposit feeders (1B), *Paracomesoma* comprised 33% with *Odondophora* 26%, *Paramonohystera* 15% and *Daptonema* 13%. *Terschellingia* comprised 92% and *Anticoma* 3% of the total selective deposit feeders (group 1A). In the trophic group predator/omnivores (2B), *Metachromadora* predominated 31%, with *Viscosia* 27%, *Synonchiella* 13%, *Oncholaimellus* 12% and *Synonchiella* 13%.

The vertical distribution of the relative trophic composition at both stations in the surface sediment layer (0-3 cm depth) was similar to the results obtained in the entire sediment layer studied (0-10 cm). Thus, at station A, non-selective deposit feeders,

predominated (1B: 43%, 14 genera), while epistrate feeders (2A: 27%, 19 genera), selective deposit feeders (1A: 23%, 11 genera) and the predator/omnivores were much less present (2B: 7%, 10 genera). However, in the low sediment layers, non-selective deposit feeders declined in their relative abundance and epistrate feeders became dominant. Within, the intermediate sediment layer (3-6 cm depth) epistrate feeders (2A: 65%, 16 genera) were dominant, followed by the selective deposit feeders (1A: 19%, 9 genera), non-selective deposit feeders (1B: 9%, 10 genera) and predator/omnivores (2B: 6%, 7 genera). In the low layer (6-10 cm depth), the trophic composition was similar to that of the intermediate sediment layer, where epistrate feeders predominated (2A: 62%, 14 genera), followed by selective deposit feeders (1A: 17%, 7 genera), predator/omnivores (2B: 10%, 6 genera) and non-selective deposit feeders (1B: 7%, 7 genera) (Fig. 5.104).

In contrast to station A, at station B, the vertical distribution of the relative trophic composition was similar within the three sediment layers studied. Thus, in the surface sediment layer (0-3 cm) the epistrate feeders predominated (2A: 39%, 17 genera) followed by the non-selective deposit feeders (1B: 31%, 13 genera), selective deposit feeders (1A: 23%, 9 genera) and predator/omnivores (2B: 7%, 8 genera). In the intermediate sediment layer (3-6 cm depth), epistrate feeders were also dominant (2A: 44%, 16 genera), with non-selective deposit feeders (1B: 34%, 13 genera), selective deposit feeders (1A: 14%, 7 genera) and predator/omnivores (2B: 7%, 9 genera). Within the lowest layer (6-10 cm depth) once more epistrate feeders predominated (2A: 41%, 17 genera), with non-selective deposit feeders (1B: 38%, 16 genera), selective deposit feeders (1A: 12%, 7 genera) and predator/omnivores (2B: 8%, 8 genera) (Fig. 5.105).

At station A, in the surface sediment layer, *Paracomesoma* genus comprised 48% and *Odontophora* 33% of the total non-selective deposit feeders (1B). Concerning epistrate feeders (2A), *Spirinia* represented 32%, *Chromadorella* 16%, *Linhomoeus* 13%, *Paracyatholaimus* 9%, *Chromadora* 8% and *Chromadorina* 7%. *Terschellingia* represented a contribution of 91% of the total selective deposit feeders (1A). In the trophic group, predator/omnivores (2B) predominated: *Viscosia* 35%, *Sphaerolaimus* 16%, *Metachromadora* 16% and *Thalassironus* 6%.

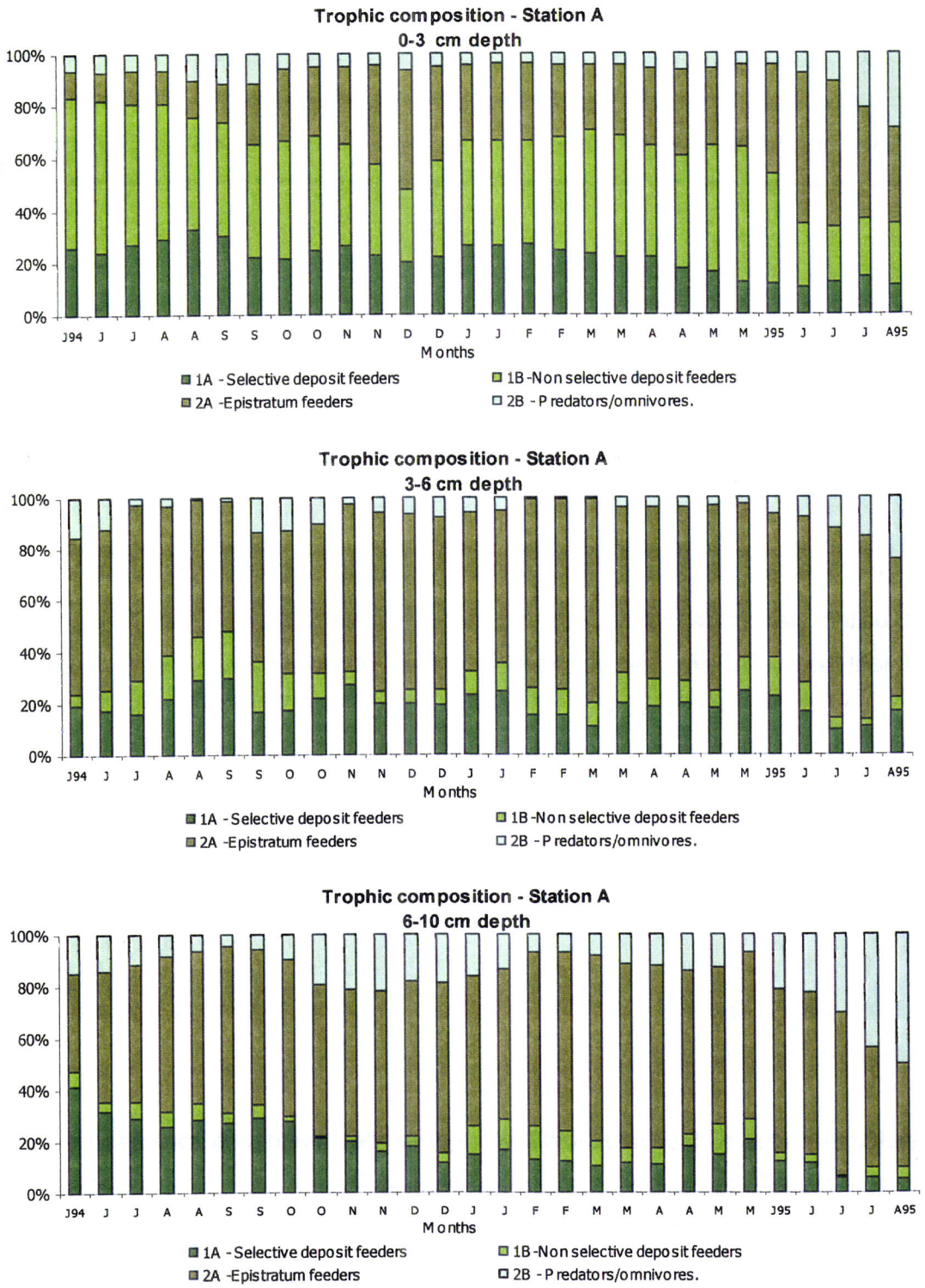


Figure 5.104– Relative variation in trophic composition of the nematode communities, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at station A, in *Zostera noltii* seagrass bed sediments of the Mira estuary.

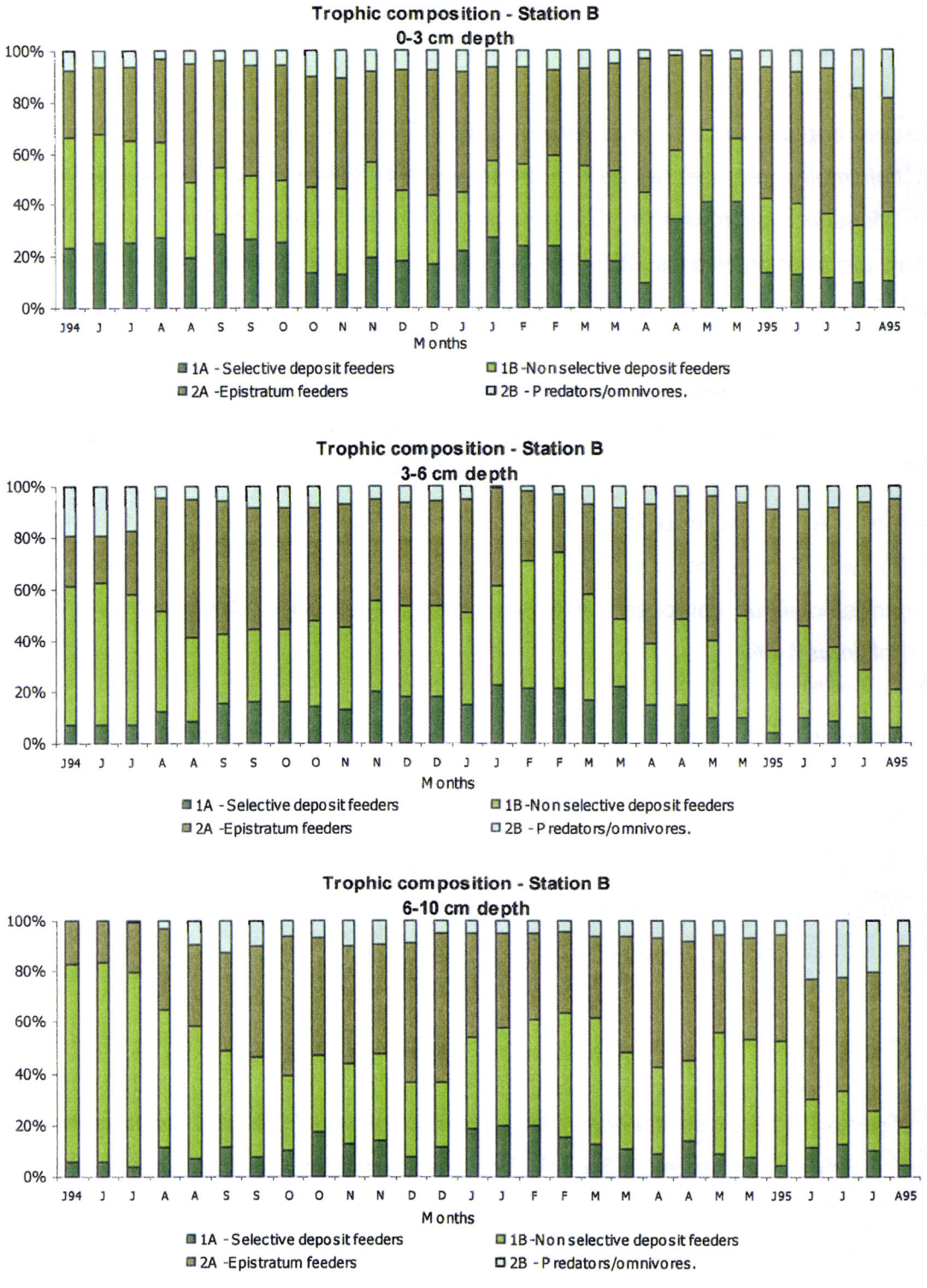


Figure 5.105 – Relative variation in trophic composition of the nematode communities, at the three depths: level 1 (0-3cm), level 2 (3-6 cm), level 3 (6-10 cm), from June 1994 to August 1995, at station B, in *Zostera noltii* seagrass bed sediments of the Mira estuary.

In the intermediate sediment layer, *Paracomesoma* represented 26% of the total epistrate feeders (2A), with *Odontophora* 16%, *Spirinia* 12%, *Linhomoeus* 12%, *Chromadorella* 9% and *Paramonohystera* 7%. *Terschellingia* was 71% of the total selective deposit feeders (1A), *Ptycholaimellus* 9%, *Anticoma* 8% and *Southernia* 6%. *Oncholaimellus* represented 26% of the total non-selective deposit feeders (group 1B), with *Megadesmolaimus* 16%, *Bathylaimus* 13% and *Paralinhomoeus* 12%. In trophic group predator/omnivores (2B) *Synonchiella* predominated with 35%, *Thalassironus* 28%, *Viscosia* 25% and *Sabatieria* 6%.

In the lowermost sediment layer, *Paracomesoma* 21%, *Odontophora* 21%, *Spirinia* 12%, *Paramonohystera* 11%, *Chromadorella* 10% and *Linhomoeus* 7% represented the epistrate feeders (2A). *Terschellingia* comprised 75% of the total selective deposit feeders (1A). In the trophic group predator/omnivores (2B), *Viscosia* predominated (70%) with *Oncholaimellus* (19%). Concerning non-selective deposit feeders (1B), *Megadesmolaimus* comprised 30%, with *Bathylaimus* 30%, *Campylaimus* 21% and *Molgolaimus* 14%.

At station B, in the surface sediment layer, *Spirinia* represented 45% of the epistrate feeders (group 2A) and *Linhomoeus* 19% of the non-selective deposit feeders (1B) *Paracomesoma* comprised 37%, *Odontophora* 30%, *Daptonema* 14%, and *Desmosdora* 5%. *Terschellingia* was 95% of the total selective deposit feeders (1A). In the trophic group predator/omnivores (2B), *Metachromadora* predominated 31%, *Viscosia* 30% and *Oncholaimellus* 15%.

In the intermediate sediment layer, *Spirinia* was 41% of the total epistrate feeders (2A) and *Linhomoeus* 27% of the non-selective deposit feeders (1B), *Paramonohystera* represented 22%, *Odontophora* 21%, *Paracomesoma* 19% and *Daptonema* 10%. *Terschellingia* contributed 83% of the total selective deposit feeders (1A) and *Southernia* (8%). In the trophic group predator/omnivores (2B) *Metachromadora* predominated 25%, *Viscosia* 25% and *Synonchiella* 15%.

In the lowermost sediment layer, epistrate feeders (2A) were represented by *Linhomoeus* 31%, *Spirinia* 31% and *Camacolaimus* 12%. *Paracomesoma* represented 24% of the total non-selective deposit feeders (1B), *Paramonohystera* 23%, *Odontophora* 14% and *Daptonema* 12%. *Terschellingia* comprised 81% of the total

selective deposit feeders (group 1A) and *Anticoma* 8%. In the trophic group predator/omnivores (2B), *Viscosia* predominated (33%), with *Oncholaimellus* (17%), *Synonchiella* (14%) and *Metachromadora* (11%)

At station A, trophic composition temporal variation clearly differed in both summers studied. In summer 94, the non-selective deposit feeders (1B) reached relatively high proportions, while in summer 95 the epistrate feeders were the most important trophic group. The non-selective deposit feeders (1B) attained relatively high proportions between June 94 and August 94 (summer 94), in February and in March (early spring). The lowest relative percentages were registered in November, December and from June 95 until August 95 (summer 95). The epistrate feeders (2A), the second most abundant trophic group, presented relatively high proportions in November and December and from June 95 until August 95 (summer 95). The lowest relative percentages were between June 94 and September 94 (summer 94). The selective deposit feeder (1A) higher percentages were found in August 94, September, January and February, followed by constinous decrease. The predators/omnivores (2B), the feeding group with relatively low proportions, exhibited the lowest percentages in February, March and the highest in July 95 and August 95.

At station B, as at station A, trophic composition temporal variation differed in both summers studied. In summer 94, the non-selective deposit feeders (1B) and epistrate feeders (2A) were present in similar proportions, while in summer 95 the epistrate reached relatively high proportions. The epistrate feeders (2A) attained the highest proportions from August 94 until January 95, and between June 95 and August 95 (summer 95). The non-selective deposit feeders (1B), the second most abundant trophic group, presented an opposite trend, the lowest relative percentages being from September 94 until October 95, and between June 95 and August 95 (summer 95). The selective deposit feeders (1A) highest percentage was found in April and May 95, and lowest in summer 95. The predators/omnivores (2B), the feeding group with relatively lower proportions, exhibited higher percentages in both sampling summers.

At both stations, in the surface sediment layer (0-3 cm depth), trophic composition temporal variations were similar to those observed in global results (0-10 cm depth). Moreover, at station B, relative trophic composition temporal patterns were similar at the three sediment depth layers studied. However, at station A, in deeper sediment

layers, the relative composition changed considerably by a shift in feeding types: epistrate feeders were dominant, the highest proportions being recorded in February and March. In the intermediate sediment layer, the second most abundant trophic group, selective deposit feeders (1A) attained the highest proportions in August 94 and September, although in the low sediment layer, proportions declined almost continuously in this period. The highest proportions of the predators/omnivores were registered in summer 95, November and December.

5.3.5. Temporal variation and structuring factors of the Nematoda communities

The CCA results illustrate the seasonal changes in abundances and genera composition in the Nematoda communities, and relate to the seasonal changes of the several environmental factors that were measured (see chapter 3).

CCA was performed to relate the temporal variation in abundance of the Nematoda community composition to temporal variation in the environmental and biological factors studied over the study period, at both sampling sites. At station A, "early summer 94" and "spring" were separated from the "summer 94", "autumn" and "summer 95" along the first axis. "Early summer 94" and "summer 94" were separated from the other seasonal periods by the second axis (Fig. 5.106). At station B, "early summer 94", "summer 94", "summer 95" and spring were separated from the other seasonal periods along the first axis, and "early summer 94", summer 94" were separated from "winter-spring" and "summer 95" by the second axis (Fig. 5.107).

At station A, the seasonal Nematoda community of the "early summer 94" (seasonal Nematoda community - group 1) was associated with high values of temperature, sediment nitrites concentration and silt percentage, while *Zostera noltii* roots biomass, sediment ammonia concentration and median grain size registered lower values. In contrast, the "summer 94" (group 2) was plotted along the planes with the lowest values of temperature, *Zostera noltii* leaves biomass and sediment nitrites concentration. As the same time, sediment ammonia concentration, clay and silt percentage were higher in this seasonal group. The "summer 95" (group 5), as observed in "early summer 94", was plotted in the planes with highest values of

temperature, salinity, *Zostera noltii* leaves biomass and sediment ammonia concentration, clay and silt percentage.

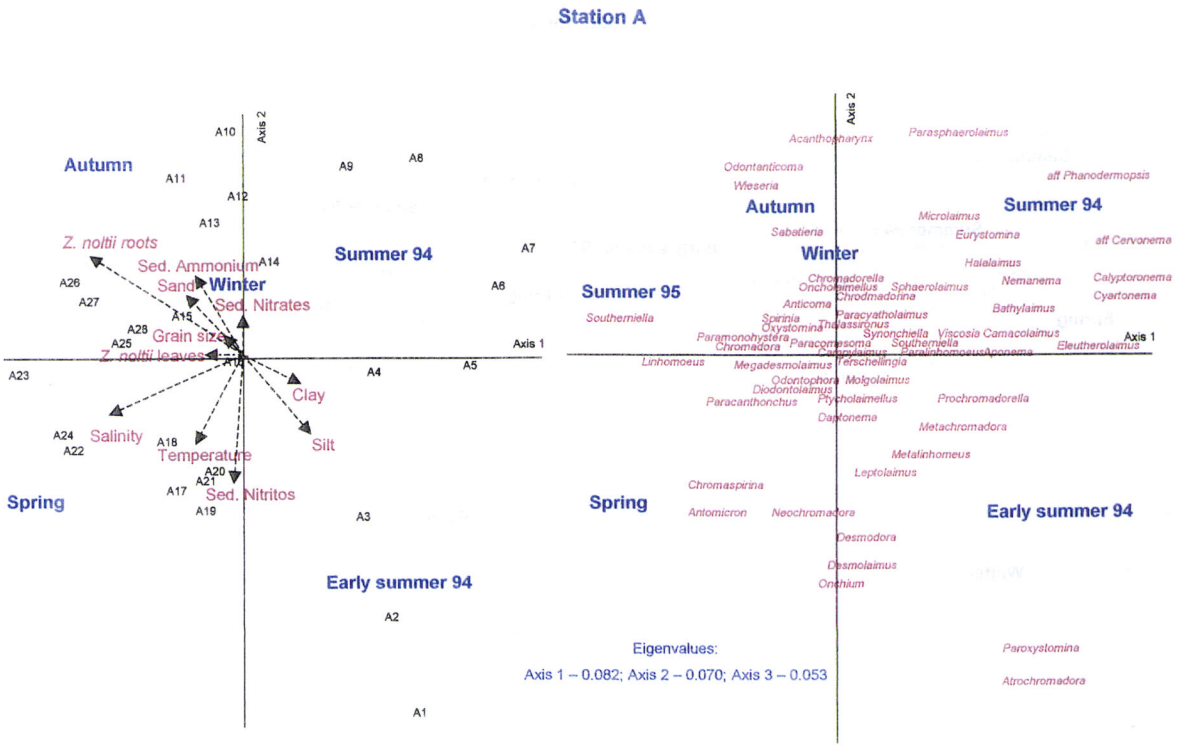


Figure 5.106 – Canonical correspondence analysis (CCA-ordination) (axis 1 vs. axis 2) based on fortnightly variation of Nematoda genera densities (0-10 cm sediment depth) and on the environmental variables, from June 94 (A1) until August 95 (A28) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary.

The Nematoda communities of "autumn" (group 3) and "winter- early spring" (group 4) were associated with lowest values of temperature. In "autumn" lowest values of salinity were attained, particularly on sampling dates A9 (October) and A10 (November), together with sediment nitrites, clay and silt percentage. The sediment nitrates concentration, *Zostera noltii* roots and leaves biomass attained high values. In "winter- early spring" (group 4), the Nematoda communities were plotted in planes with lowest values of temperature, mainly until February (A17), *Zostera noltii* leaves biomass and percentage of clay and silt, while sediment ammonia concentration and the medium grain size exhibited highest values.

The plot of Nematoda scores showed the genera very close to the middle of the graph, which indicated that the temporal pattern obtained was a consequence mainly of the temporal variation of environmental factors and not as a consequence of Nematoda

genera temporal variations. However, it was possible to identify the Nematoda assemblage associated with the environmental conditions of each seasonal group.

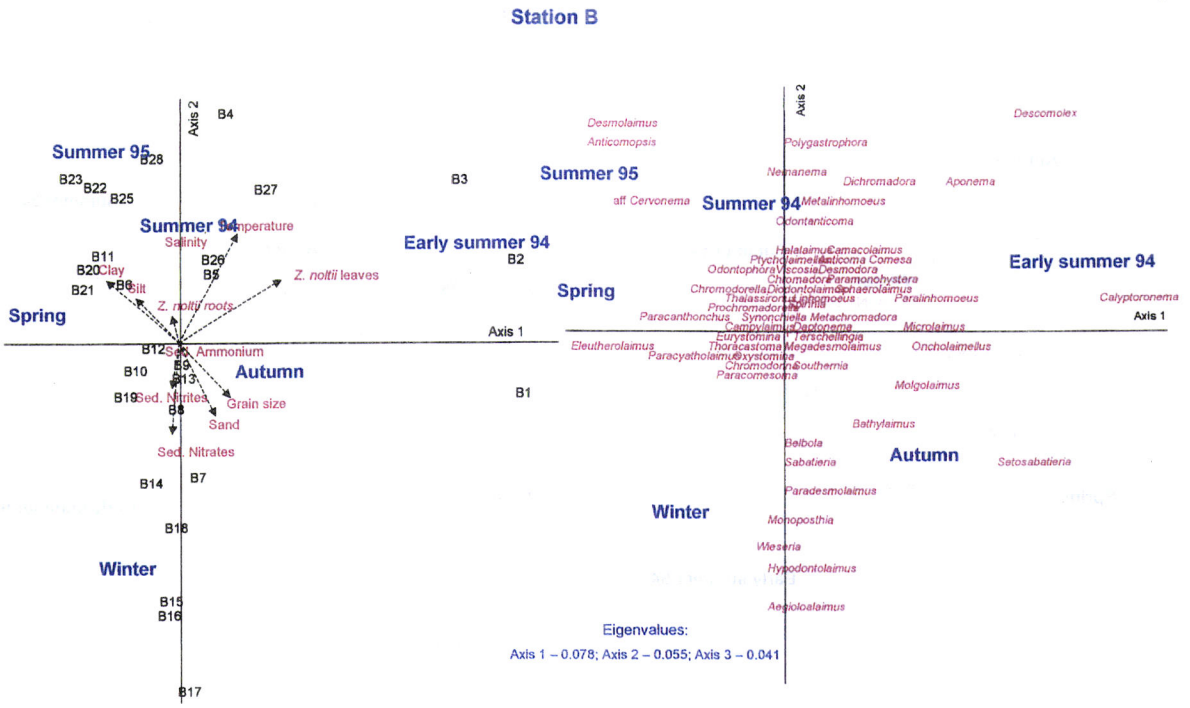


Figure 5.107 – Canonical correspondence analysis (CCA-ordination) (axis 1 vs. axis 2) based on fortnightly variation of Nematoda genera densities (0-10 cm sediment depth) and on the environmental variables, from June 94 (B1) until August 95 (B28) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary.

The most abundant genera were plotted very close to the intersection of the two axes because they were presented with higher densities throughout the sampling period. However, it is possible to identify the relationship between density seasonal variations and environmental conditions. Moreover, the plot of Nematoda scores also reflects the periods of maximal densities of the less abundant taxa: *Atrochromadora* and *Paroxystomina* were plotted in "early summer 94" (group 1); *Calyptronema*, *Cyartonema* and aff *Cervonema* - "summer 94" (group 2); *Parasphaerolaimus*, aff *Phanodermopsis* and *Acanthopharynx* - "autumn" (group 3); *Odontanticoma* - "autumn" (group 3) and "summer 95" (group 5); *Southerniella*, *Chromaspirina* and *Antomicron* - "winter- spring" (group 4); *Neochromadora*, *Desmodora*, *Desmolaimus* and *Onchium* - "early summer 94" (group 1) and "summer 95" (group 5); *Leptolaimus*, *Metalinhomoeus* and *Metachromadora* - "early summer 94" (group 1) and "summer 95" (group 5); *Eleutherolaimus* - "early summer 94" (group 1) and "summer 94"(group 2)

and "autumn" (group 3); *Prochromadorella*, *Bathylaimus*, *Sphaerolaimus* and *Aponema* - "early summer 94" (group 1) and "summer 94" (group 2); *Nemanema* - "summer 94" (group 2); *Halalaimus* - "early summer 94" (group 1), "summer 94" (group 2) and "autumn" (group 3); *Microlaimus and Eurystomina* -"summer 94" (group 2) and "autumn" (group 3). *Sabatieria* and *Anticoma* - "autumn" (group 3) and "summer" (group 5).

At station B, the seasonal Nematoda communities of "early summer 94" (group 1), "summer 94" (group 2) and "summer 95" (group 5) were associated with high values of temperature and salinity. The sediment ammonia concentration and biomass *Zostera noltii* roots were very low in "summer 94" and higher in "summer 95" (group 5). The Nematoda communities plotted in planes of "early summer 94" (group 1) and "summer 95" (group 5) were related to higher values of biomass *Zostera noltii* leaves. During the summer periods, sediment nitrites and nitrates concentrations were lower. The high percentage of clay and silt were associated with "summer 94"(group 2) and "summer 95" (group 5), when the percentage of sand was lower; nevertheless the samples B1 (June 94), B2 (July 94), B27 (July 95) and B28 (August 95) showed the highest percentage of sand.

The "autumn" (group 3) and "winter-spring" (group 4) communities were plotted in planes corresponding to lower values of temperature and salinity, particulary in winter samples, and of biomass *Zostera noltii* leaves and roots, to low percentage of silt and clay, to highest values of sediment ammonia, nitrites and nitrates concentrations and to a high percentage sand. However, temperature, salinity, silt and clay percentage were higher in late spring samples of the seasonal group 4 (winter-spring) Thus, the environmental conditions where more similar to "summer 95".

At station B, as at station A, the most abundant genera were plotted very close to the intersection of the two axes. The plot of the scores of Nematoda taxa also reflects periods of maximal densities of the less abundant taxa: *Desmoscolex* was plotted in the "early summer 94" (group 1) plane; *Aponema*, *Dichromadora*, *Polygasthrophora* and *Nemanema* - "summer 94" (group 2) and "summer 95" (group 5); *Desmolaimus* and *Anticomopsis* - "summer 95" (group 5); *Cervonema* and *Eleutherolaimus* - late samples of the "winter-spring" (group 4); *Aegioloalaimus Hypodontolaimus* and *Paradesmodora* early samples of the "winter-spring" (group 4); *Monoposthia* -

"autumn" (group 3) and early "winter-spring" (group 4); *Setosabatieria* "early summer 94" (group 1) and "early summer 94" (group 1). *Bathylaimus* and *Sabatieria* were registered in most of the sampling period, but disappeared in "summer 95" (group 5). *Metalinhomoeus* disappeared on several dates in "autumn" (group 3) and "winter-spring" (group 4).

5.4. DISCUSSION

Nematoda was the numerically dominant taxon, the density being high the ranges falling in similar habitats. Nematoda dominance in marine sediments of the intertidal systems has been largely documented (e.g. Bell, 1979; Warwick & Price, 1979; Hicks & Coull 1983; Heip *et al.*, 1985; Phillips & Fleeger, 1985; Castel *et al.*, 1989; Escaravage *et al.*, 1989; Vanhove *et al.*, 1992; Li & Vincx, 1993; Soetaert *et al.*, 1994b, 1995; Smol *et al.*, 1994; Aryutaka & Kikutchi, 1996; Schizas & Shirley; 1996; De Troch *et al.*, 2001).

Seagrasses are recognized for their ability to exert a strong influence on the density increases and the distribution of associated fauna by modifying the hydrodynamic environment, stabilizing the sediment, and thus causing the enhancing deposition of organic matter, which constitutes an important resource of food and generally provides micro-habitats, thus enhancing meiofauna colonisation (Decho *et al.*, 1985; Boström & Bonsdorff, 1997). Nematoda densities were relatively high in organically enriched muds of *Zostera* seagrass and lower in coarse sediments (Castel *et al.*, 1989; Escaravage *et al.*, 1989; Ndaro & Ólaffson, 1999). Coull and Wells (1983) proved the protective role of phytal habitats for meiofauna. However, Aryuthaka and Kikuchi (1996) found that the very low abundance in a seagrass bed compared with bare sand may be due to the high organic imput in the seagrass bed studied, and the nematode community may not be have been to utilize this food resource.

Linhomoeidae (e.g. *Terschellingia*, *Linhomoeus*), Desmodaridae (e.g. *Spirinia*, *Desmodora*), Chromadoridae (e.g *Chromadora*, *Chromadorella*, *Chromadorina*) Comesomatidae (e.g. *Paracomesoma*), Xyalidae (e.g. *Daptonema*, *Paramonohystera*) Axonolaimidae (e.g. *Odontophora*) families observed in this study occur in several intertidal flats of the world, especially in fine sediments (e.g. Tietjen, 1980; Alongi,

1989; Smol *et al.*, 1994; Li *et al.*, 1997a; Ndaro & Ólafsson, 1999; Ólafsson *et al.*, 2000). The dominant families Linhomoeidae and Comesomatidae encountered were also observed in another study in sediments associated with *Zostera noltii* in Arcachon Bay (France). They are commonly cited in the literature as mud-adapted (Wieser, 1960; Tiejten, 1977; Warwick & Gee, 1984), predominantly observed in silty sediments and preferring a more saline environment (Soetaert *et al.*, 1995). Desmodaridae, the second most abundant family at station B, commonly found in typical sandy sediments, are also described in muddy sediments (Escaravage *et al.*, 1989).

At both stations, Nematoda genera composition was similar. Most of the genera observed in this study commonly occur elsewhere in the world, in temperate or tropical seagrass beds, *Terschellingia*, *Paracomesoma*, *Odontophora*; *Spirinia*, *Linhomoeus* were the dominant genera. *Terschellingia* was observed in sediments with a high percentage of clay and silt of the marine part of the Tagus (Portugal), Gironde (France) and the Tamar (England) estuaries (Soeteart *et al.*, 1995). *Spirinia* and *Terschellingia* presented a high percentage in the Westerchelde estuary in the polyhaline area (Li & Vincx, 1993). *Terschellingia* and *Spirinia* were the dominant genera in a seagrass bed in a tropical intertidal lagoon (Ndaro & Ólafsson, 1999). *Terschellingia* was dominant in a temperate Australian mangrove mudflat (Nicholas *et al.*, 1991).

Nematoda community abundances and temporal variations were clearly different between stations, although at both sampling stations the several environmental factors structuring the Nematoda assemblages were similar. Generally, densities were highest at station B. *Chromadorella* was present in the six dominant genera at station A, whereas at station B this genus showed low densities. *Desmodora* was one of the dominant genus at station B, but at station A it showed very low densities, and the temporal trends of some abundant genera differed significantly (e.g. *Chromadorella*, *Linhomoeus*, *Daptonema*, *Paramonohystera*, *Desmodora*, *Camacolaimus*, *Chromadora*, *Ptycholaimellus*, *Oncholaimellus*, *Metachromadora*).

The spatial distribution of the nematodes is not homogeneous. Different Nematoda assemblages occupy different habitats; those in mud differ from those in sand, those in low salinity differ from those in high salinity, those living above the bottom, in or on fouling and plant communities or on various animal structures, differ from the sediment

dwellers, and often are specific to each epibenthic habitat (Walters & Bell, 1994; Coull, 1999).

Nematoda communities of estuarine and marine sediments typically have a strongly heterogenous distribution. Horizontal patchiness is particularly pronounced. Patch sizes are defined on a range from kilometre to subcentimetre scales (Findlay & Tenore, 1982; Fleeger & Decho, 1987; Hodda, 1990; Fleeger *et al.*, 1995b). On larger scales, patchiness is commonly related to abiotic gradients in sediment composition, tidal elevation and hydrodynamics (Fleeger & Decho, 1987; Fleeger *et al.*, 1995b). Physical factors may be more important in generating macro-scale heterogeneity than in generating micro-scale heterogeneity (Li *et al.*, 1997b). Soetaert, *et al.* (1995) argued that salinity and sediment characteristics (scale of hundreds of metre to kilometres) proved to be more important in explaining community structure than the latitudinal gradients (scale of hundreds of kilometres). On smaller scales, other interactions, many biotic, structure meiofauna spatial distribution. A variety of other factors have been documented, including sediment microtopography (sediment depressions) and biogenic structures (Sun & Fleeger, 1994; Wetzel *et al.*, 1995; Fenchel, 1996), intra and interspecific competition (Chandler & Fleeger, 1987) and food pactches, as perhaps being a major factor driving the heterogenous field distribution of nematodes (Li *et al.*, 1997b).

The sampling stations were ecologically very similar; they were located in sediment *Zostera noltii* seagrass near the estuary mouth. Temporal variation of temperature, salinity, ph, amount of dissolved oxygen, concentrations of nutrients in the water column and proportions of silt and sand were similar. Therefore, the main physical factors known to control Nematoda abundance and composition were similar. Significant differences were observed concerning temporal variation of organic matter content of the sediment, biomass of *Zostera noltii* and clay proportion, which could be important for the explanation of the differences obtained in Nematoda community composition, abundances and temporal variations.

However, physical factors seem not to have been determinants in explaining the differences between the Nematoda communities observed at both stations studied. Many biotic factors such as competition, reproductive behaviour and predation pressure, patchy food distribution, and biogenic structures related to *Zostera* plants

could be more important in explaining the Nematoda assemblages than the physical factors. Nevertheless, station B was further from the estuary mouth, and lower hydrodynamics probably allowed highest densities.

Nematodes were allocated to feeding types according to Wieser (1953). The sediments were mainly populated by non-selective deposit feeders and epistrate feeders. At station A, the non-selective deposit feeders dominated (1A-without a buccal armature), while at station B it was the epistrates feeders (2A–with buccal armature). Most probably they were grazing on a mixture of diatoms and other microalgae, bacteria and organic matter. Bacteria and microalgae are generally considered important food sources for meiofauna, and diatoms in particular are grazed by several nematodes (Moens & Vincx, 1997). Escaravage *et al.* (1989) also reported the predominance of deposit feeders in Arcachon Bay *Zostera* beds.

Detrital material derived from *Zostera* seagrass beds serve as important source of organic material, and a large part of the benthic food demand is certainly met by the detritic pathway. It is well know that detritus is of vital importance for the nutrition of meiofaunal organisms in sediments. However, energy flow studies on the seagrass system have shown that only a small proportion of primary production is consumed directly by benthic organisms, while benthic bacteria mineralise the major portion of detrital carbon. This supports the predominance of deposit feeders, mostly utilising bacterial biofilms, and not the detrital substrate itself. In benthic food chains, bacteria are an important key, due to their fast growth and high metabolic activity, in association with organic material, and therefore detritus mineralization, along with diatoms, may belong to the available food for the nematodes (Findlay & Tenore, 1982; Montagna *et al.*, 1983; Alkemade *et al.*, 1994).

Epigrowth feeders are characterized by the presence of a buccal armature, supposedly used to either scrape off particles from a substrate, or to damage and open food items before emptying them. Diatoms and other microalgae are an important food for many representatives of this group (Moens & Vincx, 1997).

In temperate regions, intertidal and shallow subtidal meiobenthos are known to vary seasonally. Moreover, meiobenthic communities seasonal variations are generally more pronounced intertidally than in deeper waters (Coull, 1985b, 1986; Eskin & Coull,

1987; Smol *et al.*, 1994). Nematoda assemblages change seasonally, both in abundance and in species composition, and the muddy nematode species are distinctly seasonal (Eskin & Coull, 1987). There are clear annual patterns of abundance and species succession in almost every study to date (Coull, 1999).

As expected, at both stations, Nematoda assemblages exhibited an evident seasonality, which was described in five seasonal groups. However, the seasonal patterns were clearly different at both stations, resulting from the different seasonal patterns of the several genera that compose the Nematoda assemblages.

In temperate regions, nematode seasonality generally registers maximum abundance in the warm seasons and mininum in winter, that is, they respond to increased temperature (Hicks & Coull, 1983; Coull & Dudley 1985; Rudnick *et al.*, 1985; Smol *et al.*, 1994). In this study, the densities of the dominant genera *Paracomesoma*, *Terschellingia*, *Odontophora*, *Linhomoeus*, *Paramonohystera*, *Daptonema*, *Chromadora*, *Ptycholaimellus* and *Camacolaimus* rose in autumn and/or in winter-spring. However, several temporal studies found the maximum abundances in autumn, winter and early spring, and there was no consistent correlation between abundance and temperature, with maximal numbers present during periods of the lowest temperature (Eskin & Coull, 1987; Aryuthaka & Kikuchi, 1996; Santos *et al.*, 1996). Eskin & Coull (1987) in a South Caroline estuary mud site, found the total nematode abundance in winter or spring i.e. January to March, and the 6 dominant species had their peak abundances in the winter or spring.

The seasonal patterns of Nematoda communities were different between both stations, which were closely related with the distinct seasonality of the several genera that composed the communities throughout the sampling period, and with the presence of several genera not common at both stations. Considering the seasonal variations of the dominant genera in the communities, at station A, *Terschellingia*, *Paracomesoma* and *Odontophora* were important genera from "early summer 94" (group 1) until "winter-early spring" (group 4), whereas *Spirinia* and *Viscosia* were important in "summer 95" (group 5). At station B, *Terschellingia*, *Paracomesoma*, *Odontophora*, *Linhomoeus*, *Ptycholaimellus* and *Megadesmolaimus* were important genera in "winter-early spring" (group 4) communities. The densities of *Odontophora*, *Paramonohystera*, *Metachromadora*, *Desmodora* and *Molgolaimus* were high in "early

summer" (group 1). *Spirinia* was an important genus in the remaining sampling period. *Chromadorina*, *Oncholaimellus*, *Southernia* and *Paracyatholaimus* registered the highest values in autumn (group 3). *Chromadorella*, *Daptonema*, *Chromadora* were important in both "autumn" (group 3) and "winter-early spring" (group 4). At both stations, *Viscosia* showed the highest values in "summer 95" (group 5).

In temperate waters, the densities rise during late spring and summer, accompanied by excess food resources, is responsible for meiofauna seasonality (Bowman *et al.*, 1984; Rudnick *et al.*, 1985). The seasonal abundance patterns in Nematoda populations are know to vary seasonally with the physico-chemical regime, trophic dynamics and biological factors of the environment. Temporal changes of the temperature, salinity, sediment particle size, oxygen, available food resources, trophic interactions, predation, competition and the reproductive burst of the several species have traditionally been implicated in regulating Nematoda composition inhabiting intertidal systems. However, it is very difficult to separate the effects of each factor and interpret the seasonality, as is seen in several studies.

The results of the present study indicate the Nematoda dynamics were not significantly related to temperature, salinity or to any other measured physical factor described in the literature as determining marine and estuarine free-living nematode assemblages. As in meiofauna assemblages, it was not possible, separately, to distinguish the structuring factors that are regulators of the Nematoda assemblage seasonal variations. Nevertheless, based on the interactions and the seasonality of the several environmental factors studied at both sampling stations (see chapter 3), it is possible to relate Nematoda assemblages of each seasonal group described to certain environmental conditions (taxa-environmental relations).

At station A, the densities of dominant genera *Terschellingia*, *Paracomesoma*, *Odontophora*, *Metachromadora*, *Daptonema* and *Linhomoeus* were high in "early summer" (group 1). Nematoda assemblages of "early summer" (group 1) were associated with high values of temperature, sediment nitrites and lower values of sediment ammonia concentration. The concentrations of the nitrogen compounds as nitrate and nitrite (oxidized) and ammonia (reduced) could be used to evaluate the oxidation status of the sediment. Therefore, the higher nitrate and nitrite

concentrations, and low ammonia concentration, could indicate the occurrence of the nitrification of ammonium, which occurs only in oxidized sediments.

The Nematoda assemblages of "summer 94" (group 2) were related to different environmental conditions, particularly lower values of ammonium, nitrate and nitrite sediment concentrations, suggesting a lower decomposition rate. A likely explanation could be the presence of more reduced sediments. Moreover, the increase of the percentage of clay and silt decreases the permeability of the sediments to oxygen.

The dominant genera of the Nematoda communities of "autumn" (group 3) and "winter-early spring" (group 4) exhibited higher densities. They were plotted in planes with high salinity, high biomass *Zostera noltii* roots, high sediment ammonium and nitrates concentrations and high sand percentage, which could indicate high oxygen availability. The high values of concentrations of the nitrogen compounds such as nitrate could indicate the occurrence of the nitrification of ammonium, which occurs only in oxidized sediments. The high values of biomass *Zostera noltii* roots could have enhanced the nitrification rates in the sediment because of the aerating effect of photosynthetically produced oxygen, which leaks from plant roots into sediment pore waters (Day *et al.*, 1989; Nielsen *et al.*, 2001).

In contrast, the dominant genera of the Nematoda communities in "summer 95" (group 5) decreased their densities, except for *Spirinia* and *Viscosia* which increased their densities. They were plotted in planes with high values of sediment ammonium concentration and lower values of sediment nitrites and nitrates, which could indicate a low nitrification rate, the likely explanation possible being lower oxygen availability. Moreover, the increase in the percentage of clay and silt decreases the permeability of the sediments to oxygen.

At station B, as at station A, "autumn" and "winter–early spring" seem to be periods of a higher mineralisation rate of the organic matter, and provide enough oxidized sediment. Indeed, nitrate and nitrite sediment concentrations, and the percentage of sand, recorded the highest values. The dominant genera communities attained high densities. Both summers studied corresponded to a period of the highest values of temperature and of *Zostera noltii* leaves biomass and a high percentage of clay and

silt, as at station A, suggesting a more reduced status for sediment, and a consequent decline in the densities of nematodes.

Possibly, the biological factors, and their interactions with physical factors, constituted the determining factors structuring the seasonality obtained at both stations, and the seasonality differences of both stations are also caused by trophic dynamic fluctuations. Different possible adaptive life strategies in nematodes can occur, such as seasonality in reproduction, with the number of generations restricted to particular seasons, or life strategies completely unconnected with environmental events (Heip *et al.*, 1985).

The different seasonal fluctuations obtained in several studies were also related to different species in each community, and these have distinct reproductive cycles. The study of the structure populations of the dominant Nematoda genera seems to explain the seasonality of the communities at both stations and the differences between stations. The temporal variation patterns of the juveniles were closely associated with the temporal variation patterns of the populations. As expected in temperate regions, the reproduction was continuous, the juveniles were present throughout the sampling period, and the highest densities were coupled with peak densities of the populations and consequently an increase of reproduction activity. In contrast, the lowest densities of the populations corresponded to a decline in reproduction activity. At station A, in "autumn" (group 3), the dominant genera *Terschellingia*, *Paracomesoma* and *Odontophora* registered a deep densities decline closely associated with the juveniles decline, while *Chromadorella*, *Chromadorina*; *Chromadora*, *Viscosia* increased their densities, closely linked to the increase in reproduction activity.

The other important biological factor that could explain the seasonality obtained at each sampling station was trophic dynamic fluctuations. The trophic composition of the Nematoda assemblages deeply changed in both summers. In summer 94, the non-selective deposit feeders (1B) reached relatively higher proportions at both stations, while in summer 95, epistrate feeders (2A) were the more important trophic group, suggesting enriching of diatom. This accorded with the temporal variation of the sediment silica concentration, which was highest during spring and summer. Nevertheless, this trophic group did not graze solely on diatoms, but on a diet of many detrital food sources, responding to the organic carbon in the sediments.

At station A, in "autumn" (group 3), an evident changing of the trophic dynamic was observed. The epistrate feeders (2A) increased their percentage (*Chromadorella*, *Chromadorina*; *Chromadora*, *Viscosia*), whereas the non-selective deposit feeders (1B) strongly declined (*Terschellingia*, *Paracomesoma* and *Odontophora*). A likely explanation could be the increase in the detrital food sources resulting from the decomposition of *Zostera noltii* leaves and associated with the input of river nutrient flow. The increase in sediment organic matter percentage, nitrates and nitrites concentrations and the biomass of *Zostera noltii* was registered. At station B, an increase in the non-selective deposit feeders (1B) was registered in winter, which could relate to an increase in the bacteria populations.

The strongest gradients in nematode community composition are vertically in the sediment, in terms of total abundance (Vincx *et al*, 1994), taxonomic composition (Soetaert *et al.*, 1995), tail morphology (Thistle & Sherman, 1985), or size structure (Soetaert *et al.*, 1997).

The vertical densities of the Nematoda genera showed a clear decline within sediments, although the dominant genera were common at the three sediment layers: *Paracomesoma*, *Odontophora*, *Spirinia* and *Terschellingia*. Deeper in the sediment (3-10 cm depth) *Paramonohystera* and *Viscosia* (at station A) and *Paramonohystera* and *Camacolaimus* (at station B) were becoming predominant genera. Regarding, the number of genera, a slight decrease at station A was observed, while at station B an increase was obtained

At station A, the change in relative composition of the Nematoda assemblages in depth was accompanied by a slight shift in feeding types; non selective deposit feeders (1B) and epistrate feeders (2A) dominated the surface layers, while deeper layers were dominated by epistrate feeders (2A) and selective deposit feeders (1A). At station B, within the sediments, a change in feeding types was not observed, with epistrate feeders (2A) dominating in the three sediment layers studied.

The temporal patterns of the vertical variations in Nematoda assemblages showed clear seasonality at both sampling sites. The density patterns of the uppermost sediment layer structured the seasonality of the sediment layer of the 0-10 cm depth

due to the majority of the nematodes being concentrated in the uppermost 3 cm (>80%).

The seasonal patterns of the dominant genera within the three depths studied were very similar, even at the 6-10 cm depth, where sediments were strongly reduced. However, at station B, the seasonal patterns of several Nematoda genera, *Terschellingia*, *Odontophora*, *Linhomoeus*, *Metachromadora*, *Desmodora* and *Paramonohystera* registered some differences, while at station A, *Daptonema* and *Chromadorella* exhibited some differences.

That meiofauna and nematodes do occur more frequently in the uppermost sediment layers has been demonstrated in all types of biotopes (Heip *et al.*, 1985; Giere, 1993). Meiofaunal vertical zonation was generally related to the richer supply of oxygen and food available at the surface. Nematode assemblages vertical zonation is typically controlled by the oxygen regime in sediments, this being a limiting factor for the maximum depth. As a consequence, the largest part of the nematodes is restricted to the uppermost oxic layers of the sediment where the free oxygen is freely available (Joint *et al.*, 1982). The oxygen supply to the sediment, which is undoubedtly related to granulometry, is known as one of the most important structuring parameters (Giere, 1993). Many other factors structure the vertical distribution of nematodes by creating chemical microenvironments: biogenic structures such as rhizomes and roots in seagrasses, bioturbation, biogenic structures of benthic organisms (Cullen, 1973; Bell & Coull, 1978; Nehring *et al.*, 1990; Wetzel *et al.*, 1995; Fenchel, 1996), predation (Coull *et al.*, 1989), competition for food (Joint *et al.*, 1982), association with ectosymbiotic bacteria (Hentschel *et al*, 1999), physiological adaptations (Vopel *et al*, 1996; Forster, 1998).

The highest densities of *Paramonohystera*, *Camacolaimus* and *Viscosia* occurred in deeper layers, therefore in anoxic and sulphidic sediment layers. A likely explanation could be related to the resistance of these species to anoxia and sulphide, or to other physiological adaptations that are present in the reduced sediments, e.g. association with bacterial ectosymbionts. Another explanation could be biological interaction between species that seem to occupy the same position relative to each other; vertical stratification may play a role in allowing species with similar food requirements and feeding behaviour to co-exist in the same locality.

At station A, *Daptonema* and *Chromadorella* exhibited an opposite trend in "summer 95" (goup 5) at depth. At station B some genera (*Terschellingia*, *Odontophora*, *Linhomoeus*, *Metachromadora*, *Desmodora* and *Paramonohystera*) also presented an opposite trend, with their density increasing in the lower sediment layers. This suggests a migration in depth may be due to an increase in oxygen or food availability; as a consequence, *Zostera* biomass increases and sediments seem more oxidized.

5.5. CONCLUSIONS

The study of temporal variation of Nematoda communities at two stations in sediments of the *Zostera noltii* seagrass in Mira estuary leads to the following conclusions:

1-The high densities and the Nematoda genus composition observed throughout the study agree with the results of previous observations carried out in vegetated intertidal muddy sediments, including *Zostera noltii* seagrass beds.

2-Seasonality for Nematoda at both stations contradicts the seasonality generally observed in other studies, which usually peaks in the warmest months. In this study the densities of the dominant genera *Paracomesoma*, *Terschellingia*, *Odontophora*, *Linhomoeus*, *Paramonoshystera*, *Daptonema*, *Chromadora*, *Ptycholaimellus* and *Camacolaimus* rose in autumn and/or in winter-spring.

3-The analysis of the temporal variations of the Nematoda assemblages, at both sampling stations, indicated an evident seasonality. The results of the present study indicated that it was not possible to identify a single environmental factor which can explain the seasonal variation of the Nematoda abundance and composition. However, it was possible to recognize that the combined effect of a given set of factors creates the habitat conditions which explain the seasonal variation of Nematoda assemblages.

4-The densities and seasonal patterns of the Nematoda assemblages between sampling stations were different. However, the temporal variations of the important factors structuring Nematoda communities, such as temperature,

salinity, pH, amount of dissolved oxygen (DO) and concentrations of nutrients in the water and in sediment proportions of silt and clay, were similar between stations.

5-Abiotic differences between both sites studied were not the main factors affecting the temporal changes of the Nematoda communities. Biotic factors, such as food availability, life cycles and trophic conditions, may play an important role in structuring the seasonal changes of these communities. The study of the structure populations of the dominant Nematoda genera seems to explain the seasonality of the communities at both stations, and the differences between stations. The temporal variation patterns of the juveniles were closely associated with the temporal variation patterns of the populations. Juveniles were present throughout the sampling period, and the highest densities were coupled with peak densities of the populations and consequently an increase in reproduction activity. In contrast, the lowest densities of the populations corresponded to a decline in reproduction activity. The other important biological factor that could explain the seasonality obtained at each sampling station is trophic dynamic fluctuations. Indeed, an evident changing of the trophic group dominance was observed, suggesting changes in food availability.

6-Nematodes were allocated to feeding types according to Wieser (1953). As expected, sediments were mainly populated by non-selective deposit feeders and epistrate feeders. Detrital material derived from *Zostera* seagrass beds serve as an important source of organic material, and a large part of the benthic food demand is certainly met by the detritic pathway.

7-The seasonal changes in the vertical distribution and densities of the Nematoda assemblages were also very evident. The seasonality of the deeper sediment layer was very consistent with the seasonality obtained in the surface sediment layer.

6 - GENERAL CONCLUSIONS

6- GENERAL CONCLUSIONS

This work essentially centres on the study of the dynamics of meiofauna communities associated with sediments of *Zostera noltii* seagrass in the Mira estuary (SW Portugal), focusing on temporal density and vertical variations in relation to the temporal variation of environmental conditions.

Two sampling sites were chosen to compare meiofauna composition, Nematoda assemblages, and temporal and vertical variation patterns, and to discuss the structuring factors of meiofauna and Nematoda assemblages at both sampling sites.

A total of 17 meiofauna taxa were registered and Nematoda was the dominant taxon (>87%). Larger relative densities of Nematoda structured the temporal variations and consequently the seasonality of meiofauna assemblages. The study of the temporal variation of the dominant genera, age and trophic composition and the several relationships with environmental factors allowed an explanation of the structuring factors of the temporal dynamics of meiofauna communities.

Environmental conditions

The seasonality of the environmental factors studied was very similar between both sampling stations. A comparison of both sampling sites with regards to the temporal variations of environmental factors showed them to be similar, regarding temperature, salinity, ph, amount of dissolved oxygen (DO), concentrations of nutrients (ammonia, nitrate, nitrite, silicates, phosphates) in the water column and proportions of silt and sand.

However, there were clear differences between both sampling sites concerning temporal variations of some environmental factors, such as the organic matter content of the sediment, which determined differences in ammonia sediment concentration and phosphate sediment concentration. We observed differences in the temporal variation of the biomass of *Zostera noltii* and in clay proportions as well.

Throughout the study period, the sediments were sufficienty oxidized for the benthos communities. Nevertheless, in late autumn and early winter the results obtained suggest the sediments were more oxidized, while in both summers it seems they were reduced.

Temporal and vertical variations of the environmental factors in the seagrass beds of *Zostera noltii* in the Mira estuary were influenced mainly by seasonal variations and by the exchange of water with the adjacent open sea. The characteristics that have made estuaries into eutrophicated ecosystems, such as an unstable detritus/mineralisation system, with frequent oscillations between aerobic and anaerobic states, were not observed over the study period.

Meiofauna

The results obtained concerning the composition of meiofauna abundances were consistent with the results of previous observations carried out in vegetated intertidal muddy sediments, including *Zostera noltii* seagrass beds.

The analysis of the temporal variations of the meiofauna assemblages, at both sampling stations, indicated an evident seasonality. However, the densities and seasonal patterns of the meiofauna assemblages between sampling stations were different.

The vertical distribution of meiobenthic organisms in sediment showed the animals concentrated in the upper sediment layers, confirming the general patterns drawn from sediment studies.

The temporal variations of the important factors structuring meiofauna communities, such as temperature, salinity, pH, amount of dissolved oxygen (DO) and concentrations of nutrients in the water and in sediment proportions of silt and clay, were similar between stations, which seems to explain the similarity of meiofauna composition between the stations.

The results indicated that, it was not possible to identify any specific environmental factor able to explain the seasonal variation of the meiofauna abundance and composition.

However, it was possible to recognize that the combined effect of a given set of parameters creates the habitat conditions able to explain the seasonal variation of meiofauna densities and composition.

Abiotic differences between both sites studied seem not to be the main factors affecting the temporal changes of the meiofauna communities. Biotic factors, *i.e.* food availability, life cycles, trophic conditions, may play an important role in structuring the seasonal changes of the communities, although they were not considered in this study.

The seasonal changes in the vertical distribution and densities of the meiofauna assemblages were also very evident. The seasonality of the surface sediments was very consistent with the seasonality obtained at 0-10 cm depth.

Nematoda

The higher abundances and the Nematoda genera observed throughout the study agree with the results of previous observations carried out in vegetated intertidal muddy sediments, including *Zostera* seagrass beds.

The seasonality found for Nematoda at both stations contradicts the seasonality generally observed in other studies, which usually peaks in the warmest months. In this study the densities of the dominant genera *Paracomesoma*, *Terchellingia*, *Odontophora*, *Linhomoeus*, *Paramonoshystera*, *Daptonema*, *Chromadora*, *Pthycholaimellus* and *Camacolaimus* rose in autumn and/or in winter-spring.

Nematodes were allocated to feeding types according to Wieser (1953). As expected, sediments were mainly populated by non-selective deposit feeders and epistrate feeders. Detrital material derived from *Zostera* seagrass beds serve as in important source of organic material, and a large part of the benthic food demand is certainly met by the detritic pathway.

The temporal patterns of the vertical variations Nematoda assemblages showed clearly seasonality at both sampling sites. The density patterns of the uppermost sediment layer structured the seasonality of the sediment layer between 0-10 cm depth due the majority of the nematodes being concentrated in the uppermost 3 cm. The highest densities of *Paramonohystera*, *Camacolaimus* and *Viscosia* occurred in deeper layers.

The analysis of the temporal variations of the Nematoda assemblages, at both sampling stations, indicated an evident seasonality. However, the seasonal patterns were different at both stations.

The temporal variations of the important factors structuring Nematoda communities, such as temperature, salinity, pH, amount of dissolved oxygen (DO) and concentrations of nutrients in the water and in sediment proportions of silt and clay, were similar between stations, which seems to explain the similarity of Nematoda genera composition between the stations.

Abiotic differences between both sites studied were not the main factors affecting the temporal changes of the Nematoda communities. Biotic factors, such as food availability, life cycles and trophic conditions, may play an important role in structuring the seasonal changes of these communities.

The temporal variation patterns in trophic structure and the life history of the Nematoda genus assemblages seem to be very important in explaining the seasonality obtained and the differences between sampling sites. The temporal variation patterns of the juveniles were closely associated with the temporal variation patterns of the populations. The juveniles were present throughout the sampling period and the highest densities were coupled with peak densities of the populations and consequently an increase in reproduction activity. In contrast, the lowest densities of the populations corresponded to a decline in reproduction activity. The other important biological factor that could explain the seasonality obtained at each sampling station was trophic dynamic fluctuations. Indeed, an evident changing of the trophic group dominance was observed, suggesting changes in food availability.

Conclusion

A general conclusion of this study in sediments associated with *Zostera noltii* seagrass in the Mira estuary was that the temporal variation of environmental factors considered determinant of the seasonality in temperate regions, such as temperature, salinity, pH, amount of dissolved oxygen (DO) and granulometry, were not of fundamental importance for structuring the seasonality and composition of meiofauna and Nematoda assemblages. The range of environmental factors at both sampling sites did not allow any specific factor to be identified.

The combined effect of a given set of biotic and abiotic factors creates the habitat conditions able to explain the seasonal variations. Life cycles and trophic dynamics are the most important biotic factors for structuring the seasonality and composition of meiofauna assemblages.

The meiofauna and Nematoda abundance and composition of sediments associated with *Zostera noltii* in the Mira estuary were typical of seagrass conditions

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ANNEX I

- Tables of the temporal variations of environmental parameters from June 94 to August 95 (average values).

Station A – Sediment (0-10cm depth)

Date	Organic matter %	Silica (µmol.l^{-1})	Ammonium (µmol.l^{-1})	Nitrite (µmol.l^{-1})	Nitrate (µmol.l^{-1})	Phosphate (µmol.l^{-1})	Median Grain Size (µm)	Clay (%)	Silt (%)	Sand (%)
Jun-94	7,5321	78,9706	74,6645	6,8517	11,7622	5,5048	21,2433	14,2133	63,0833	22,7233
Jul-94	10,3095	10,4665	310,4184	4,1649	14,5419	8,4208	15,7700	17,5000	66,4900	16,0100
Jul-94	7,6250	31,0395	348,2200	0,1874	1,2319	4,2552				
Aug-94	8,6586	59,9273	331,5956	1,0652	5,4854	3,6208	32,7467	10,9100	53,3900	35,7000
Aug-94	6,6953	41,6134	257,4538	2,3900	10,3663	11,4685	24,7513	16,7800	58,0500	25,1700
Sept-94	8,8012	41,1586	384,8184	1,9018	8,3327	24,0720	13,9400	21,9900	62,4933	15,5167
Sept-94	8,9097	75,7361	270,0543	0,4386	4,0714	3,6667	28,5900	12,9233	53,7667	33,3100
Oct-94	8,8808	5,4757	499,5055	0,5252	19,3007	14,1006	15,7500	19,3033	63,0567	17,6400
Oct-94	9,1096	24,9567	394,0048	1,1672	6,2136	18,3389	46,9867	8,0033	44,1133	47,8833
Nov-94	9,9788	42,6921	174,6540		26,8787	27,8137	43,0133	8,9833	43,8667	47,1500
Nov-94	8,1130	12,5816	367,1083	0,8368	10,5451	13,7523	20,4260	19,7700	56,5133	23,9233
Dec-94	12,1588	30,1201	268,6248	1,3771	6,5135	15,5062				
Dec-94	9,9045	47,4540	342,8197	2,1255	11,0441	13,6484	32,1367	12,7700	53,8200	33,4100
Jan-95	8,4180	28,1814	382,1045	0,4635	16,4720	2,0267	64,9933	6,1667	36,9267	56,9067
Jan-95	9,6083	27,1186	602,1379	1,0876	10,8401	22,2507	23,9367	28,2700	44,6567	27,0733
Feb-95	10,1404	14,7734	476,0900	4,3909	6,8640	29,5308	58,0167	6,5233	38,0700	55,4067
Feb-95	9,0273	45,6915	316,2071	1,7440	23,2161	2,5860	22,2400	15,7200	57,2700	27,0100
Mar-95	8,7054	37,2416	210,9840	3,1229	8,6324	8,4094	65,0867	6,9667	37,6867	55,3467
Mar-95	11,2606	15,5542	421,5428	0,8310	4,2982	25,1319	50,7533	7,2667	43,5333	49,2000
Apr-95	9,6159	80,3798	232,0894	1,7148	6,5425	30,5039	9,1183	27,0600	67,4300	5,5100
Apr-95	10,6899	19,9792	413,0013	3,4181	17,8895	6,5820	30,3233	12,0933	53,6600	34,1967
May-95	10,5224	35,4325	571,0273	0,8403	6,7770	31,4030	18,1517	19,8100	57,9300	22,2600
May-95	8,1008	34,4640	229,0274	0,8079	17,2197	10,5559	17,2567	18,6500	61,8700	19,4800
Jun-95	10,7899		266,7830	0,9902	6,1596	25,1928				
Jun-95	10,5605	27,3584	298,8659	2,6793	5,5839	16,4528	29,3733	14,7767	55,8333	29,3900
Jul-95	10,2751	27,7341	586,6809	2,1260	10,4013	26,7133	15,0590	21,0967	62,0533	16,8433
Jul-95	10,8949	27,5216	363,2095	1,0205	4,7094	51,9205	37,6900	10,0933	49,8600	40,0467
Aug-95	10,1701	31,3279	432,5590	0,5057	2,6808	10,0668	9,5333	24,9667	71,0067	4,0067

Station B – Sediment (0-10cm depth)

Date	Organic matter %	Silica (µmol.l^{-1})	Ammonium (µmol.l^{-1})	Nitrite (µmol.l^{-1})	Nitrate (µmol.l^{-1})	Phosphate (µmol.l^{-1})	Median Grain Size (µm)	Clay (%)	Silt (%)	Sand (%)
Jun-94	8,0118	29,4130	66,9767	1,1697	5,1484	7,6257	54,6850	6,6850	40,5800	52,7350
Jul-94	12,2543	27,5157	308,3294	0,8883	8,0567	16,8900	23,4333	14,3800	60,7633	24,8567
Jul-94	8,9023	27,7558	188,0810	1,5776	5,2221	4,5441	34,3500	11,2100	49,2100	39,5800
Aug-94	8,8895	37,2565	251,2288	0,6730	9,9851	4,1399	21,4867	16,8567	57,7333	25,4100
Aug-94	9,8598	26,4395	278,8255	1,1517	8,2702	6,5430	17,2633	20,1800	58,3533	21,4667
Sept-94	10,3742	36,4271	447,1954	0,6692	2,0376	9,2775	17,8633	17,9700	65,5200	17,8433
Sept-94	10,0932		313,6452	0,2505	1,4800	16,7073	30,3570	16,1000	52,4567	31,4433
Oct-94	9,2552	36,5544	511,7520	0,9249	4,8530	4,7589	36,0967	11,5000	51,2500	37,2500
Oct-94	9,6548	6,1326	427,8731	2,4092	5,9197	8,9890	36,8133	12,8333	48,7967	38,3700
Nov-94	8,5185	12,7502	209,4252	1,3305	4,4693	8,6332	26,4700	18,7167	51,1767	30,1000
Nov-94	10,2429	21,2752	363,6736	1,1111	7,9856	14,6434	36,6500	11,9267	51,4033	36,6767
Dec-94	12,7930	46,6464	227,9534	0,9203	5,8831	17,2531	28,0267	14,0133	50,8700	35,1167
Dec-94	8,4865	27,2368	363,3319	4,5538	8,2379	7,5028	32,0000	11,1533	52,6333	36,2133
Jan-95	10,2864	24,4408	332,9889	0,9969	8,6012	9,7078	55,1933	7,8967	38,5567	53,2133
Jan-95	8,8855	26,6718	620,7643	3,1575	4,2390	19,7731	19,3677	19,2600	59,6333	22,1067
Feb-95	9,7036	20,8193	472,5405	0,8420	3,7407	10,2842	43,2233	9,1600	45,2467	45,5933
Feb-95	9,9787	21,0262	176,8518	2,4494	5,6610	9,5486	36,6900	11,7067	50,8600	37,4333
Mar-95	10,7072	26,1912	202,0953	0,8161	6,9066	6,6142	43,7000	11,0967	44,0500	44,8533
Mar-95	11,9242	43,5331	278,5816	0,9737	4,8135	7,5192	29,9400	11,6367	53,7500	34,6133
Apr-95	11,2811	44,0891	175,4613	2,4156	4,3972	38,3924	32,0967	12,5367	52,7967	34,6667
Apr-95	8,6107	14,6745	504,9560	1,1516	7,2602	5,5761	20,0300	16,7867	59,1533	24,0600
May-95	9,9979	22,3117	562,7623	1,3479	6,5100	21,6859	36,8800	10,3200	48,2550	41,4250
May-95	7,9274	45,1071	215,5908	1,1328	5,7155	10,5410	18,7933	20,0233	55,0367	25,1400
Jun-95	10,5060	20,8119	348,8905	0,6032	3,8813	9,3426	27,0867	14,9033	52,6467	32,4500
Jun-95	10,4724	47,2680	276,4172	2,1190	7,2275	5,9361	10,3667	24,5200	66,5833	8,8967
Jul-95	10,4719	32,6513	568,0799	2,3310	5,6118	22,6752	35,3000	12,2100	50,8467	36,9433
Jul-95	10,2899	38,8659	448,6499	1,4788	12,1284	30,8701	61,2300	8,6933	37,8033	53,5033
Aug-95	9,5205	22,8063	398,5421	0,4226	3,0196	9,7769	38,6400	12,4100	48,7033	40,8867

Station A – Water

Date	Nitrite (µmol.l^{-1})	Nitrate (µmol.l^{-1})	Phosphate (µmol.l^{-1})	Silica (µmol.l^{-1})	Ammonium (µmol.l^{-1})	Temperature (°C)	pH	DO (mg.l^{-1})	Salinity (psu)	Conductivity
Jun-94	0,3077	0,1048	0,2166	1,650	8,6429	24,5333	8,05	13,9667	35,3333	480,000
Jul-94	0,2115	1,1473	0,6498	1,500	12,4060	23,7333	8,80	13,7000	33,6667	480,000
Jul-94	0,1346	1,3698	0,1733	3,900	11,2714	22,6667	8,58	15,0333	34,0000	480,000
Aug-94	0,1346	0,3507	0,7798	1,950	14,5986	23,3667	8,44	10,3333	31,6667	470,000
Aug-94	0,1538	0,8167	0,6931	3,000	9,9571	19,2333	8,20	13,8000	33,0000	440,000
Sept-94						17,7000	8,57	10,8667	34,6667	450,000
Sept-94	0,1923	1,2150		7,650	3,9429	18,1333	8,81	8,7333	33,6667	456,667
Oct-94	0,6486		0,0000		11,1686	17,9333	8,00	5,7333	27,0000	400,000
Oct-94	0,2885	1,1917	0,5199	5,100	15,2271	14,000	8,21	8,0000	24,6667	330,000
Nov-94	0,1154	1,0493	0,0000	12,300	31,5143	10,8333	7,91	6,7333	35,0000	366,667
Nov-94	0,4286	1,9751	0,3032	11,850	25,7676	21,1667	8,29	12,6333	34,0000	456,667
Dec-94	0,2562	4,4581	0,6931	5,250	21,2857	15,5000	8,84	13,8500		470,000
Dec-94	0,2595	0,7672	0,0000	4,950	27,7886	16,7000	8,76	14,6667	32,3333	413,333
Jan-95	0,5357	1,6412	0,4891	9,000	37,1429	18,9333	8,94	15,2000	34,0000	460,000
Jan-95	0,2143	2,1893	0,4891	7,500	30,0000	16,8667	8,90	18,2333	35,3333	443,333
Feb-95	0,1071	0,0145		5,850	24,2857	16,6000	8,38	9,5000	35,1667	446,667
Feb-95	1,0054	0,8016		3,000	17,8071	18,5333	9,24	13,1333	35,5000	463,333
Mar-95	0,1071	2,2965	0,2446	3,150	10,6951	25,1333	9,01	18,4333	34,8333	496,667
Mar-95	0,3568	0,0000	0,0000	5,400	2,5974	17,8333	8,66	13,0000	35,6667	460,000
Apr-95	0,1946	0,4625	0,1600	5,400	2,2857	27,1333	8,70	16,1667	37,3333	500,000
Apr-95	0,1281	1,4637	0,0949	3,000	13,7143	27,7667	9,14	15,8000	36,5000	500,000
May-95	0,2349	0,5304	0,0949	0,900	13,8571	20,4000	8,61	14,6333	36,0000	485,000
May-95	0,1714	2,2322	0,5380	3,450	18,8243	25,0333	8,86	18,7333	36,6667	500,000
Jun-95	0,1281	1,1270	0,4269	5,700	16,5714	18,9333	8,49	12,5000	36,6667	470,000
Jun-95	0,6811	0,5920	0,0000	11,250		27,3667	8,95	15,3333	35,3333	
Jul-95	0,0854	0,5268	0,3320	5,250	14,0857	29,7000	8,68	14,0000	36,3333	
Jul-95	0,4541	0,3262	0,0000	0,000	1,0286	28,8000	8,78	13,7667	36,0000	
Aug-95	0,1154	0,7096	1,0830	24,000	8,0827	29,0000	8,24	11,3000	35,0000	490,000

Station B – Water

Date	Nitrite (µmol.l^{-1})	Nitrate (µmol.l^{-1})	Phosphate (µmol.l^{-1})	Silica (µmol.l^{-1})	Ammonium (µmol.l^{-1})	Temp (°C)	pH	Dissolved oxygen (mg.l^{-1})	Salinity (psu)	Conductivity
Jun-94	0,11538	0,70961	1,08303	24,000	8,0827	29,0000	8,24	11,3000	35,0000	490,000
Jul-94	0,09615	0,77737	0,30325	8,100	7,2727	24,9000		12,3667	34,6667	470,000
Jul-94			0,38989	15,450	19,4662	24,7333		13,2667	35,0000	480,000
Aug-94	0,17308	4,38865	1,08303	33,300	7,0130	22,7000	8,58	9,9000	33,6667	476,667
Aug-94	0,15385	0,11306	0,38989	9,900	16,3265	21,4667	8,48	8,3667	32,3333	
Sept-94	0,32692	0,64366	0,99639	17,700	19,1523	19,7667	8,39		32,0000	436,667
Sept-94	0,21154	1,00169		8,850		18,2667	8,67	19,8333	34,6667	
Oct-94	0,11538	0,80667	0,47653	9,000	15,2276	21,5333	8,68	12,0000	35,0000	485,000
Oct-94	0,48649	0,00000	0,01240	22,350	4,1558	18,7333	8,62	9,5500	33,6667	443,333
Nov-94	0,19231	0,55989	0,86643	22,350	47,2906	18,7667	8,69	12,9000	32,3333	438,333
Nov-94	0,15385	0,84100	0,64982	22,050	47,2906	15,3667	7,81	5,8333	34,3333	
Dec-94	0,25714	10,51383		5,400	11,7647	20,1667	8,43	11,0333	34,8333	486,667
Dec-94	0,15000	1,07449	0,33071		19,8932	11,1000	8,59	11,7333	32,0000	350,000
Jan-95					29,3740	18,3667	8,62	18,0667	34,3333	453,333
Jan-95	0,08571	0,68526	0,33071	5,550	15,4873	15,7000	9,11	13,2667	32,6667	410,000
Feb-95	0,04679	0,97055	0,23715	3,150	16,6234	11,5333	8,63	14,0000	34,6667	390,000
Feb-95	0,47143	0,91179		6,450	9,6253	16,8000	8,84	11,8333	34,3333	440,000
Mar-95	0,48649	0,17965	0,00000	2,550	28,1589	17,8000	8,90	12,6000	34,6667	446,667
Mar-95	0,04159	1,77729	0,23715	1,650	14,0816	23,2667	9,16	14,8467	35,0000	488,333
Apr-95	0,03640	1,35089	0,09486	1,800	21,8182	24,1667	8,95	16,9000	35,6667	500,000
Apr-95	0,42162	0,76791	0,00000	9,450	8,3117	25,7000	8,68	12,2333	36,8333	
May-95	0,25946	0,00000	0,00000	7,800		22,8667	8,74	14,8000	36,0000	488,333
May-95	0,05199	2,44512	0,18972		36,5971	23,7667	8,86	16,2333	35,6667	500,000
Jun-95	0,58378	0,00000	0,09000	6,900	0,1039	27,4333	8,35	11,2667	37,0000	500,000
Jun-95	0,05199	1,33529	0,94862		38,6838	18,0667	8,12	9,6333	35,3333	456,667
Jul-95	0,42162	0,00000	0,00000	3,600	9,0909	27,7333	9,01		36,3333	
Jul-95	0,05199	3,80157	0,14229	1,950	20,1299	32,1333	8,82	16,6667	37,0000	
Aug-95	0,05199	1,30446	0,33202	6,900	13,8775	31,1333	8,90	13,5333	37,1667	

Station A - Zostera *noltii* Biomass (g m^{-2})

Date	Leaves (Dry weight)	Roots (Dry weight)	Leaves (AFDW)	Roots (AFDW)
Jun-94	93,62	112,89	21,58	30,76
Jul-94	207,38	71,55	52,33	17,55
Jul-94	64,00	71,76	19,96	14,80
Aug-94	120,14	105,73	27,93	19,81
Aug-94	75,32	72,23	20,07	31,52
Sept-94	41,94	135,16	9,35	42,10
Sept-94	81,67	122,44	21,54	35,47
Oct-94	102,07	132,83	23,85	32,82
Oct-94	211,45	104,50	52,53	29,28
Nov-94	145,18	188,99	33,05	66,53
Nov-94	140,52	142,41	37,91	45,54
Dec-94	104,21	182,40	28,62	59,12
Dec-94	65,65	164,62	15,93	63,00
Jan-95	70,96	118,27	17,95	37,72
Jan-95	48,43	109,94	11,91	35,63
Feb-95	80,18	191,72	30,28	58,99
Feb-95	106,38	188,55	25,20	52,84
Mar-95	81,50	105,59	19,34	34,35
Mar-95	94,87	120,06	14,56	32,69
Apr-95	112,88	138,09	33,47	44,35
Apr-95	124,68	112,82	34,94	41,43
May-95	120,44	96,11	38,15	37,82
May-95	139,96	189,51	40,09	57,03
Jun-95	271,50	184,21	44,78	39,73
Jun-95	237,67	191,65	41,79	49,90
Jul-95	192,36	204,74	33,08	50,43
Jul-95	101,73	139,99	36,18	40,73
Aug-95	162,13	158,49	26,81	37,43

Station B - Zostera *noltii* Biomass (g m^{-2}

Date	Leaves (Dry weight)	Roots (Dry weight)	Leaves (AFDW)	Roots (AFDW)
Jun-94	127,86	73,39	23,39	24,86
Jul-94	230,87	118,81	64,03	29,65
Jul-94	143,59	88,87	24,16	15,17
Aug-94	159,20	110,59	26,19	19,06
Aug-94	115,16	115,94	19,68	21,66
Sept-94	138,00	133,00	26,65	23,41
Sept-94	131,21	156,87	23,96	33,20
Oct-94	126,28	159,17	20,84	29,53
Oct-94	112,81	102,66	19,77	16,89
Nov-94	96,53	129,99	15,01	25,35
Nov-94	88,96	116,46	17,14	27,41
Dec-94	93,62	71,71	14,67	10,04
Dec-94	79,88	94,27	14,65	26,20
Jan-95	63,38	110,55	13,14	25,28
Jan-95	78,99	136,74	14,22	32,10
Feb-95	41,46	78,25	9,80	18,48
Feb-95	66,02	98,47	11,84	25,97
Mar-95	72,06	92,12	12,61	26,60
Mar-95	61,90	102,40	14,58	16,56
Apr-95	32,18	94,29	5,24	19,50
Apr-95	89,81	119,05	18,24	26,96
May-95	51,47	104,17	9,78	23,28
May-95	112,41	160,45	18,79	32,13
Jun-95	123,34	164,59	19,90	50,32
Jun-95	172,89	165,01	32,42	33,61
Jul-95	206,97	159,77	49,34	51,20
Jul-95	95,70	115,34	18,83	20,58
Aug-95	143,24	172,66	24,14	40,61

ANNEX II

MEIOFAUNA

- Tables of the temporal variation of meiofauna densities from June 94 to August 95 (average values).

- Temporal and vertical variations of the meiofauna groups which registered lowest densities.

Station A – Meiofauna Densities (individuals 10 cm^{-2}) (0-10 cm depth)

Date	Nematoda	Copepoda	Polychaeta	Oligochaeta	Ostracoda	Turbellaria	Kinorhyncha	Larvae nauplii	Amphipoda
Jun-94	2024,37	128,80	26,90	16,14	19,62	0,32	0,00	0,00	3,80
Jul-94	2542,72	104,43	8,54	7,91	25,32	0,95	34,81	0,00	1,58
Jul-94	1656,12	578,06	13,08	10,97	18,57	0,84	57,38	0,00	3,38
Aug-94	2670,89	306,75	14,77	3,38	13,92	8,44	39,24	78,48	2,53
Aug-94	2268,99	316,77	20,25	10,76	35,13	5,38	48,73	137,34	6,01
Sept-94	2141,77	178,16	32,91	6,65	12,03	12,34	40,82	46,84	3,16
Sept-94	1531,65	135,86	29,96	5,49	18,14	0,84	65,40	52,74	5,49
Oct-94	1515,19	260,76	105,06	26,58	62,03	1,27	26,58	70,89	10,13
Oct-94	3220,68	237,13	90,30	32,07	15,19	2,11	61,18	45,99	5,49
Nov-94	2979,32	82,70	68,35	17,30	7,17	4,64	62,87	21,94	5,91
Nov-94	2713,50	150,63	88,19	35,44	3,80	13,92	51,48	19,41	10,55
Dec-94	1453,59	102,95	38,40	18,14	5,91	5,91	7,17	42,19	9,28
Dec-94	1713,50	59,07	30,38	11,39	1,27	2,53	36,29	14,77	0,42
Jan-95	3466,46	69,62	24,68	36,71	1,27	3,16	10,13	20,25	6,96
Jan-95	2639,24	43,67	49,37	19,62	5,06	1,27	8,86	2,53	2,53
Feb-95	3051,27	166,46	31,65	27,22	5,06	0,00	84,81	0,00	3,16
Feb-95	3779,11	79,75	46,20	31,65	13,29	0,00	87,34	0,00	1,90
Mar-95	2809,49	98,10	11,39	22,15	1,90	0,00	33,54	0,00	0,00
Mar-95	2079,11	75,95	8,23	21,52	1,27	0,00	7,59	0,00	0,00
Apr-95	1233,54	45,57	20,89	24,68	1,27	0,00	19,62	0,00	0,00
Apr-95	1419,62	60,76	22,78	27,22	2,53	0,00	10,13	0,00	0,63
May-95	1622,78	455,06	48,73	47,47	31,65	0,00	69,62	0,00	1,27
May-95	1499,37	46,20	0,63	19,62	0,63	0,00	2,53	0,00	0,63
Jun-95	656,96	410,76	12,66	58,86	3,80	0,00	5,06	0,00	2,53
Jun-95	1139,24	82,28	29,11	25,32	10,76	38,61	24,68	27,85	1,27
Jul-95	692,41	24,68	42,41	36,71	0,00	22,15	2,53	0,00	1,90
Jul-95	791,77	50,63	53,16	31,65	0,63	51,90	4,43	5,70	1,90
Aug-95	752,53	7,59	102,53	33,54	0,63	58,23	6,33	0,00	1,27

Date	Gastropoda	Bivalvia	Ciliate	Cnidaria	Tardigrada	Gastrotricha	Halacaroidea	Insecta	Acari
Jun-94	0,00	0,95	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	1,58	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	1,69	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	8,44	0,00	0,00	0,00	0,00	0,00	0,00	0,42
Aug-94	0,63	48,10	0,00	0,00	0,00	0,00	0,00	0,63	0,00
Sept-94	1,58	15,51	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,42	4,64	0,00	0,00	0,00	0,00	0,42	0,00	0,00
Oct-94	6,33	3,80	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	19,83	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,84	11,39	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	5,49	21,52	2,53	0,00	0,00	0,00	0,84	0,00	0,00
Dec-94	1,69	7,17	670,04	0,00	0,00	1,27	0,00	0,00	0,00
Dec-94	0,42	1,27	3,38	1,27	0,00	0,00	0,00	0,00	0,00
Jan-95	1,90	3,16	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	1,27	0,63	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	5,06	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	4,43	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	1,27	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,63	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	1,27	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	3,80	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	6,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	2,53	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	1,27	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,63	0,00	0,00	0,00
Jul-95	0,00	0,63	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	1,27	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	7,59	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Station B – Meiofauna Densities (individuals 10 cm^{-2}) (0-10 cm depth)

Date	Nematoda	Copepoda	Polychaeta	Oligochaeta	Ostracoda	Turbellaria	Kinorhyncha	Larv.nauplii	Amphipoda
Jun-94	3023,42	213,29	22,78	0,63	0,00	1,27	68,99	6,33	0,00
Jul-94	7270,25	348,10	10,76	1,90	12,66	1,27	291,14	10,13	0,63
Jul-94	3978,48	449,37	30,38	6,33	18,99	3,16	581,65	6,96	0,00
Aug-94	1430,38	179,75	40,51	5,06	9,49	27,85	122,15	4,43	0,63
Aug-94	3286,71	218,35	31,01	5,70	6,33	5,70	233,54	0,00	0,00
Sept-94	1417,72	217,09	49,37	6,33	15,19	4,43	75,32	2,53	0,63
Sept-94	5686,71	206,96	37,97	4,43	38,61	10,13	487,97	23,42	0,00
Oct-94	2637,97	315,82	55,70	5,70	11,39	7,59	350,00	6,96	1,90
Oct-94	2464,14	132,91	83,12	10,97	4,64	3,38	124,05	3,38	0,84
Nov-94	4745,57	211,39	71,52	13,92	1,27	0,63	335,44	14,56	0,63
Nov-94	986,08	118,99	71,52	12,03	1,27	3,16	127,85	31,65	1,27
Dec-94	3205,91	149,79	57,38	6,75	0,84	1,27	100,00	3,80	0,42
Dec-94	2076,58	132,28	54,43	29,75	1,90	3,80	211,39	0,00	0,63
Jan-95	2509,28	275,53	54,01	33,33	2,53	3,38	132,91	10,13	0,42
Jan-95	4394,94	197,05	22,36	2,11	0,00	2,11	70,46	6,75	0,84
Feb-95	6981,01	431,01	48,10	11,39	0,00	7,59	251,90	43,04	0,63
Feb-95	6470,25	305,06	56,33	19,62	1,27	3,16	208,23	17,09	0,00
Mar-95	2384,18	110,76	31,01	15,19	0,63	1,90	122,78	1,90	0,00
Mar-95	6631,01	353,16	53,80	34,18	0,00	2,53	315,19	3,80	0,00
Apr-95	4529,11	325,32	28,48	18,35	0,63	6,96	149,37	8,23	0,00
Apr-95	2799,37	247,47	33,54	21,52	3,16	6,33	254,43	27,22	0,63
May-95	8339,87	183,54	66,46	33,54	1,90	3,16	62,03	4,43	0,00
May-95	1773,84	164,56	18,57	10,13	2,95	3,80	53,59	16,03	1,69
Jun-95	3014,56	174,68	20,25	5,70	0,00	5,06	77,22	1,27	0,00
Jun-95	1920,25	67,72	34,18	5,70	1,27	3,80	10,13	0,63	0,00
Jul-95	1838,61	473,42	23,42	6,33	2,53	2,53	65,82	40,51	8,86
Jul-95	3689,24	213,29	50,00	4,43	5,06	7,59	89,87	2,53	3,80
Aug-95	3551,27	277,22	48,73	7,59	5,06	5,06	81,01	1,90	0,63

Date	Gastropoda	Bivalvia	Ciliate	Cnidaria	Tardigrada	Gastrotricha	Halacaroidea	Insecta	Acari
Jun-94	0,63	0,63	0,63	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	1,90	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,63	1,27	0,00	0,00	0,00	0,63	0,00	0,00	0,00
Aug-94	1,27	3,80	0,00	0,00	0,00	3,16	0,00	0,00	0,00
Aug-94	0,00	3,80	0,00	0,00	0,00	1,27	0,00	0,00	0,00
Sept-94	0,63	8,86	0,00	0,63	0,00	0,00	0,00	0,00	0,00
Sept-94	0,63	12,03	0,00	0,63	1,90	1,27	0,00	0,00	0,00
Oct-94	1,90	9,49	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,84	7,59	0,00	0,00	0,00	0,42	0,00	0,00	0,00
Nov-94	0,00	8,23	0,00	1,27	0,00	0,63	0,00	0,00	0,00
Nov-94	2,53	3,16	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,42	0,00	0,00	0,00	1,27	0,00	0,00	0,00
Dec-94	0,63	8,23	1,27	0,63	0,00	1,27	0,00	0,00	0,00
Jan-95	0,42	3,80	0,00	0,42	0,00	0,42	0,00	0,00	0,42
Jan-95	0,84	2,53	0,00	0,42	0,00	0,42	0,00	0,00	0,00
Feb-95	0,00	4,43	0,00	0,00	0,00	0,63	0,00	0,00	0,00
Feb-95	0,00	6,33	4,43	2,53	1,27	1,27	0,00	0,63	0,00
Mar-95	1,27	0,00	1,27	0,63	0,00	0,00	0,00	0,00	0,00
Mar-95	1,27	3,80	0,00	0,63	0,00	0,00	0,00	0,00	0,00
Apr-95	0,63	2,53	0,63	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	15,19	2,53	0,00	0,00	0,00	0,00	0,00	0,00
May-95	3,16	1,27	0,00	0,00	0,00	1,27	0,00	0,00	0,00
May-95	0,84	3,80	0,00	0,42	0,42	0,00	0,00	0,00	0,00
Jun-95	0,00	1,27	0,00	0,63	0,00	0,63	0,00	0,00	0,00
Jun-95	0,00	0,63	0,00	0,00	0,00	0,63	0,00	0,00	0,00
Jul-95	0,00	2,53	0,00	1,90	0,00	2,53	0,00	0,00	0,00
Jul-95	0,63	8,23	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,63	0,00	0,00	0,00	0,63	0,00	0,00	0,00

Station A – Meiofauna Densities (individuals 10 cm^{-2}) (0-3 cm depth)

Date	Nematoda	Copepoda	Polychaeta	Oligochaeta	Ostracoda	Turbellaria	Kinorhyncha	Larv. nauplii	Amphipoda
Jun-94	1605.06	83.23	1.27	12.66	15.19	0.32	0.00	0.00	1.27
Jul-94	2355.70	84.18	7.28	5.70	14.24	0.95	25.63	0.00	0.95
Jul-94	1370.04	514.35	10.55	6.75	14.35	0.00	47.68	0.00	2.11
Aug-94	2495.36	286.92	12.66	3.38	13.08	8.44	38.40	76.79	2.11
Aug-94	1965.82	245.89	18.99	10.13	29.43	1.90	36.71	103.48	5.70
Sept-94	2022.47	162.34	32.28	3.80	9.49	12.03	36.08	44.62	2.85
Sept-94	1419.41	133.33	29.11	3.80	11.81	0.84	64.98	52.74	5.49
Oct-94	1440.51	258.23	102.53	22.78	54.43	1.27	22.78	70.89	10.13
Oct-94	2982.70	221.94	87.76	30.38	10.13	1.69	57.81	44.30	5.06
Nov-94	2664.56	71.73	63.71	10.13	6.33	4.64	55.27	20.25	5.49
Nov-94	2435.44	134.18	85.23	33.33	2.95	13.92	47.68	18.57	8.44
Dec-94	1156.54	95.36	33.76	15.19	3.38	5.91	6.75	41.35	8.02
Dec-94	1579.32	56.96	28.69	10.55	0.84	2.53	36.29	13.92	0.42
Jan-95	3022.78	58.86	20.89	27.22	1.27	3.16	9.49	13.92	6.96
Jan-95	2482.91	42.41	44.94	18.99	5.06	1.27	7.59	2.53	2.53
Feb-95	2844.30	160.76	29.11	24.05	4.43	0.00	84.81	0.00	2.53
Feb-95	2350.00	36.08	36.08	8.23	6.33	0.00	54.43	0.00	0.00
Mar-95	2690.51	89.24	11.39	21.52	1.90	0.00	32.28	0.00	0.00
Mar-95	1613.29	45.57	4.43	14.56	0.00	0.00	3.80	0.00	0.00
Apr-95	813.29	24.68	6.33	20.25	0.00	0.00	13.29	0.00	0.00
Apr-95	1244.30	51.90	18.99	25.95	1.27	0.00	8.86	0.00	0.63
May-95	1222.78	293.04	44.30	35.44	5.70	0.00	21.52	0.00	0.63
May-95	1417.72	44.30	0.63	15.19	0.63	0.00	2.53	0.00	0.63
Jun-95	301.90	364.56	2.53	20.25	3.16	0.00	0.63	0.00	2.53
Jun-95	767.72	56.33	18.99	18.35	9.49	32.28	19.62	24.68	1.27
Jul-95	420.25	15.82	27.22	31.01	0.00	22.15	1.90	0.00	0.63
Jul-95	713.92	48.10	48.73	27.85	0.63	51.90	2.53	5.70	1.90
Aug-95	529.11	3.16	50.00	29.75	0.63	55.06	3.80	0.00	0.63

Date	Gastropoda	Bivalvia	Ciliate	Cnidaria	Tardigrada	Gastrotricha	Halacaroidea	Insecta	Acari
Jun-94	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-94	0.00	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-94	0.00	8.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-94	0.63	34.81	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Sept-94	1.58	15.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept-94	0.42	4.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-94	6.33	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-94	0.00	18.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-94	0.42	9.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-94	5.49	19.83	0.00	2.53	0.00	0.00	0.00	0.84	0.00
Dec-94	0.84	6.75	0.00	668.35	0.00	0.00	1.27	0.00	0.00
Dec-94	0.42	1.27	0.00	3.38	1.27	0.00	0.00	0.00	0.00
Jan-95	1.90	2.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan-95	0.00	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb-95	0.00	5.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb-95	0.00	2.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-95	0.00	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-95	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00
Apr-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-95	0.00	3.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-95	0.00	3.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-95	0.00	2.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-95	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-95	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-95	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-95	0.00	6.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Station B – Meiofauna Densities (individuals 10 cm^{-2}) (0-3 cm depth)

Date	Nematoda	Copepoda	Polychaeta	Oligochaeta	Ostracoda	Turbellaria	Kinorhyncha	Larv. nauplii	Amphipoda
Jun-94	2776.58	177.22	12.03	0.63	0.00	0.63	65.19	3.80	0.00
Jul-94	6484.18	270.25	10.13	1.27	8.23	1.27	267.72	4.43	0.63
Jul-94	3737.34	427.85	28.48	3.16	8.86	3.16	555.70	5.70	0.00
Aug-94	948.10	103.16	34.18	2.53	6.96	7.59	94.30	2.53	0.63
Aug-94	2964.56	204.43	29.11	5.06	5.70	5.06	213.92	0.00	0.00
Sept-94	1089.24	181.65	46.84	5.06	11.39	4.43	52.53	1.90	0.63
Sept-94	5020.89	184.18	34.18	3.80	36.71	10.13	457.59	22.78	0.00
Oct-94	1663.29	246.84	36.08	1.27	5.70	6.33	286.71	2.53	1.27
Oct-94	1866.67	93.67	61.18	8.02	4.64	2.95	109.70	1.69	0.42
Nov-94	3623.42	158.86	37.97	6.96	0.00	0.63	160.76	1.90	0.63
Nov-94	520.89	105.70	41.77	8.23	0.00	1.90	102.53	30.38	0.63
Dec-94	2856.96	135.86	54.43	6.33	0.42	0.84	92.83	3.38	0.42
Dec-94	2791.98	118.35	46.52	23.63	1.27	2.53	268.35	0.00	0.84
Jan-95	1939.24	262.03	46.95	30.38	2.53	2.11	126.58	10.13	0.00
Jan-95	4425.32	146.20	12.03	1.90	0.00	1.90	36.08	1.90	0.63
Feb-95	6419.62	381.01	46.84	11.39	0.00	4.43	237.34	41.14	0.00
Feb-95	273.42	12.66	4.43	1.90	0.00	0.00	8.86	0.00	0.00
Mar-95	2127.22	94.94	25.95	12.03	0.00	1.90	112.66	1.90	0.00
Mar-95	5910.13	335.44	47.47	27.22	0.00	2.53	282.28	3.80	0.00
Apr-95	4081.65	306.96	25.95	16.46	0.63	6.96	144.30	6.96	0.00
Apr-95	1920.89	219.62	27.85	20.25	3.16	6.33	221.52	26.58	0.63
May-95	7876.58	162.03	63.92	32.28	1.27	3.16	54.43	3.80	0.00
May-95	1116.88	72.15	9.70	2.95	1.69	2.53	24.47	5.06	0.00
Jun-95	2475.32	143.67	17.72	5.70	0.00	5.06	47.47	1.27	0.00
Jun-95	1486.08	41.77	23.42	5.70	1.27	3.80	6.33	0.00	0.00
Jul-95	949.37	329.96	10.97	0.42	1.27	1.69	47.26	23.63	5.91
Jul-95	3275.32	201.90	43.04	3.16	5.06	6.96	86.08	2.53	3.80
Aug-95	3254.43	263.29	51.90	6.75	2.53	2.95	74.68	1.27	0.42

Date	Gastropoda	Bivalvia	Ciliate	Cnidaria	Tardigrada	Gastrotricha	Halacaroidea	Insecta	Acari
Jun-94	0.63	0.63	0.00	0.63	0.00	0.00	0.00	0.00	0.00
Jul-94	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-94	0.63	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-94	0.63	2.53	0.00	0.00	0.00	0.00	0.00	1.27	0.00
Aug-94	0.00	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept-94	0.00	8.86	0.00	0.00	0.63	0.00	0.00	0.00	0.00
Sept-94	0.63	10.76	0.00	0.00	0.63	1.90	0.00	0.63	0.00
Oct-94	1.90	6.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-94	0.42	6.75	0.00	0.00	0.00	0.00	0.00	0.42	0.00
Nov-94	0.00	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-94	0.63	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-94	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-94	0.42	5.91	0.00	0.84	0.42	0.00	0.00	0.42	0.00
Jan-95	0.42	3.38	0.00	0.00	0.42	0.00	0.00	0.42	0.00
Jan-95	0.63	1.90	0.00	0.00	0.63	0.00	0.00	0.63	0.00
Feb-95	0.00	4.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-95	0.63	0.00	0.00	1.27	0.63	0.00	0.00	0.00	0.00
Mar-95	1.27	2.53	0.00	0.00	0.63	0.00	0.00	0.00	0.00
Apr-95	0.63	2.53	0.00	0.63	0.00	0.00	0.00	0.00	0.00
Apr-95	0.00	13.29	0.00	2.53	0.00	0.00	0.00	0.00	0.00
May-95	3.16	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-95	0.00	1.27	0.00	0.00	0.00	0.42	0.00	0.00	0.00
Jun-95	0.00	0.63	0.00	0.00	0.63	0.00	0.00	0.63	0.00
Jun-95	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-95	0.00	0.84	0.00	0.00	1.27	0.00	0.00	0.00	0.00
Jul-95	0.63	7.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-95	0.42	1.69	0.00	0.00	0.00	0.00	0.00	0.42	0.00

Station A – Meiofauna Densities (individuals 10 cm^{-2}) (6-10 cm depth)

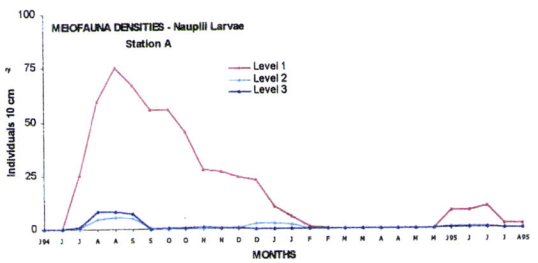
Date	Nematoda	Copepoda	Polychaeta	Oligochaeta	Ostracoda	Turbellaria	Kinorhyncha	Larv. nauplii	Amphipoda
Jun-94	60.76	16.14	9.49	0.63	2.22	0.00	0.00	0.00	1.27
Jul-94	40.51	5.06	0.00	0.95	3.16	0.00	3.80	0.00	0.00
Jul-94	154.43	36.71	0.00	1.27	3.80	0.42	3.38	0.00	0.84
Aug-94	83.23	9.49	0.63	0.00	0.63	0.00	1.58	3.16	0.32
Aug-94	167.09	34.18	0.32	0.63	1.90	3.48	6.96	20.89	0.00
Sept-94	28.80	4.11	0.32	0.32	0.63	0.32	1.90	0.32	0.32
Sept-94	36.29	0.42	0.42	0.00	5.49	0.00	0.00	0.00	0.00
Oct-94	34.18	2.53	2.53	0.00	6.33	0.00	0.00	0.00	0.00
Oct-94	125.32	8.86	1.27	0.42	3.38	0.42	2.53	1.27	0.42
Nov-94	105.91	8.44	0.84	4.64	0.00	0.00	2.11	0.42	0.42
Nov-94	217.72	11.39	0.84	1.69	0.84	0.00	3.80	0.84	1.27
Dec-94	29.96	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.84
Dec-94	18.14	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00
Jan-95	136.71	4.43	0.00	3.80	0.00	0.00	0.63	0.00	0.00
Jan-95	53.80	0.63	0.00	0.63	0.00	0.00	0.63	0.00	0.00
Feb-95	31.65	2.53	2.53	0.00	0.00	0.00	0.00	0.00	0.00
Feb-95	655.70	24.05	4.43	18.99	0.63	0.00	17.72	0.00	1.90
Mar-95	35.44	3.16	0.00	0.00	0.00	0.00	0.63	0.00	0.00
Mar-95	320.25	27.85	1.90	4.43	1.27	0.00	3.80	0.00	0.00
Apr-95	137.34	6.33	0.63	1.90	1.27	0.00	5.70	0.00	0.00
Apr-95	40.51	1.27	0.00	0.00	0.63	0.00	0.63	0.00	0.00
May-95	37.34	55.70	0.00	0.00	1.90	0.00	0.00	0.00	0.00
May-95	27.22	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-95	99.37	16.46	3.80	18.35	0.63	0.00	0.00	0.00	0.00
Jun-95	153.80	20.25	3.16	2.53	1.27	1.90	1.27	1.27	0.00
Jul-95	31.65	1.27	3.16	1.27	0.00	0.00	0.63	0.00	0.63
Jul-95	27.85	1.27	2.53	1.90	0.00	0.00	0.00	0.00	0.00
Aug-95	81.65	4.43	18.99	1.27	0.00	1.27	1.90	0.00	0.63

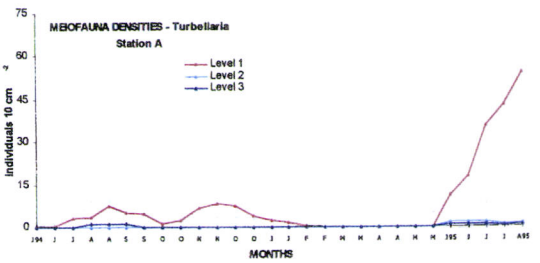
Date	Gastropoda	Bivalvia	Ciliate	Cnidaria	Tardigrada	Gastrotricha	Halacaroidea	Insecta	Acari
Jun-94	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-94	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-94	0.00	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-94	0.00	0.00	0.00	0.84	0.00	0.00	0.00	0.00	0.00
Dec-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb-95	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-95	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-95	0.00	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-95	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00
Jul-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-95	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-95	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00

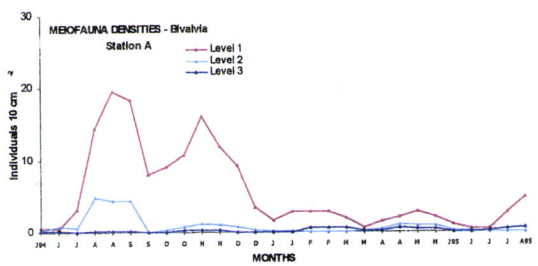
Station B– Meiofauna Densities (individuals 10 cm^{-2}) (6-10 cm depth)

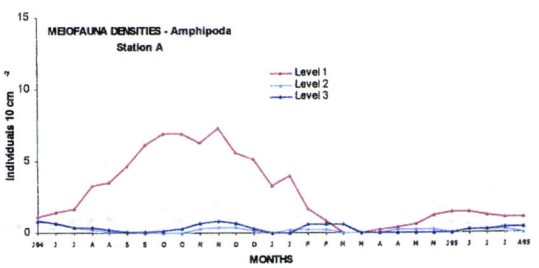
Date	Nematoda	Copepoda	Polychaeta	Oligochaeta	Ostracoda	Turbellaria	Kinorhyncha	Larv. nauplii	Amphipoda
Jun-94	94.30	8.23	0.00	0.00	0.00	0.00	1.27	0.63	0.00
Jul-94	403.16	10.13	0.00	0.63	2.53	0.00	6.96	0.63	0.00
Jul-94	122.78	11.39	1.90	3.16	5.06	0.00	12.66	0.00	0.00
Aug-94	207.59	21.52	6.33	0.00	1.27	0.00	15.82	1.27	0.00
Aug-94	62.03	1.27	0.00	0.00	0.00	0.00	5.06	0.00	0.00
Sept-94	126.58	13.29	1.27	1.27	1.90	0.00	16.46	0.63	0.00
Sept-94	96.84	5.06	0.00	0.00	0.00	0.00	3.80	0.63	0.00
Oct-94	85.44	4.43	3.16	0.63	0.00	0.00	1.90	0.00	0.63
Oct-94	150.63	17.72	0.32	1.58	0.00	0.00	0.95	1.27	0.00
Nov-94	330.38	4.43	1.27	0.00	0.00	0.00	14.56	0.00	0.00
Nov-94	287.97	8.86	24.68	3.16	1.27	1.27	19.62	1.27	0.63
Dec-94	73.00	2.95	2.53	0.42	0.42	0.42	2.53	0.42	0.00
Dec-94	218.99	4.43	0.63	0.00	0.00	0.00	1.90	0.00	0.00
Jan-95	334.18	6.75	2.11	0.84	0.00	0.00	4.64	0.00	0.00
Jan-95	940.08	84.39	12.66	0.84	0.00	0.84	40.51	5.06	0.00
Feb-95	179.75	25.95	0.63	0.00	0.00	0.00	6.33	0.63	0.00
Feb-95	273.42	12.66	4.43	1.90	0.00	0.00	8.86	0.00	0.00
Mar-95	72.15	4.43	1.27	2.53	0.00	0.00	0.63	0.00	0.00
Mar-95	136.71	1.27	3.80	1.90	0.00	0.00	0.63	0.00	0.00
Apr-95	254.43	11.39	1.90	1.90	0.00	0.00	4.43	1.27	0.00
Apr-95	184.81	6.33	0.63	0.00	0.00	0.00	17.09	0.63	0.00
May-95	182.91	11.39	0.63	0.63	0.00	0.00	5.06	0.63	0.00
May-95	382.28	83.54	5.91	5.91	0.84	0.84	25.32	10.97	1.69
Jun-95	223.42	19.62	0.00	0.00	0.00	0.00	18.99	0.00	0.00
Jun-95	115.82	17.09	1.90	0.00	0.00	0.00	2.53	0.63	0.00
Jul-95	639.24	34.18	3.16	3.80	0.00	0.00	8.23	2.53	0.00
Jul-95	196.84	8.23	3.80	1.27	0.00	0.00	0.63	0.00	0.00
Aug-95	281.65	3.16	0.63	0.00	0.00	0.63	3.80	0.00	0.00

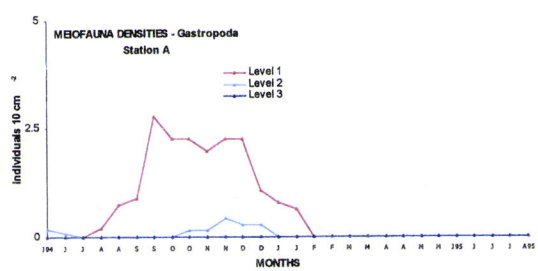
Date	Gastropoda	Bivalvia	Ciliate	Cnidaria	Tardigrada	Gastrotricha	Halacaroidea	Insecta	Acari
Jun-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-94	0.00	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-94	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.63	0.00
Aug-94	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.63	0.00
Aug-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00
Sept-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00
Oct-94	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct-94	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00
Nov-94	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.00
Dec-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan-95	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan-95	0.42	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr-95	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00
May-95	0.84	2.53	0.42	0.00	0.42	0.00	0.00	0.00	0.00
Jun-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul-95	0.00	0.63	0.00	0.00	0.00	0.00	0.00	2.53	0.00
Jul-95	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

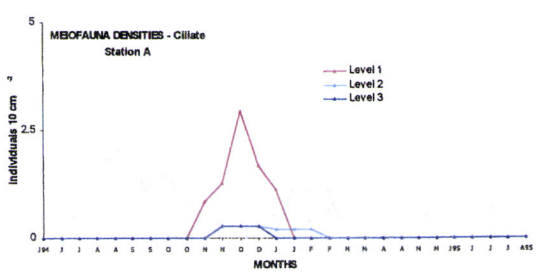


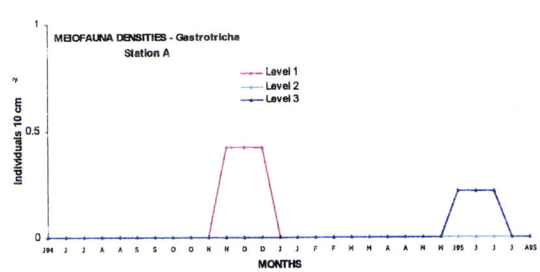


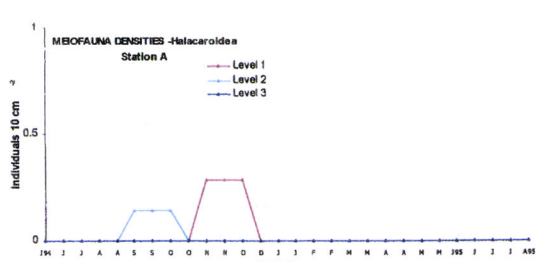


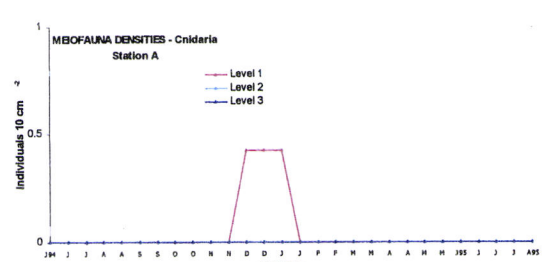




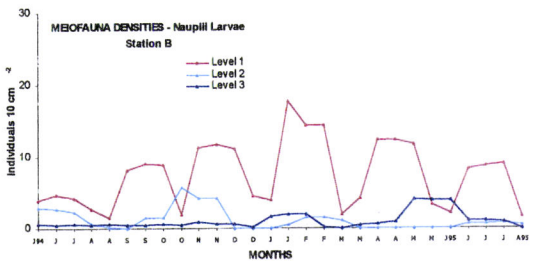


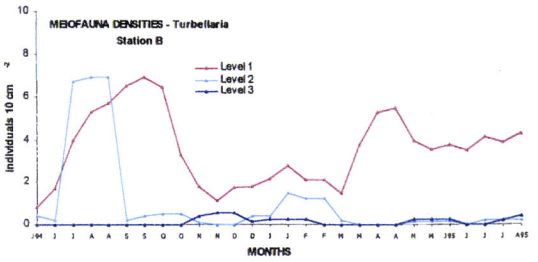


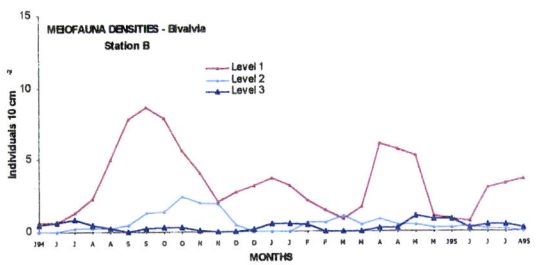


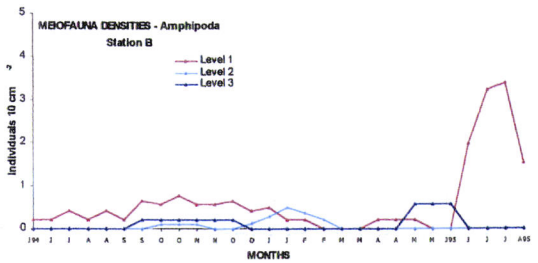


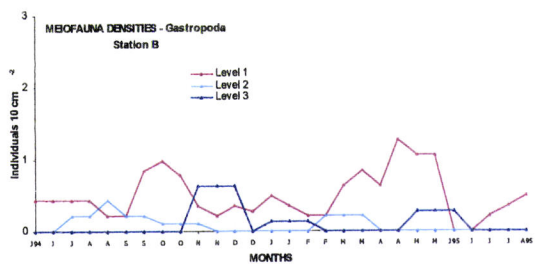
Temporal and vertical variations of the meiofauna groups, which registered the lowest densities at the three depths: level 1(0-3 cm), level 2 (3-6 cm) and level 3 (6-10 cm), at station A.

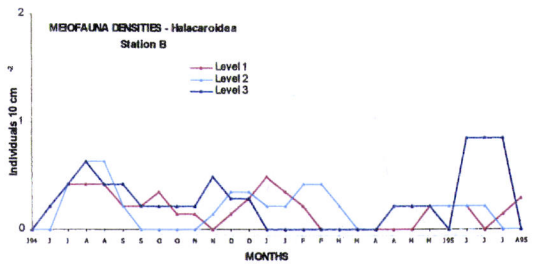


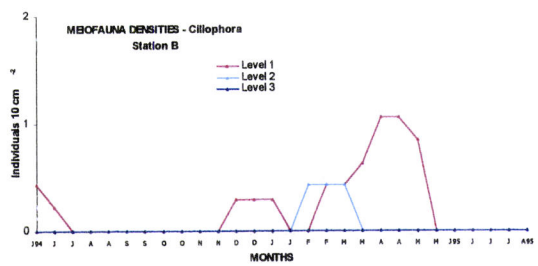


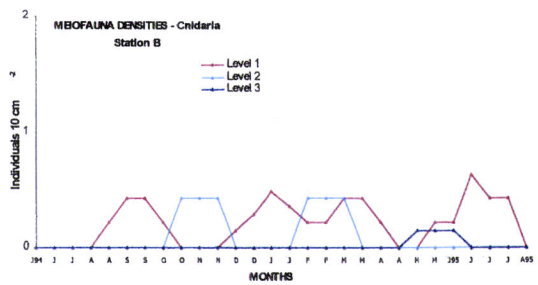


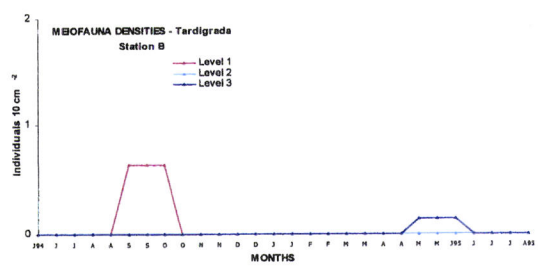












Temporal and vertical variations of the meiofauna groups, which registered the lowest densities at the three depths: level 1(0-3 cm), level 2 (3-6 cm) and level 3 (6-10 cm), at station B.

ANNEX III

NEMATODA

- Tables of the temporal variation of Nematoda genera densities from June 94 to August 95 (average values).

- Temporal and vertical variations of the Nematoda genera which registered lowest densities.

- Spearman correlation results between Nematoda densities and environmental parameters.

Station A - Nematoda Genera Densities (individuals $10cm^{-2}$) (0-10 cm depth)

Date	*Acanthopharynx*	*Anticomopsis*	*Anticoma*	*Antomicron*	*Atrochromodora*	*Aponema*	*Bathylaimus*	*Calyptronema*
Jun-94	0,00	0,00	0,00	0,00	11,47	0,00	11,47	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	30,64	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	86,91	82,08	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	17,51	17,51	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	78,47	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	50,54	101,09
Sept-94	0,00	0,00	19,03	0,00	0,00	14,27	9,51	0,00
Oct-94	0,00	0,00	9,59	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	18,83	0,00	0,00	0,00	47,09	0,00
Nov-94	0,00	0,00	26,13	0,00	0,00	17,42	121,96	0,00
Nov-94	17,12	0,00	68,48	0,00	0,00	0,00	34,24	0,00
Dec-94	8,53	0,00	38,36	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	21,62	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	47,41	0,00	0,00	15,80	15,80	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	35,27	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	42,82	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	99,75	0,00
Mar-95	0,00	0,00	11,81	11,81	0,00	11,81	11,81	0,00
Apr-95	0,00	0,00	72,14	0,00	0,00	7,21	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	56,12	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	36,22	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	3,60	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	40,89	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	16,14	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	15,88	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	8,91	0,00	0,00	0,00	0,00	0,00

Date	*aff Cervonema*	*Chromaspirina*	*Chromadora*	*Chromadora nudicapitata*	*Chromadorina*	*Chromadorina germanica*	*Chromadora macrolaima*	*Chromadorella*	*Chromadorella duopapillata*
Jun-94	0,00	0,00	11,47	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	30,64	0,00	45,95	15,32	0,00	30,64
Jul-94	0,00	0,00	0,00	48,28	0,00	9,66	0,00	0,00	43,45
Aug-94	0,00	0,00	0,00	17,51	17,51	35,03	0,00	0,00	148,87
Aug-94	0,00	0,00	0,00	0,00	0,00	13,08	0,00	0,00	104,62
Sept-94	12,64	0,00	0,00	12,64	0,00	31,59	0,00	0,00	94,77
Sept-94	0,00	0,00	0,00	19,03	0,00	23,78	0,00	0,00	104,65
Oct-94	0,00	0,00	0,00	62,33	0,00	28,77	0,00	0,00	119,87
Oct-94	0,00	0,00	0,00	113,01	18,83	113,01	18,83	18,83	244,85
Nov-94	0,00	0,00	0,00	0,00	0,00	69,69	0,00	0,00	226,50
Nov-94	0,00	0,00	0,00	68,48	0,00	171,20	0,00	0,00	804,63
Dec-94	0,00	0,00	0,00	170,51	0,00	196,08	0,00	0,00	161,98
Dec-94	0,00	0,00	0,00	32,43	0,00	129,73	21,62	0,00	64,86
Jan-95	0,00	0,00	0,00	0,00	0,00	119,19	19,87	0,00	337,71
Jan-95	0,00	0,00	31,61	102,72	79,02	150,14	0,00	0,00	189,65
Feb-95	0,00	0,00	0,00	149,92	0,00	202,83	17,64	0,00	97,01
Feb-95	0,00	0,00	0,00	85,65	0,00	53,53	21,41	0,00	74,94
Mar-95	0,00	0,00	0,00	16,62	0,00	16,62	33,25	0,00	74,81
Mar-95	0,00	11,81	47,25	53,16	0,00	23,63	47,25	23,63	53,16
Apr-95	0,00	0,00	7,21	7,21	21,64	14,43	14,43	0,00	79,35
Apr-95	0,00	7,95	15,91	15,91	0,00	0,00	7,95	0,00	15,91
May-95	0,00	0,00	9,35	0,00	0,00	32,74	9,35	0,00	65,47
May-95	0,00	0,00	0,00	7,24	0,00	25,35	0,00	0,00	36,22
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	39,80
Jun-95	0,00	0,00	0,00	6,78	0,00	6,78	0,00	0,00	101,72
Jul-95	0,00	0,00	0,00	3,59	0,00	0,00	0,00	0,00	19,73
Jul-95	0,00	0,00	0,00	49,91	0,00	9,07	0,00	0,00	47,84
Aug-95	0,00	0,00	0,00	8,91	0,00	8,91	0,00	0,00	26,72

Date	*Camacolaimus*	*Campylaimus*	*Cyartonema*	*Daptonema*	*Desmodora*	*Desmolaimus*	*Diodontolaimus*	*Eleutherolaimus*	*Eurystomina*
Jun-94	0,00	0,00	0,00	189,25	0,00	22,94	0,00	0,00	0,00
Jul-94	15,32	15,32	0,00	107,22	15,32	0,00	15,32	30,64	0,00
Jul-94	0,00	0,00	0,00	77,25	0,00	0,00	0,00	9,66	0,00
Aug-94	70,06	0,00	0,00	52,54	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	13,08	0,00	71,93	0,00	0,00	0,00	13,08	26,16
Sept-94	75,81	12,64	88,45	12,64	0,00	0,00	0,00	12,64	63,18
Sept-94	66,59	0,00	0,00	33,30	0,00	0,00	9,51	0,00	0,00
Oct-94	23,97	0,00	0,00	14,38	0,00	0,00	0,00	0,00	0,00
Oct-94	18,83	0,00	0,00	18,83	0,00	0,00	0,00	18,83	37,67
Nov-94	0,00	17,42	0,00	17,42	0,00	0,00	0,00	17,42	0,00
Nov-94	68,48	34,24	0,00	51,36	0,00	0,00	0,00	0,00	17,12
Dec-94	21,31	0,00	0,00	42,63	0,00	0,00	17,05	0,00	8,53
Dec-94	43,24	21,62	0,00	37,84	0,00	0,00	21,62	0,00	0,00
Jan-95	139,06	0,00	0,00	178,79	0,00	0,00	19,87	0,00	0,00
Jan-95	158,04	31,61	0,00	134,33	0,00	0,00	31,61	0,00	0,00
Feb-95	132,28	0,00	0,00	141,10	0,00	0,00	17,64	0,00	0,00
Feb-95	42,82	107,06	0,00	192,70	0,00	0,00	0,00	0,00	0,00
Mar-95	16,62	16,62	0,00	207,80	0,00	0,00	0,00	0,00	16,62
Mar-95	47,25	0,00	0,00	70,88	0,00	0,00	0,00	0,00	0,00
Apr-95	7,21	14,43	0,00	180,34	0,00	0,00	21,64	0,00	0,00
Apr-95	19,88	0,00	0,00	71,58	0,00	0,00	0,00	0,00	7,95
May-95	0,00	28,06	0,00	79,50	0,00	0,00	0,00	0,00	0,00
May-95	28,97	14,49	0,00	54,32	0,00	0,00	0,00	0,00	0,00
Jun-95	72,00	0,00	0,00	12,60	0,00	0,00	7,20	0,00	0,00
Jun-95	20,34	0,00	0,00	115,28	6,78	6,78	0,00	0,00	13,56
Jul-95	0,00	0,00	0,00	41,26	0,00	0,00	3,59	0,00	0,00
Jul-95	18,15	13,61	0,00	140,66	0,00	0,00	13,61	0,00	0,00
Aug-95	13,36	8,91	0,00	42,30	0,00	0,00	0,00	0,00	0,00

Station A - Nematoda Genera Densities (individuals $10cm^{-2}$) (0-10cm depth)

Date	*Halaphanolaimus*	*Halalaimus*	*Leptolaimus*	*Linhomoeus*	*Megadesmolaimus*	*Metachromadora remanei*	*Metadesmolaimus*	*Metalinhomoeus*
Jun-94	0,00	11,47	0,00	160,57	0,00	91,76	0,00	11,47
Jul-94	0,00	0,00	0,00	130,20	0,00	53,61	0,00	0,00
Jul-94	0,00	19,31	9,66	77,25	0,00	43,45	0,00	9,66
Aug-94	0,00	0,00	0,00	131,36	17,51	26,27	0,00	70,06
Aug-94	0,00	0,00	0,00	45,77	0,00	0,00	0,00	0,00
Sept-94	0,00	25,27	0,00	120,04	12,64	63,18	0,00	164,27
Sept-94	0,00	0,00	0,00	71,35	0,00	9,51	0,00	19,03
Oct-94	0,00	0,00	0,00	71,92	0,00	9,59	0,00	0,00
Oct-94	0,00	18,83	0,00	113,01	0,00	18,83	0,00	0,00
Nov-94	0,00	17,42	0,00	139,38	0,00	34,85	0,00	0,00
Nov-94	0,00	17,12	0,00	94,16	0,00	17,12	0,00	0,00
Dec-94	0,00	8,53	0,00	238,71	29,84	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	135,13	21,62	0,00	0,00	0,00
Jan-95	0,00	19,87	0,00	188,72	19,87	0,00	0,00	0,00
Jan-95	0,00	0,00	15,80	47,41	110,63	0,00	0,00	31,61
Feb-95	0,00	0,00	17,64	114,64	35,27	52,91	0,00	0,00
Feb-95	0,00	0,00	0,00	182,00	64,23	107,06	0,00	21,41
Mar-95	0,00	0,00	0,00	157,93	33,25	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	53,16	11,81	11,81	0,00	11,81
Apr-95	0,00	0,00	0,00	100,99	0,00	0,00	0,00	0,00
Apr-95	0,00	15,91	0,00	83,51	39,77	0,00	0,00	0,00
May-95	0,00	0,00	0,00	98,21	9,35	0,00	0,00	0,00
May-95	0,00	0,00	0,00	108,65	14,49	0,00	0,00	7,24
Jun-95	0,00	0,00	0,00	32,40	14,40	0,00	0,00	3,60
Jun-95	0,00	0,00	0,00	47,47	0,00	0,00	0,00	0,00
Jul-95	0,00	3,59	0,00	30,49	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	22,69	9,07	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	82,38	4,45	0,00	0,00	4,45

Date	*Microlaimus*	*Molgolaimus*	*Nemanema*	*Neochromadora*	*Odonthophora*	*Odontanticoma*	*Oncholaimellus*	*Onchium*	*Oxystomina*
Jun-94	0,00	34,41	0,00	22,94	286,74	0,00	0,00	22,94	0,00
Jul-94	0,00	0,00	0,00	0,00	758,22	0,00	0,00	0,00	15,32
Jul-94	0,00	9,66	0,00	0,00	434,55	0,00	86,91	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	394,07	0,00	35,03	0,00	0,00
Aug-94	0,00	52,31	0,00	0,00	326,94	0,00	39,23	0,00	0,00
Sept-94	12,64	37,91	0,00	0,00	259,03	0,00	75,81	0,00	50,54
Sept-94	0,00	0,00	9,51	0,00	233,08	0,00	28,54	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	239,75	0,00	28,77	0,00	9,59
Oct-94	18,83	0,00	0,00	0,00	461,44	0,00	18,83	0,00	0,00
Nov-94	17,42	34,85	0,00	0,00	531,40	69,69	17,42	0,00	34,85
Nov-94	0,00	0,00	0,00	0,00	273,92	85,60	128,40	0,00	0,00
Dec-94	0,00	8,53	0,00	0,00	59,68	0,00	8,53	0,00	0,00
Dec-94	0,00	27,03	0,00	0,00	167,57	0,00	32,43	0,00	10,81
Jan-95	0,00	19,87	0,00	0,00	496,63	0,00	19,87	0,00	19,87
Jan-95	0,00	15,80	0,00	0,00	276,57	0,00	31,61	0,00	0,00
Feb-95	0,00	35,27	0,00	0,00	370,38	0,00	35,27	0,00	17,64
Feb-95	0,00	21,41	0,00	0,00	556,70	0,00	0,00	0,00	21,41
Mar-95	0,00	83,12	0,00	0,00	440,54	0,00	16,62	0,00	0,00
Mar-95	0,00	11,81	0,00	11,81	313,05	0,00	35,44	0,00	0,00
Apr-95	7,21	14,43	0,00	0,00	137,06	0,00	50,50	0,00	7,21
Apr-95	0,00	23,86	7,95	0,00	178,94	0,00	0,00	0,00	7,95
May-95	9,35	0,00	0,00	0,00	369,45	0,00	37,41	0,00	18,71
May-95	0,00	0,00	0,00	0,00	257,14	0,00	21,73	0,00	7,24
Jun-95	0,00	0,00	0,00	0,00	104,39	0,00	3,60	7,20	0,00
Jun-95	0,00	6,78	0,00	0,00	132,23	0,00	13,56	0,00	6,78
Jul-95	0,00	0,00	0,00	0,00	37,67	23,32	14,35	0,00	3,59
Jul-95	0,00	0,00	0,00	18,15	43,11	0,00	4,54	0,00	4,54
Aug-95	0,00	4,45	0,00	0,00	44,53	0,00	4,45	0,00	0,00

Dates	*Parscomesoma*	*Parsecanthonchus*	*Paralinhomeus*	*Parecyatholaimus*	*Parasphaerolaimus*	*Paramonohystera*	*Paraxystomina*
Jun-94	653,76	22,94	34,41	0,00	0,00	11,47	11,47
Jul-94	467,19	0,00	0,00	15,32	0,00	61,27	0,00
Jul-94	511,80	9,66	0,00	9,66	0,00	0,00	0,00
Aug-94	726,83	0,00	17,51	122,60	0,00	0,00	0,00
Aug-94	680,04	0,00	0,00	39,23	0,00	0,00	0,00
Sept-94	303,26	0,00	0,00	82,13	0,00	25,27	0,00
Sept-94	499,45	0,00	19,03	38,05	0,00	14,27	0,00
Oct-94	388,39	0,00	57,54	47,95	0,00	67,13	0,00
Oct-94	687,45	0,00	0,00	75,34	18,83	301,35	0,00
Nov-94	635,94	17,42	17,42	34,85	0,00	60,98	0,00
Nov-94	308,16	42,80	0,00	102,72	0,00	17,12	0,00
Dec-94	123,62	8,53	0,00	59,68	0,00	25,58	0,00
Dec-94	275,67	0,00	21,62	32,43	0,00	10,81	0,00
Jan-95	854,20	19,87	0,00	59,60	0,00	218,52	0,00
Jan-95	529,43	0,00	31,61	47,41	0,00	110,63	0,00
Feb-95	388,02	0,00	0,00	149,92	0,00	52,91	0,00
Feb-95	1252,57	21,41	0,00	246,23	0,00	53,53	0,00
Mar-95	814,59	33,25	0,00	174,55	0,00	49,87	0,00
Mar-95	555,22	112,22	11,81	88,60	0,00	35,44	0,00
Apr-95	111,81	36,07	14,43	100,99	0,00	21,64	0,00
Apr-95	262,45	15,91	15,91	11,93	0,00	135,20	0,00
May-95	252,54	18,71	0,00	32,74	0,00	23,38	0,00
May-95	300,60	7,24	0,00	10,86	0,00	134,00	0,00
Jun-95	152,99	0,00	39,60	3,60	0,00	39,60	0,00
Jun-95	50,86	13,56	0,00	0,00	0,00	91,55	0,00
Jul-95	39,46	0,00	0,00	10,76	0,00	39,46	0,00
Jul-95	11,34	0,00	0,00	13,61	0,00	52,18	0,00
Aug-95	26,72	0,00	0,00	4,45	0,00	35,62	0,00

Station B - Nematoda Genera Densities (individuals $10cm^{-2}$) (0-10 cm depth)

Date	*Acanthopharynx*	*Anticomopsis*	*Anticoma*	*Antomicron*	*Atrochromodora*	*Aponema*	*Bathylaimus*	*Calyptronema*
Jun-94	0,00	0,00	18,88	0,00	0,00	18,88	37,75	18,88
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	79,89	0,00
Jul-94	0,00	0,00	18,42	0,00	0,00	0,00	73,68	0,00
Aug-94	0,00	0,00	26,35	0,00	0,00	7,53	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	30,66	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	15,21	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	128,26	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	24,65	0,00	0,00	0,00	6,16	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	19,06	0,00
Dec-94	0,00	0,00	20,00	0,00	0,00	0,00	10,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	23,80	0,00
Feb-95	0,00	0,00	32,32	0,00	0,00	0,00	48,48	0,00
Feb-95	0,00	0,00	32,60	0,00	0,00	0,00	163,02	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	22,28	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	23,05	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	15,05	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	9,21	9,21	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	49,15	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	115,77	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	18,00	0,00	0,00	18,00	35,99	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Date	*aff Cervonema*	*Chromaspirina*	*Chromadora*	*Chromadora nudicapitata*	*Chromadorina*	*Chromadorina germanica*	*Chromadora microlaima*	*Chromadorella*	*Chromadorella duopapillata*
Jun-94	0,00	0,00	0,00	37,75	0,00	18,88	0,00	0,00	18,88
Jul-94	0,00	0,00	0,00	79,89	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	46,05	0,00	18,42	0,00	0,00	79,82
Aug-94	0,00	0,00	0,00	15,06	15,06	75,28	0,00	0,00	15,06
Aug-94	0,00	0,00	0,00	0,00	0,00	18,36	0,00	0,00	36,72
Sept-94	0,00	0,00	0,00	8,39	0,00	92,28	0,00	0,00	29,36
Sept-94	0,00	0,00	0,00	61,31	0,00	91,97	30,66	0,00	45,98
Oct-94	0,00	0,00	0,00	125,97	0,00	377,91	0,00	0,00	155,61
Oct-94	0,00	0,00	0,00	91,26	0,00	228,16	0,00	0,00	91,26
Nov-94	0,00	0,00	0,00	128,26	0,00	106,88	0,00	0,00	64,13
Nov-94	0,00	0,00	0,00	6,16	0,00	104,77	0,00	0,00	21,57
Dec-94	0,00	0,00	0,00	76,26	0,00	209,70	0,00	0,00	76,26
Dec-94	0,00	0,00	0,00	34,99	0,00	137,48	0,00	10,00	22,85
Jan-95	0,00	0,00	0,00	125,56	0,00	143,50	11,96	11,96	43,85
Jan-95	0,00	0,00	0,00	333,19	95,20	356,99	0,00	0,00	71,40
Feb-95	0,00	0,00	0,00	96,96	0,00	436,31	0,00	0,00	80,80
Feb-95	0,00	0,00	0,00	65,21	0,00	32,60	32,60	0,00	108,68
Mar-95	0,00	0,00	0,00	33,42	0,00	33,42	0,00	0,00	33,42
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	34,18	102,54
Apr-95	0,00	0,00	0,00	46,10	0,00	46,10	23,05	0,00	69,15
Apr-95	15,05	0,00	0,00	60,20	0,00	0,00	30,10	0,00	15,05
May-95	0,00	0,00	0,00	44,72	0,00	111,79	313,02	0,00	0,00
May-95	0,00	0,00	0,00	9,21	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	16,38	0,00	0,00	16,38	0,00	16,38
Jun-95	0,00	0,00	0,00	0,00	0,00	41,93	41,93	0,00	10,48
Jul-95	0,00	0,00	0,00	8,27	0,00	0,00	0,00	0,00	24,81
Jul-95	0,00	0,00	0,00	18,00	0,00	35,99	0,00	0,00	53,99
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	36,80

Date	*Camacolaimus*	*Campylaimus*	*Cyartonema*	*Daptonema*	*Desmodora*	*Desmolaimus*	*Diodontolaimus*	*Eleutherolaimus*	*Eurystomina*
Jun-94	0,00	37,75	0,00	122,70	18,88	0,00	56,63	0,00	0,00
Jul-94	39,95	0,00	0,00	159,79	1677,75	0,00	0,00	0,00	0,00
Jul-94	36,84	55,26	0,00	36,84	0,00	0,00	0,00	0,00	0,00
Aug-94	63,99	0,00	0,00	37,64	60,23	0,00	15,06	0,00	0,00
Aug-94	211,16	0,00	0,00	36,72	55,08	0,00	18,36	0,00	0,00
Sept-94	96,47	0,00	0,00	46,14	41,94	0,00	0,00	0,00	0,00
Sept-94	214,59	61,31	0,00	153,28	337,22	0,00	0,00	0,00	0,00
Oct-94	74,10	0,00	0,00	437,19	29,64	0,00	29,64	0,00	14,82
Oct-94	174,92	15,21	0,00	68,45	15,21	0,00	15,21	0,00	0,00
Nov-94	149,64	0,00	0,00	619,92	149,64	0,00	21,38	0,00	85,51
Nov-94	95,53	0,00	0,00	43,14	0,00	0,00	6,16	0,00	0,00
Dec-94	123,92	57,19	0,00	133,45	0,00	0,00	19,06	0,00	0,00
Dec-94	126,98	10,00	0,00	31,00	59,99	0,00	20,00	0,00	20,00
Jan-95	143,50	0,00	0,00	205,29	0,00	0,00	23,92	0,00	0,00
Jan-95	119,00	23,80	0,00	333,19	0,00	0,00	23,80	0,00	23,80
Feb-95	64,64	0,00	0,00	242,40	161,60	0,00	32,32	0,00	0,00
Feb-95	97,81	76,08	0,00	211,93	65,21	0,00	65,21	0,00	0,00
Mar-95	11,14	38,99	0,00	50,13	0,00	0,00	11,14	11,14	22,28
Mar-95	85,45	51,27	0,00	307,62	34,18	0,00	0,00	0,00	68,36
Apr-95	218,98	23,05	0,00	69,15	0,00	0,00	46,10	0,00	0,00
Apr-95	97,83	15,05	0,00	120,40	15,05	0,00	15,05	0,00	0,00
May-95	134,15	0,00	0,00	693,13	89,44	0,00	89,44	0,00	44,72
May-95	59,84	0,00	0,00	82,86	46,03	174,93	18,41	0,00	9,21
Jun-95	57,34	32,77	0,00	245,75	16,38	0,00	16,38	16,38	16,38
Jun-95	52,42	0,00	0,00	94,35	83,87	0,00	52,42	0,00	10,48
Jul-95	68,91	8,27	0,00	104,75	45,48	0,00	16,54	0,00	0,00
Jul-95	125,97	0,00	0,00	86,98	287,94	0,00	53,99	0,00	18,00
Aug-95	73,60	0,00	0,00	55,20	0,00	0,00	36,80	0,00	36,80

Station A - Nematoda Genera Densities (individuals 10cm^{-2}) (0-10cm depth)

Date	*Prochromadorella*	*Prochromadorella ditlevseni*	*aff Phanodermopsis*	*Ptycholaimellus*	*Spirinia*	*Sabatieria*	*Southernella*	*Southernia*	*Sphaerolaimus*
Jun-94	0,00	0,00	0,00	0,00	40,14	0,00	0,00	11,47	34,41
Jul-94	15,32	0,00	0,00	15,32	38,29	0,00	0,00	0,00	0,00
Jul-94	19,31	9,66	0,00	0,00	53,11	0,00	0,00	38,63	28,97
Aug-94	0,00	0,00	0,00	0,00	43,79	0,00	0,00	17,51	43,79
Aug-94	0,00	0,00	0,00	13,08	117,70	0,00	0,00	26,16	78,47
Sept-94	0,00	0,00	0,00	25,27	101,09	0,00	0,00	12,64	113,72
Sept-94	9,51	0,00	9,51	0,00	33,30	0,00	0,00	42,81	9,51
Oct-94	38,36	0,00	9,59	9,59	201,39	9,59	0,00	9,59	0,00
Oct-94	0,00	0,00	0,00	37,67	216,60	0,00	0,00	18,83	18,83
Nov-94	0,00	0,00	0,00	0,00	243,92	0,00	0,00	34,85	17,42
Nov-94	0,00	0,00	0,00	0,00	248,24	34,24	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	225,92	8,53	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	32,43	156,76	0,00	0,00	10,81	64,86
Jan-95	0,00	0,00	0,00	59,60	307,91	0,00	39,73	39,73	0,00
Jan-95	31,61	0,00	0,00	47,41	39,51	15,80	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	17,64	308,65	0,00	0,00	141,10	17,64
Feb-95	0,00	0,00	0,00	53,53	171,29	0,00	0,00	64,23	0,00
Mar-95	0,00	0,00	0,00	49,87	174,55	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	118,13	112,22	0,00	0,00	0,00	23,63
Apr-95	0,00	0,00	0,00	61,32	122,63	7,21	0,00	14,43	0,00
Apr-95	0,00	0,00	0,00	43,74	222,69	0,00	0,00	15,91	7,95
May-95	0,00	0,00	0,00	88,86	383,48	0,00	9,35	18,71	0,00
May-95	0,00	0,00	0,00	97,78	159,35	7,24	7,24	7,24	0,00
Jun-95	0,00	0,00	0,00	12,60	147,59	0,00	0,00	10,80	0,00
Jun-95	6,78	0,00	0,00	13,56	495,03	0,00	0,00	6,78	0,00
Jul-95	0,00	0,00	0,00	7,18	310,33	0,00	0,00	7,18	0,00
Jul-95	0,00	0,00	0,00	13,61	149,73	27,22	0,00	49,91	0,00
Aug-95	0,00	0,00	0,00	13,36	104,64	0,00	0,00	13,36	0,00

Date	*Synonchiella*	*Thalassironus*	*Terschellingia*	*Viscosia*	*Wieseria*	*Dichocromadora cephalata*	*Monoposthia*
Jun-94	126,16	0,00	556,27	11,47	0,00	0,00	0,00
Jul-94	15,32	0,00	742,90	61,27	0,00	0,00	0,00
Jul-94	0,00	38,63	202,79	19,31	0,00	0,00	0,00
Aug-94	0,00	0,00	901,97	52,54	0,00	0,00	0,00
Aug-94	0,00	13,08	836,98	0,00	0,00	0,00	0,00
Sept-94	12,64	0,00	669,70	12,64	0,00	0,00	0,00
Sept-94	9,51	9,51	323,45	19,03	0,00	0,00	0,00
Oct-94	14,38	95,90	143,85	38,36	0,00	0,00	0,00
Oct-94	18,83	0,00	894,63	75,34	0,00	0,00	0,00
Nov-94	34,85	0,00	723,05	130,67	17,42	0,00	0,00
Nov-94	0,00	0,00	453,68	119,84	0,00	0,00	0,00
Dec-94	17,05	8,53	136,41	8,53	0,00	0,00	0,00
Dec-94	10,81	10,81	529,73	64,86	0,00	0,00	0,00
Jan-95	109,26	19,87	705,21	99,33	0,00	0,00	0,00
Jan-95	15,80	0,00	671,66	23,71	0,00	0,00	0,00
Feb-95	0,00	0,00	899,51	44,09	0,00	0,00	0,00
Feb-95	0,00	0,00	706,58	42,82	0,00	0,00	0,00
Mar-95	0,00	33,25	556,91	66,50	0,00	0,00	0,00
Mar-95	0,00	0,00	348,49	35,44	0,00	0,00	0,00
Apr-95	7,21	0,00	180,34	43,28	0,00	0,00	0,00
Apr-95	7,95	39,77	222,69	23,86	0,00	0,00	0,00
May-95	18,71	28,06	102,89	0,00	0,00	0,00	0,00
May-95	18,11	7,24	184,70	7,24	0,00	0,00	0,00
Jun-95	3,60	10,80	149,39	3,60	0,00	0,00	0,00
Jun-95	13,56	20,34	47,47	135,62	0,00	0,00	0,00
Jul-95	10,76	8,97	35,88	57,40	3,59	0,00	0,00
Jul-95	0,00	27,22	88,48	68,06	0,00	0,00	0,00
Aug-95	8,91	48,98	44,53	242,68	0,00	0,00	0,00

Date	*Paradesmodora*	*Setosabatieria*	*Belbolla*	*Desmoscolex*	*Hypodontolaimus*	*Aegialoalaimus*	*Bathyeurystomina*	*Thoracostoma*	*Polygastrophora*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Station B - Nematoda Genera Densities (individuals $10cm^{-2}$) (0-10 cm depth)

Date	*Prochromadorella*	*Prochromadorella ditlevseni*	*aff Phanodermopsis*	*Ptycholaimellus*	*Spirinia*	*Sabatieria*	*Southernella*	*Southernia*	*Sphaerolaimus*
Jun-94	0,00	0,00	0,00	75,51	298,88	113,26	0,00	0,00	18,88
Jul-94	0,00	0,00	0,00	79,89	599,20	0,00	0,00	39,95	39,95
Jul-94	18,42	0,00	0,00	36,84	294,70	0,00	0,00	0,00	18,42
Aug-94	7,53	7,53	0,00	7,53	225,85	0,00	0,00	11,29	0,00
Aug-94	0,00	0,00	0,00	0,00	706,92	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	615,18	8,39	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	30,66	1609,45	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	44,46	333,45	0,00	0,00	44,46	0,00
Oct-94	0,00	0,00	0,00	0,00	816,31	30,42	0,00	0,00	0,00
Nov-94	21,38	0,00	0,00	42,75	929,88	0,00	0,00	106,88	0,00
Nov-94	0,00	0,00	0,00	6,16	295,82	0,00	0,00	0,00	0,00
Dec-94	19,06	0,00	0,00	47,66	200,17	0,00	0,00	114,38	19,06
Dec-94	20,00	0,00	0,00	30,00	567,60	114,98	0,00	10,00	10,00
Jan-95	23,92	0,00	0,00	29,90	623,83	0,00	0,00	11,96	0,00
Jan-95	0,00	0,00	0,00	142,80	119,00	23,80	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	113,12	193,92	0,00	0,00	32,32	0,00
Feb-95	65,21	0,00	0,00	107,13	952,53	342,35	0,00	0,00	76,08
Mar-95	0,00	0,00	0,00	11,14	200,54	11,14	0,00	11,14	22,28
Mar-95	34,18	0,00	0,00	341,80	922,87	0,00	0,00	0,00	0,00
Apr-95	0,00	23,05	0,00	138,29	1532,75	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	105,35	1053,53	0,00	0,00	0,00	0,00
May-95	44,72	44,72	0,00	268,31	89,44	0,00	0,00	0,00	44,72
May-95	9,21	9,21	0,00	59,84	856,23	0,00	0,00	0,00	9,21
Jun-95	16,38	0,00	0,00	49,15	1294,29	0,00	0,00	16,38	0,00
Jun-95	41,93	0,00	0,00	47,18	499,72	20,97	0,00	26,21	10,48
Jul-95	8,27	0,00	0,00	8,27	707,05	0,00	0,00	8,27	16,54
Jul-95	0,00	0,00	0,00	89,98	1568,68	0,00	0,00	0,00	35,99
Aug-95	0,00	0,00	0,00	147,20	884,82	0,00	0,00	0,00	0,00

Date	*Synonchiella*	*Thalassironus*	*Terschellingia*	*Viscosia*	*Wieseria*	*Dichocromadora cephalata*	*Monoposthia*
Jun-94	0,00	0,00	673,27	18,88	0,00	0,00	0,00
Jul-94	39,95	0,00	1018,63	119,84	0,00	0,00	0,00
Jul-94	0,00	0,00	1019,18	18,42	0,00	18,42	0,00
Aug-94	41,41	7,53	154,33	18,82	0,00	0,00	0,00
Aug-94	36,72	18,36	807,91	36,72	0,00	0,00	0,00
Sept-94	46,14	50,33	41,94	54,53	0,00	0,00	0,00
Sept-94	61,31	0,00	1824,04	122,62	0,00	0,00	30,66
Oct-94	44,46	29,64	333,45	125,97	0,00	0,00	0,00
Oct-94	76,05	15,21	218,02	76,05	0,00	0,00	0,00
Nov-94	85,51	42,75	769,55	96,19	0,00	0,00	0,00
Nov-94	24,65	6,16	49,30	58,55	0,00	0,00	0,00
Dec-94	0,00	0,00	905,53	38,13	0,00	19,06	0,00
Dec-94	33,33	30,00	298,62	69,99	0,00	0,00	0,00
Jan-95	111,61	0,00	247,14	59,79	0,00	0,00	0,00
Jan-95	0,00	23,80	1558,85	35,70	23,80	0,00	0,00
Feb-95	0,00	0,00	2036,13	64,64	0,00	0,00	32,32
Feb-95	97,81	32,60	1106,75	208,67	0,00	0,00	0,00
Mar-95	11,14	0,00	718,60	44,56	0,00	0,00	0,00
Mar-95	119,63	68,36	905,78	34,18	0,00	0,00	0,00
Apr-95	46,10	46,10	829,76	23,05	0,00	0,00	0,00
Apr-95	0,00	15,05	188,13	60,20	0,00	0,00	0,00
May-95	0,00	0,00	3532,71	0,00	0,00	0,00	0,00
May-95	0,00	18,41	107,41	58,31	0,00	0,00	0,00
Jun-95	16,38	16,38	237,56	262,14	0,00	0,00	0,00
Jun-95	15,73	31,45	214,91	20,97	0,00	0,00	0,00
Jul-95	16,54	71,67	175,04	197,09	0,00	33,06	0,00
Jul-95	18,00	35,99	119,98	98,98	0,00	0,00	0,00
Aug-95	92,00	73,60	184,00	174,80	0,00	0,00	0,00

Date	*Paradesmodora*	*Setosabatieria*	*Belbolla*	*Desmoecolex*	*Hypodontolaimus*	*Aegiolaimus*	*Bathyeurystomina*	*Thoracostoma*	*Polygastrophora*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	18,88	0,00	0,00
Jul-94	0,00	559,25	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	36,84	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	14,82	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	10,00	0,00
Jan-95	0,00	11,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	64,64	0,00	0,00	0,00	0,00
Feb-95	163,02	97,81	0,00	0,00	97,81	32,60	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	34,18	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	8,27	8,27
Jul-95	18,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Station B - Nematoda Genera Densities (individuals 10cm^{-2}) (0-10 cm depth)

Date	*Halaphanolaimus*	*Halalaimus*	*Leptolaimus*	*Linhomoeus*	*Megadesmolaimus*	*Metachromadora remanei*	*Metadesmolaimus*	*Metalinhomoeus*
Jun-94	0,00	0,00	0,00	327,20	18,88	103,82	0,00	0,00
Jul-94	0,00	0,00	0,00	559,25	0,00	1158,45	0,00	39,95
Jul-94	0,00	18,42	0,00	353,03	46,05	36,84	0,00	0,00
Aug-94	0,00	7,53	0,00	233,38	60,23	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	422,31	45,90	73,45	0,00	0,00
Sept-94	0,00	0,00	0,00	162,19	33,56	0,00	0,00	16,78
Sept-94	0,00	0,00	0,00	459,84	76,64	61,31	0,00	0,00
Oct-94	0,00	0,00	0,00	163,02	59,28	29,64	0,00	0,00
Oct-94	0,00	0,00	0,00	220,56	38,03	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	213,76	74,82	42,75	0,00	0,00
Nov-94	0,00	6,16	0,00	70,87	21,57	6,16	0,00	0,00
Dec-94	0,00	0,00	0,00	171,57	57,19	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	336,04	32,72	23,33	0,00	10,00
Jan-95	0,00	0,00	0,00	328,86	41,85	11,96	0,00	11,96
Jan-95	0,00	23,80	0,00	717,95	71,40	142,80	0,00	0,00
Feb-95	0,00	0,00	0,00	694,87	177,76	129,28	0,00	0,00
Feb-95	0,00	0,00	0,00	987,20	130,42	116,45	0,00	0,00
Mar-95	0,00	11,14	0,00	217,25	55,71	77,99	0,00	0,00
Mar-95	0,00	0,00	0,00	1486,85	136,72	102,54	0,00	0,00
Apr-95	0,00	0,00	0,00	242,01	242,01	23,05	0,00	23,05
Apr-95	0,00	0,00	0,00	316,06	45,15	90,30	0,00	0,00
May-95	0,00	0,00	0,00	693,13	89,44	134,15	0,00	0,00
May-95	0,00	0,00	0,00	245,51	119,69	0,00	0,00	27,62
Jun-95	0,00	32,77	0,00	155,64	16,38	49,15	0,00	0,00
Jun-95	0,00	0,00	0,00	270,83	125,80	10,48	0,00	0,00
Jul-95	0,00	0,00	0,00	219,14	33,08	24,81	0,00	0,00
Jul-95	0,00	18,00	0,00	698,86	0,00	53,99	0,00	35,99
Aug-95	0,00	0,00	0,00	377,21	18,40	18,40	0,00	0,00

Dates	*Microlaimus*	*Molgolaimus*	*Nemanema*	*Neochromadora*	*Odonthophora*	*Odontanticoma*	*Oncholaimellus*	*Onchium*	*Oxystomina*
Jun-94	37,75	37,75	0,00	0,00	500,23	0,00	18,88	0,00	0,00
Jul-94	119,84	279,63	0,00	0,00	758,98	0,00	0,00	0,00	0,00
Jul-94	18,42	128,93	0,00	0,00	828,85	0,00	18,42	0,00	18,42
Aug-94	0,00	11,29	7,53	0,00	131,75	0,00	22,58	0,00	7,53
Aug-94	18,36	18,36	18,36	0,00	394,77	0,00	0,00	0,00	0,00
Sept-94	0,00	8,39	0,00	0,00	142,61	0,00	8,39	0,00	0,00
Sept-94	0,00	30,66	0,00	0,00	229,92	0,00	61,31	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	281,58	44,46	44,46	0,00	29,64
Oct-94	0,00	0,00	0,00	0,00	304,21	0,00	45,63	0,00	15,21
Nov-94	0,00	0,00	0,00	0,00	342,02	0,00	192,39	0,00	0,00
Nov-94	0,00	0,00	6,16	0,00	117,10	0,00	58,55	0,00	0,00
Dec-94	0,00	47,66	0,00	0,00	257,36	0,00	19,06	0,00	0,00
Dec-94	10,00	20,00	0,00	0,00	142,54	0,00	49,99	0,00	20,00
Jan-95	0,00	0,00	0,00	0,00	201,30	0,00	23,92	0,00	35,88
Jan-95	0,00	0,00	0,00	0,00	273,69	0,00	47,60	0,00	0,00
Feb-95	32,32	193,92	0,00	0,00	678,71	0,00	0,00	0,00	32,32
Feb-95	65,21	97,81	0,00	0,00	572,40	0,00	65,21	0,00	32,60
Mar-95	11,14	55,71	0,00	0,00	551,48	0,00	22,28	0,00	11,14
Mar-95	34,18	102,54	0,00	0,00	683,61	0,00	0,00	0,00	34,18
Apr-95	0,00	57,62	0,00	0,00	299,64	0,00	92,20	0,00	23,05
Apr-95	0,00	0,00	0,00	0,00	586,96	0,00	0,00	0,00	0,00
May-95	0,00	245,95	0,00	0,00	715,49	0,00	0,00	0,00	0,00
May-95	13,81	18,41	9,21	0,00	92,07	0,00	9,21	0,00	13,81
Jun-95	0,00	16,38	0,00	0,00	155,64	0,00	49,15	0,00	16,38
Jun-95	0,00	10,48	0,00	0,00	235,88	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	85,45	0,00	33,08	0,00	8,27
Jul-95	0,00	0,00	18,00	0,00	221,95	35,99	35,99	0,00	35,99
Aug-95	18,40	18,40	18,40	0,00	138,00	0,00	36,80	0,00	18,40

Date	*Paracomesoma*	*Paracanthonchus*	*Paralinhomeus*	*Paracyatholaimus*	*Parasphaerolaimus*	*Paramonohystera*	*Paraxystomina*
Jun-94	707,88	18,88	0,00	18,88	0,00	141,58	0,00
Jul-94	299,60	0,00	39,95	0,00	0,00	1198,39	0,00
Jul-94	924,01	0,00	0,00	18,42	0,00	82,89	0,00
Aug-94	158,09	7,53	7,53	7,53	0,00	188,21	0,00
Aug-94	495,76	0,00	0,00	18,36	0,00	91,81	0,00
Sept-94	25,17	0,00	0,00	8,39	0,00	137,02	0,00
Sept-94	536,48	30,66	30,66	91,97	0,00	137,95	0,00
Oct-94	44,46	37,05	0,00	148,20	0,00	155,61	0,00
Oct-94	91,26	0,00	0,00	106,47	0,00	144,50	0,00
Nov-94	566,48	32,06	0,00	192,39	0,00	320,65	0,00
Nov-94	12,33	0,00	0,00	30,81	0,00	24,65	0,00
Dec-94	438,47	57,19	0,00	95,32	0,00	428,94	0,00
Dec-94	267,46	69,99	0,00	43,33	0,00	69,99	0,00
Jan-95	77,73	83,71	0,00	83,71	0,00	155,46	0,00
Jan-95	773,48	47,60	0,00	119,00	0,00	285,59	0,00
Feb-95	1389,74	0,00	0,00	64,64	0,00	403,99	0,00
Feb-95	1206,38	91,29	32,60	97,81	0,00	451,03	0,00
Mar-95	440,07	55,71	0,00	22,28	0,00	66,85	0,00
Mar-95	1401,40	136,72	34,18	68,36	0,00	34,18	0,00
Apr-95	507,08	80,67	0,00	92,20	0,00	103,72	0,00
Apr-95	60,20	30,10	0,00	30,10	0,00	142,98	0,00
May-95	1721,64	44,72	0,00	0,00	0,00	67,08	0,00
May-95	82,86	0,00	0,00	27,62	0,00	78,26	0,00
Jun-95	49,15	32,77	0,00	81,92	0,00	393,20	0,00
Jun-95	110,08	36,69	0,00	20,97	0,00	167,74	0,00
Jul-95	41,35	24,81	8,27	16,54	0,00	126,80	0,00
Jul-95	125,97	29,99	71,99	53,99	0,00	62,99	0,00
Aug-95	73,60	36,80	55,20	18,40	0,00	184,00	0,00

Station A - Nematoda Genera Densities (individuals 10 cm^{-2}) (0-3 cm depth)

Date	*Halaphanolaimus*	*Halalaimus*	*Leptolaimus*	*Linhomoeus*	*Megadesmolaimus*	*Metachromadora remanei*	*Metadesmolaimus*	*Metalinhomoeus*
Jun-94	0,00	0,00	0,00	74,81	0,00	68,01	0,00	13,60
Jul-94	0,00	0,00	0,00	149,39	0,00	80,44	0,00	0,00
Jul-94	0,00	13,50	13,50	47,24	0,00	20,25	0,00	13,50
Aug-94	0,00	0,00	0,00	99,37	22,08	33,12	0,00	88,33
Aug-94	0,00	0,00	0,00	47,95	0,00	0,00	0,00	0,00
Sept-94	0,00	19,35	0,00	125,80	0,00	58,06	0,00	193,54
Sept-94	0,00	0,00	0,00	49,19	0,00	14,05	0,00	14,05
Oct-94	0,00	0,00	0,00	48,71	0,00	13,92	0,00	0,00
Oct-94	0,00	0,00	0,00	59,36	0,00	29,68	0,00	0,00
Nov-94	0,00	25,87	0,00	77,61	0,00	25,87	0,00	0,00
Nov-94	0,00	0,00	0,00	78,56	0,00	22,45	0,00	0,00
Dec-94	0,00	0,00	0,00	126,67	22,03	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	110,55	15,79	0,00	0,00	0,00
Jan-95	0,00	29,49	0,00	58,98	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	24,34	48,68	24,34	0,00	0,00	0,00
Feb-95	0,00	0,00	26,96	134,80	26,96	80,88	0,00	0,00
Feb-95	0,00	0,00	0,00	112,98	0,00	67,79	0,00	22,60
Mar-95	0,00	0,00	0,00	168,16	25,87	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	29,33	14,67	14,67	0,00	14,67
Apr-95	0,00	0,00	0,00	60,69	0,00	0,00	0,00	0,00
Apr-95	0,00	24,04	0,00	18,03	24,04	0,00	0,00	0,00
May-95	0,00	0,00	0,00	11,93	11,93	0,00	0,00	0,00
May-95	0,00	0,00	0,00	20,95	13,97	0,00	0,00	13,97
Jun-95	0,00	0,00	0,00	14,04	8,43	0,00	0,00	2,81
Jun-95	0,00	0,00	0,00	15,67	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	19,82	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	13,80	13,80	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	47,38	5,26	0,00	0,00	5,26

Date	*Microlaimus*	*Molgolaimus*	*Nemanema*	*Neochromadora*	*Odonthophora*	*Odontanticoma*	*Oncholaimellus*	*Onchium*	*Oxystomina*
Jun-94	0,00	13,60	0,00	13,60	217,64	0,00	0,00	27,20	0,00
Jul-94	0,00	0,00	0,00	0,00	723,95	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	391,44	0,00	53,99	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	386,45	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	172,61	0,00	0,00	0,00	0,00
Sept-94	0,00	19,35	0,00	0,00	212,89	0,00	38,71	0,00	58,06
Sept-94	0,00	0,00	14,05	0,00	224,86	0,00	28,11	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	257,48	0,00	13,92	0,00	0,00
Oct-94	29,68	0,00	0,00	0,00	445,18	0,00	0,00	0,00	0,00
Nov-94	25,87	51,74	0,00	0,00	530,32	51,74	25,87	0,00	51,74
Nov-94	0,00	0,00	0,00	0,00	291,80	89,79	101,01	0,00	0,00
Dec-94	0,00	11,01	0,00	0,00	55,07	0,00	0,00	0,00	0,00
Dec-94	0,00	23,69	0,00	0,00	189,52	0,00	0,00	0,00	15,79
Jan-95	0,00	29,49	0,00	0,00	575,07	0,00	0,00	0,00	29,49
Jan-95	0,00	24,34	0,00	0,00	328,62	0,00	24,34	0,00	0,00
Feb-95	0,00	53,92	0,00	0,00	444,84	0,00	26,96	0,00	26,96
Feb-95	0,00	22,60	0,00	0,00	305,05	0,00	0,00	0,00	0,00
Mar-95	0,00	51,74	0,00	0,00	413,92	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	14,67	234,66	0,00	14,67	0,00	0,00
Apr-95	8,09	16,18	0,00	0,00	93,06	0,00	8,09	0,00	8,09
Apr-95	0,00	0,00	12,02	0,00	138,26	0,00	0,00	0,00	12,02
May-95	11,93	0,00	0,00	0,00	304,21	0,00	35,79	0,00	0,00
May-95	0,00	0,00	0,00	0,00	293,32	0,00	13,97	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	51,95	0,00	0,00	5,62	0,00
Jun-95	0,00	0,00	0,00	0,00	54,84	0,00	15,67	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	27,75	25,77	0,00	0,00	3,96
Jul-95	0,00	0,00	0,00	0,00	65,53	0,00	0,00	0,00	6,90
Aug-95	0,00	0,00	0,00	0,00	31,59	0,00	0,00	0,00	0,00

Date	*Paracomesoma*	*Paracanthonchus*	*Paralinhomeus*	*Paracyatholaimus*	*Parasphaerolaimus*	*Paramonohystera*	*Paraxystomina*
Jun-94	591,70	0,00	40,81	0,00	0,00	0,00	0,00
Jul-94	390,70	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	452,18	0,00	0,00	13,50	0,00	0,00	0,00
Aug-94	717,69	0,00	22,08	110,41	0,00	0,00	0,00
Aug-94	690,44	0,00	0,00	19,18	0,00	0,00	0,00
Sept-94	290,31	0,00	0,00	29,03	0,00	0,00	0,00
Sept-94	527,01	0,00	0,00	28,11	0,00	0,00	0,00
Oct-94	431,46	0,00	13,92	27,84	0,00	13,92	0,00
Oct-94	786,48	0,00	0,00	59,36	29,68	0,00	0,00
Nov-94	633,80	0,00	0,00	25,87	0,00	0,00	0,00
Nov-94	336,70	33,67	0,00	44,89	0,00	0,00	0,00
Dec-94	137,68	0,00	0,00	66,09	0,00	0,00	0,00
Dec-94	236,90	0,00	31,59	15,79	0,00	15,79	0,00
Jan-95	796,25	29,49	0,00	88,47	0,00	29,49	0,00
Jan-95	377,31	0,00	24,34	0,00	0,00	48,68	0,00
Feb-95	390,92	0,00	0,00	202,20	0,00	26,96	0,00
Feb-95	610,10	0,00	0,00	146,88	0,00	0,00	0,00
Mar-95	672,63	0,00	0,00	116,42	0,00	0,00	0,00
Mar-95	439,99	0,00	14,67	95,33	0,00	0,00	0,00
Apr-95	84,97	8,09	0,00	72,83	0,00	0,00	0,00
Apr-95	284,49	0,00	24,04	18,03	0,00	0,00	0,00
May-95	244,56	0,00	0,00	17,89	0,00	0,00	0,00
May-95	405,06	0,00	0,00	20,95	0,00	0,00	0,00
Jun-95	84,25	0,00	30,89	2,81	0,00	0,00	0,00
Jun-95	0,00	7,83	0,00	0,00	0,00	0,00	0,00
Jul-95	31,72	0,00	0,00	7,93	0,00	0,00	0,00
Jul-95	17,24	0,00	0,00	6,90	0,00	6,90	0,00
Aug-95	21,06	0,00	0,00	5,26	0,00	5,26	0,00

Station A - Nematoda Genera Densities (individuals $10cm^{-2}$) (0-3 cm depth)

Date	Acanthopharynx	*Anticomopsis*	*Anticoma*	*Antomicron*	*Atrochromodora*	*Aponema*	*Bathylaimus*	*Calyptoromena*
Jun-94	0,00	0,00	0,00	0,00	13,60	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	22,98	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	27,00	80,99	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	22,08	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	19,18	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	38,71	154,83
Sept-94	0,00	0,00	14,05	0,00	0,00	21,08	14,05	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	29,68	0,00
Nov-94	0,00	0,00	38,80	0,00	0,00	25,87	155,22	0,00
Nov-94	0,00	0,00	67,34	0,00	0,00	0,00	44,89	0,00
Dec-94	0,00	0,00	49,57	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	31,59	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	24,34	0,00	0,00	24,34	24,34	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	26,96	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	22,60	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	51,74	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	14,67	0,00	0,00
Apr-95	0,00	0,00	16,18	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	11,93	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	13,97	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	31,34	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	9,91	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	10,35	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Date	*aff Cervonema*	*Chromaspirina*	*Chromadora*	*Chromadora nudicapitata*	*Chromadorina*	*Chromadorina germanica*	*Chromadora macrolaima*	*Chromadorella*	*Chromadorella duopapillata*
Jun-94	0,00	0,00	13,60	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	22,98	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	13,50
Aug-94	0,00	0,00	0,00	22,08	22,08	0,00	0,00	0,00	121,46
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	19,18
Sept-94	19,35	0,00	0,00	0,00	0,00	0,00	0,00	0,00	116,12
Sept-94	0,00	0,00	0,00	14,05	0,00	0,00	0,00	0,00	119,46
Oct-94	0,00	0,00	0,00	90,47	0,00	0,00	0,00	0,00	90,47
Oct-94	0,00	0,00	0,00	0,00	29,68	148,39	0,00	29,68	207,75
Nov-94	0,00	0,00	0,00	0,00	0,00	25,87	0,00	0,00	129,35
Nov-94	0,00	0,00	0,00	22,45	0,00	67,34	0,00	0,00	594,83
Dec-94	0,00	0,00	0,00	198,26	0,00	170,73	0,00	0,00	82,61
Dec-94	0,00	0,00	0,00	15,79	0,00	63,17	31,59	0,00	63,17
Jan-95	0,00	0,00	0,00	0,00	0,00	117,96	29,49	0,00	176,94
Jan-95	0,00	0,00	24,34	133,88	121,71	133,88	0,00	0,00	121,71
Feb-95	0,00	0,00	0,00	134,80	0,00	67,40	26,96	0,00	40,44
Feb-95	0,00	0,00	0,00	90,38	0,00	56,49	22,60	0,00	33,89
Mar-95	0,00	0,00	0,00	0,00	0,00	25,87	25,87	0,00	64,68
Mar-95	0,00	14,67	58,67	51,33	0,00	0,00	0,00	29,33	22,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	8,09	0,00	8,09
Apr-95	0,00	12,02	24,04	12,02	0,00	0,00	12,02	0,00	0,00
May-95	0,00	0,00	11,93	0,00	0,00	0,00	11,93	0,00	11,93
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	13,97
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	14,04
Jun-95	0,00	0,00	0,00	7,83	0,00	7,83	0,00	0,00	70,51
Jul-95	0,00	0,00	0,00	15,86	0,00	0,00	0,00	0,00	15,86
Jul-95	0,00	0,00	0,00	68,98	0,00	6,90	0,00	0,00	51,73
Aug-95	0,00	0,00	0,00	5,26	0,00	0,00	0,00	0,00	7,90

Date	*Camacolaimus*	*Campylaimus*	*Cyartonema*	*Daptonema*	*Desmodora*	*Desmolaimus*	*Diodontolaimus*	*Eleutherolaimus*	*Eurystomina*
Jun-94	0,00	0,00	0,00	156,43	0,00	27,20	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	68,95	0,00	0,00	0,00	45,96	0,00
Jul-94	0,00	0,00	0,00	67,49	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	44,17	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	19,18	0,00	47,95	0,00	0,00	0,00	0,00	19,18
Sept-94	0,00	0,00	135,48	0,00	0,00	0,00	0,00	0,00	19,35
Sept-94	14,05	0,00	0,00	21,08	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	20,88	0,00	0,00	0,00	0,00	0,00
Oct-94	29,68	0,00	0,00	29,68	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	25,87	0,00	25,87	0,00	0,00	0,00	0,00	0,00
Nov-94	22,45	22,45	0,00	67,34	0,00	0,00	0,00	0,00	0,00
Dec-94	11,01	0,00	0,00	44,06	0,00	0,00	0,00	0,00	0,00
Dec-94	47,38	31,59	0,00	23,69	0,00	0,00	31,59	0,00	0,00
Jan-95	88,47	0,00	0,00	235,92	0,00	0,00	29,49	0,00	0,00
Jan-95	24,34	24,34	0,00	158,22	0,00	0,00	24,34	0,00	0,00
Feb-95	26,96	0,00	0,00	161,76	0,00	0,00	26,96	0,00	0,00
Feb-95	0,00	90,38	0,00	112,98	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	25,87	0,00	206,96	0,00	0,00	0,00	0,00	25,87
Mar-95	0,00	0,00	0,00	73,33	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	16,18	0,00	153,76	0,00	0,00	16,18	0,00	0,00
Apr-95	0,00	0,00	0,00	84,16	0,00	0,00	0,00	0,00	12,02
May-95	0,00	11,93	0,00	65,61	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	62,85	0,00	0,00	0,00	0,00	0,00
Jun-95	8,43	0,00	0,00	5,62	0,00	0,00	5,62	0,00	0,00
Jun-95	0,00	0,00	0,00	109,67	7,83	7,83	0,00	0,00	15,67
Jul-95	0,00	0,00	0,00	15,86	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	20,69	0,00	72,43	0,00	0,00	13,80	0,00	0,00
Aug-95	5,26	10,53	0,00	39,49	0,00	0,00	0,00	0,00	0,00

Station A - Nematoda Genera Densities (individuals $10cm^{-2}$) (3-6 cm depth)

Date	*Acanthopharynx*	*Anticomopsis*	*Anticoma*	*Antomicron*	*Atrochromadora*	*Aponema*	*Bathylaimus*	*Calyptronema*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	8,54	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	3,02	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	18,43	3,95	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	13,34	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	4,02	0,00
Sept-94	0,00	0,00	1,88	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	3,35	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	4,26	0,00
Nov-94	2,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	5,34	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	2,30	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	3,54	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	3,31	0,00
Mar-95	0,00	0,00	3,16	3,16	0,00	0,00	3,16	0,00
Apr-95	0,00	0,00	33,61	0,00	0,00	5,60	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	28,44	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	4,27	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	4,35	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	8,67	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,96	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	5,85	0,00	0,00	0,00	0,00	0,00

Date	*aff Cervonema*	*Chromaspirina*	*Chromadora*	*Chromadora nudicapitata*	*Chromadorina*	*Chromadorina germanica*	*Chromadora macrolaima*	*Chromadorella*	*Chromadorella duopapillata*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	6,04	0,00	6,04	3,02	0,00	6,04
Jul-94	0,00	0,00	0,00	13,16	0,00	2,63	0,00	0,00	3,95
Aug-94	0,00	0,00	0,00	0,00	0,00	4,16	0,00	0,00	12,47
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	18,68
Sept-94	0,00	0,00	0,00	2,01	0,00	5,03	0,00	0,00	3,02
Sept-94	0,00	0,00	0,00	1,88	0,00	2,81	0,00	0,00	1,88
Oct-94	0,00	0,00	0,00	0,00	0,00	4,92	0,00	0,00	14,77
Oct-94	0,00	0,00	0,00	8,92	0,00	0,00	2,23	0,00	8,92
Nov-94	0,00	0,00	0,00	0,00	0,00	12,79	0,00	0,00	25,57
Nov-94	0,00	0,00	0,00	0,00	0,00	14,08	0,00	0,00	32,18
Dec-94	0,00	0,00	0,00	5,34	0,00	29,38	0,00	0,00	45,41
Dec-94	0,00	0,00	0,00	4,51	0,00	13,52	0,00	0,00	2,25
Jan-95	0,00	0,00	0,00	0,00	0,00	5,90	0,00	0,00	53,13
Jan-95	0,00	0,00	2,30	2,30	0,00	9,22	0,00	0,00	6,91
Feb-95	0,00	0,00	0,00	5,31	0,00	28,33	0,00	0,00	10,63
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	29,46
Mar-95	0,00	0,00	0,00	1,65	0,00	0,00	1,65	0,00	1,65
Mar-95	0,00	0,00	0,00	0,00	0,00	3,16	9,49	0,00	6,33
Apr-95	0,00	0,00	5,60	5,60	16,81	5,60	0,00	0,00	33,61
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,90
May-95	0,00	0,00	0,00	0,00	0,00	24,89	0,00	0,00	28,44
May-95	0,00	0,00	0,00	0,00	0,00	3,74	0,00	0,00	4,27
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	9,30
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	6,50
Jul-95	0,00	0,00	0,00	0,00	0,00	0,96	0,00	0,00	1,92
Aug-95	0,00	0,00	0,00	0,00	0,00	2,92	0,00	0,00	10,23

Date	*Camacolaimus*	*Campylaimus*	*Cyartonema*	*Daptonema*	*Desmodora*	*Desmolaimus*	*Diodontolaimus*	*Eleutherolaimus*	*Eurystomina*
Jun-94	0,00	0,00	0,00	17,07	0,00	0,00	0,00	0,00	0,00
Jul-94	3,02	3,02	0,00	6,04	3,02	0,00	3,02	0,00	0,00
Jul-94	0,00	0,00	0,00	7,90	0,00	0,00	0,00	2,63	0,00
Aug-94	8,32	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	2,67	0,00	0,00	0,00	0,00	2,67
Sept-94	8,05	2,01	0,00	2,01	0,00	0,00	0,00	0,00	6,03
Sept-94	8,44	0,00	0,00	1,88	0,00	0,00	1,88	0,00	0,00
Oct-94	12,31	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,46
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,26	0,00
Nov-94	4,02	2,01	0,00	0,00	0,00	0,00	0,00	0,00	2,01
Dec-94	8,01	0,00	0,00	0,00	0,00	0,00	10,68	0,00	5,34
Dec-94	2,25	0,00	0,00	2,25	0,00	0,00	0,00	0,00	0,00
Jan-95	17,71	0,00	0,00	5,90	0,00	0,00	0,00	0,00	0,00
Jan-95	6,91	2,30	0,00	4,61	0,00	0,00	0,00	0,00	0,00
Feb-95	17,71	0,00	0,00	7,08	0,00	0,00	0,00	0,00	0,00
Feb-95	29,46	0,00	0,00	29,46	0,00	0,00	0,00	0,00	0,00
Mar-95	1,65	0,00	0,00	5,79	0,00	0,00	0,00	0,00	0,00
Mar-95	6,33	0,00	0,00	3,16	0,00	0,00	0,00	0,00	0,00
Apr-95	5,60	0,00	0,00	25,21	0,00	0,00	5,60	0,00	0,00
Apr-95	2,45	0,00	0,00	4,90	0,00	0,00	0,00	0,00	0,00
May-95	0,00	14,22	0,00	14,22	0,00	0,00	0,00	0,00	0,00
May-95	0,00	2,13	0,00	2,13	0,00	0,00	0,00	0,00	0,00
Jun-95	65,09	0,00	0,00	6,97	0,00	0,00	0,00	0,00	0,00
Jun-95	13,06	0,00	0,00	13,06	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	26,17	0,00	0,00	4,33	0,00	0,00
Jul-95	2,88	0,00	0,00	18,27	0,00	0,00	0,96	0,00	0,00
Aug-95	5,85	0,00	0,00	2,92	0,00	0,00	0,00	0,00	0,00

Station A - Nematoda Genera Densities (individuals $10cm^{-2}$) (0-3 cm depth)

Date	*Prochromadorella*	*Prochromadorella ditlevseni*	*aff Phanodermopsis*	*Ptycholaimellus*	*Spirinia*	*Sabatieria*	*Southernella*	*Southernia*	*Sphaerolaimus*
Jun-94	0,00	0,00	0,00	0,00	20,40	0,00	0,00	0,00	13,60
Jul-94	22,98	0,00	0,00	22,98	34,47	0,00	0,00	0,00	0,00
Jul-94	27,00	13,50	0,00	0,00	47,24	0,00	0,00	13,50	27,00
Aug-94	0,00	0,00	0,00	0,00	33,12	0,00	0,00	0,00	55,21
Aug-94	0,00	0,00	0,00	0,00	115,07	0,00	0,00	0,00	115,07
Sept-94	0,00	0,00	0,00	19,35	77,42	0,00	0,00	0,00	174,18
Sept-94	14,05	0,00	14,05	0,00	35,13	0,00	0,00	0,00	14,05
Oct-94	55,67	0,00	13,92	0,00	250,52	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	222,59	0,00	0,00	0,00	29,68
Nov-94	0,00	0,00	0,00	0,00	258,69	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	235,69	22,45	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	198,26	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	15,79	181,62	0,00	0,00	0,00	63,17
Jan-95	0,00	0,00	0,00	58,98	191,69	0,00	58,98	58,98	0,00
Jan-95	48,68	0,00	0,00	24,34	60,86	24,34	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	26,96	229,16	0,00	0,00	26,96	26,96
Feb-95	0,00	0,00	0,00	33,89	90,38	0,00	0,00	45,19	0,00
Mar-95	0,00	0,00	0,00	0,00	219,90	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	95,33	73,33	0,00	0,00	0,00	14,67
Apr-95	0,00	0,00	0,00	16,18	76,88	0,00	0,00	16,18	0,00
Apr-95	0,00	0,00	0,00	48,09	246,46	0,00	0,00	12,02	12,02
May-95	0,00	0,00	0,00	47,72	339,99	0,00	0,00	23,86	0,00
May-95	0,00	0,00	0,00	111,74	181,58	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	9,83	89,87	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	7,83	497,45	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	7,93	194,27	0,00	0,00	7,93	0,00
Jul-95	0,00	0,00	0,00	20,69	141,41	0,00	0,00	13,80	0,00
Aug-95	0,00	0,00	0,00	10,53	89,50	0,00	0,00	0,00	0,00

Date	Synonchiela	Thalassironus	Terschellingia	Viscosia	Wieseria
Jun-94	13,60	0,00	374,06	0,00	0,00
Jul-94	22,98	0,00	758,42	68,95	0,00
Jul-94	0,00	0,00	175,47	13,50	0,00
Aug-94	0,00	0,00	828,11	44,17	0,00
Aug-94	0,00	19,18	776,74	0,00	0,00
Sept-94	0,00	0,00	716,09	19,35	0,00
Sept-94	0,00	14,05	259,99	28,11	0,00
Oct-94	0,00	13,92	111,34	41,75	0,00
Oct-94	0,00	0,00	920,04	89,04	0,00
Nov-94	25,87	0,00	672,61	51,74	0,00
Nov-94	0,00	0,00	370,37	44,89	0,00
Dec-94	11,01	0,00	93,62	0,00	0,00
Dec-94	15,79	15,79	416,52	78,97	0,00
Jan-95	58,98	29,49	676,28	58,98	0,00
Jan-95	0,00	0,00	754,61	36,51	0,00
Feb-95	0,00	0,00	700,97	40,44	0,00
Feb-95	0,00	0,00	598,80	22,60	0,00
Mar-95	0,00	0,00	620,89	103,48	0,00
Mar-95	0,00	0,00	351,99	14,67	0,00
Apr-95	0,00	0,00	149,71	40,46	0,00
Apr-95	12,02	36,07	252,47	24,04	0,00
May-95	23,86	11,93	59,65	0,00	0,00
May-95	20,95	0,00	209,52	13,97	0,00
Jun-95	2,81	5,62	46,34	0,00	0,00
Jun-95	7,83	7,83	19,58	23,50	0,00
Jul-95	3,96	0,00	27,75	47,58	3,96
Jul-95	0,00	27,59	100,02	82,77	0,00
Aug-95	0,00	15,79	31,59	189,53	0,00

Station A - Nematoda Genera Densities (individuals $10cm^{-2}$) (3-6 cm depth)

Date	*Halaphanolaimus*	*Halalaimus*	*Leptolaimus*	*Linhomoeus*	*Megadesmolaimus*	*Metachromadora*	*Metadesmolaimus*	*Metalinhomoeus*
Jun-94	0,00	8,54	0,00	38,42	0,00	17,07	0,00	0,00
Jul-94	0,00	0,00	0,00	6,04	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	9,22	0,00	2,63	0,00	0,00
Aug-94	0,00	0,00	0,00	12,47	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	2,67	0,00	0,00	0,00	0,00
Sept-94	0,00	2,01	0,00	4,02	2,01	4,02	0,00	6,03
Sept-94	0,00	0,00	0,00	7,50	0,00	0,00	0,00	1,88
Oct-94	0,00	0,00	0,00	19,70	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	4,46	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	17,05	0,00	4,26	0,00	0,00
Nov-94	0,00	2,01	0,00	2,01	0,00	0,00	0,00	0,00
Dec-94	0,00	5,34	0,00	82,80	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	10,14	2,25	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	20,66	5,90	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	6,91	0,00	0,00	4,61
Feb-95	0,00	0,00	0,00	0,00	3,54	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	36,83	29,46	14,73	0,00	0,00
Mar-95	0,00	0,00	0,00	3,31	1,65	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	4,75	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	19,61	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	13,48	2,45	0,00	0,00	0,00
May-95	0,00	0,00	0,00	60,44	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	9,07	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	18,60	4,65	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	21,77	0,00	0,00	0,00	0,00
Jul-95	0,00	4,33	0,00	10,83	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	2,88	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	27,77	0,00	0,00	0,00	0,00

Date	*Microlaimus*	*Molgolaimus*	*Nemanema*	*Neochromadora*	*Odonthophora*	*Odontanticoma*	*Oncholaimellus*	*Onchium*	*Oxystomina*
Jun-94	0,00	8,54	0,00	0,00	68,29	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	40,78	0,00	0,00	0,00	3,02
Jul-94	0,00	2,63	0,00	0,00	34,23	0,00	7,90	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	12,47	0,00	4,16	0,00	0,00
Aug-94	0,00	8,00	0,00	0,00	25,35	0,00	8,00	0,00	0,00
Sept-94	2,01	4,02	0,00	0,00	15,08	0,00	2,01	0,00	2,01
Sept-94	0,00	0,00	0,00	0,00	6,56	0,00	1,88	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	14,77	0,00	9,85	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	18,96	0,00	2,23	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	27,71	8,52	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	2,01	2,01	6,03	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	5,34	0,00	0,00	0,00	0,00
Dec-94	0,00	2,25	0,00	0,00	5,63	0,00	2,25	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	32,47	0,00	5,90	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	4,61	0,00	2,30	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	5,31	0,00	3,54	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	103,12	0,00	0,00	0,00	14,73
Mar-95	0,00	3,31	0,00	0,00	11,58	0,00	1,65	0,00	0,00
Mar-95	0,00	3,16	0,00	0,00	20,57	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	30,81	0,00	28,01	0,00	0,00
Apr-95	0,00	2,45	0,00	0,00	19,61	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	67,55	0,00	7,11	0,00	7,11
May-95	0,00	0,00	0,00	0,00	10,14	0,00	1,07	0,00	1,07
Jun-95	0,00	0,00	0,00	0,00	25,57	0,00	0,00	0,00	0,00
Jun-95	0,00	4,35	0,00	0,00	32,66	0,00	0,00	0,00	4,35
Jul-95	0,00	0,00	0,00	0,00	10,83	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	3,85	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	5,85	0,00	2,92	0,00	0,00

Date	*Paracomesoma*	*Paracanthonchus*	*Paralinhomeus*	*Paracyatholaimus*	*Parasphaerolaimus*	*Paramonohystera*	*Paraxystomina*
Jun-94	98,17	17,07	0,00	0,00	0,00	0,00	0,00
Jul-94	33,23	0,00	0,00	3,02	0,00	9,06	0,00
Jul-94	34,23	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	16,63	0,00	0,00	8,32	0,00	0,00	0,00
Aug-94	21,35	0,00	0,00	2,67	0,00	0,00	0,00
Sept-94	8,05	0,00	0,00	10,06	0,00	0,00	0,00
Sept-94	16,88	0,00	3,75	1,88	0,00	2,81	0,00
Oct-94	32,01	0,00	24,62	0,00	0,00	14,77	0,00
Oct-94	8,92	0,00	0,00	2,23	0,00	35,69	0,00
Nov-94	29,84	4,26	4,26	4,26	0,00	10,66	0,00
Nov-94	3,02	2,01	0,00	2,01	0,00	2,01	0,00
Dec-94	5,34	5,34	0,00	5,34	0,00	0,00	0,00
Dec-94	16,90	0,00	0,00	4,51	0,00	0,00	0,00
Jan-95	70,84	0,00	0,00	0,00	0,00	17,71	0,00
Jan-95	35,71	0,00	2,30	6,91	0,00	9,22	0,00
Feb-95	12,40	0,00	0,00	3,54	0,00	3,54	0,00
Feb-95	419,86	14,73	0,00	44,20	0,00	22,10	0,00
Mar-95	34,74	1,65	0,00	4,96	0,00	1,65	0,00
Mar-95	37,97	14,24	0,00	0,00	0,00	9,49	0,00
Apr-95	28,01	22,41	11,20	0,00	0,00	11,20	0,00
Apr-95	23,29	4,90	0,00	0,00	0,00	26,96	0,00
May-95	17,78	7,11	0,00	0,00	0,00	10,67	0,00
May-95	2,67	1,07	0,00	0,00	0,00	1,60	0,00
Jun-95	37,19	0,00	0,00	0,00	0,00	13,95	0,00
Jun-95	32,66	0,00	0,00	0,00	0,00	15,24	0,00
Jul-95	13,00	0,00	0,00	0,00	0,00	43,33	0,00
Jul-95	0,00	0,00	0,00	1,92	0,00	3,37	0,00
Aug-95	2,92	0,00	0,00	0,00	0,00	20,46	0,00

Station A - Nematoda Genera Densities (individuals $10cm^{-2}$) (3-6 cm depth)

Date	*Prochromadorella*	*Prochromadorella ditlevseni*	*aff Phanodermopsis*	*Ptycholaimellus*	*Spirinia*	*Sabatieria*	*Southernella*	*Southernia*	*Sphaerolaimus*
Jun-94	0,00	0,00	0,00	0,00	8,54	0,00	0,00	0,00	17,07
Jul-94	0,00	0,00	0,00	0,00	3,02	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	5,27	0,00	0,00	0,00	2,63
Aug-94	0,00	0,00	0,00	0,00	4,16	0,00	0,00	4,16	0,00
Aug-94	0,00	0,00	0,00	0,00	5,34	0,00	0,00	2,67	0,00
Sept-94	0,00	0,00	0,00	0,00	6,03	0,00	0,00	2,01	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,69	0,00
Oct-94	0,00	0,00	0,00	0,00	9,85	4,92	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	8,92	0,00	0,00	2,23	0,00
Nov-94	0,00	0,00	0,00	0,00	12,79	0,00	0,00	4,26	4,26
Nov-94	0,00	0,00	0,00	0,00	5,03	2,01	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	29,38	5,34	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	4,51	6,76	0,00	0,00	0,00	2,25
Jan-95	0,00	0,00	0,00	5,90	41,32	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	2,30	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	10,63	0,00	0,00	3,54	0,00
Feb-95	0,00	0,00	0,00	14,73	0,00	0,00	0,00	14,73	0,00
Mar-95	0,00	0,00	0,00	4,96	1,65	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	11,08	9,49	0,00	0,00	0,00	3,16
Apr-95	0,00	0,00	0,00	28,01	30,81	5,60	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	3,68	18,38	0,00	0,00	2,45	0,00
May-95	0,00	0,00	0,00	21,33	56,89	0,00	7,11	0,00	0,00
May-95	0,00	0,00	0,00	3,20	8,54	0,00	1,07	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	37,19	0,00	0,00	9,30	0,00
Jun-95	4,35	0,00	0,00	4,35	34,84	0,00	0,00	4,35	0,00
Jul-95	0,00	0,00	0,00	0,00	119,17	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	5,29	5,77	0,00	8,65	0,00
Aug-95	0,00	0,00	0,00	2,92	14,62	0,00	0,00	8,77	0,00

Date	*Synonchiella*	*Thalassironus*	*Terschellingia*	*Viscosia*	*Wieseria*
Jun-94	85,37	0,00	76,83	0,00	0,00
Jul-94	0,00	0,00	30,21	0,00	0,00
Jul-94	0,00	10,53	13,16	0,00	0,00
Aug-94	0,00	0,00	22,87	0,00	0,00
Aug-94	0,00	0,00	50,69	0,00	0,00
Sept-94	2,01	0,00	16,09	0,00	0,00
Sept-94	1,88	0,00	14,06	0,00	0,00
Oct-94	7,39	39,40	22,16	4,92	0,00
Oct-94	2,23	0,00	27,89	0,00	0,00
Nov-94	0,00	0,00	61,81	0,00	0,00
Nov-94	0,00	0,00	12,07	2,01	0,00
Dec-94	5,34	5,34	29,38	5,34	0,00
Dec-94	0,00	0,00	48,44	2,25	0,00
Jan-95	14,76	0,00	59,03	17,71	0,00
Jan-95	2,30	0,00	17,28	0,00	0,00
Feb-95	0,00	0,00	77,92	3,54	0,00
Feb-95	0,00	0,00	51,56	0,00	0,00
Mar-95	0,00	3,31	10,75	0,00	0,00
Mar-95	0,00	0,00	11,08	6,33	0,00
Apr-95	5,60	0,00	25,21	5,60	0,00
Apr-95	0,00	4,90	9,80	0,00	0,00
May-95	0,00	7,11	35,55	0,00	0,00
May-95	0,00	1,07	5,34	0,00	0,00
Jun-95	0,00	0,00	88,33	4,65	0,00
Jun-95	4,35	8,71	15,24	21,77	0,00
Jul-95	4,33	10,83	8,67	8,67	0,00
Jul-95	0,00	1,92	2,88	0,96	0,00
Aug-95	5,85	20,46	8,77	16,08	0,00

Station A - Nematoda Genera Densities (individuals 10cm^{-2}) (6-10 cm depth)

Date	*Acanthopharynx*	*Anticomopsis*	*Anticoma*	*Antomicron*	*Atrochromadora*	*Aponema*	*Bathylaimus*	*Calyptronema*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	6,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	4,38	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	3,02	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	6,27	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	10,89	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	2,62	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	32,78	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	4,89	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	13,73	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	1,87	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	4,97	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	7,69	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	1,47	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Date	*affCervonema*	*Chromaspirina*	*Chromadora*	*Chro.nudicapitata*	*Chromadorina*	*C. germanica*	*C. macrolaima*	*Chromadorella*	*Chromadorella duopapillata*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	11,99
Aug-94	0,00	0,00	0,00	0,00	0,00	4,38	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	8,35	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	1,86	0,00	0,00	2,79
Oct-94	0,00	0,00	0,00	0,00	0,00	6,05	0,00	0,00	9,07
Oct-94	0,00	0,00	0,00	12,53	0,00	6,27	0,00	0,00	12,53
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	11,15
Nov-94	0,00	0,00	0,00	32,66	0,00	0,00	0,00	0,00	48,99
Dec-94	0,00	0,00	0,00	1,93	0,00	3,87	0,00	0,00	5,80
Dec-94	0,00	0,00	0,00	0,00	0,00	5,18	0,00	0,00	2,59
Jan-95	0,00	0,00	0,00	0,00	0,00	6,84	0,00	0,00	13,67
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	10,50
Feb-95	0,00	0,00	0,00	3,52	0,00	1,76	0,00	0,00	1,76
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,44
Mar-95	0,00	0,00	0,00	16,01	0,00	16,01	16,01	0,00	16,01
Apr-95	0,00	0,00	0,00	0,00	0,00	6,87	6,87	0,00	27,47
Apr-95	0,00	0,00	0,00	2,03	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3,73
May-95	0,00	0,00	0,00	0,50	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	19,87
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	46,14
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	1,47	0,00	0,00	0,00	0,00	1,47

Date	*Camacolaimus*	*Campylaimus*	*Cyartonema*	*Daptonema*	*Desmodora*	*Desmolaimus*	*Diodontolaimus*	*Eleutherolaimus*	*Eurystomina*
Jun-94	0,00	0,00	0,00	11,05	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	6,24	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	8,76	0,00	0,00	4,38	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	16,71	0,00	0,00	0,00	8,35	0,00
Sept-94	2,88	0,00	0,00	0,00	0,00	0,00	0,00	1,44	1,44
Sept-94	2,79	0,00	0,00	1,86	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	6,27	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	10,89	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	1,93	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	2,59	0,00	0,00	0,00	0,00	0,00
Jan-95	6,84	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	15,75	0,00	0,00	0,00	0,00	0,00	2,62	0,00	0,00
Feb-95	2,64	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	32,78	0,00	65,57	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	2,44	0,00	0,00	0,00	0,00	0,00
Mar-95	32,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	10,30	0,00	0,00	0,00	0,00	0,00
Apr-95	3,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	1,87	0,00	0,00	0,00	0,00	0,00
May-95	2,00	0,00	0,00	0,50	0,00	0,00	0,00	0,00	0,00
Jun-95	14,91	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	1,00	0,00	0,00	0,00	0,00	0,00
Jul-95	1,47	0,00	0,00	2,20	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	4,08	0,00	0,00	0,00	0,00	0,00

Station A - Nematoda Genera Densities (individuals $10cm^{-2}$) (6-10cm depth)

Date	*Halaphanolaimus*	*Halalaimus*	*Leptolaimus*	*Linhomoeus*	*Megadesmolaimus*	*Metachromadora remanei*	*Metadesmolaimus*	*Metalinhomoeus*
Jun-94	0,00	0,00	0,00	14,73	0,00	3,68	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	6,00	0,00	6,00	0,00	11,99	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	1,44	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	6,27	0,00	12,53	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	5,57	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	10,89	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	1,93	2,90	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	2,59	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	27,34	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	2,62	7,87	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	2,64	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	32,78	32,78	32,78	0,00	0,00
Mar-95	0,00	0,00	0,00	2,44	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	16,01	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	20,60	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	7,09	4,05	0,00	0,00	0,00
May-95	0,00	0,00	0,00	1,87	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	2,50	0,50	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	1,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Date	Microlaimus	*Molgolaimus*	*Nemanema*	*Neochromadora*	*Odonthophora*	*Odontanticoma*	*Oncholaimellus*	*Onchium*	*Oxystomina*
Jun-94	0,00	3,68	0,00	3,68	3,68	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	14,05	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	17,99	0,00	11,99	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	8,76	0,00	4,38	0,00	0,00
Aug-94	0,00	8,35	0,00	0,00	54,30	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	2,88	0,00	4,32	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	9,30	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	10,58	0,00	0,00	0,00	3,02
Oct-94	0,00	0,00	0,00	0,00	6,27	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	19,51	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	21,77	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	1,93	0,00	1,93	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	2,59	0,00	5,18	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	5,25	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	5,27	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	180,32	0,00	0,00	0,00	0,00
Mar-95	0,00	2,44	0,00	0,00	8,56	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	64,05	0,00	32,03	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	13,73	0,00	6,87	0,00	0,00
Apr-95	0,00	4,05	0,00	0,00	6,08	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	8,40	0,00	0,00	0,00	1,87
May-95	0,00	0,00	0,00	0,00	2,50	0,00	0,50	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	24,84	0,00	4,97	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	38,45	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	1,00	0,00	4,02	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	1,47	0,00	0,00
Aug-95	0,00	4,08	0,00	0,00	8,16	0,00	0,00	0,00	0,00

Date	Paracomesoma	*Paracanthonchus*	*Paralinhomeus*	*Paracyatholaimus*	*Parasphaerolaimus*	*Paramonohystera*	*Paraxystomina*
Jun-94	7,36	0,00	0,00	0,00	0,00	3,68	3,68
Jul-94	7,61	0,00	0,00	0,00	0,00	3,12	0,00
Jul-94	38,98	6,00	0,00	0,00	0,00	0,00	0,00
Aug-94	21,90	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	66,84	0,00	0,00	8,35	0,00	0,00	0,00
Sept-94	7,20	0,00	0,00	0,00	0,00	2,88	0,00
Sept-94	11,17	0,00	0,00	1,86	0,00	0,00	0,00
Oct-94	9,07	0,00	0,00	9,07	0,00	9,07	0,00
Oct-94	37,59	0,00	0,00	6,27	0,00	0,00	0,00
Nov-94	27,87	0,00	0,00	0,00	0,00	5,57	0,00
Nov-94	16,33	0,00	0,00	32,66	0,00	0,00	0,00
Dec-94	1,93	0,00	0,00	0,00	0,00	5,80	0,00
Dec-94	7,78	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	27,34	0,00	0,00	0,00	0,00	47,85	0,00
Jan-95	6,56	0,00	0,00	0,00	0,00	2,62	0,00
Feb-95	7,03	0,00	0,00	0,00	0,00	1,76	0,00
Feb-95	98,35	0,00	0,00	65,57	0,00	32,78	0,00
Mar-95	4,89	2,44	0,00	7,33	0,00	4,89	0,00
Mar-95	80,06	80,06	0,00	16,01	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	34,34	0,00	6,87	0,00
Apr-95	3,04	0,00	0,00	0,00	0,00	12,15	0,00
May-95	7,47	1,87	0,00	3,73	0,00	1,87	0,00
May-95	4,99	0,00	0,00	0,00	0,00	8,49	0,00
Jun-95	22,36	0,00	0,00	0,00	0,00	39,75	0,00
Jun-95	0,00	7,69	0,00	0,00	0,00	76,90	0,00
Jul-95	0,00	0,00	0,00	1,00	0,00	1,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	10,26	0,00
Aug-95	4,08	0,00	0,00	0,00	0,00	0,00	0,00

Station A - Nematoda Genera Densities (individuals $10cm^{-2}$) (6-10 cm depth)

Date	*Prochromadorella*	*Prochromadorella ditlevseni*	*aff Phanodermopsis*	*Ptycholaimellus*	*Spirinia*	*Sabatieria*	*Southernella*	*Southernia*	*Sphaerolaimus*
Jun-94	0,00	0,00	0,00	0,00	3,68	0,00	0,00	3,68	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	17,99	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	8,35	8,35	0,00	0,00	8,35	0,00
Sept-94	0,00	0,00	0,00	1,44	1,44	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	1,86	0,00	0,00	3,72	0,00
Oct-94	0,00	0,00	0,00	3,02	3,02	0,00	0,00	3,02	0,00
Oct-94	0,00	0,00	0,00	12,53	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	5,57	0,00	0,00	5,57	0,00
Nov-94	0,00	0,00	0,00	0,00	16,33	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	5,80	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,59	2,59
Jan-95	0,00	0,00	0,00	0,00	13,67	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	2,62	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	10,55	0,00	0,00	10,55	0,00
Feb-95	0,00	0,00	0,00	0,00	131,14	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	2,44	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	24,02	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	10,30	13,73	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	4,67	8,40	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	1,25	0,50	0,50	0,00	0,50	0,00
Jun-95	0,00	0,00	0,00	0,00	4,97	0,00	0,00	4,97	0,00
Jun-95	0,00	0,00	0,00	0,00	11,53	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	10,05	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	10,26	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	6,12	0,00	0,00	0,00	0,00

Date	*Synonchiella*	*Thalassironus*	*Terschellingia*	*Viscosia*	*Wieserla*
Jun-94	0,00	0,00	44,19	3,68	0,00
Jul-94	0,00	0,00	17,17	3,12	0,00
Jul-94	0,00	0,00	17,99	6,00	0,00
Aug-94	0,00	0,00	37,23	4,38	0,00
Aug-94	0,00	0,00	37,59	0,00	0,00
Sept-94	0,00	0,00	11,52	0,00	0,00
Sept-94	0,00	0,00	14,89	0,00	0,00
Oct-94	0,00	3,02	7,56	0,00	0,00
Oct-94	0,00	0,00	25,06	6,27	0,00
Nov-94	5,57	0,00	5,57	30,66	5,57
Nov-94	0,00	0,00	43,54	43,54	0,00
Dec-94	0,00	0,00	3,87	0,00	0,00
Dec-94	0,00	0,00	2,59	0,00	0,00
Jan-95	6,84	0,00	17,09	0,00	0,00
Jan-95	0,00	0,00	10,50	0,00	0,00
Feb-95	0,00	0,00	5,27	0,00	0,00
Feb-95	0,00	0,00	98,35	32,78	0,00
Mar-95	0,00	0,00	7,33	0,00	0,00
Mar-95	0,00	0,00	32,03	0,00	0,00
Apr-95	0,00	0,00	13,73	0,00	0,00
Apr-95	0,00	0,00	6,08	2,03	0,00
May-95	0,00	1,87	1,87	0,00	0,00
May-95	0,50	0,00	2,75	0,00	0,00
Jun-95	0,00	4,97	29,81	0,00	0,00
Jun-95	0,00	0,00	7,69	92,28	0,00
Jul-95	1,00	0,00	1,00	2,01	0,00
Jul-95	0,00	0,00	2,93	2,93	0,00
Aug-95	0,00	4,08	4,08	53,07	0,00

Station B - Nematoda Genera Densities (individuals 10 cm^{-2}) (0-3 cm depth)

Date	*Acanthopharynx*	*Anticomopsis*	*Anticoma*	*Antomicron*	*Atrochromodora*	*Aponema*	*Bathylaimus*	*Calyptoromena*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	27,74	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	64,84	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	50,17	0,00
Aug-94	0,00	0,00	14,15	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	19,96	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	110,90	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	15,71	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	28,57	0,00
Dec-94	0,00	0,00	49,71	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	42,55	0,00
Feb-95	0,00	0,00	63,88	0,00	0,00	0,00	95,82	0,00
Feb-95	0,00	0,00	57,12	0,00	0,00	0,00	57,12	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	50,63	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	40,82	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	19,91	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	5,30	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	48,77	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	7,55	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	22,78	0,00	0,00	22,78	45,56	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Date	*aff Cervonema*	*Chromaspirina*	*Chromadora*	*Chromadora nudicapitata*	*Chromadorina*	*Chromadorina germanica*	*Chromadora macrolaima*	*Chromadorella*	*Chromadorella duopapillata*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	25,08	0,00	25,08	0,00	0,00	50,17
Aug-94	0,00	0,00	0,00	9,43	0,00	18,87	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	26,95	0,00	0,00	26,95
Sept-94	0,00	0,00	0,00	10,68	0,00	42,72	0,00	0,00	16,02
Sept-94	0,00	0,00	0,00	48,28	0,00	144,83	0,00	0,00	72,42
Oct-94	0,00	0,00	0,00	74,85	0,00	291,08	0,00	0,00	124,75
Oct-94	0,00	0,00	0,00	59,89	0,00	219,61	0,00	0,00	59,89
Nov-94	0,00	0,00	0,00	27,73	0,00	55,45	0,00	0,00	27,73
Nov-94	0,00	0,00	0,00	5,24	0,00	62,82	0,00	0,00	18,32
Dec-94	0,00	0,00	0,00	85,71	0,00	228,56	0,00	0,00	57,14
Dec-94	0,00	0,00	0,00	0,00	0,00	24,85	0,00	0,00	24,85
Jan-95	0,00	0,00	0,00	92,75	0,00	118,04	16,86	16,86	44,97
Jan-95	0,00	0,00	0,00	595,72	170,20	595,72	0,00	0,00	85,10
Feb-95	0,00	0,00	0,00	191,63	0,00	191,63	0,00	0,00	95,82
Feb-95	0,00	0,00	0,00	57,12	0,00	57,12	57,12	0,00	76,16
Mar-95	0,00	0,00	0,00	50,63	0,00	50,63	0,00	0,00	50,63
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	123,77
Apr-95	0,00	0,00	0,00	40,82	0,00	40,82	40,82	0,00	40,82
Apr-95	0,00	0,00	0,00	19,91	0,00	0,00	19,91	0,00	19,91
May-95	0,00	0,00	0,00	0,00	0,00	78,77	393,83	0,00	0,00
May-95	0,00	0,00	0,00	5,30	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	24,39	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	22,99	0,00	0,00	22,99
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	7,55
Jul-95	0,00	0,00	0,00	0,00	0,00	22,78	0,00	0,00	68,34
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	29,59

Date	*Camacolaimus*	*Campylaimus*	*Cyartonema*	*Daptonema*	*Desmodora*	*Desmolaimus*	*Diodontolaimus*	*Eleutherolaimus*	*Eurystomina*
Jun-94	0,00	27,74	0,00	83,22	0,00	0,00	27,74	0,00	0,00
Jul-94	0,00	0,00	0,00	194,53	842,94	0,00	0,00	0,00	0,00
Jul-94	0,00	50,17	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	28,30	0,00	0,00	28,30	9,43	0,00	0,00	0,00	0,00
Aug-94	53,90	0,00	0,00	26,95	0,00	0,00	0,00	0,00	0,00
Sept-94	10,68	0,00	0,00	32,04	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	48,28	0,00	0,00	482,78	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	349,29	0,00	0,00	33,27	0,00	16,63
Oct-94	0,00	0,00	0,00	69,88	0,00	0,00	0,00	0,00	0,00
Nov-94	27,73	0,00	0,00	554,51	194,08	0,00	27,73	0,00	83,18
Nov-94	10,47	0,00	0,00	36,65	0,00	0,00	0,00	0,00	0,00
Dec-94	85,71	28,57	0,00	99,99	0,00	0,00	0,00	0,00	0,00
Dec-94	37,28	0,00	0,00	24,85	24,85	0,00	0,00	0,00	0,00
Jan-95	67,45	0,00	0,00	196,73	0,00	0,00	16,86	0,00	0,00
Jan-95	0,00	0,00	0,00	297,86	0,00	0,00	42,55	0,00	0,00
Feb-95	0,00	0,00	0,00	319,38	0,00	0,00	0,00	0,00	0,00
Feb-95	171,37	76,16	0,00	199,93	57,12	0,00	57,12	0,00	0,00
Mar-95	0,00	75,95	0,00	75,95	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	92,83	0,00	309,43	61,89	0,00	0,00	0,00	0,00
Apr-95	122,45	40,82	0,00	40,82	0,00	0,00	40,82	0,00	0,00
Apr-95	19,91	19,91	0,00	79,62	19,91	0,00	19,91	0,00	0,00
May-95	0,00	0,00	0,00	748,28	0,00	0,00	0,00	0,00	0,00
May-95	21,19	0,00	0,00	47,69	0,00	0,00	5,30	0,00	0,00
Jun-95	24,39	24,39	0,00	170,71	0,00	0,00	0,00	0,00	24,39
Jun-95	0,00	0,00	0,00	137,92	0,00	0,00	22,99	0,00	0,00
Jul-95	10,07	7,55	0,00	50,36	0,00	0,00	7,55	0,00	0,00
Jul-95	45,56	0,00	0,00	75,94	0,00	0,00	22,78	0,00	22,78
Aug-95	0,00	0,00	0,00	59,17	0,00	0,00	29,59	0,00	59,17

Station B - Nematoda Genera Densities (individuals 10 cm^{-2}) (0-3 cm depth)

Date	*Halaphanolaimus*	*Halalaimus*	*Leptolaimus*	*Linhomoeus*	*Megadesmolaimus*	*Metachromadora remanei*	*Metadesmolaimus*	*Metalinhomoeus*
Jun-94	0,00	0,00	0,00	221,92	0,00	124,63	0,00	0,00
Jul-94	0,00	0,00	0,00	518,73	0,00	453,89	0,00	0,00
Jul-94	0,00	0,00	0,00	288,45	25,08	50,17	0,00	0,00
Aug-94	0,00	9,43	0,00	127,36	28,30	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	404,26	40,43	53,90	0,00	0,00
Sept-94	0,00	0,00	0,00	90,77	10,68	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	193,11	0,00	48,28	0,00	0,00
Oct-94	0,00	0,00	0,00	41,58	16,63	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	99,82	19,96	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	110,90	41,59	27,73	0,00	0,00
Nov-94	0,00	0,00	0,00	20,94	0,00	5,24	0,00	0,00
Dec-94	0,00	0,00	0,00	185,70	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	389,39	24,85	24,85	0,00	0,00
Jan-95	0,00	0,00	0,00	224,84	0,00	16,86	0,00	0,00
Jan-95	0,00	0,00	0,00	191,48	42,55	255,31	0,00	0,00
Feb-95	0,00	0,00	0,00	702,65	0,00	255,51	0,00	0,00
Feb-95	0,00	0,00	0,00	558,53	114,25	146,89	0,00	0,00
Mar-95	0,00	0,00	0,00	379,75	0,00	202,53	0,00	0,00
Mar-95	0,00	0,00	0,00	1268,67	123,77	123,77	0,00	0,00
Apr-95	0,00	0,00	0,00	122,45	0,00	40,82	0,00	0,00
Apr-95	0,00	0,00	0,00	49,76	19,91	39,81	0,00	0,00
May-95	0,00	0,00	0,00	433,21	0,00	78,77	0,00	0,00
May-95	0,00	0,00	0,00	45,92	42,39	0,00	0,00	5,30
Jun-95	0,00	48,77	0,00	85,36	0,00	24,39	0,00	0,00
Jun-95	0,00	0,00	0,00	160,90	160,90	22,99	0,00	0,00
Jul-95	0,00	0,00	0,00	100,73	15,11	15,11	0,00	0,00
Jul-95	0,00	22,78	0,00	235,40	0,00	68,34	0,00	0,00
Aug-95	0,00	0,00	0,00	133,14	0,00	0,00	0,00	0,00

Date	*Microlaimus*	*Molgolaimus*	*Nemanema*	*Neochromadora*	*Odonthophora*	*Odontanticoma*	*Oncholaimellus*	*Onchium*	*Oxystomina*
Jun-94	27,74	27,74	0,00	0,00	554,81	0,00	27,74	0,00	0,00
Jul-94	194,53	389,05	0,00	0,00	648,42	0,00	0,00	0,00	0,00
Jul-94	0,00	125,41	0,00	0,00	752,48	0,00	0,00	0,00	25,08
Aug-94	0,00	14,15	0,00	0,00	127,36	0,00	9,43	0,00	9,43
Aug-94	26,95	26,95	26,95	0,00	336,88	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	154,84	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	193,11	0,00	48,28	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	149,70	49,90	49,90	0,00	16,63
Oct-94	0,00	0,00	0,00	0,00	269,52	0,00	39,93	0,00	19,96
Nov-94	0,00	0,00	0,00	0,00	221,80	0,00	221,80	0,00	0,00
Nov-94	0,00	0,00	5,24	0,00	52,35	0,00	44,50	0,00	0,00
Dec-94	0,00	71,42	0,00	0,00	257,13	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	182,27	0,00	74,56	0,00	24,85
Jan-95	0,00	0,00	0,00	0,00	224,84	0,00	33,73	0,00	16,86
Jan-95	0,00	0,00	0,00	0,00	212,78	0,00	0,00	0,00	0,00
Feb-95	63,88	287,45	0,00	0,00	670,71	0,00	0,00	0,00	0,00
Feb-95	57,12	171,37	0,00	0,00	660,09	0,00	114,25	0,00	57,12
Mar-95	0,00	0,00	0,00	0,00	835,44	0,00	101,27	0,00	0,00
Mar-95	0,00	123,77	0,00	0,00	835,46	0,00	0,00	0,00	0,00
Apr-95	0,00	61,22	0,00	0,00	326,53	0,00	81,63	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	537,45	0,00	0,00	0,00	0,00
May-95	0,00	275,68	0,00	0,00	315,08	0,00	0,00	0,00	0,00
May-95	7,95	10,60	5,30	0,00	30,02	0,00	0,00	0,00	7,95
Jun-95	0,00	24,39	0,00	0,00	109,74	0,00	48,77	0,00	24,39
Jun-95	0,00	0,00	0,00	0,00	425,25	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	35,26	0,00	7,55	0,00	7,55
Jul-95	0,00	0,00	22,78	0,00	235,40	45,56	22,78	0,00	45,56
Aug-95	29,59	29,59	29,59	0,00	147,93	0,00	59,17	0,00	0,00

Date	*Paracomesoma*	*Paracanthonchus*	*Paralinhomeus*	*Paracyatholaimus*	*Parasphaerolaimus*	*Paramonohystera*	*Paraxystomina*
Jun-94	624,16	0,00	0,00	27,74	0,00	83,22	0,00
Jul-94	324,21	0,00	64,84	0,00	0,00	0,00	0,00
Jul-94	790,11	0,00	0,00	25,08	0,00	37,62	0,00
Aug-94	94,34	9,43	0,00	9,43	0,00	18,87	0,00
Aug-94	525,54	0,00	0,00	26,95	0,00	53,90	0,00
Sept-94	21,36	0,00	0,00	10,68	0,00	0,00	0,00
Sept-94	555,19	48,28	48,28	96,56	0,00	0,00	0,00
Oct-94	49,90	41,58	0,00	116,43	0,00	16,63	0,00
Oct-94	79,86	0,00	0,00	59,89	0,00	0,00	0,00
Nov-94	609,96	41,59	0,00	110,90	0,00	55,45	0,00
Nov-94	5,24	0,00	0,00	26,18	0,00	0,00	0,00
Dec-94	542,82	85,71	0,00	57,14	0,00	57,14	0,00
Dec-94	389,39	124,27	0,00	66,28	0,00	24,85	0,00
Jan-95	67,45	84,31	0,00	67,45	0,00	16,86	0,00
Jan-95	319,13	0,00	0,00	85,10	0,00	319,13	0,00
Feb-95	1437,23	0,00	0,00	63,88	0,00	0,00	0,00
Feb-95	971,09	159,94	57,12	57,12	0,00	381,78	0,00
Mar-95	1037,97	101,27	0,00	0,00	0,00	50,63	0,00
Mar-95	1330,55	247,54	61,89	0,00	0,00	0,00	0,00
Apr-95	591,84	142,86	0,00	0,00	0,00	0,00	0,00
Apr-95	59,72	19,91	0,00	19,91	0,00	19,91	0,00
May-95	1063,34	78,77	0,00	0,00	0,00	0,00	0,00
May-95	37,09	0,00	0,00	10,60	0,00	39,74	0,00
Jun-95	48,77	48,77	0,00	73,16	0,00	146,32	0,00
Jun-95	126,42	80,45	0,00	22,99	0,00	45,97	0,00
Jul-95	37,77	0,00	0,00	7,55	0,00	47,85	0,00
Jul-95	113,91	37,97	22,78	45,56	0,00	0,00	0,00
Aug-95	29,59	59,17	88,76	29,59	0,00	207,10	0,00

Station B - Nematoda Genera Densities (individuals 10 cm^{-2}) (0-3 cm depth)

Date	*Prochromadorella*	*Prochromadorella ditlevseni*	*aff Phanodermopsis*	*Ptycholaimellus*	*Spirinia*	*Sabatieria*	*Southernella*	*Southernia*	*Sphaerolaimus*
Jun-94	0,00	0,00	0,00	83,22	305,15	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	713,26	0,00	0,00	64,84	0,00
Jul-94	25,08	0,00	0,00	25,08	313,54	0,00	0,00	0,00	0,00
Aug-94	0,00	9,43	0,00	0,00	231,13	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	633,34	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	598,01	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	48,28	1400,05	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	16,63	182,96	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	818,54	0,00	0,00	0,00	0,00
Nov-94	27,73	0,00	0,00	0,00	804,04	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	5,24	133,49	0,00	0,00	0,00	0,00
Dec-94	28,57	0,00	0,00	42,85	185,70	0,00	0,00	0,00	28,57
Dec-94	0,00	0,00	0,00	0,00	969,32	0,00	0,00	0,00	24,85
Jan-95	0,00	0,00	0,00	25,29	427,20	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	212,76	85,10	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	95,82	255,51	0,00	0,00	0,00	0,00
Feb-95	57,12	0,00	0,00	187,69	1468,87	0,00	0,00	0,00	133,29
Mar-95	0,00	0,00	0,00	50,83	607,59	0,00	0,00	0,00	101,27
Mar-95	61,89	0,00	0,00	433,20	711,69	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	163,27	1795,92	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	59,72	895,75	0,00	0,00	0,00	0,00
May-95	0,00	78,77	0,00	275,68	78,77	0,00	0,00	0,00	0,00
May-95	5,30	5,30	0,00	18,54	249,02	0,00	0,00	0,00	5,30
Jun-95	0,00	0,00	0,00	73,16	1243,76	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	80,45	676,10	22,99	0,00	0,00	22,99
Jul-95	7,55	0,00	0,00	7,55	463,35	0,00	0,00	7,55	0,00
Jul-95	0,00	0,00	0,00	45,56	1473,18	0,00	0,00	0,00	45,56
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Date	*Synonchiella*	*Thalassironus*	*Terschellingia*	*Viscosia*	*Wieseria*	*Dichocromadora*	*Monoposthia*
Jun-94	0,00	0,00	693,51	0,00	0,00	0,00	0,00
Jul-94	64,84	0,00	1426,52	129,68	0,00	0,00	0,00
Jul-94	0,00	0,00	1128,73	0,00	0,00	25,08	0,00
Aug-94	33,02	0,00	155,66	23,58	0,00	0,00	0,00
Aug-94	53,90	0,00	795,04	26,95	0,00	0,00	0,00
Sept-94	21,36	10,68	42,72	48,05	0,00	0,00	0,00
Sept-94	48,28	0,00	1955,25	48,28	0,00	0,00	0,00
Oct-94	33,27	33,27	216,23	58,22	0,00	0,00	0,00
Oct-94	39,93	0,00	139,75	59,89	0,00	0,00	0,00
Nov-94	55,45	27,73	540,65	83,18	0,00	0,00	0,00
Nov-94	0,00	5,24	31,41	44,50	0,00	0,00	0,00
Dec-94	0,00	0,00	785,66	28,57	0,00	0,00	0,00
Dec-94	49,71	24,85	289,97	149,13	0,00	0,00	0,00
Jan-95	84,31	0,00	196,73	67,45	0,00	0,00	0,00
Jan-95	0,00	42,55	1765,87	63,83	0,00	0,00	0,00
Feb-95	0,00	0,00	1852,43	127,75	0,00	0,00	0,00
Feb-95	57,12	57,12	1110,72	137,09	0,00	0,00	0,00
Mar-95	0,00	0,00	1848,10	202,53	0,00	0,00	0,00
Mar-95	0,00	0,00	587,92	61,89	0,00	0,00	0,00
Apr-95	0,00	0,00	530,61	0,00	0,00	0,00	0,00
Apr-95	0,00	19,91	59,72	39,81	0,00	0,00	0,00
May-95	0,00	0,00	4371,50	0,00	0,00	0,00	0,00
May-95	0,00	0,00	45,92	17,66	0,00	0,00	0,00
Jun-95	24,39	0,00	256,07	195,10	0,00	0,00	0,00
Jun-95	0,00	0,00	367,78	22,99	0,00	0,00	0,00
Jul-95	7,55	45,33	80,58	94,43	0,00	0,00	0,00
Jul-95	22,78	22,78	129,09	34,17	0,00	0,00	0,00
Aug-95	29,59	88,76	147,93	221,89	0,00	0,00	0,00

Date	*Paradesmodora*	*Setosabatieria hiraiula*	*Balbolla*	*Desmoscolex*	*Hypodontolaimus*	*Aegialoalaimus*	*Bathyeurystomina*	*Thoracostoma*	*Polygastrophora*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	324,21	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	25,08	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	16,63	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	285,61	171,37	0,00	0,00	171,37	57,12	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	22,78	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Station B- Nematoda Genera Densities (individuals 10 cm^{-2}) (3-6 cm depth)

Date	*Acanthopharynx*	*Anticomopsis*	*Anticoma*	*Antomicron*	*Atrochromadora*	*Aponema*	*Bathylaimus*	*Calyptronema*
Jun-94	0,00	0,00	3,23	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	7,51	0,00
Jul-94	0,00	0,00	2,52	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	10,56	0,00	0,00	5,28	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	9,10	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	17,44	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	3,89	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	8,82	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	10,33	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	2,25	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	50,17	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Date	*aff Cervonema*	*Chromaspirina*	*Chromadora*	*Chromadora nudicapitata*	*Chromadorina*	*Chromadorina germanica*	*Chromadora macrolaima*	*Chromadorella*	*Chromadorella duopapillata*
Jun-94	0,00	0,00	0,00	3,23	0,00	0,00	0,00	0,00	3,23
Jul-94	0,00	0,00	0,00	7,51	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	3,78	0,00	0,00	0,00	0,00	5,88
Aug-94	0,00	0,00	0,00	0,00	10,56	5,28	0,00	0,00	5,28
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5,15
Sept-94	0,00	0,00	0,00	0,00	0,00	33,65	0,00	0,00	9,61
Sept-94	0,00	0,00	0,00	9,10	0,00	0,00	9,10	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	108,04	0,00	0,00	33,24
Oct-94	0,00	0,00	0,00	32,28	0,00	32,28	0,00	0,00	32,28
Nov-94	0,00	0,00	0,00	17,44	0,00	34,89	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	19,47	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	5,81	0,00	0,00	5,81
Dec-94	0,00	0,00	0,00	30,87	0,00	94,81	0,00	8,82	11,34
Jan-95	0,00	0,00	0,00	20,16	0,00	12,10	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	8,20
Feb-95	0,00	0,00	0,00	0,00	0,00	36,35	0,00	0,00	5,19
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	20,66
Mar-95	0,00	0,00	0,00	0,00	0,00	2,25	0,00	0,00	4,51
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	10,25	10,25
Apr-95	0,00	0,00	0,00	3,09	0,00	3,09	0,00	0,00	3,09
Apr-95	0,00	0,00	0,00	24,34	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	10,48	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	5,79	0,00	5,79
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	6,04	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	3,39	0,00	3,39	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Date	Camacolaimus	Campylaimus	Cyartonema	Daptonema	Desmodora	Desmolaimus	Diodontolaimus	Eleutherolaimus	Eurystomina
Jun-94	0,00	3,23	0,00	6,46	3,23	0,00	3,23	0,00	0,00
Jul-94	0,00	0,00	0,00	7,51	217,73	0,00	0,00	0,00	0,00
Jul-94	5,04	2,52	0,00	2,52	0,00	0,00	0,00	0,00	0,00
Aug-94	23,77	0,00	0,00	5,28	5,28	0,00	5,28	0,00	0,00
Aug-94	38,63	0,00	0,00	5,15	15,45	0,00	5,15	0,00	0,00
Sept-94	28,84	0,00	0,00	7,21	4,81	0,00	0,00	0,00	0,00
Sept-94	18,21	0,00	0,00	45,52	9,10	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	74,80	16,62	0,00	0,00	0,00	0,00
Oct-94	53,80	0,00	0,00	10,76	10,76	0,00	10,76	0,00	0,00
Nov-94	78,49	0,00	0,00	87,21	0,00	0,00	0,00	0,00	17,44
Nov-94	44,79	0,00	0,00	0,00	0,00	0,00	3,89	0,00	0,00
Dec-94	14,52	0,00	0,00	11,62	0,00	0,00	0,00	0,00	0,00
Dec-94	28,22	8,82	0,00	18,52	44,10	0,00	8,82	0,00	17,64
Jan-95	24,19	0,00	0,00	14,11	0,00	0,00	4,03	0,00	0,00
Jan-95	32,80	0,00	0,00	16,40	0,00	0,00	0,00	0,00	0,00
Feb-95	5,19	0,00	0,00	5,19	25,96	0,00	0,00	0,00	0,00
Feb-95	0,00	10,33	0,00	20,66	0,00	0,00	0,00	0,00	0,00
Mar-95	2,25	2,25	0,00	2,25	0,00	0,00	2,25	0,00	0,00
Mar-95	15,37	0,00	0,00	20,50	0,00	0,00	0,00	0,00	20,50
Apr-95	13,90	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	12,17	0,00	0,00	36,51	0,00	0,00	0,00	0,00	0,00
May-95	15,72	0,00	0,00	10,48	10,48	0,00	0,00	0,00	0,00
May-95	4,82	0,00	0,00	0,00	0,00	0,00	4,82	0,00	4,82
Jun-95	14,49	5,79	0,00	11,59	5,79	0,00	5,79	0,00	0,00
Jun-95	18,13	0,00	0,00	12,09	48,36	0,00	12,09	0,00	6,04
Jul-95	11,15	0,00	0,00	22,30	19,51	0,00	5,57	0,00	0,00
Jul-95	6,78	0,00	0,00	0,00	16,96	0,00	6,78	0,00	0,00
Aug-95	15,19	0,00	0,00	15,19	0,00	0,00	0,00	0,00	0,00

Station B- Nematoda Genera Densities (individuals 10 cm^{-2}) (3-6 cm depth)

Date	*Halaphanolaimus*	*Halalaimus*	*Leptolaimus*	*Linhomoeus*	*Megadesmolaimus*	*Metachromadora remanei*	*Metadesmolaimus*	*Metalinhomoeus*
Jun-94	0,00	0,00	0,00	17,22	3,23	3,23	0,00	0,00
Jul-94	0,00	0,00	0,00	45,05	0,00	165,18	0,00	7,51
Jul-94	0,00	2,52	0,00	9,23	3,78	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	68,67	21,13	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	30,91	5,15	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	35,25	4,81	0,00	0,00	9,61
Sept-94	0,00	0,00	0,00	72,83	13,66	9,10	0,00	0,00
Oct-94	0,00	0,00	0,00	108,04	49,86	16,62	0,00	0,00
Oct-94	0,00	0,00	0,00	43,04	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	61,05	34,89	0,00	0,00	0,00
Nov-94	0,00	3,89	0,00	21,42	5,84	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	5,81	17,43	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	89,45	20,04	11,76	0,00	8,82
Jan-95	0,00	0,00	0,00	30,24	4,03	0,00	0,00	4,03
Jan-95	0,00	0,00	0,00	112,07	16,40	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	38,94	18,17	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	92,99	20,66	10,33	0,00	0,00
Mar-95	0,00	0,00	0,00	13,52	11,27	4,51	0,00	0,00
Mar-95	0,00	0,00	0,00	107,61	10,25	10,25	0,00	0,00
Apr-95	0,00	0,00	0,00	9,27	13,90	0,00	0,00	3,09
Apr-95	0,00	0,00	0,00	121,70	24,34	12,17	0,00	0,00
May-95	0,00	0,00	0,00	41,93	10,48	0,00	0,00	0,00
May-95	0,00	0,00	0,00	62,65	19,28	0,00	0,00	4,82
Jun-95	0,00	0,00	0,00	28,97	5,79	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	104,77	12,09	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	53,89	11,15	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	78,02	0,00	0,00	0,00	6,78
Aug-95	0,00	0,00	0,00	83,54	15,19	0,00	0,00	0,00

Date	*Microlaimus*	*Molgolaimus*	*Nemanema*	*Neochromadora*	*Odonthophora*	*Odontanticoma*	*Oncholaimellus*	*Onchium*	*Oxystomina*
Jun-94	3,23	3,23	0,00	0,00	11,30	0,00	0,00	0,00	0,00
Jul-94	0,00	7,51	0,00	0,00	67,57	0,00	0,00	0,00	0,00
Jul-94	2,52	2,52	0,00	0,00	30,22	0,00	2,52	0,00	0,00
Aug-94	0,00	0,00	5,28	0,00	15,85	0,00	10,56	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	30,91	0,00	0,00	0,00	0,00
Sept-94	0,00	4,81	0,00	0,00	12,02	0,00	4,81	0,00	0,00
Sept-94	0,00	9,10	0,00	0,00	22,76	0,00	9,10	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	116,35	0,00	0,00	0,00	16,62
Oct-94	0,00	0,00	0,00	0,00	37,66	0,00	10,76	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	69,77	0,00	17,44	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	11,68	0,00	3,89	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	17,43	0,00	0,00	0,00	0,00
Dec-94	8,82	17,64	0,00	0,00	43,42	0,00	8,82	0,00	8,82
Jan-95	0,00	0,00	0,00	0,00	4,03	0,00	0,00	0,00	4,03
Jan-95	0,00	0,00	0,00	0,00	45,10	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	33,75	0,00	0,00	0,00	5,19
Feb-95	10,33	0,00	0,00	0,00	51,66	0,00	0,00	0,00	0,00
Mar-95	0,00	4,51	0,00	0,00	31,55	0,00	0,00	0,00	2,25
Mar-95	10,25	0,00	0,00	0,00	56,37	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	9,27	0,00	3,09	0,00	3,09
Apr-95	0,00	0,00	0,00	0,00	91,27	0,00	0,00	0,00	0,00
May-95	0,00	5,24	0,00	0,00	47,17	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	11,24	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	23,18	0,00	5,79	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	6,04	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	20,44	0,00	5,57	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	3,39	0,00	3,39	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	37,97	0,00	0,00	0,00	15,19

Date	*Paracomesoma*	*Paracanthonchus*	*Paralinhomeus*	*Paracyatholaimus*	*Parasphaerolaimus*	*Paramonohystera*	*Paraxystomina*
Jun-94	23,68	3,23	0,00	0,00	0,00	14,53	0,00
Jul-94	18,77	0,00	0,00	0,00	0,00	7,51	0,00
Jul-94	31,90	0,00	0,00	0,00	0,00	5,04	0,00
Aug-94	21,13	0,00	0,00	0,00	0,00	60,75	0,00
Aug-94	25,76	0,00	0,00	0,00	0,00	10,30	0,00
Sept-94	4,81	0,00	0,00	0,00	0,00	20,83	0,00
Sept-94	40,97	0,00	0,00	9,10	0,00	27,31	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	58,17	0,00
Oct-94	10,76	0,00	0,00	32,28	0,00	64,56	0,00
Nov-94	61,05	0,00	0,00	17,44	0,00	139,54	0,00
Nov-94	3,89	0,00	0,00	0,00	0,00	15,58	0,00
Dec-94	8,71	0,00	0,00	5,81	0,00	78,43	0,00
Dec-94	84,52	17,64	0,00	14,70	0,00	52,91	0,00
Jan-95	4,03	0,00	0,00	8,06	0,00	30,24	0,00
Jan-95	98,40	0,00	0,00	16,40	0,00	28,70	0,00
Feb-95	70,10	0,00	0,00	5,19	0,00	41,54	0,00
Feb-95	103,32	0,00	0,00	10,33	0,00	61,99	0,00
Mar-95	29,30	6,76	0,00	4,51	0,00	11,27	0,00
Mar-95	51,24	0,00	0,00	20,50	0,00	0,00	0,00
Apr-95	20,08	0,00	0,00	6,18	0,00	9,27	0,00
Apr-95	12,17	12,17	0,00	0,00	0,00	36,51	0,00
May-95	107,44	0,00	0,00	0,00	0,00	7,86	0,00
May-95	4,82	0,00	0,00	4,82	0,00	4,82	0,00
Jun-95	0,00	0,00	0,00	5,79	0,00	92,72	0,00
Jun-95	24,18	0,00	0,00	0,00	0,00	45,34	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	50,17	0,00
Jul-95	6,78	0,00	3,39	3,39	0,00	0,00	0,00
Aug-95	15,19	0,00	0,00	0,00	0,00	30,38	0,00

Station B - Nematoda Genera Densities (individuals $10cm^{-2}$)(6-10cm depth)

Date	Acanthopharynx	*Anticomopsis*	*Anticoma*	*Antomicron*	*Atrochromadora*	*Aponema*	*Bathylaimus*	*Calyptronema*
Jun-94	0,00	0,00	0,00	0,00	0,00	4,64	4,64	4,64
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	12,28	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	6,61	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	19,20	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	16,43	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	16,90	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	7,98	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	59,46	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Date	*aff Cervonema*	*Chromaspirina*	*Chromadora*	*Chromadora nudicapitata*	*Chromadorina*	*Chromadorina germanica*	*Chromadora macrolaima*	*Chromadorella*	*Chromadorella duopapillata*
Jun-94	0,00	0,00	0,00	4,64	0,00	4,64	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	13,01	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	5,54	0,00	38,75	0,00	0,00	5,54
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	13,95	0,00	5,23	0,00	0,00	3,49
Oct-94	0,00	0,00	0,00	0,00	0,00	6,03	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	26,43	0,00	6,61	0,00	0,00	13,22
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	3,53	0,00	7,06	0,00	0,00	3,53
Dec-94	0,00	0,00	0,00	0,00	0,00	12,69	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	18,40	0,00	0,00	9,20
Jan-95	0,00	0,00	0,00	0,00	0,00	34,82	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	14,98	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	6,14	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	4,65	0,00	2,33	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	7,48
Apr-95	5,69	0,00	0,00	5,69	0,00	0,00	5,69	0,00	0,00
May-95	0,00	0,00	0,00	5,54	0,00	8,31	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	8,61	8,61	0,00	0,00
Jul-95	0,00	0,00	0,00	14,87	0,00	0,00	0,00	0,00	29,73
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	9,71

Date	*Camacolaimus*	*Campylaimus*	*Cyartonema*	*Daptonema*	*Desmodora*	*Desmolaimus*	*Diodontolaimus*	*Eleutherolaimus*	*Eurystomina*
Jun-94	0,00	0,00	0,00	6,96	0,00	0,00	4,64	0,00	0,00
Jul-94	13,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	6,14	0,00	0,00	0,00	0,00	0,00
Aug-94	5,54	0,00	0,00	5,54	33,22	0,00	5,54	0,00	0,00
Aug-94	6,71	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	22,78	0,00	0,00	5,06	20,25	0,00	0,00	0,00	0,00
Sept-94	25,48	5,10	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	17,44	0,00	0,00	13,95	3,49	0,00	0,00	0,00	0,00
Oct-94	39,16	6,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	9,91	0,00	0,00	26,43	0,00	0,00	0,00	0,00	0,00
Nov-94	38,40	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	3,53	7,06	0,00	5,30	0,00	0,00	3,53	0,00	0,00
Dec-94	50,78	0,00	0,00	0,00	0,00	0,00	6,35	0,00	0,00
Jan-95	18,40	0,00	0,00	18,40	0,00	0,00	0,00	0,00	0,00
Jan-95	34,82	34,82	0,00	174,09	0,00	0,00	0,00	0,00	34,82
Feb-95	4,28	0,00	0,00	6,42	0,00	0,00	4,28	0,00	0,00
Feb-95	0,00	0,00	0,00	6,14	6,14	0,00	6,14	0,00	0,00
Mar-95	0,00	2,33	0,00	4,65	0,00	0,00	0,00	2,33	4,65
Mar-95	3,29	0,00	0,00	6,59	0,00	0,00	0,00	0,00	0,00
Apr-95	14,97	0,00	0,00	14,97	0,00	0,00	7,48	0,00	0,00
Apr-95	25,59	0,00	0,00	5,69	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	22,17	0,00	0,00	11,09	0,00	5,54
May-95	25,35	0,00	0,00	0,00	84,51	321,15	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	47,88	0,00	0,00	0,00	7,98	0,00
Jun-95	5,74	0,00	0,00	2,87	0,00	0,00	5,74	0,00	0,00
Jul-95	74,33	0,00	0,00	29,73	29,73	0,00	0,00	0,00	0,00
Jul-95	14,58	0,00	0,00	7,29	53,46	0,00	0,00	0,00	0,00
Aug-95	29,14	0,00	0,00	0,00	0,00	0,00	9,71	0,00	0,00

Station B- Nematoda Genera Densities (individuals 10 cm^{-2}) (3-6 cm depth)

Date	Prochromadorella	*Prochromadorella*	*Antiphanodermopsis*	*Ptycholaimellus*	*Spirinia*	*Sabatieria*	*Southernielle*	*Southernia*	*Sphaerolaimus*
Jun-94	0,00	0,00	0,00	3,23	10,76	19,37	0,00	0,00	3,23
Jul-94	0,00	0,00	0,00	15,02	30,03	0,00	0,00	0,00	7,51
Jul-94	0,00	0,00	0,00	2,52	3,78	0,00	0,00	0,00	2,52
Aug-94	5,28	0,00	0,00	5,28	21,13	0,00	0,00	7,92	0,00
Aug-94	0,00	0,00	0,00	0,00	69,54	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	64,09	4,81	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	163,87	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	33,24	157,90	0,00	0,00	33,24	0,00
Oct-94	0,00	0,00	0,00	0,00	64,56	21,52	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	17,44	183,15	0,00	0,00	52,33	0,00
Nov-94	0,00	0,00	0,00	0,00	62,32	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	5,81	8,71	0,00	0,00	34,86	0,00
Dec-94	17,64	0,00	0,00	26,46	50,88	92,60	0,00	8,82	0,00
Jan-95	8,06	0,00	0,00	0,00	70,56	0,00	0,00	4,03	0,00
Jan-95	0,00	0,00	0,00	0,00	16,40	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	5,19	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	10,33	108,48	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	2,25	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	30,75	128,11	0,00	0,00	0,00	0,00
Apr-95	0,00	3,09	0,00	3,09	33,97	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	36,51	279,90	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	5,24	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	4,82	165,45	0,00	0,00	0,00	0,00
Jun-95	5,79	0,00	0,00	0,00	63,74	0,00	0,00	5,79	0,00
Jun-95	24,18	0,00	0,00	0,00	82,61	0,00	0,00	9,07	0,00
Jul-95	0,00	0,00	0,00	0,00	87,33	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	3,39	57,66	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	562,03	0,00	0,00	0,00	0,00

Date	*Synonchiela*	*Thalassironus*	*Terschellingia*	*Viscosia*	*Wieserla*	*Dichocromadora cephalata*	*Monoposthia*
Jun-94	0,00	0,00	21,52	3,23	0,00	0,00	0,00
Jul-94	0,00	0,00	26,28	7,51	0,00	0,00	0,00
Jul-94	0,00	0,00	18,47	2,52	0,00	0,00	0,00
Aug-94	5,28	5,28	7,92	0,00	0,00	0,00	0,00
Aug-94	0,00	5,15	36,06	0,00	0,00	0,00	0,00
Sept-94	12,02	4,81	4,81	0,00	0,00	0,00	0,00
Sept-94	9,10	0,00	136,56	18,21	0,00	0,00	0,00
Oct-94	16,62	0,00	108,04	66,49	0,00	0,00	0,00
Oct-94	21,52	0,00	53,80	10,76	0,00	0,00	0,00
Nov-94	34,89	0,00	95,94	0,00	0,00	0,00	0,00
Nov-94	7,79	0,00	7,79	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	98,76	0,00	0,00	0,00	0,00
Dec-94	11,76	17,64	114,65	8,82	0,00	0,00	0,00
Jan-95	8,06	0,00	18,14	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	114,80	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	127,22	0,00	0,00	0,00	0,00
Feb-95	10,33	0,00	87,82	10,33	0,00	0,00	0,00
Mar-95	2,25	0,00	42,82	0,00	0,00	0,00	0,00
Mar-95	10,25	20,50	117,86	0,00	0,00	0,00	0,00
Apr-95	3,09	3,09	63,32	3,09	0,00	0,00	0,00
Apr-95	0,00	0,00	66,93	24,34	0,00	0,00	0,00
May-95	0,00	0,00	62,89	0,00	0,00	0,00	0,00
May-95	0,00	9,64	9,64	9,64	0,00	0,00	0,00
Jun-95	0,00	5,79	23,18	28,97	0,00	0,00	0,00
Jun-95	9,07	18,13	0,00	6,04	0,00	0,00	0,00
Jul-95	5,57	9,29	33,45	13,01	0,00	11,15	0,00
Jul-95	0,00	0,00	0,00	13,57	0,00	0,00	0,00
Aug-95	30,38	0,00	45,57	15,19	0,00	0,00	0,00

Date	*Paradesmodora*	*Setosabatieria*	*Bellolla*	*Desmoscolex*	*Hypodontolaimus*	*Aegiolaimus*	*Bathyeurystomina*	*Thoracostoma*	*Polygastrophora*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	3,23	0,00	0,00
Jul-94	0,00	67,57	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	2,52	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	8,82	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	10,25	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Station B - Nematoda Genera Densities (individuals $10cm^{-2}$) (6-10cm depth)

Date	*Prochromadorella*	*Prochromadorella ditlevseni*	*aff Phanodermopsis*	*Ptycholaimellus*	*Spirinia*	*Sabatieria*	*Southernielle*	*Southernia*	*Sphaerolaimus*
Jun-94	0,00	0,00	0,00	0,00	6,96	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	12,28	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	8,30	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	5,03	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	20,25	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	28,03	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	6,97	0,00	0,00	3,49	0,00
Oct-94	0,00	0,00	0,00	0,00	40,17	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	6,61	26,43	0,00	0,00	13,22	0,00
Nov-94	0,00	0,00	0,00	0,00	124,79	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	8,83	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	76,17	6,35	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	9,20	85,84	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	34,82	34,82	34,82	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	8,56	4,28	0,00	0,00	4,28	0,00
Feb-95	6,14	0,00	0,00	0,00	15,36	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	11,64	2,33	0,00	2,33	0,00
Mar-95	0,00	0,00	0,00	0,00	9,88	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	7,48	86,06	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	5,69	11,37	0,00	0,00	0,00	0,00
May-95	5,54	0,00	0,00	13,86	0,00	0,00	0,00	0,00	5,54
May-95	0,00	0,00	0,00	33,81	197,20	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	135,65	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	2,87	12,91	2,87	0,00	2,87	0,00
Jul-95	0,00	0,00	0,00	0,00	126,36	0,00	0,00	0,00	29,73
Jul-95	0,00	0,00	0,00	9,72	26,73	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	77,70	97,12	0,00	0,00	0,00	0,00

Date	Synonchiella	*Thalassironus*	*Terschellingia*	*Viscosia*	*Wieseria*	*Dichocromadora*	*Monoposthia*
Jun-94	0,00	0,00	18,55	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	18,42	0,00	0,00	0,00	0,00
Aug-94	5,54	0,00	13,84	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	25,15	3,35	0,00	0,00	0,00
Sept-94	5,06	20,25	0,00	10,13	0,00	0,00	0,00
Sept-94	0,00	0,00	20,39	5,10	0,00	0,00	5,10
Oct-94	0,00	0,00	10,46	3,49	0,00	0,00	0,00
Oct-94	6,03	6,03	14,06	6,03	0,00	0,00	0,00
Nov-94	0,00	6,61	72,68	9,91	0,00	0,00	0,00
Nov-94	36,40	0,00	0,00	19,20	0,00	0,00	0,00
Dec-94	0,00	0,00	10,60	3,53	0,00	3,53	0,00
Dec-94	0,00	0,00	31,74	0,00	0,00	0,00	0,00
Jan-95	21,46	0,00	41,39	9,20	0,00	0,00	0,00
Jan-95	0,00	0,00	348,18	0,00	34,82	0,00	0,00
Feb-95	0,00	0,00	40,66	0,00	0,00	0,00	4,28
Feb-95	6,14	0,00	36,87	18,43	0,00	0,00	0,00
Mar-95	0,00	0,00	20,95	0,00	0,00	0,00	0,00
Mar-95	8,24	0,00	18,12	0,00	0,00	0,00	0,00
Apr-95	7,48	7,48	18,71	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	22,75	0,00	0,00	0,00	0,00
May-95	0,00	0,00	63,74	0,00	0,00	0,00	0,00
May-95	0,00	0,00	16,90	16,90	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	23,94	0,00	0,00	0,00
Jun-95	0,00	0,00	12,91	0,00	0,00	0,00	0,00
Jul-95	0,00	14,87	66,90	133,79	0,00	29,73	0,00
Jul-95	0,00	4,86	4,86	0,00	0,00	0,00	0,00
Aug-95	19,42	9,71	19,42	9,71	0,00	0,00	0,00

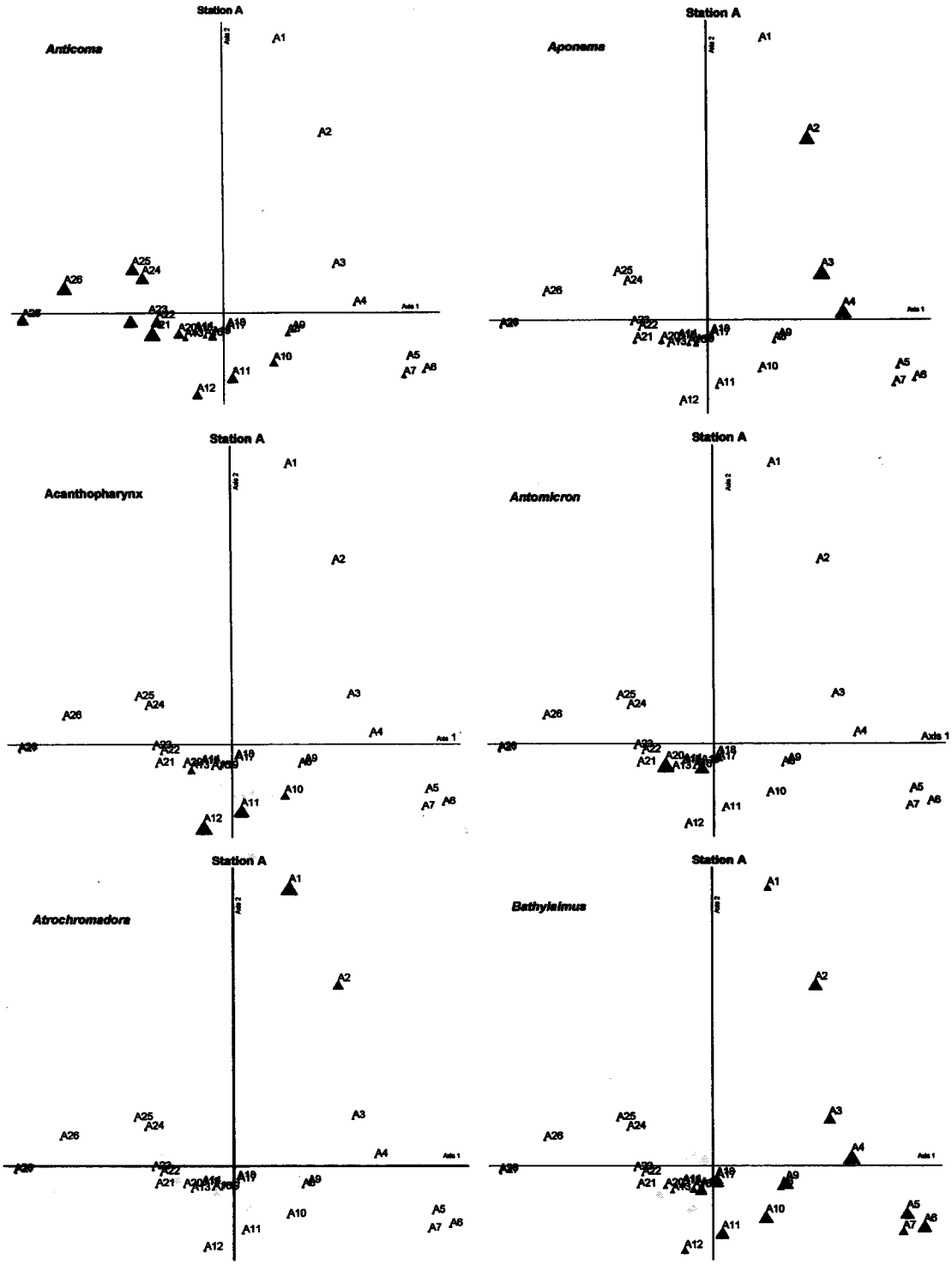
Date	*Paradesmodora*	*Setosabatieria hirakata*	*Belbolla*	*Desmocolex*	*Hypodontolaimus*	*Aegialoalaimus*	*Bathyeurystomina*	*Thoracostoma*	*Polygastrophora*
Jun-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	9,20	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	8,56	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	14,87	14,87
Jul-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Station B - Nematoda Genera Densities (individuals 10cm^{-2}) (6-10cm depth)

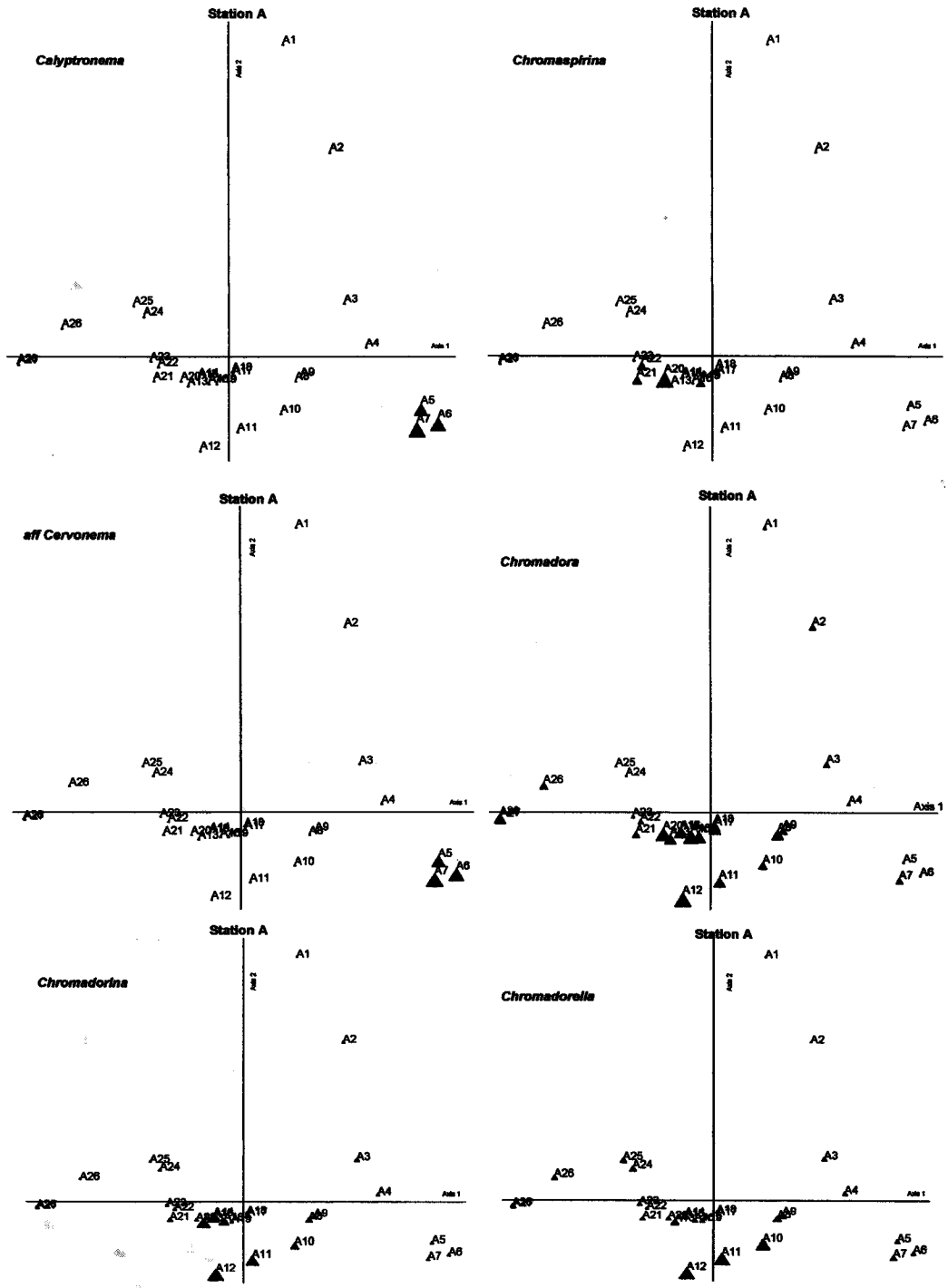
Date	*Halaphanolaimus*	*Halalaimus*	*Leptolaimus*	*Linhomoeus*	*Megadesmolaimus*	*Metachromadora remanei*	*Metadesmolaimus*	*Metalinhomoeus*
Jun-94	0,00	0,00	0,00	18,55	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	24,56	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	24,91	5,54	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	6,71	0,00	6,71	0,00	0,00
Sept-94	0,00	0,00	0,00	17,72	10,13	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	15,29	5,10	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	6,97	0,00	3,49	0,00	0,00
Oct-94	0,00	0,00	0,00	33,14	9,04	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	16,52	0,00	6,61	0,00	0,00
Nov-94	0,00	0,00	0,00	38,40	38,40	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	5,30	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	50,78	0,00	0,00	0,00	0,00
Jan-95	0,00	0,00	0,00	61,32	22,99	0,00	0,00	0,00
Jan-95	0,00	34,82	0,00	417,82	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	12,84	8,56	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	70,66	0,00	0,00	0,00	0,00
Mar-95	0,00	2,33	0,00	13,96	0,00	2,33	0,00	0,00
Mar-95	0,00	0,00	0,00	41,18	3,29	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	33,67	44,90	0,00	0,00	0,00
Apr-95	0,00	0,00	0,00	48,33	0,00	17,06	0,00	0,00
May-95	0,00	0,00	0,00	11,09	0,00	11,09	0,00	0,00
May-95	0,00	0,00	0,00	84,51	16,90	0,00	0,00	16,90
Jun-95	0,00	0,00	0,00	7,98	0,00	15,96	0,00	0,00
Jun-95	0,00	0,00	0,00	4,30	8,61	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	52,03	0,00	14,87	0,00	0,00
Jul-95	0,00	0,00	0,00	26,73	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	101,98	0,00	9,71	0,00	0,00

Date	Microlaimus	*Molgolaimus*	*Nemaneme*	*Neochromadora*	*Odonthophora*	*Odontanticoma*	*Oncholaimellus*	*Onchium*	*Oxystomina*
Jun-94	0,00	0,00	0,00	0,00	13,91	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	6,14	0,00	0,00	18,42	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	5,54	0,00	0,00	0,00	0,00
Aug-94	0,00	0,00	0,00	0,00	10,06	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sept-94	0,00	0,00	0,00	0,00	5,10	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	10,46	0,00	0,00	0,00	0,00
Oct-94	0,00	0,00	0,00	0,00	18,08	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	26,43	0,00	0,00	0,00	0,00
Nov-94	0,00	0,00	0,00	0,00	115,19	0,00	0,00	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	5,30	0,00	3,53	0,00	0,00
Dec-94	0,00	0,00	0,00	0,00	12,69	0,00	6,35	0,00	0,00
Jan-95	0,00	0,00	0,00	0,00	22,99	0,00	0,00	0,00	9,20
Jan-95	0,00	0,00	0,00	0,00	34,82	0,00	69,64	0,00	0,00
Feb-95	0,00	6,42	0,00	0,00	17,12	0,00	0,00	0,00	0,00
Feb-95	0,00	0,00	0,00	0,00	6,14	0,00	0,00	0,00	0,00
Mar-95	2,33	6,98	0,00	0,00	44,22	0,00	0,00	0,00	0,00
Mar-95	0,00	3,29	0,00	0,00	3,29	0,00	0,00	0,00	3,29
Apr-95	0,00	7,48	0,00	0,00	14,97	0,00	7,48	0,00	0,00
Apr-95	0,00	0,00	0,00	0,00	25,59	0,00	0,00	0,00	0,00
May-95	0,00	5,54	0,00	0,00	16,63	0,00	0,00	0,00	0,00
May-95	0,00	0,00	0,00	0,00	33,81	0,00	16,90	0,00	0,00
Jun-95	0,00	0,00	0,00	0,00	7,98	0,00	0,00	0,00	0,00
Jun-95	0,00	2,87	0,00	0,00	8,61	0,00	0,00	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	29,73	0,00	29,73	0,00	0,00
Jul-95	0,00	0,00	0,00	0,00	4,86	0,00	0,00	0,00	0,00
Aug-95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Date	*Paracomesoma*	*Paracanthonchus*	*Paralinhomeus*	*Paracyatholaimus*	*Parasphaerolaimus*	*Paramonohystera*	*Paraxystomina*
Jun-94	35,56	0,00	0,00	0,00	0,00	0,00	0,00
Jul-94	0,00	0,00	0,00	0,00	0,00	377,15	0,00
Jul-94	36,84	0,00	0,00	0,00	0,00	6,14	0,00
Aug-94	38,75	0,00	5,54	0,00	0,00	63,66	0,00
Aug-94	8,38	0,00	0,00	0,00	0,00	3,35	0,00
Sept-94	0,00	0,00	0,00	0,00	0,00	60,76	0,00
Sept-94	7,64	0,00	0,00	0,00	0,00	7,64	0,00
Oct-94	0,00	0,00	0,00	10,46	0,00	20,92	0,00
Oct-94	6,03	0,00	0,00	6,03	0,00	21,09	0,00
Nov-94	6,61	0,00	0,00	26,43	0,00	33,04	0,00
Nov-94	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Dec-94	8,83	0,00	0,00	7,06	0,00	24,72	0,00
Dec-94	9,52	0,00	0,00	0,00	0,00	0,00	0,00
Jan-95	13,80	18,40	0,00	9,20	0,00	41,39	0,00
Jan-95	452,63	69,64	0,00	34,82	0,00	34,82	0,00
Feb-95	29,96	0,00	0,00	0,00	0,00	19,26	0,00
Feb-95	61,44	0,00	0,00	6,14	0,00	9,22	0,00
Mar-95	13,96	0,00	0,00	0,00	0,00	0,00	0,00
Mar-95	47,77	0,00	0,00	0,00	0,00	3,29	0,00
Apr-95	7,48	0,00	0,00	14,97	0,00	11,22	0,00
Apr-95	0,00	0,00	0,00	5,69	0,00	31,28	0,00
May-95	24,94	0,00	0,00	0,00	0,00	0,00	0,00
May-95	16,90	0,00	0,00	0,00	0,00	0,00	0,00
Jun-95	7,98	0,00	0,00	7,98	0,00	15,96	0,00
Jun-95	2,87	0,00	0,00	2,87	0,00	18,65	0,00
Jul-95	0,00	44,60	14,87	14,87	0,00	0,00	0,00
Jul-95	0,00	0,00	9,72	0,00	0,00	17,01	0,00
Aug-95	19,42	0,00	0,00	0,00	0,00	9,71	0,00



Results of the PCA-ordination based on fortnightly variation of Nematoda genera, which registered the lowest relative percentage (0-10 cm sediment depth) from June 94 (A1) until August (A28) at station A, in a *Zostera noltii* seagrass bed of the Mira estuary. **The larger triangles correspond to a higher percentage during the sampling period**



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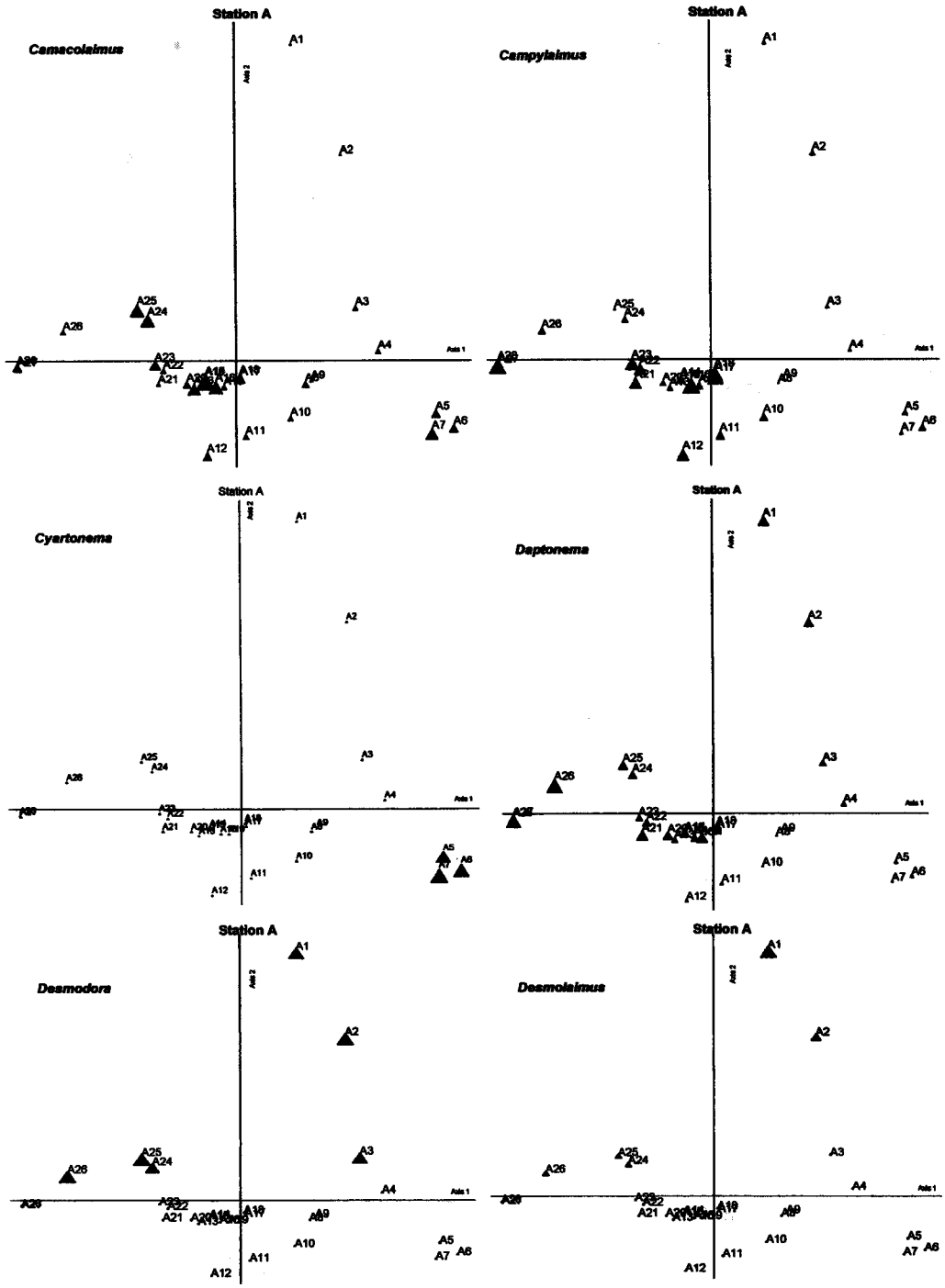

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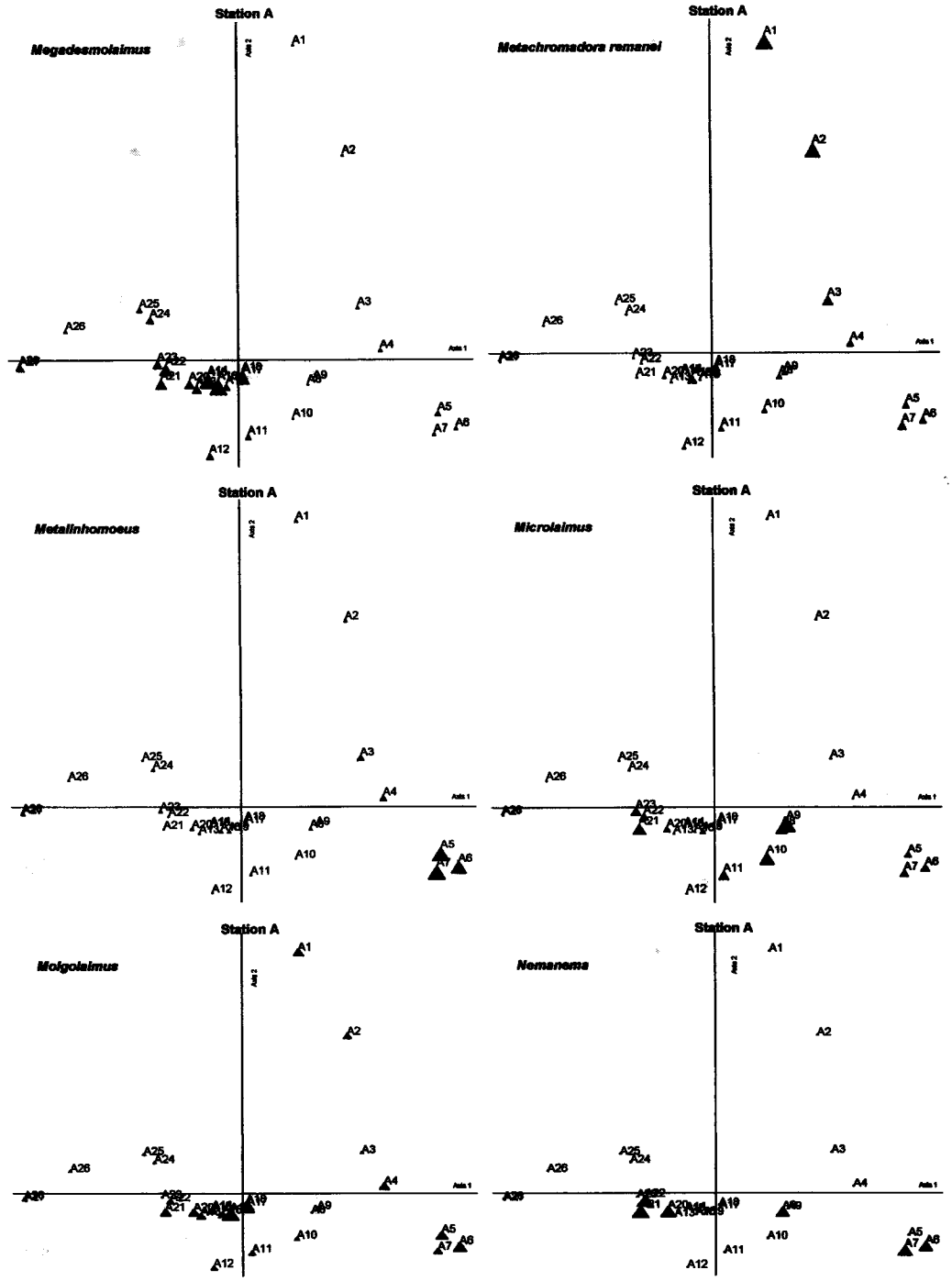

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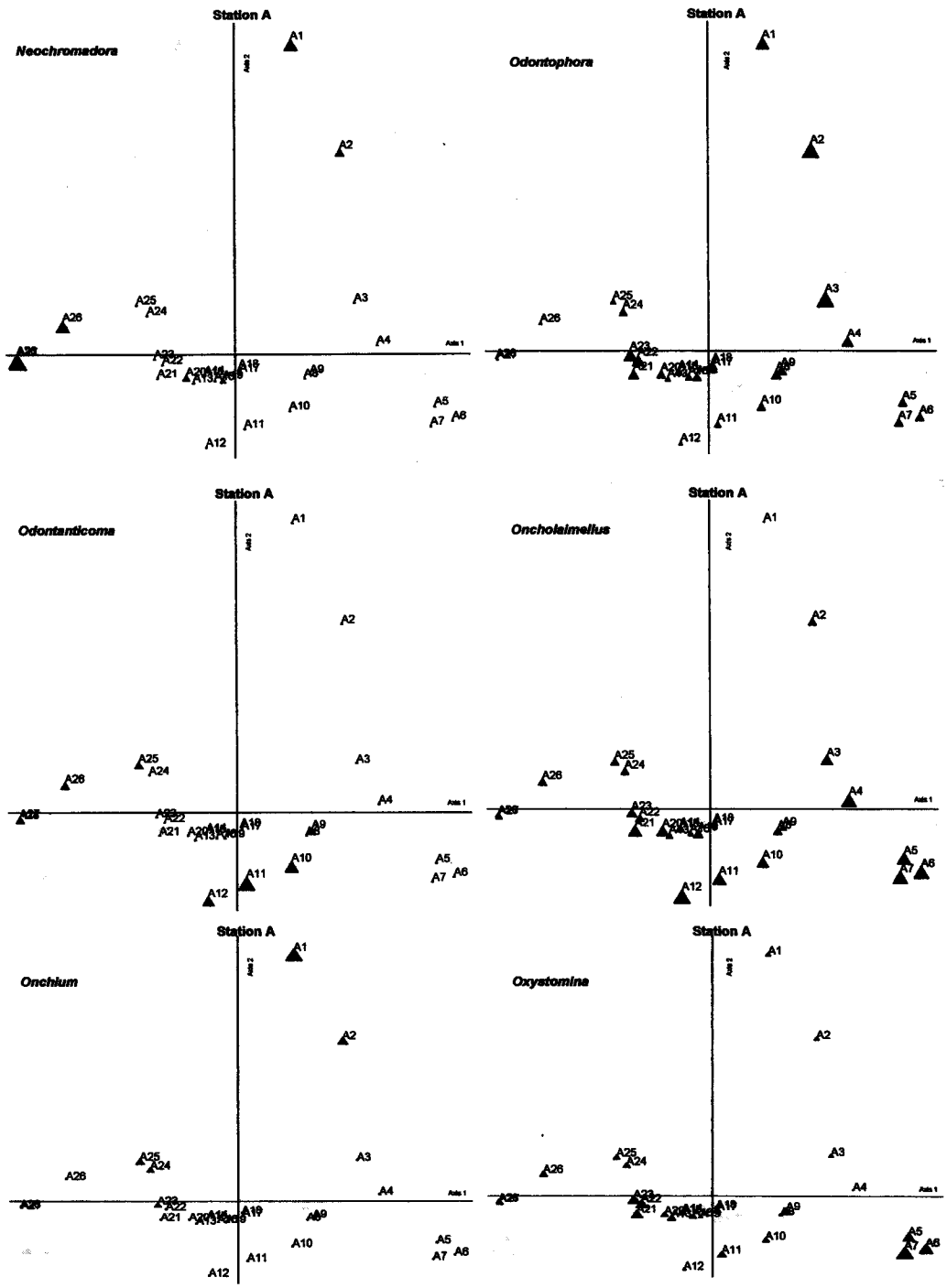

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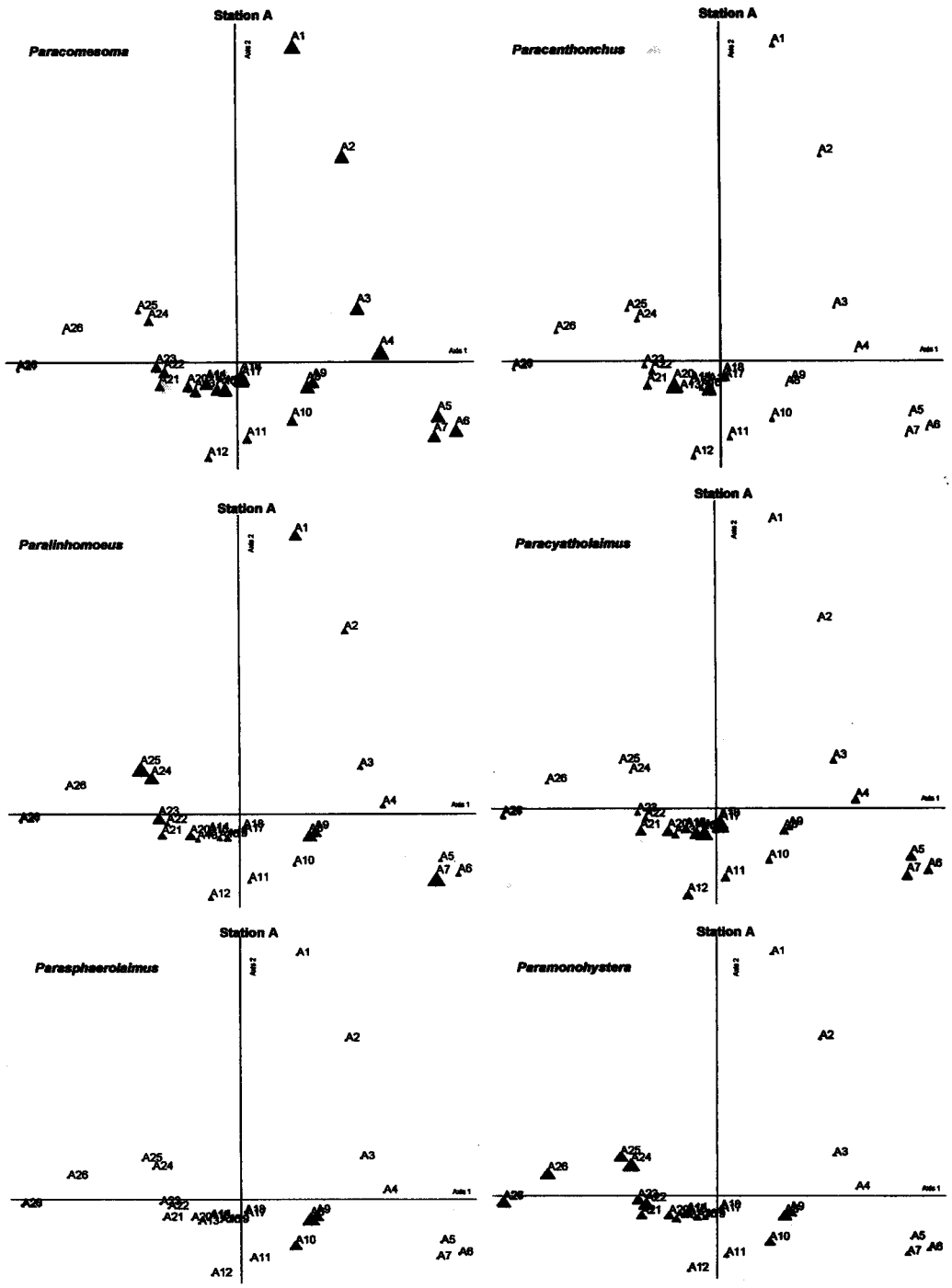

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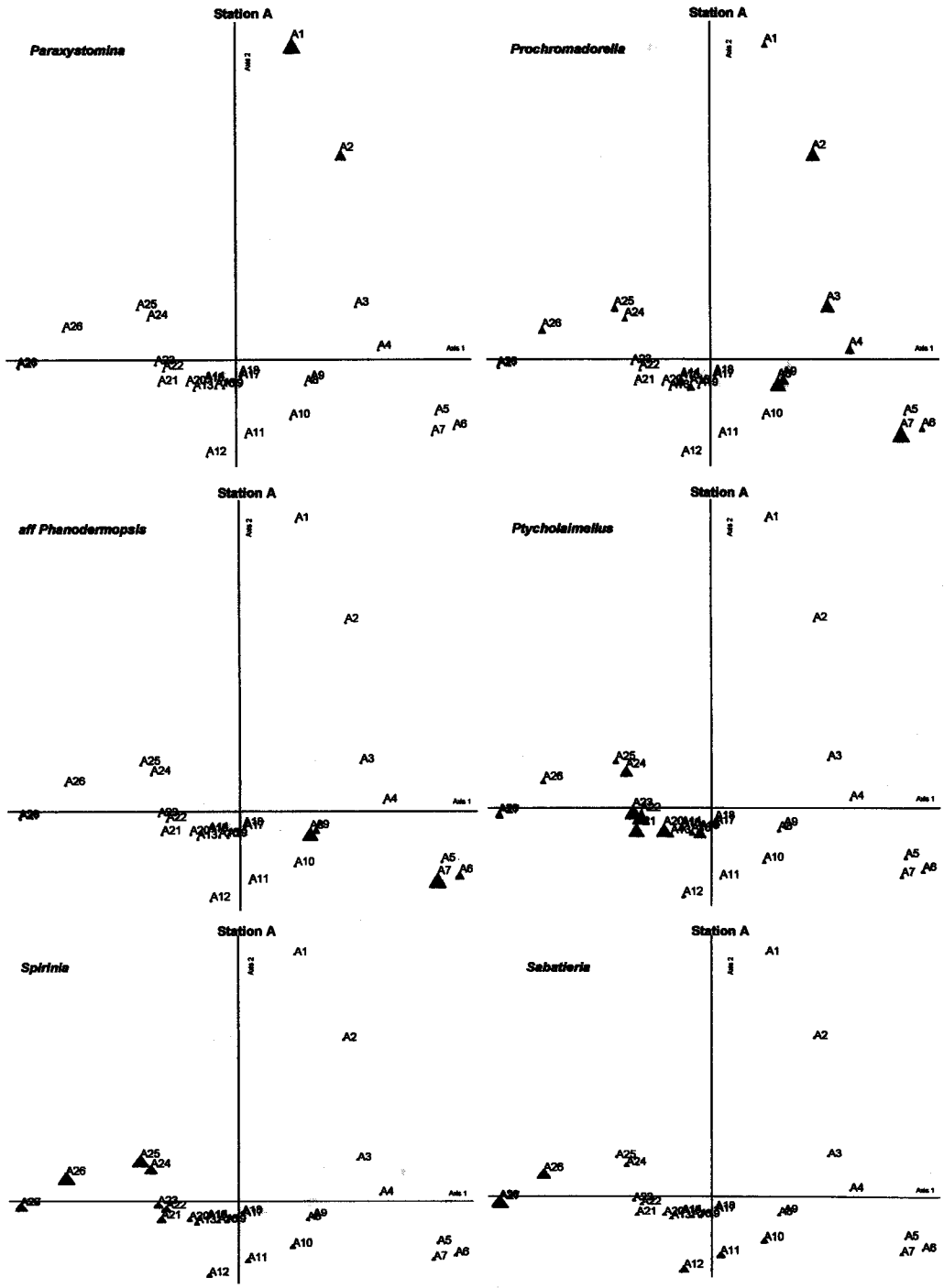

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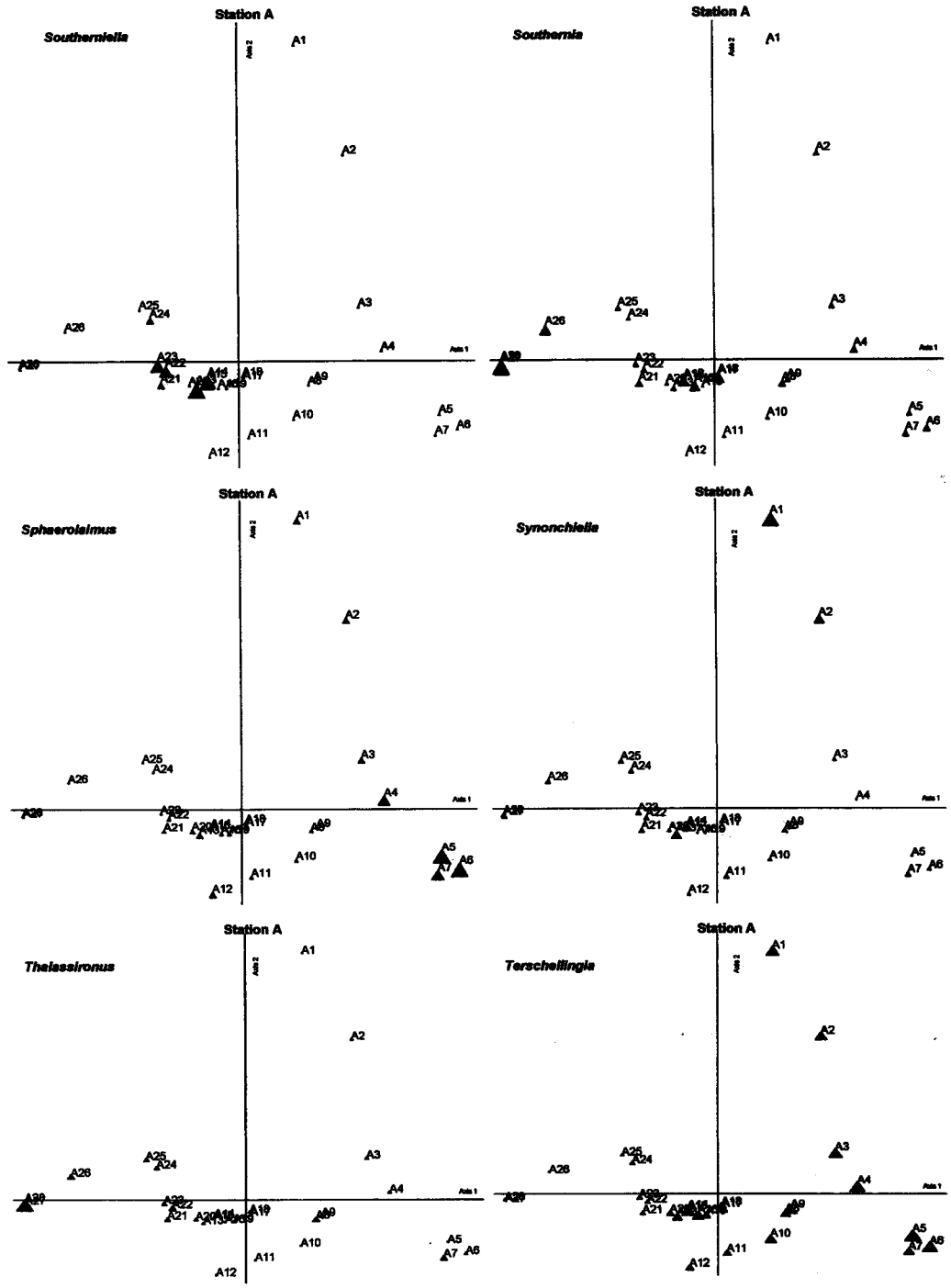

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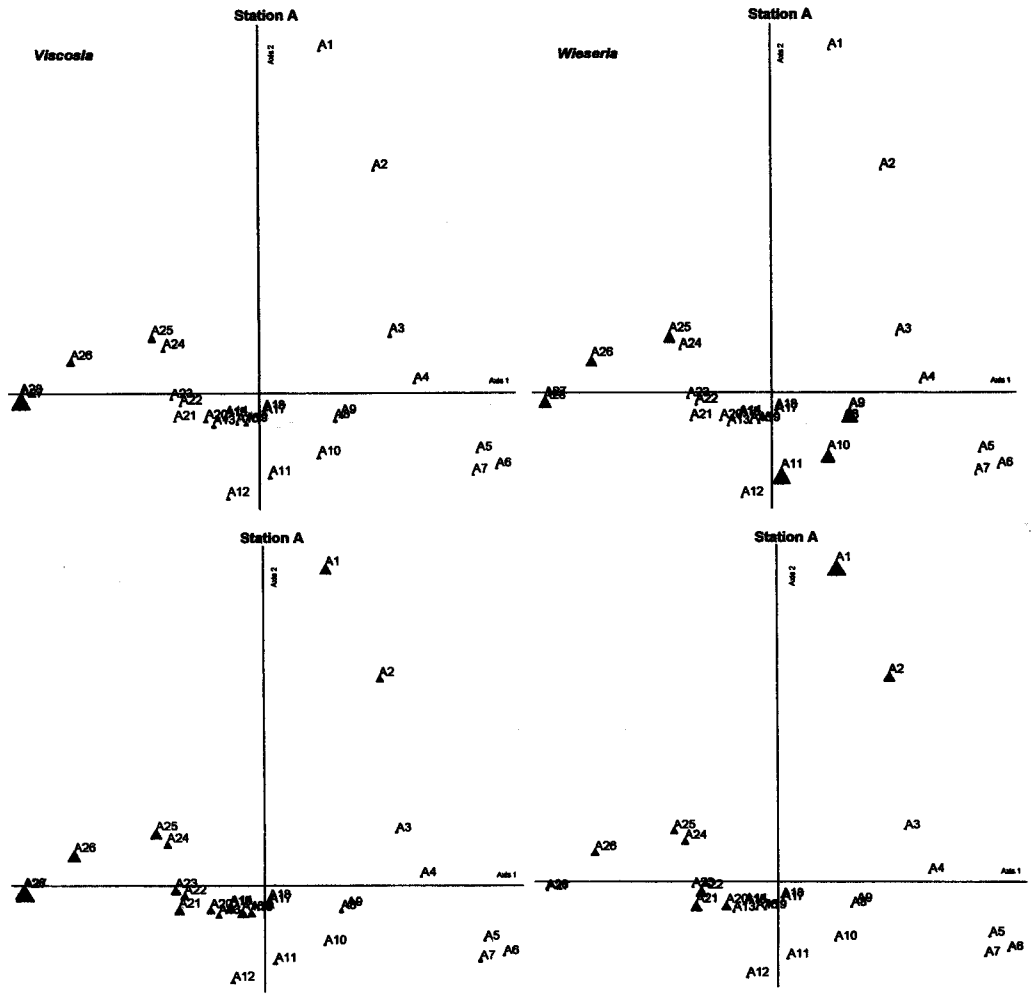

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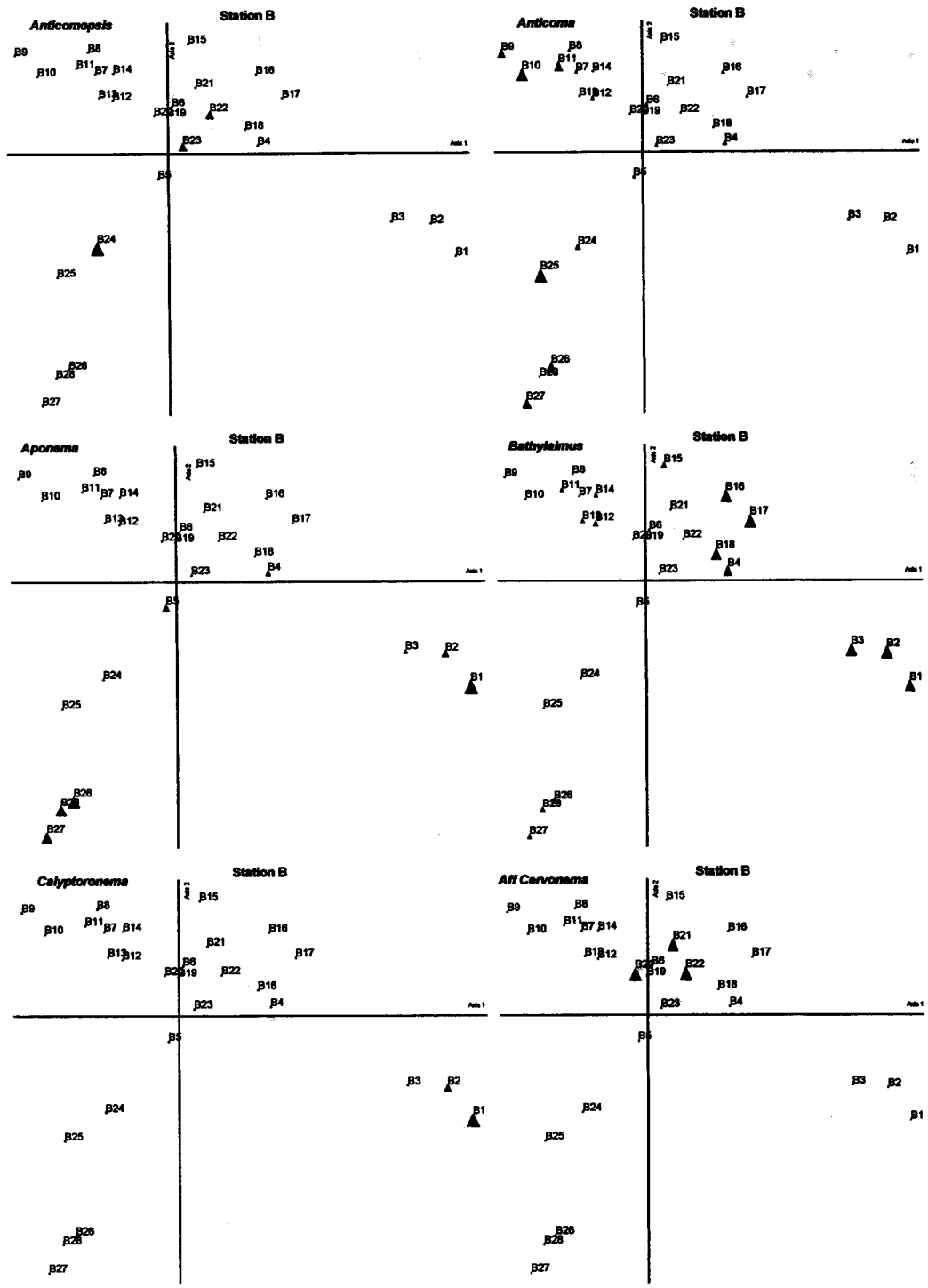
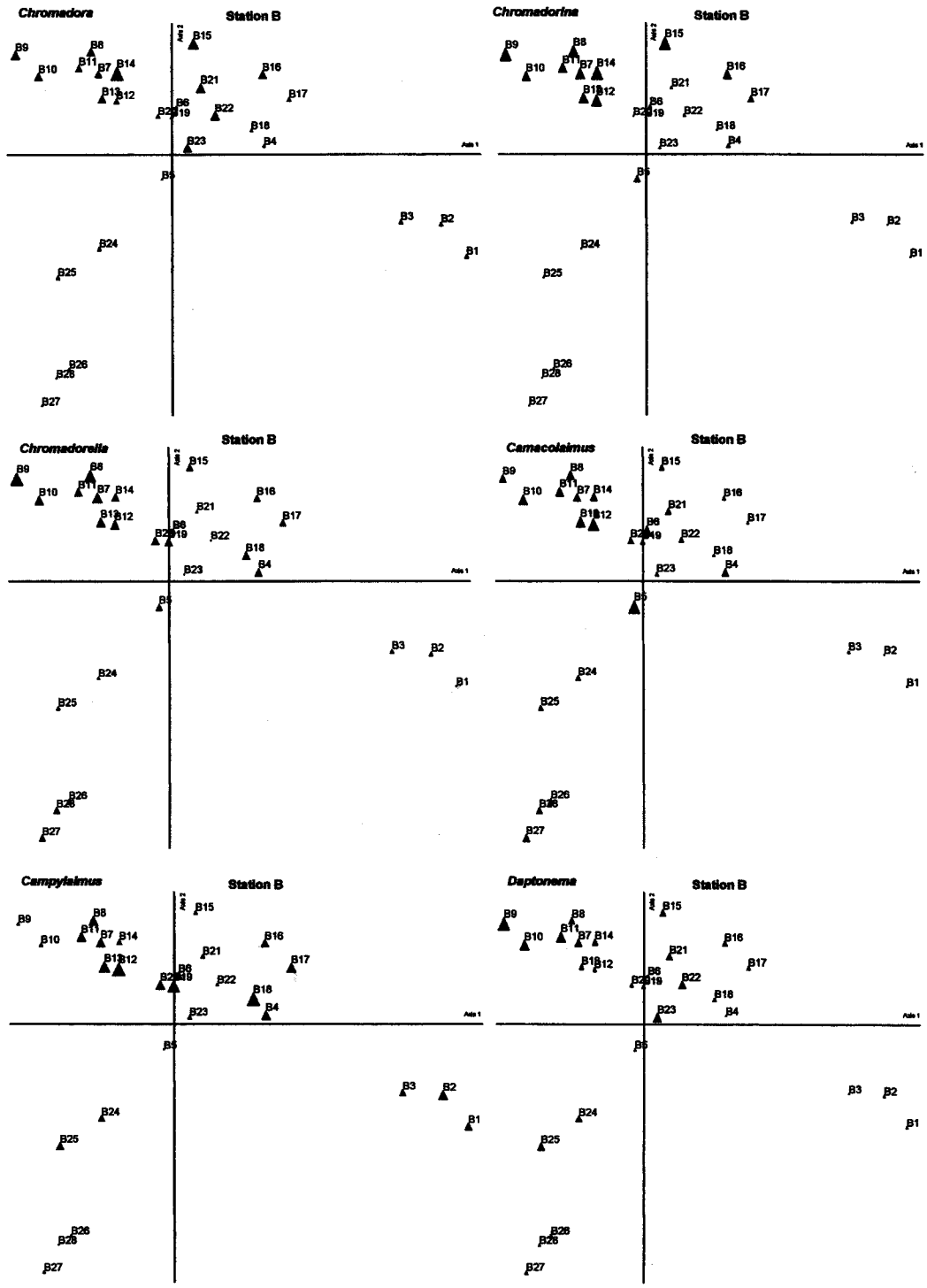


Results of the PCA-ordination based on fortnightly variation of Nematoda genera, which registered the lowest relative percentage (0-10 cm sediment depth) from June 94 (A1) until August (A28) at station B, in a *Zostera noltii* seagrass bed of the Mira estuary. **The larger triangles correspond to a higher percentage during the sampling period.**



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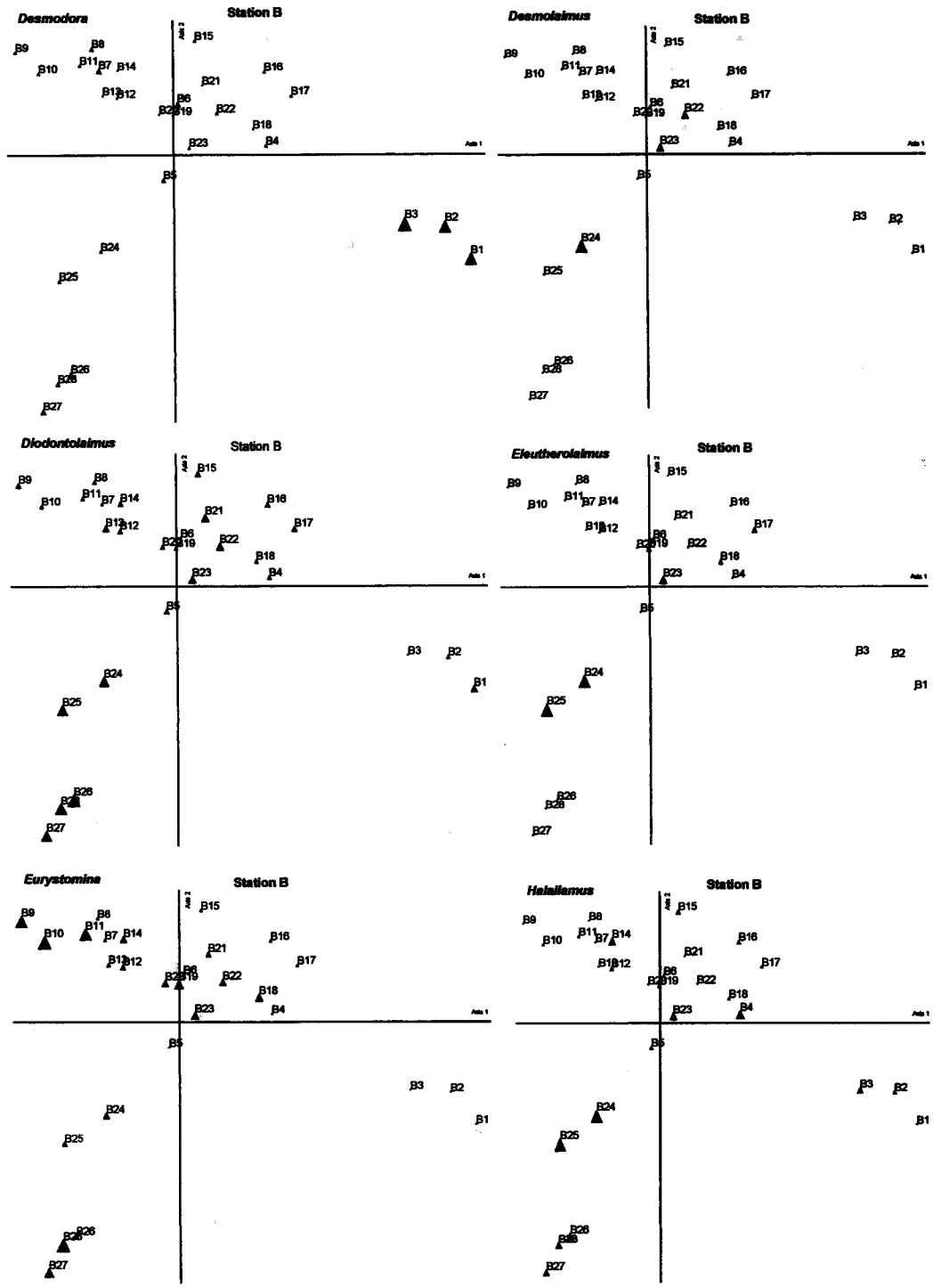

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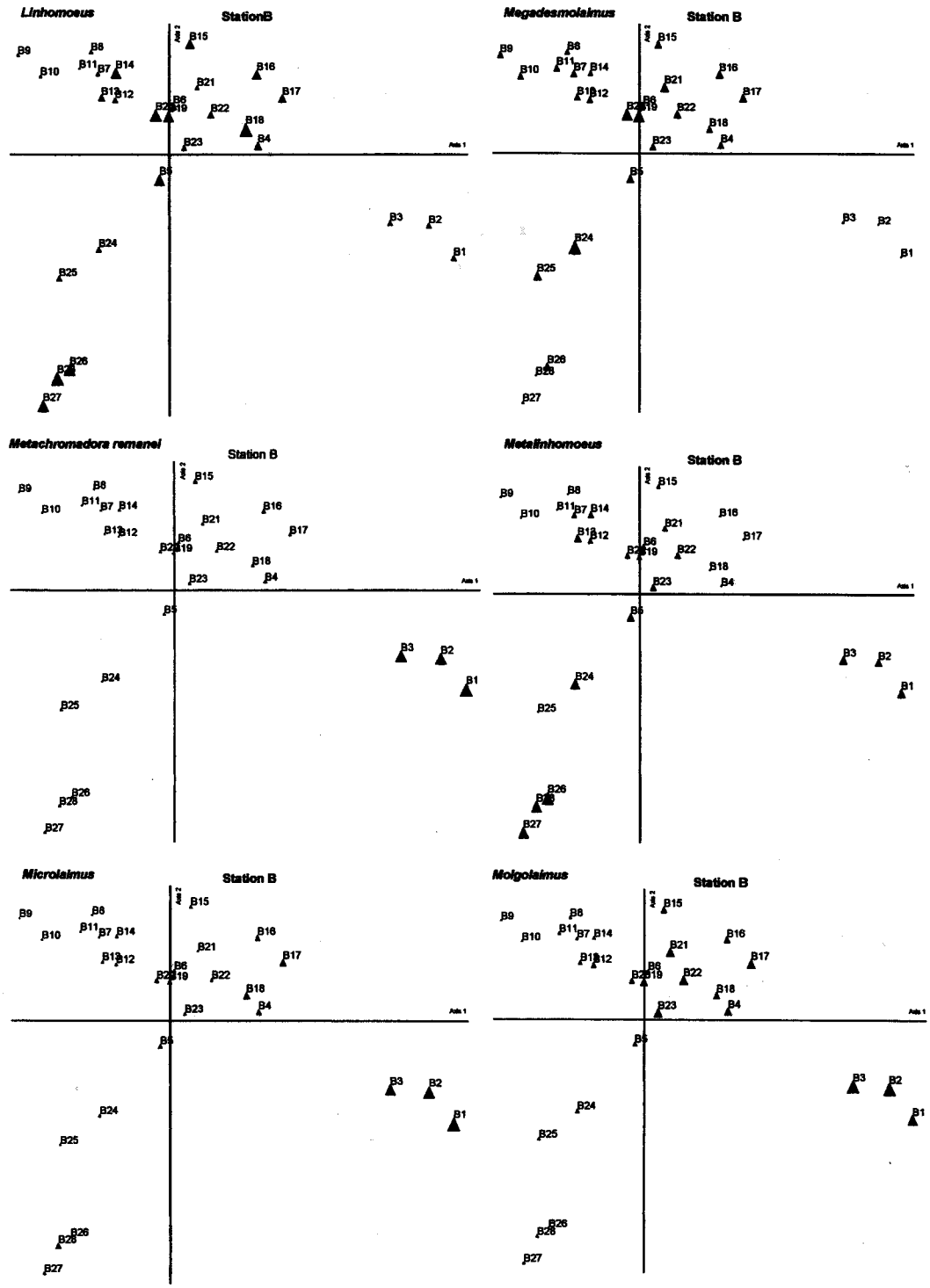

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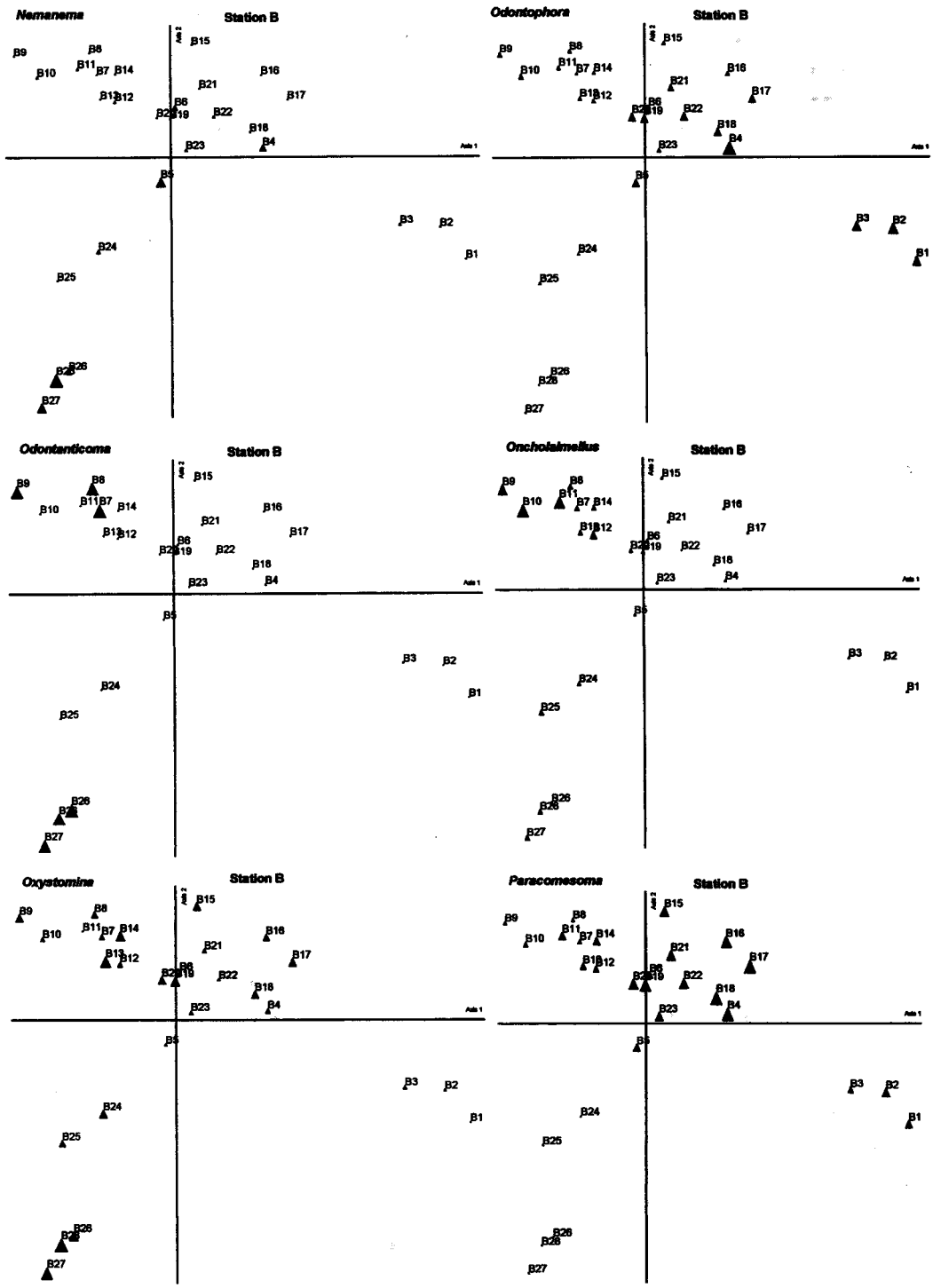

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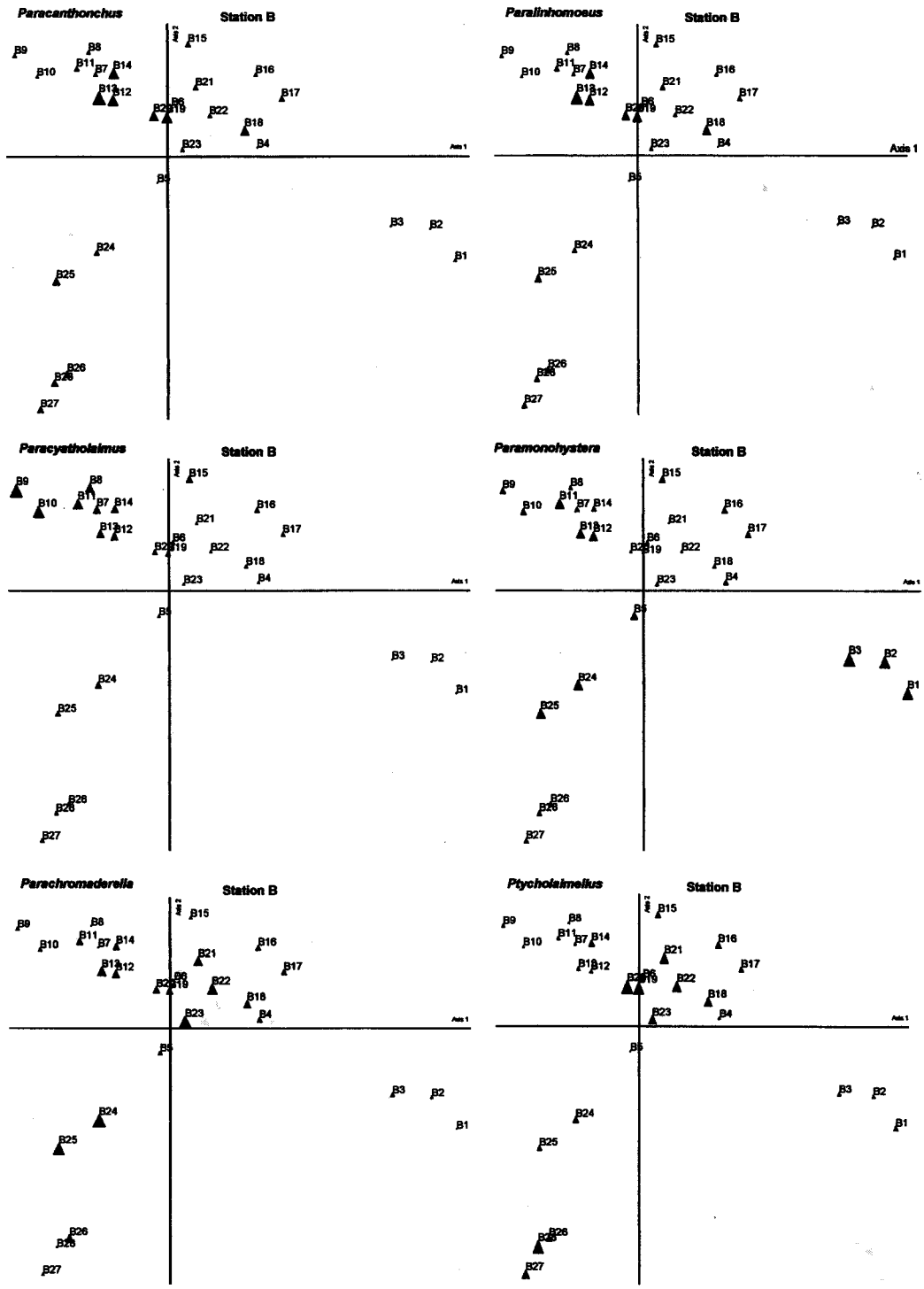

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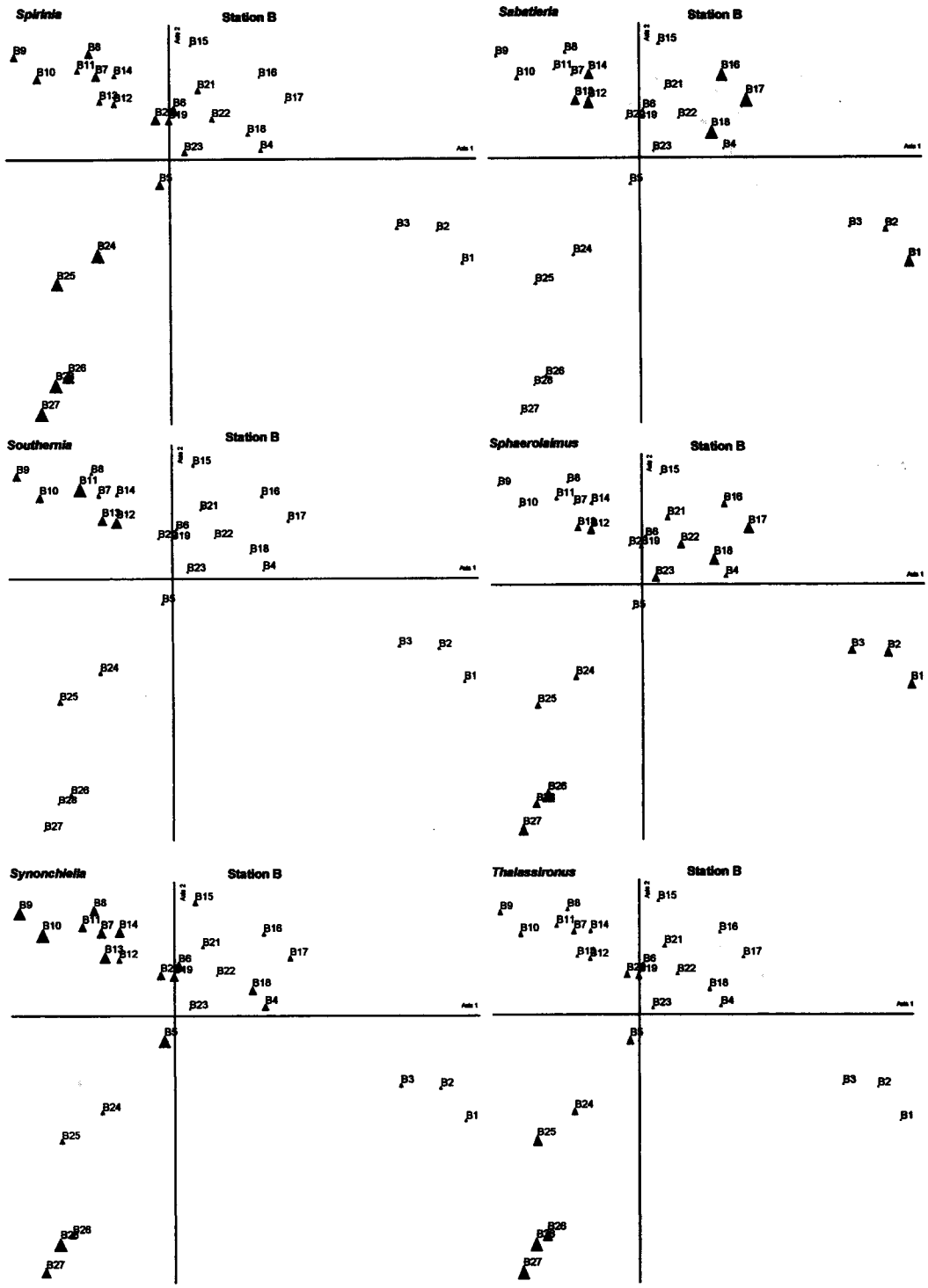

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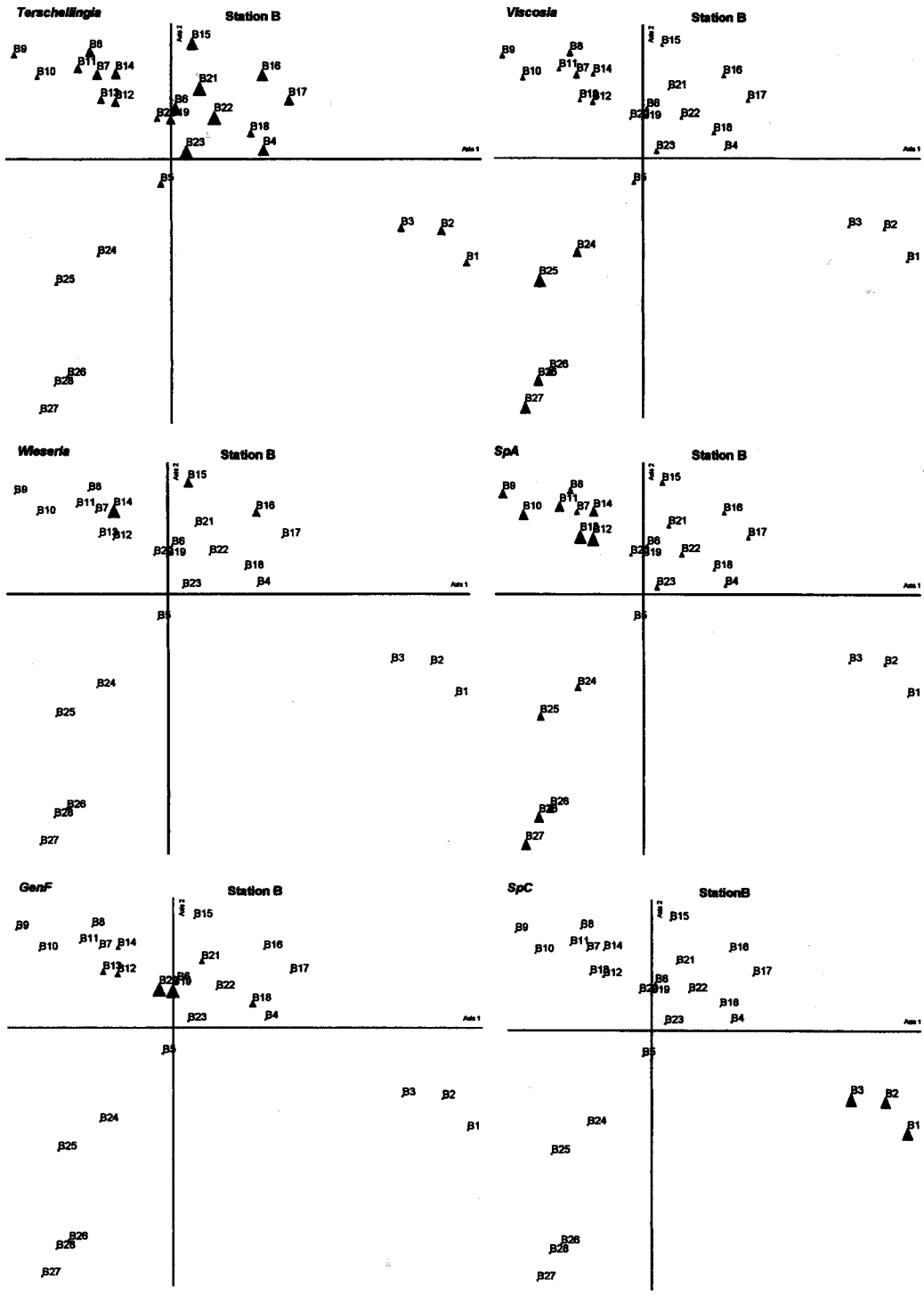

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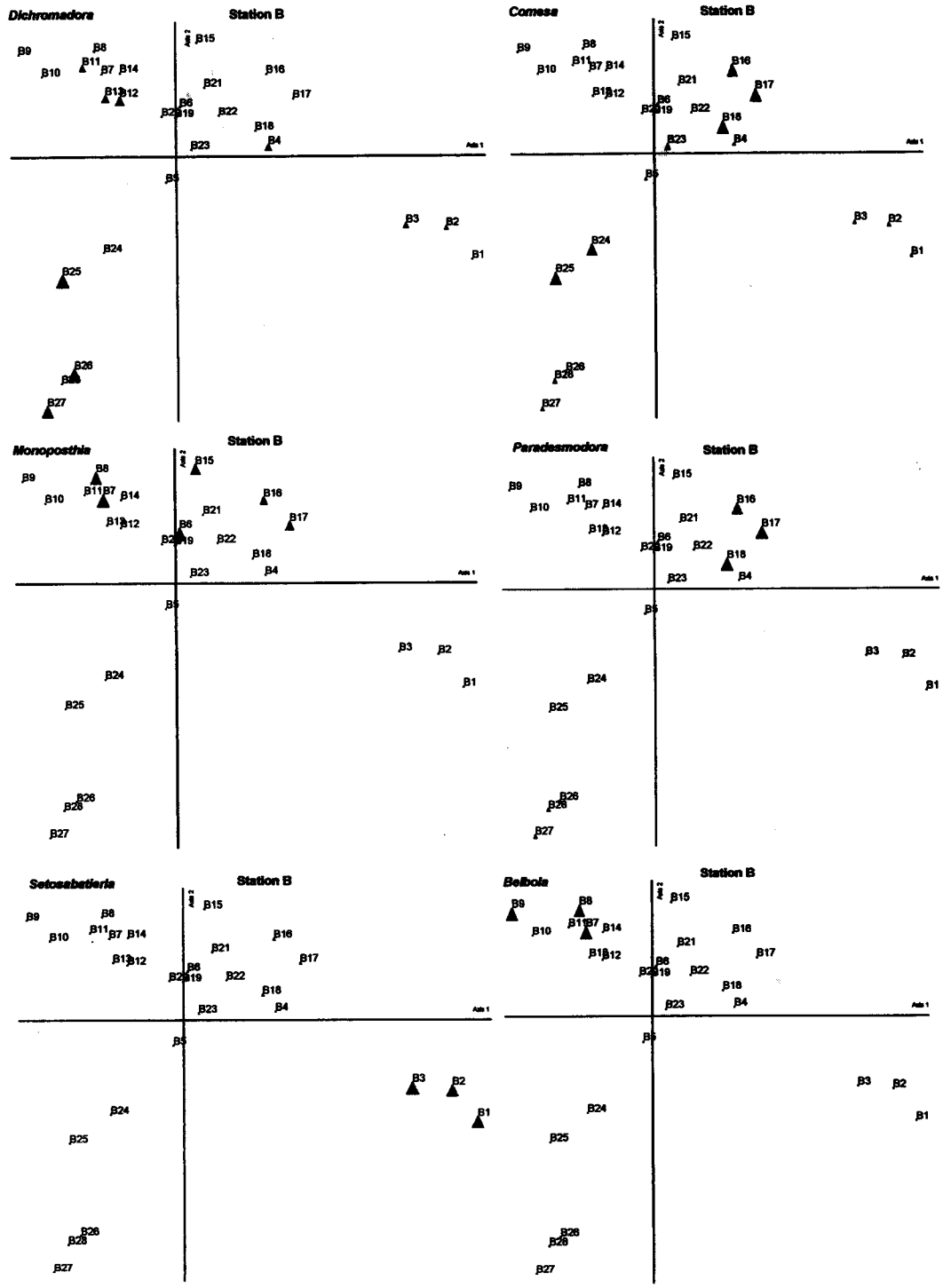

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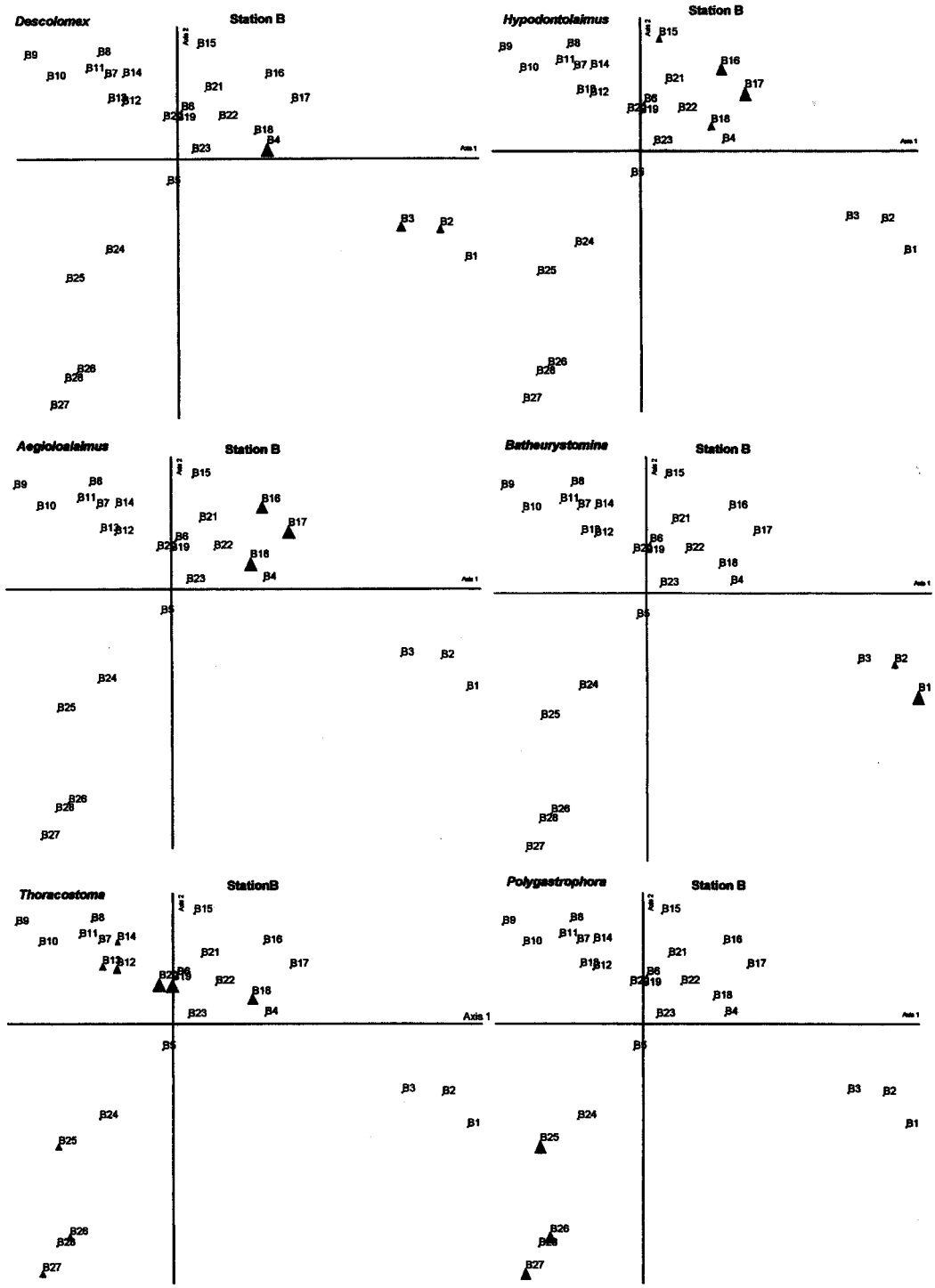

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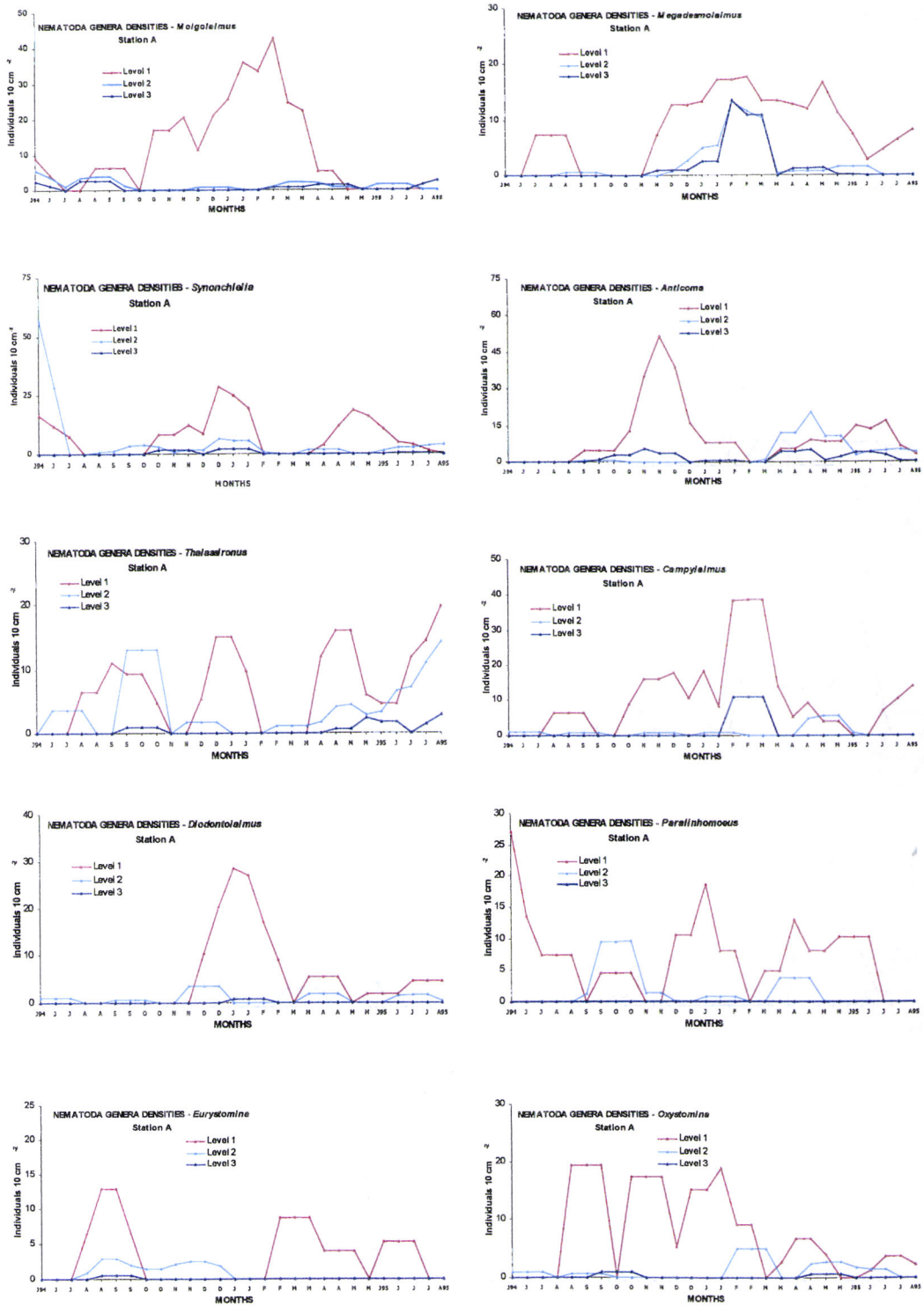
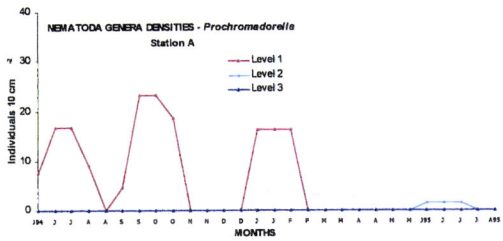
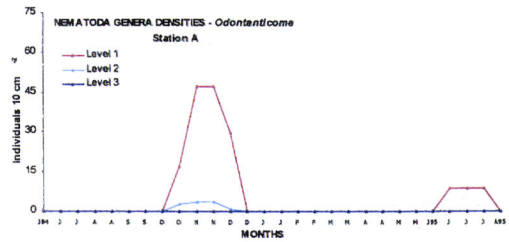
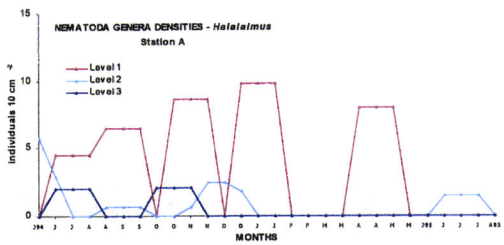
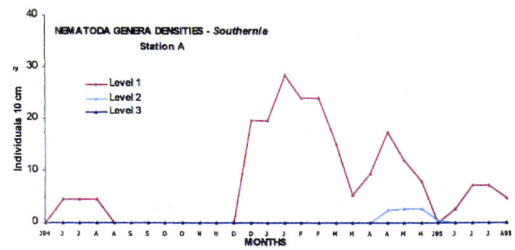


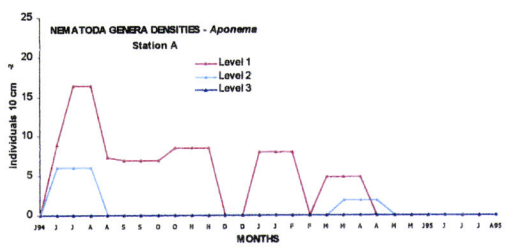
Temporal and vertical variations of the Nematoda genera, which registered the lowest densities at the three depths: level 1 (0-3 cm), level 2 (3-6 cm) and level 3 (6-10 cm), at station A.

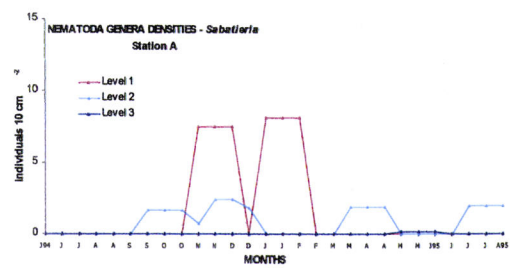


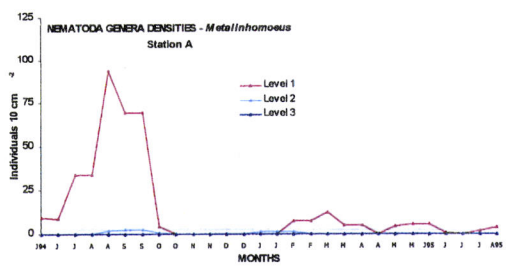


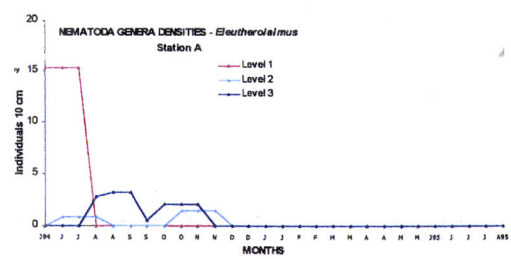


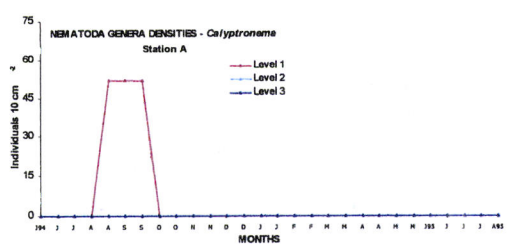


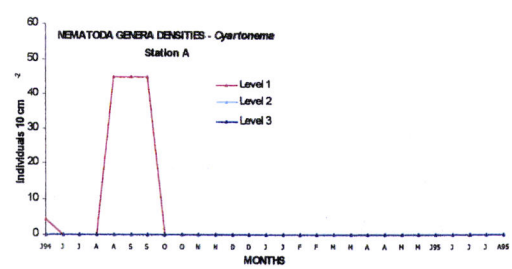




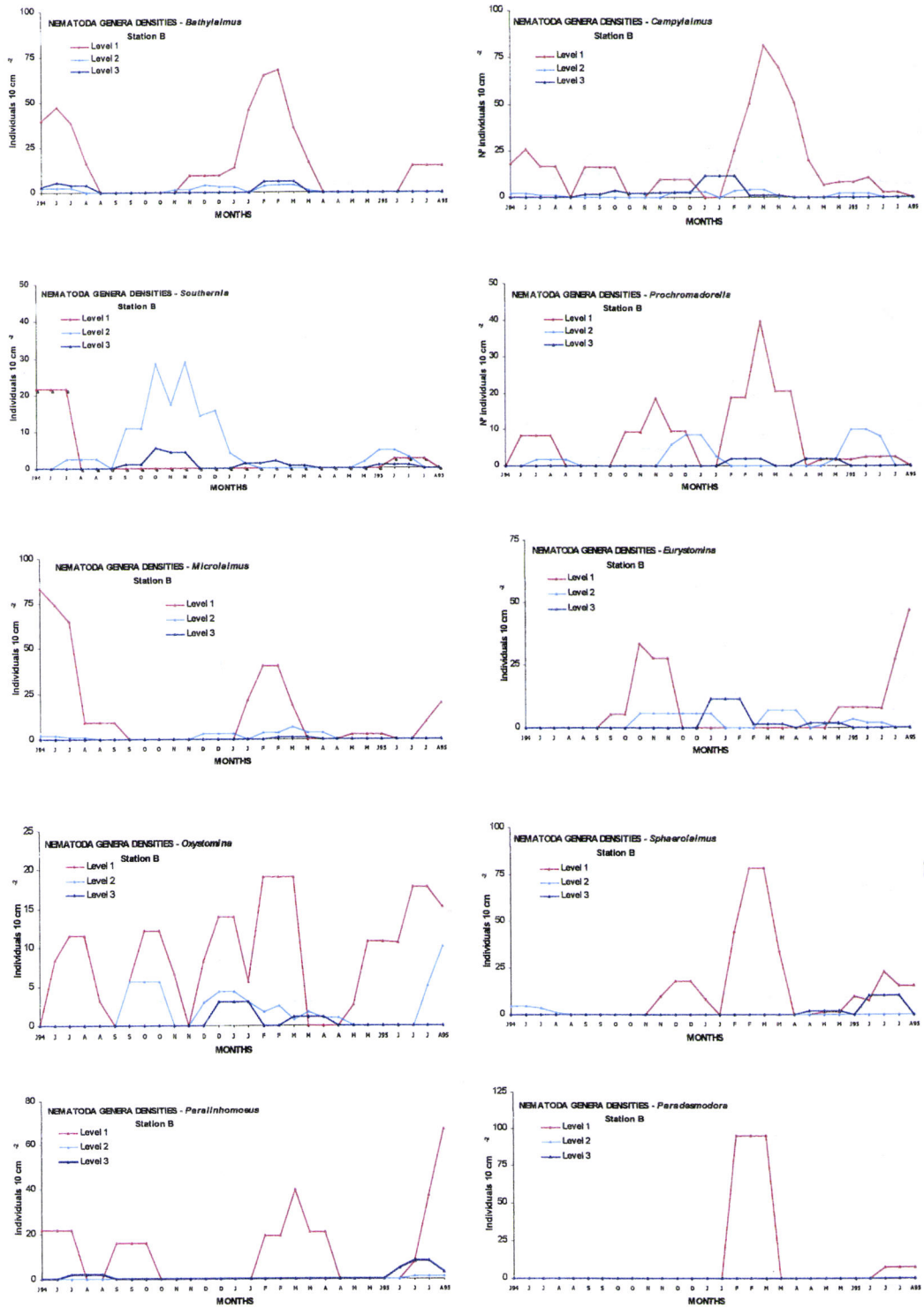




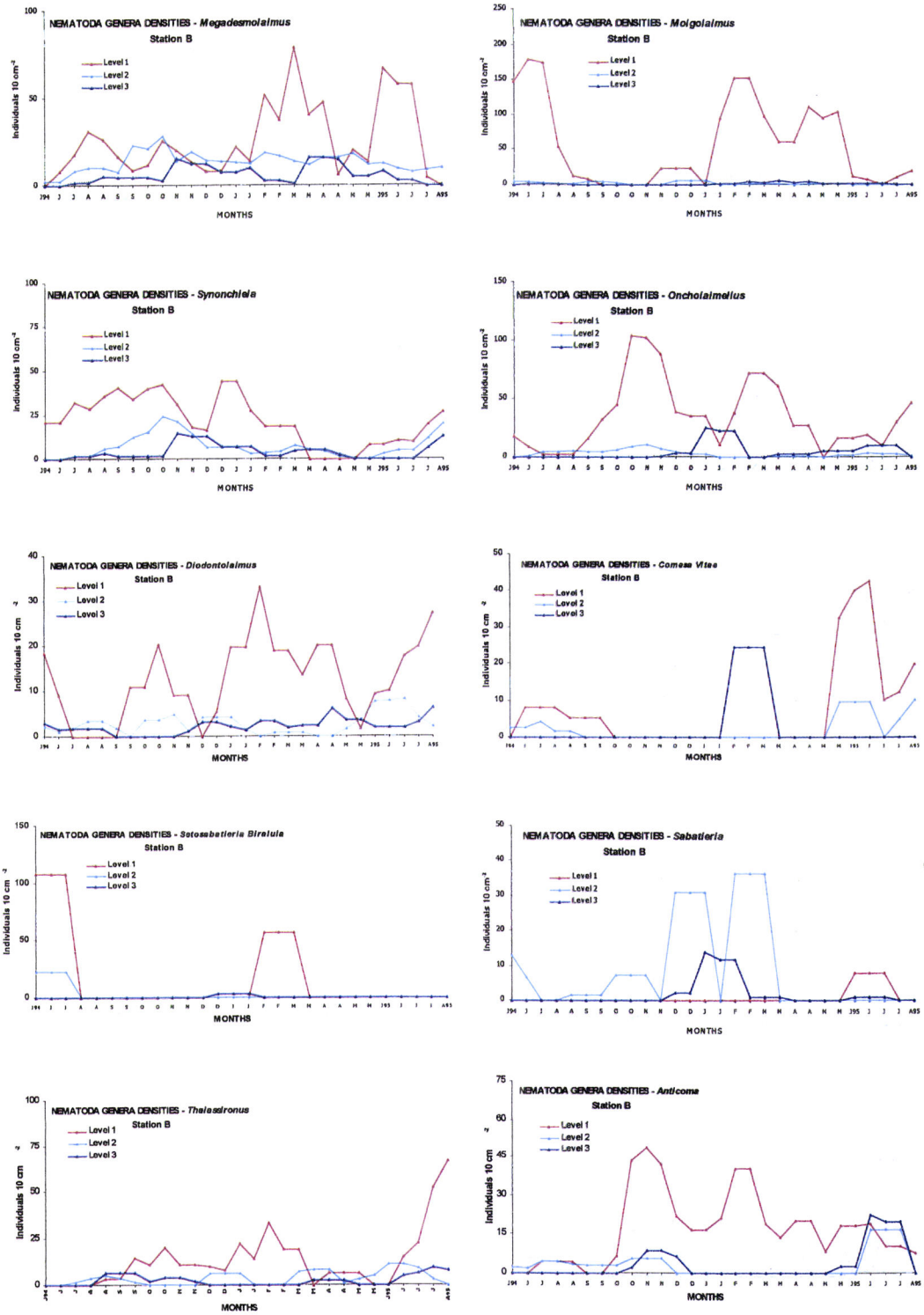




Temporal and vertical variations of the Nematoda genera, which registered the lowest densities at the three depths: level 1 (0-3 cm), level 2 (3-6 cm) and level 3 (6-10 cm), at station A.



Temporal and vertical variations of the Nematoda genera, which registered the lowest densities at the three depths: level 1 (0-3 cm), level 2 (3-6 cm) and level 3 (6-10 cm), at station B.



Temporal and vertical variations of the Nematoda genera, which registered the lowest densities at the three depths: level 1 (0-3 cm), level 2 (3-6 cm) and level 3 (6-10 cm), at station B.

Results of Spearman correlation between forthnightly Nematoda densities and sediment organic matter content, nutrients concentration (ammonium, nitrate, nitrite, silicate and phosphate), granulometry (clay, silt, sand and median grain size), and leaves and roots **biomass of *Zostera noltii***, at station B. Ns: not significant; -: significantly negative ($p \leq 0.05$); –: highly significant negative ($0.05 < p \leq 0.01$); —: very highly significant negative ($0.001 < p \leq 0.01$); +: significant positive ($p \leq 0.05$); ++: highly significant positive ($0.05 < p \leq 0.01$); +++: very highly significant positive ($0.01 < p \leq 0.001$).

Nematoda	OM	NH4	NO_3	NO_2	PO_4	Si	Clay	Silt	Sand	GS	Leaves	Roots
Terschellingia	(—)	ns	ns	ns	ns	(-)	ns	ns	ns	ns	(+)	ns
Paracomesoma	ns	ns	(+)	ns	ns	ns	ns	ns	ns	ns	(—)	ns
Odontophora	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	(+)
Spirinia	ns	ns	(–)	ns	(+)	ns	ns	ns	ns	ns	ns	(+)
Chromadorella	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	(–)	(-)
Linhomoeus	ns	ns	ns	ns	ns	ns	(–)	(-)	(+)	(+)	(-)	ns
Daptonema	ns	ns	ns	ns	ns	(–)	ns	ns	ns	ns	(–)	ns
Paramonohystera	(-)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Chromadorina	ns	ns	(++)	ns	ns	(–)	ns	ns	ns	ns	(-)	ns
Paracyatholaimus	ns	ns	(+)	(+)	ns	(-)	ns	ns	ns	ns	(–)	ns
Viscosia	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	(+++)
Chromadora	ns	ns	(–)	ns	ns	(—)	ns	ns	ns	ns	(–)	ns
Camacolaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	(-)	ns
Ptycholaimellus	ns	ns	ns	ns	(++)	ns	(-)	ns	(+)	ns	(–)	ns
Oncholaimellus	ns	(+)	ns	ns	ns	ns	ns	ns	ns	ns	(-)	ns
Bathylaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Southernia	ns	ns	ns	ns	ns	ns	(–)	(-)	(+)	(+)	ns	ns
Metachromodora	ns	ns	ns	ns	ns	ns	(—)	(—)	(++)	(+++)	ns	ns
Anticoma	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Synonchiella	ns	ns	ns	ns	ns	ns	(-)	ns	ns	ns	ns	ns
Sphaerolaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Megadesmolaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Molgolaimus	ns	ns	ns	ns	ns	ns	(–)	ns	(+)	(+)	ns	ns
Thalassironus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	(—)	ns
Paracanthonchus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Metalinhomoeus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Campylaimus	(++)	ns	ns	(+++)	(++)	ns	(-)	(-)	(+)	(+)	(—)	ns
Paralinhomoeus	ns	ns	(-)	ns	ns	(+)	ns	ns	ns	ns	(+)	ns
Oxystomina	(+)	ns	ns	ns	ns	ns	(-)	ns	ns	ns	ns	(-)
Eurystomina	ns	ns	(–)	ns	ns	ns	ns	ns	ns	(+)	ns	ns
Odontanticoma	ns	ns	ns	ns	ns	ns	ns	(-)	(+)	(++)	ns	ns
Diodontolaimus	ns	ns	ns	ns	ns	ns	(-)	(–)	(++)	(++)	(–)	ns
Aponema	ns	ns	ns	ns	(+)	ns	ns	ns	ns	ns	(-)	ns
Halalaimus	ns	ns	(-)	ns	ns	ns	ns	ns	ns	ns	ns	(-)
Prochromadorella	ns	ns	ns	ns	(++)	ns	ns	ns	ns	ns	ns	(++)
Sabatieria	ns	ns	(-)	ns	ns	ns	ns	ns	ns	ns	(+++)	ns
Eleutherolaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Calyptoronema	ns	ns	(++)	(+)	ns	ns	ns	ns	ns	ns	(–)	ns
Cyartonema	ns	ns	(++)	(++)	ns	ns	(-)	(-)	(+)	(+)	ns	ns
Microlaimus	ns	(-)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Southerniella	ns	ns	ns	ns	ns	ns	(-)	ns	ns	ns	(+)	ns
Neochromodora	ns	ns	ns	ns	ns	ns	(-)	ns	ns	ns	ns	ns
Leptolaimus	ns	ns	ns	ns	ns	ns	(+)	ns	ns	(-)	ns	ns
Onchium	ns	ns	ns	(–)	ns	ns	ns	ns	ns	ns	ns	(+)
Desmolaimus	ns	ns	(+)	(+)	ns	(-)	ns	ns	ns	ns	(+++)	(+)
Acanthopharynx	ns	ns	ns	(-)	ns	ns	(+)	ns	ns	ns	(-)	ns
Desmodora	(+)	ns	ns	ns	ns	ns	ns	ns	ns	ns	(+)	ns
Wieseria	ns	ns	ns	ns	(-)	ns	ns	ns	ns	ns	(+)	ns
Chromaspirina	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	(+)	ns
Aff.Phanodermopsis	(+++)	ns	ns	(++)	ns	(++)	ns	ns	ns	ns	ns	ns
Parasphaerolaimus	ns	ns	(++)	ns	ns	ns	ns	ns	ns	ns	ns	ns
Nemanema	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Aff Cervonema	ns	ns	ns	ns	ns	ns	(—)	(–)	(++)	(++)	ns	ns
Antomicron	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Paroxystomina	ns	ns	ns	ns	(+)	(+)	ns	ns	ns	ns	ns	ns
Atrochromodora	ns	ns	ns	ns	ns	ns	(+)	ns	ns	(-)	(+)	(++)

Results of Spearman correlation between forthnightly Nematoda densities and water nutrients concentrations (ammonium, nitrate, nitrite, silicate and phosphate), temperature, pH, dissolved oxygen, and chorophyll *a*, at station B. Ns: not significant; -: significantly negative ($p \leq 0.05$); --: highly significant negative ($0.05 < p \leq 0.01$); ---: very highly significant negative ($0.001 < p \leq 0.01$); +: significantly positive ($p \leq 0.05$); ++: highly significant positive ($0.05 < p \leq 0.01$); +++: very highly significant positive ($0.01 < p \leq 0.001$).

Nematoda	NH_4	NO_3	NO_2	PO_4	Si	Temp	pH	DO	Sal	cla
Terschellingia	(+)	ns	ns	(++)	ns	(---)	ns	ns	(---)	(--)
Paracomesoma	ns	ns	ns	ns	ns	ns	(+)	ns	ns	(---)
Odontophora	ns	ns	ns	ns	ns	ns	ns	ns	ns	(-)
Spirinia	ns	ns	ns	(-)	(-)	(+)	(+)	(+)	(+)	ns
Chromadorella	ns	ns	ns	ns	ns	(---)	(+)	ns	(-)	ns
Linhomoeus	ns	ns	ns	(---)	(---)	ns	(+++)	(+++)	ns	(---)
Daptonema	ns	(--)	(+)	(-)	ns	ns	ns	ns	ns	(-)
Paramonohystera	ns	ns	ns	(+)	ns	ns	ns	ns	ns	ns
Chromadorina	ns	ns	ns	ns	ns	(---)	ns	ns	(---)	ns
Paracyatholaimus	(+)	ns	ns	ns	ns	(---)	ns	ns	ns	ns
Viscosia	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Chromadora	ns	ns	ns	ns	ns	(--)	ns	ns	ns	(-)
Camacolaimus	ns	ns	ns	ns	ns	(-)	ns	ns	(--)	ns
Ptycholaimellus	ns	ns	ns	(---)	(---)	ns	(+++)	(++)	(+++)	(---)
Oncholaimellus	(+)	ns	ns	ns	ns	(-)	ns	ns	ns	ns
Comesa	(-)	ns	ns	ns	ns	ns	ns	ns	ns	ns
Setosabatieria	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Bathylaimus	ns	ns	(-)	ns	ns	ns	ns	ns	ns	ns
Southernia	ns	ns	ns	(+)	(+)	(-)	(--)	(--)	(-)	(+)
Metachromadora	(--)	ns	ns	ns	ns	ns	(+)	ns	ns	(--)
Anticoma	ns	ns	ns	ns	ns	ns	ns	(--)	ns	ns
Synonchiella	ns	ns	ns	ns	ns	ns	(+)	ns	ns	ns
Sphaerolaimus	ns	ns	ns	ns	(-)	ns	ns	ns	(++)	(-)
Megadesmolaimus	ns	ns	(+)	(---)	(---)	ns	(++)	(+)	ns	(--)
Molgolaimus	(-)	ns	ns	ns	ns	ns	ns	ns	ns	(---)
Thalassironus	ns	ns	ns	ns	(-)	ns	ns	ns	ns	ns
Paracanthonchus	ns	ns	ns	(---)	(---)	ns	(+++)	(+)	ns	(---)
Metalinhomoeus	ns	ns	(--)	ns	ns	(+++)	ns	ns	(++)	ns
Campylaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Paralinhomoeus	(--)	ns	ns	ns	ns	(++)	(+)	ns	(+)	ns
Paradesmodora	ns	ns	ns	ns	(---)	ns	(++)	ns	ns	ns
Oxystomina	ns	ns	ns	(---)	(---)	ns	(+++)	(++)	ns	ns
Eurystomina	(++)	ns	ns	(--)	(--)	ns	(++)	ns	ns	ns
Odontanticoma	ns	ns	ns	ns	ns	ns	ns	ns	ns	(++)
Diodontolaimus	ns	ns	ns	(---)	(---)	ns	(+)	ns	(+++)	(---)
Aponema	(--)	ns	(--)	(+)	ns	(+++)	ns	ns	ns	ns
Halalaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Prochromadorella	ns	ns	(+)	(--)	(-)	ns	ns	ns	ns	(---)
Sabatieria	ns	ns	ns	ns	ns	(--)	ns	ns	ns	ns
Eleutherolaimus	ns	ns	(++)	ns	(-)	ns	ns	ns	(+)	ns
Calyptoronema	(-)	ns	ns	(+)	ns	(+)	ns	ns	ns	ns
Microlaimus	(--)	ns	ns	ns	ns	ns	ns	ns	ns	ns
Desmolaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Desmodora	(-)	ns	ns	(+)	ns	ns	ns	ns	ns	(+)
Wieseria	ns	ns	ns	ns	ns	(--)	ns	ns	ns	ns
Nemanema	ns	(+)	ns	ns	ns	(+)	ns	ns	ns	ns
Dichromadora	ns	(+)	ns	ns	ns	ns	ns	ns	ns	ns
Desmoscolex	(-)	ns	ns	(+)	(+)	ns	ns	ns	ns	ns
Monoposthia	ns	(-)	ns	ns	ns	(--)	ns	ns	ns	ns
Thoracostoma	ns	ns	ns	ns	(-)	ns	ns	ns	ns	ns
Aegialoalaimus	ns	ns	ns	ns	(-)	(-)	(+)	ns	ns	ns
Belbolla	ns	(-)	ns	ns	ns	ns	ns	ns	ns	(+)
Bathyeurystomina	(-)	ns	ns	ns	ns	ns	ns	ns	ns	ns
Aff Cervonema	ns	ns	ns	(--)	ns	ns	ns	ns	ns	(--)
Polygastrophora	ns	ns	ns	ns	ns	(+)	ns	ns	(+)	ns
Anticomopsis	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Results of Spearman correlation between forthnightly Nematoda densities and sediment organic matter content, nutrients concentration (ammonium, nitrate, nitrite, silicate and phosphate), granulometry (clay, silt, sand and median grain size), and leaves and roots **biomass of *Zostera noltii***, at station A. Ns: not significant; -: significantly negative ($p \leq 0.05$); --: highly significant negative ($0.05 < p \leq 0.01$); ---: very highly significant negative ($0.001 < p \leq 0.01$); +: significantly positive ($p \leq 0.05$); ++: highly significant positive ($0.05 < p \leq 0.01$); +++: very highly significant positive ($0.01 < p \leq 0.001$).

Nematoda	OM	NH4	NO_3	NO_2	PO_4	Si	Clay	Silt	Sand	GS	Leaves	Roots
Terschellingia	---	ns	+	ns	---	ns	--	-	++	+	+	ns
Paracomesoma	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Odontophora	---	-	+	ns	---	ns	---	ns	+	ns	ns	ns
Spirinia	+++	+	ns	ns	+++	---	ns	ns	ns	ns	++	+++
Chromadorella	ns	ns	+	ns	ns	ns	-	---	+++	+++	ns	+
Linhomoeus	ns	-	+++	ns	--	ns	---	-	++	++	ns	ns
Daptonema	ns	ns	ns	+++	ns	ns	ns	ns	ns	ns	ns	ns
Paramonohystera	ns	++	++	ns	ns	--	ns	ns	ns	ns	ns	+
Chromadorina	ns	ns	++	ns	ns	ns	--	---	+++	+++	-	ns
Paracyatholaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Viscosia	++	ns	ns	ns	+	---	ns	ns	ns	ns	ns	ns
Chromadora	ns	ns	+	ns	ns	ns	---	---	+++	+++	-	ns
Camacolaimus	ns	ns	ns	ns	ns	ns	ns	---	++	++	--	ns
Ptycholaimellus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Oncholaimellus	-	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Bathylaimus	---	-	ns	ns	--	ns	---	ns	++	+	ns	ns
Southernia	ns	+	ns	ns	ns	ns	ns	ns	ns	ns	-	ns
Metachromodora	---	-	ns	+	---	ns	-	ns	ns	ns	ns	-
Anticoma	+++	ns	ns	ns	+++	-	ns	ns	ns	ns	++	+++
Synonchiella	ns	ns	++	ns	ns	ns	ns	ns	ns	ns	ns	ns
Sphaerolaimus	ns	ns	ns	ns	---	++	ns	ns	ns	ns	---	-
Megadesmolaimus	ns	ns	ns	ns	ns	ns	ns	--	+	++	-	+
Molgolaimus	-	ns	ns	++	-	ns	ns	-	+	+	---	ns
Thalassironus	ns	ns	ns	-	ns	ns	ns	+	-	ns	ns	ns
Paracanthonchus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Metalinhomoeus	---	ns	ns	ns	---	++	ns	ns	ns	ns	ns	ns
Campylaimus	ns	ns	++	ns	ns	ns	ns	-	ns	ns	ns	+
Paralinhomoeus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Oxystomina	-	ns	+++	ns	ns	ns	ns	ns	ns	ns	ns	ns
Eurystomina	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Odontanticoma	ns	ns	ns	ns	+	---	ns	ns	ns	ns	+	++
Diodontolaimus	ns	ns	ns	+	ns	ns	ns	ns	ns	ns	ns	ns
Aponema	-	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	-
Halalaimus	-	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Prochromadorella	--	ns	ns	ns	-	ns	ns	ns	ns	ns	ns	-
Sabatieria	+	++	ns	-	ns	---	ns	ns	ns	ns	ns	++
Eleutherolaimus	---	-	ns	ns	--	ns	ns	ns	ns	ns	ns	--
Calyptoronema	---	ns	ns	ns	ns	+	ns	ns	ns	ns	--	ns
Cyartonema	-	ns	ns	ns	ns	+	ns	ns	ns	ns	--	ns
Microlaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Southerniella	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	-	ns
Neochromodora	ns	ns	-	ns	ns	ns	ns	+	ns	ns	ns	ns
Leptolaimus	ns	ns	ns	ns	-	ns	ns	-	+	ns	ns	ns
Onchium	ns	ns	ns	ns	ns	ns	ns	+	-	ns	+	ns
Desmolaimus	ns	ns	ns	+	ns	ns	ns	ns	ns	ns	ns	ns
Acanthopharynx	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	+
Desmodora	ns	ns	ns	+	ns	ns	ns	+	ns	ns	ns	+
Wieseria	ns	ns	ns	ns	ns	---	ns	ns	ns	ns	ns	ns
Chromaspirina	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Aff.Phanodermopsis	ns	ns	ns	-	ns	ns	ns	ns	ns	ns	ns	ns
Parasphaerolaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Nemanema	ns	ns	ns	ns	ns	+	ns	ns	ns	ns	ns	ns
Aff Cervonema	-	ns	ns	ns	ns	+	ns	ns	ns	ns	++	ns
Antomicron	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Paroxystomina	ns	-	ns	+	-	ns	ns	ns	ns	ns	ns	++
Atrochromodora	ns	-	ns	+	-	ns	ns	-	ns	ns	++	ns

Results of Spearman correlation between forthnightly Nematoda densities and water nutrients concentrations (ammonium, nitrate, nitrite, silicate and phosphate), temperature, pH, dissolved oxygen, and chorophyll *a*, at station A. Ns: not significant; -: significantly negative ($p \leq 0.05$); --: highly significant negative ($0.05 < p \leq 0.01$); ---: very highly significant negative ($0.001 < p \leq 0.01$); +: significantly positive ($p \leq 0.05$); ++: highly significant positive ($0.05 < p \leq 0.01$); +++: very highly significant positive ($0.01 < p \leq 0.001$).

Nematoda	NH_4	NO_3	NO_2	PO_4	Si	Temp	pH	DO	Sal	cla
Terschellingia	+	Ns	ns	++	ns	---	ns	ns	---	ns
Paracomesoma	ns	Ns	ns	ns	ns	ns	ns	ns	ns	ns
Odontophora	ns	Ns	ns	ns	ns	-	ns	ns	--	ns
Spirinia	ns	Ns	ns	ns	+ +	ns	ns	ns	ns	ns
Chromadorella	+++	+++	ns	+	+++	---	-	-	---	ns
Linhomoeus	+	+	ns	ns	ns	---	ns	ns	-	ns
Daptonema	ns	ns	ns	ns	ns	ns	+++	+	+	-
Paramonohystera	ns	+	+	ns	ns	ns	ns	ns	ns	ns
Chromadorina	+++	+++	ns	ns	++	---	ns	ns	---	ns
Paracyatholaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Viscosia	ns	ns	+++	ns	++	ns	ns	ns	ns	ns
Chromadora	+	+	++	ns	++	---	ns	ns	ns	ns
Camacolaimus	+++	++	ns	+++	ns	---	ns	ns	ns	---
Ptycholaimellus	ns	ns	ns	ns	ns	ns	++++	+++	+	ns
Oncholaimellus	ns	ns	ns	+	ns	--	ns	-	---	ns
Bathylaimus	ns	ns	ns	+	ns	---	--	---	---	ns
Southernia	ns	-	ns	ns	ns	ns	ns	ns	ns	ns
Metachromodora	ns	ns	ns	+	ns	ns	-	--	-	ns
Anticoma	ns	++	ns	--	+	ns	ns	ns	ns	ns
Synonchiella	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Sphaerolaimus	ns	ns	ns	++	ns	-	--	--	---	ns
Megadesmolaimus	ns	ns	ns	+	ns	ns	+++	++	ns	--
Molgolaimus	ns	ns	ns	+	ns	-	ns	ns	ns	---
Thalassironus	---	ns	ns	ns	ns	++	ns	ns	ns	+
Paracanthonchus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Metalinhomoeus	ns	ns	ns	+++	--	ns	ns	ns	ns	-
Campylaimus	++	ns	ns	ns	ns	-	ns	ns	ns	ns
Paralinhomoeus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Oxystomina	ns	ns	ns	+	ns	ns	ns	ns	ns	-
Eurystomina	ns	ns	ns	ns	ns	ns	-	---	--	ns
Odontanticoma	ns	ns	ns	ns	+++	ns	-	-	ns	ns
Diodontolaimus	+	++	ns	ns	++	ns	ns	ns	ns	ns
Aponema	ns	ns	ns	ns	ns	ns	ns	ns	--	ns
Halalaimus	ns	ns	ns	ns	ns	-	---	---	---	ns
Prochromadorella	ns	ns	ns	+	ns	ns	ns	ns	ns	ns
Sabatieria	ns	ns	ns	ns	+++	ns	ns	ns	ns	ns
Eleutherolaimus	ns	ns	ns	ns	ns	ns	---	---	---	ns
Calyptoronema	ns	ns	-	++	ns	ns	ns	ns	ns	ns
Cyartonema	ns	ns	-	++	ns	ns	ns	ns	ns	ns
Microlaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Southerniella	ns	+	ns	ns	ns	ns	+	++	ns	ns
Neochromodora	-	-	ns	-	ns	++	ns	ns	ns	ns
Leptolaimus	+	ns	ns	+	ns	ns	ns	ns	ns	ns
Onchium	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Desmolaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Acanthopharynx	+	+	ns	ns	+++	--	--	-	-	ns
Desmodora	ns	ns	ns	ns	ns	+	ns	ns	ns	ns
Wieseria	ns	ns	ns	ns	++	ns	ns	ns	ns	ns
Chromaspirina	-	ns	ns	-	ns	ns	+++	+	+	ns
Aff.Phanodermopsis	ns	ns	ns	ns	ns	ns	ns	--	-	ns
Parasphaerolaimus	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Nemanema	---	ns	ns	ns	ns	ns	ns	ns	ns	ns
Aff Cervonema	ns	ns	-	+ +	ns	ns	ns	ns	ns	ns
Antomicron	ns	ns	ns	ns	ns	ns	+	ns	ns	ns
Paroxystomina	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Atrochromodora	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Esta dissertação não incliu errata.

Évora 12 de Janeiro de 2004

Maria Helena Soares Martins Adão