Cah. Biol. Mar. (2000) 41 : 321 - 328

# Suprabenthic pycnogonids from Creixell beach (Tarragona, west mediterranean)

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**Abstract:** Five stations from the Creixell sublittoral zone were sampled monthly in 1991-1992, parallel to the coastline, with a suprabenthic sledge. On these soft bottoms 211 pycnogonids belonging to the following ten species were recorded between 0 and 3.5 m depth: *Ammothella longipes, Tanystylum conirostre, Achelia echinata, Achelia vulgaris, Nymphonella tapetis, Endeis spinosa, Callipallene emaciata, Callipallene tiberi, Anoplodactylus petiolatus* and *Anoplodactylus virescens*. *Ammothella longipes* was the most abundant species (82.0% of the taxocoenosis) and the only resident throughout the year; 2/3 of their specimens were postlarvae and juveniles and 1/3 adults. The mean density of this species was 5.3 specimens 100 $m^{-2}$ and its biomass 2 mg 100 $m^{-2}$. The data of *A. longipes* obtained on this beach are compared with the corresponding ones from a photophilous algal hard substratum on the Costa Brava (Gerona) at the same depth.

A *Posidonia oceanica* meadow, located 500 m off the coastline, is probably the source of the majority of pycnogonids and the passive migration of specimens (mainly subadults) regulates their presence on the sandy bottoms. Moreover, hydrodynamics appears to be the main environmental factor influencing the bathymetric pycnogonid distribution in the sublittoral zone of the beach.

**Résumé** : *Pycnogonides suprabenthiques de la plage de Creixell (Tarragona, Méditerranée occidentale).* En 1991-1992, cinq stations de la plage de Creixell, situées entre 0 et 3,5 m de profondeur, ont été échantillonnées avec un traîneau suprabenthique manoeuvré parallèlement à la ligne de côte. Au cours de cet échantillonnage sur fonds meubles, 211 individus appartenant à dix espèces de pycnogonides ont été récoltés : *Ammothella longipes, Tanystylum conirostre, Achelia echinata, A. vulgaris, Nymphonella tapetis, Endeis spinosa, Callipallene emaciata, C. tiberi, Anoplodactylus petiolatus* et *A. virescens*. L'espèce *Ammothella longipes* est la plus abondante de cette taxocénose (82,0 % d'individus) et la seule présente toute l'année. Les deux-tiers des spécimens récoltés sont des juvéniles et des post-larves, le tiers restant étant représenté par des adultes. La densité moyenne annuelle de cette population est estimée à 5,3 ind. 100 $m^{-2}$ et sa biomasse à 2 mg 100 $m^{-2}$. Les données sur *Ammothella longipes* à Creixell sont comparées à celles d'autres peuplements récoltés dans les algues photophiles de la Costa Brava (S. Francesc cove), à même profondeur.

La riche taxocénose des sables de Creixell est probablement liée à la proximité d'un herbier de Posidonies (situé à 500 m de la ligne de rivage) à partir duquel s'effectue une migration passive de Pycnogonides. L'hydrodynamisme littoral doit être considéré comme le principal facteur responsable de la distribution bathymétrique des pycnogonides de cette plage.

*Keywords* : Pycnogonids, suprabenthos, sand beach, Creixell, western Mediterranean, Spain.

Reçu le 20 janvier 2000 ; accepté après révision le 17 juillet 2000.
Received 20 January 2000; accepted in revised form 17 July 2000.

## Introduction

Over the last decades numerous studies have described the sand beach infaunas all over the world, but the suprabenthic fauna of these areas has received less attention (Brown & McLachlan, 1990). Few works were carried out on suprabenthic communities of the Spanish sandy beaches (Munilla & Corrales, 1995; Munilla et al., 1998; San Vicente & Sorbe, 1993b; San Vicente, 1996), the Ria Formosa in Portugal (Lock & Mees, 1999) and the French Mediterranean beaches (Macquart-Moulin, 1977). The mysids was the most abundant group and also predominated on some shores of South Africa (Wooldridge, 1983, 1989) and Japan (Takahashi & Kawasushi, 1995), while the pycnogonids were not reported in the literature consulted.

A single annual work (Child, 1992a) quoted eleven species on soft-bottoms from the Gulf of Mexico, between 6 and 73 m depth (Hourglass Cruises), sampled with dredges and trawls. Out of these, only four species were captured in coastal sands between 6 and 18 m depth, but none were caught on the near shore beaches.

The aim of this work, performed on coastal sandy areas, was to realize a study of pycnogonid populations of a Mediterranean submarine beach through time and space. This objective is part of a wider project on European beaches that was initiated in 1991 (San Vicente & Sorbe, 1993a, 1993b).

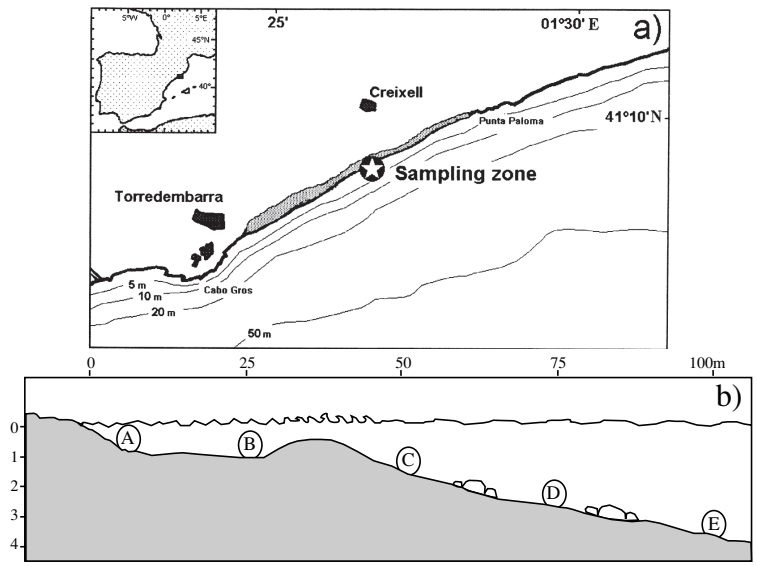



**Figure 1.** Location of the stations A-E, sampled in 1991-1992 at different depths in the sublittoral zone of Creixell beach.

**Figure 1.** Emplacement des stations A-E, échantillonnées en 1991-1992, à diférentes profondeurs sur les fonds littoraux de Creixell.

## Material and methods

According to the classification scale of Brown & Mclachlan (1990), the Creixell beach is a boundary case between an exposed and a protected beach (10/20 rate). Nevertheless, it is an intermediate beach close to the dissipative type; so it can be classified as an exposed beach within its geographical enclosure, owing to the small extent of western Mediterranean tides. Moreover, this beach receives no significant fresh water during heavy rains.

On the other hand, a *Posidonia oceanica* Delile, 1813, meadow including some *Cymodocea nodosa* (Ucria) Ascherson is located at 12 m depth and 500 m from the coastline.

The Creixell beach suprabenthos was sampled once every month from January 1991 to January 1992, during day-time, approximately in the middle of the beach (Fig.1). Quantitative samples were performed with a small suprabenthic sledge equipped with a net of 0.5 mm mesh size and with a rectangular opening of 50 (base) by 20 cm (height). This gear was used at five stations (A, B, C, D and E), located at 0.5, 1, 1.5, 2.5 and 3.5 m depth, and positioned at 5, 25, 50, 75 and 100 m from the coast line respectively (Fig.1). The sledge was pushed by hand at stations A, B and C, while it was operated by a diver at stations D and E. After a 10 m haul, always parallel to the coastline, the net was closed by a 10 m rope which was anchored at the initial sample point. Ten successive hauls were monthly performed at each station. Thus, the total area sampled every month at each station was 50 $m^2$ .

The beach sediment (500 g of dry sand per sample) was monthly sieved at each station. Sand size characteristics changed slightly in the standard sample zone during the study period. This substratum was basically characterized by fine sands, with a mean grain size of 0.185 mm (84.51% of sediment dry weight; annual mean) and a low silt-clay content (< 0.5%). Its organic matter content (measured as ash-free dry weight) ranged between 4.08% and 7.63%, with an annual mean of 6.17% ± 0.30 (x ± C.I. 95%; n=20).

The water temperature in the standard sample zone oscillated between 12.4°C (January) and 26.1°C (August) during the 1991-92 study period, with an annual mean of 17.2 ± 2.9°C (x ± C.I. 95%; n=13).

In addition to the biological material, the sledge also collected an appreciable quantity of vegetal detritus (Fig. 2), basically consisting of marine phanerogams and Ectocarpacea fragments. These detritus, distributed parallel to the coastline, are generally more abundant at station C (annual mean weight 351.72 ± 333.93 mg a.f.d.w. 5 $m^{-2}$

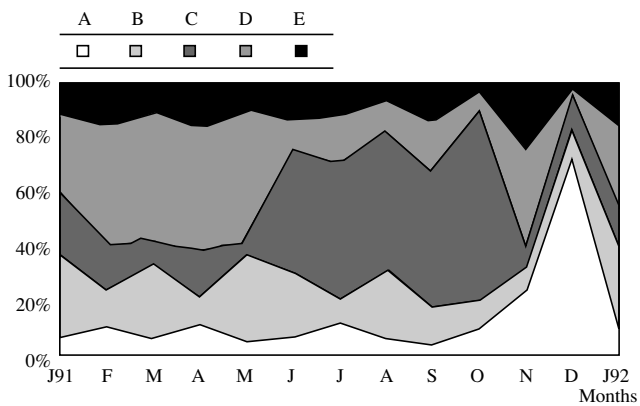



**Figure 2.** Monthly percentages of detritus, collected in 1991-1992 by the sledge, at the five sampled stations A- E of Creixell beach.

**Figure 2.** Pourcentages mensuels de détritus récoltés par le traineau, aux cinq stations A-B échantillonnées en 1991-1992.

(x ± C.I. 95% ; n= 65). This detritic factor showed a marked seasonal trend, with higher values in summer.

The collected fauna was first fixed with formalin in sea water (4%) and definitively preserved in ethanol (70º). The specimens were separated, identified, weighed (wet weight) and measured (dorsal trunk length) with an ocular micrometer. Sex and developmental stages were determined for each pycnogonid, separating them into six classes (Munilla, 1980): postlarvae (specimens with larval and juvenile characteristics), juveniles, larvigerous or ovigerous males, males without eggs, gravid females and females without ovules.

## Results

1. Pycnogonid taxocoenosis

During the 1991-1992 monitoring survey, 211 pycnogonids belonging to ten species were recorded in 43 samples

**Table 1.** Cumulative number of pycnogonids recorded at the stations A - E in 1991-92, and their abundance (ind. 250 m $^{-2}$) on Creixell submarine beach. S: Species richness (mean by month: 2.5).

**Tableau 1.** Nombre cumulatif de Pycnogonides récoltés sur les fonds de Creixell dans les stations A-E en 1991-1992 et leur abondance (ind. 250 m$^{-2}$) de janvier à janvier.

| SPECIES | STATIONS | | | | | | | | MONTHS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | Total | mean | % | J-91 | F | M | A | M | J | J | A | S | O | N | D | J-92 |
| *Ammothella longipes* (Hodge, 1864) | 18 | 39 | 49 | 32 | 35 | 173 | 34.6 | 82.0 | 8 | 7 | 30 | 34 | 27 | 9 | 3 | 2 | 3 | 2 | 19 | 21 | 8 |
| *Tanystylum conirostre* (Dohrn, 1881) | 8 | 3 | 2 | 4 | 4 | 21 | 4.2 | 10.0 | | | 2 | 1 | 2 | | | | 2 | | 2 | 9 | 3 |
| *Achelia echinata* (Hodge, 1864) | | 2 | | | | 2 | 0.4 | 1.0 | | | | | | | | | | | | | 2 |
| *Achelia vulgaris* (Costa, 1861) | | 1 | | | | 1 | 0.2 | 0.5 | | | | | | 1 | | | | | | | |
| *Nymphonella tapetis* Ohshima, 1927 | | | | | 2 | 2 | 0.4 | 1.0 | | | | | | | 2 | | | | | | |
| *Endeis spinosa* (Montagu, 1808) | | | 1 | 2 | | 3 | 0.6 | 1.4 | | | | | | | | | | | 2 | 1 | |
| *Callipallene tiberi* (Dohrn, 1881) | | | 2 | | | 2 | 0.4 | 1.0 | 1 | | | | | | | | | | | 1 | |
| *Callipallene emaciata* (Dohrn, 1881) | | 1 | | | | 1 | 0.2 | 0.5 | | | 1 | | | | | | | | | | |
| *Anoplodactylus petiolatus* (Kroyer, 1844) | | 1 | | | 2 | 3 | 0.6 | 1.4 | | | 2 | | | | | | | | 1 | | |
| *Anoplodactylus virescens* (Hodge, 1864) | | | 1 | | 2 | 3 | 0.6 | 1.4 | | | | 1 | | | | | | | 2 | | |
| TOTAL | 26 | 47 | 55 | 38 | 45 | 211 | 42.2 | 100 | 9 | 7 | 35 | 36 | 29 | 10 | 5 | 2 | 5 | 2 | 26 | 32 | 13 |
| % | 12.3 | 22.3 | 26.1 | 18.0 | 21.3 | 100 | | | 4.3 | 3.3 | 16.6 | 17.1 | 13.7 | 4.7 | 2.4 | 1.0 | 2.4 | 1.0 | 12.3 | 15.2 | 6.2 |
| S | 2 | 6 | 5 | 3 | 5 | 10 | | | 2 | 1 | 4 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 5 | 4 | 3 |

(frequency of occurrence 66.2%) out of the 65 taken in this study.

The pycnogonid taxocoenosis structure of the Creixell beach is detailed in Table 1. *Ammothella longipes* Hodge, 1884 is the commonest species according to its abundance (82.0%) and frequency of occurrence (60%). This is the only species captured throughout the year. The second most dominant species is *Tanystylun conirostre* (Dohrn, 1881) (abundance 10% and frequency of occurrence 17%). These were the only two species collected at all the five stations. The remaining species were sporadic. The mean pycnogonid density for the beach was 6.6 ind. 100 $m^{-2}$ which represents a mean biomass of 2.2 mg 100 $m^{-2}$ (wet weight).

2. Biology of *Ammothella longipes*

During the 1991-1992 annual cycle, 173 specimens of *A. longipes* were collected at the Creixell beach. The monthly evolution of the population structure is shown in Table 2 and Fig. 3a. Its annual cycle presents two clear periods of juvenile recruitment (greater in spring than in autumn), which, together with postlarvae, disappear in summer (from July to October).

The annual beach population is composed for 2/3 of postlarvae and juvenile stages and 1/3 of adults, whose sex-ratio (♂♂ / ♀♀) is 1.23 (not significant difference). Its mean density is 5.29 ind. 100 $m^{-2}$; its mean biomass is 2 mg 100 $m^{-2}$. The monthly density and biomass fluctuations are shown Fig. 3a and Fig. 4 respectively.

The demographic changes with depth are shown in tables 2 and 3. Stations B and C are the only two stations in which the six development stages have been collected. Stations B, C, D and E, show the maximum presence rate, and station A the minimum one. No males carrying eggs or larvae have been found in stations D and E, which are the deepest and most distant from the coastline. The juveniles predominate throughout the five stations, in spring as well as in autumn (annual mean of 60.1 %). 88.5% of them and 91.4% of adults were recorded at stations B, C, D and E, ($c^2$=9.76, p<0.01). This distribution is probably due to the hydrodynamic conditions of the surf zone, while the sand-bar, located at 1 m depth, constitutes a protection to the waves. Thus, the beach shows two quite different zones: station A, next to the coast line, is the first zone, the less densely populated and influenced by higher hydrodynamics;

**Table 2**. Developmental stages (demographic categories: ind. 250 $m^{-2}$) and number of specimens of the *Ammothella longipe*s population, recorded at stations A-E of the Creixell beach, sampled from January 1991 to January 1992.

Developmental stages: M, ovigerous males (* larvigerous males); m, males without eggs; F, gravid females; f, females without ovules; J, juveniles; PL, postlarvae. N: number of specimens. $\overline{\chi}$ : mean abundance by month. $\overline{\chi}$ : mean abundance by station and month. F %: frequency of occurrence for 13 samples by station.

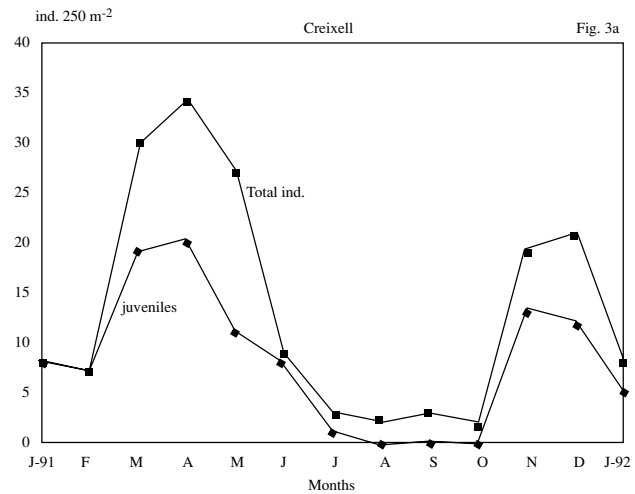
**Tableau 2**. Différents stades de développement (catégories démographiques : ind. 250 $m^{-2}$) et nombre d'individus dans la population de *Ammothella longipes*, récoltée aux stations A-E chaque mois de janvier 1991 à janvier 1992.

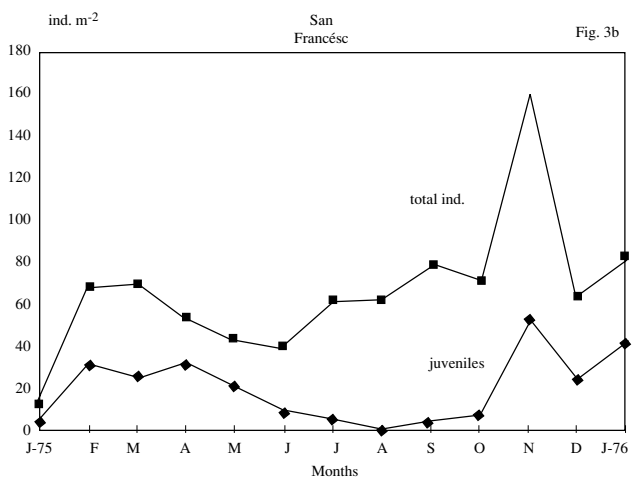
Stades de développement : M, mâles ovigères (* mâle larvigères); m, mâles sans œufs ; F, femelles gravides ; f, femelles sans ovules ; J, juvéniles ; PL, postlarves. N : nombre de spécimens. $\overline{\chi}$ : abondance moyenne par mois. $\overline{\chi}$ : abondance moyenne par mois et par station. F% : fréquence pour 13 échantillons par station.

| | DEVELOPMENTAL STAGES | | | | | | | | | STATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Months | M | m | F | f | J | PL | N | $\overline{\chi}$ | F % | A | B | C | D | E | $\overline{\chi}$ |
| J-91 | | | | | 8:1B5C2D | | 8 | 0.62 | 4.65 | | 1 | 5 | 2 | | 1.6 |
| F | | | | | 7:1C4D2E | | 7 | 0.54 | 4.07 | | | 1 | 4 | 2 | 1.4 |
| M | 2:1A1B | 4:2C2D | 5:1A1B1C2D | | 19: 3A7B5C4E | | 30 | 2.31 | 17.44 | 5 | 9 | 8 | 4 | 4 | 6.0 |
| A | | 9:1A1B1C6E | 1:1C | | 20:3B7C8D2E | 4:2C2D | 34 | 2.62 | 19.77 | 1 | 4 | 11 | 10 | 8 | 6.8 |
| M | 1:1C* | 2:1B1C | 8:3B1C2D2E | 4:1B1C2D | 11:1C6D4E | 1:1C | 27 | 2.08 | 15.70 | | 5 | 6 | 10 | 6 | 5.4 |
| J | | 1:1C | | | 8:2C6E | | 9 | 0.69 | 5.23 | | | 3 | | 6 | 1.8 |
| Jul. | | | 2:2E | | :1B | | 3 | 0.23 | 1.74 | | 1 | | | 2 | 0.6 |
| A | 2:2A | | | | | | 2 | 0.15 | 1.16 | 2 | | | | | 0.4 |
| S | 1:1B | 2:2E | | | | | 3 | 0.23 | 1.74 | | 1 | | | 2 | 0.6 |
| O | 2:2B | | | | | | 2 | 0.15 | 1.16 | | 2 | | | | 0.4 |
| N | 2:1B1C* | 2:1B1C | | | 13:1A2B8C2E | 2:1A1C | 19 | 1.46 | 11.00 | 2 | 4 | 11 | | 2 | 3,8 |
| D | | 2:2B | | 5:4B1E | 12:8A2C2E | 2:2B | 21 | 1.62 | 12.21 | 8 | 8 | 2 | | 3 | 4.2 |
| J-92 | | 2:1B1C | | | 5:2B1C2D | 1:1B | 8 | 0.62 | 4.65 | | 4 | 2 | 2 | | 1.6 |
| TOTAL | 10 | 24 | 16 | 9 | 104 | 10 | 173 | 13.30 | 100.0 | 18 | 39 | 49 | 32 | 35 | |
| % | 5.8 | 13.9 | 9.2 | 5.2 | 60.1 | 5.8 | | | | 10.4 | 22.5 | 28.3 | 18.5 | 20.2 | |
| F % | 46.2 | 61.5 | 30.8 | 15.4 | 76.9 | 38.5 | | | | 38.5 | 76.9 | 69.2 | 46.2 | 69.2 | |

**Figure 3.** Monthly densities of *Ammothella longipes* (bottom line: juveniles; top line: total specimens). **3a**: Creixell beach, soft substratum, number of specimens for 250 $m^2$, **3b**: S. Françèsc cove, rocky substratum, number of specimens $m^{-2}$ (modified from Munilla, 1980).

**Figure 3.** Densités mensuelles de *Ammothella longipes* (ligne inférieure: juvéniles; ligne supérieure: total des individus). **3a**: substrats meubles de Creixell, nombre d'individus pour 250 $m^2$, **3b**: anse de S. Francesc, substrat dur, nombre d'individus $m^{-2}$ (adapté de Munilla, 1980).



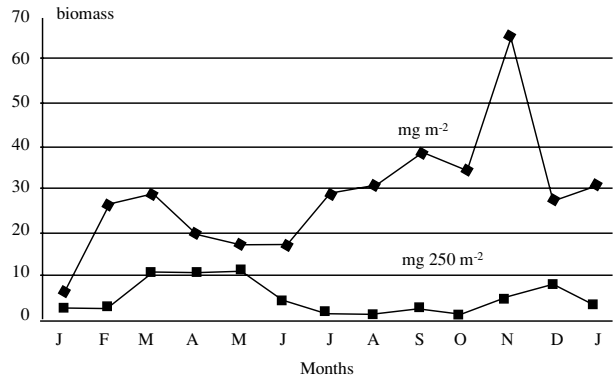

the second zone is represented by the remaining more stable stations, station C being the most populated and the only one that shows larvigerous males.

## Discussion

Most coastal pycnogonids are usually associated with hard substrata, since their principal food and shelter are the algae and sessile invertebrates that live there. Nevertheless, there are at least 61 species recorded in coastal sediments round

**Figure 4.** Monthly biomass (wet weight) of *Ammothella longipes,* recorded from January to January on hard substratum (top line, S.Françèsc cove, 1975-1976, biomass in mg $m^{-2}$) and soft substratum (bottom line, Creixell beach, 1991-1992, biomass in mg 250 $m^{-2}$).

**Figure 4**. Biomasses mensuelles (poids frais) de *Ammothella longipes* de janvier à janvier, obtenues en mg $m^{-2}$ sur substrat dur (anse de S. Francesc, 1975-1976 ligne supérieure) et en mg 250 $m^{-2}$ sur substrat meuble (Creixell, 1991-1992 ligne inférieure).




the world, located between 0 and 25 m depth (Arnaud, 1973a, 1973b, 1988; Arnaud & Bamber, 1987; Arnaud & Krapp, 1990; Chimenz, 1990; Chimenz & Cottarelli, 1986; Chimenz et al., 1993; Child, 1979, 1992a, 1992b; Hedgpeth, 1948, 1951; Müller, 1993; Stock, 1959, 1979, 1986, 1989). Out of these, only 24 species were reported on interstitial shore habitats or near to them, 14 being from the Mediterranean Sea (table 4).

The pycnogonid fauna of Creixell beach is characterized by a surprisingly important richness, with ten recorded species. *Ammothella longipes* is the only resident species (Table 1). Generally, pycnogonids are represented by a few species (two to four) with small densities in soft substrata (Ledoyer, 1966; Sorbe, 1984). In this context, no

**Table 3**. Abondance of different developmental stages of the pycnogonid *Ammothella longipes* sampled at stations A-E of the Creixell submarine beach during 1991-1992. *: larvigerous males (sampled surface each month for each station: 50 $m^2$).

**Tableau 3**. Abondance des différents stades de développement de *Ammothella longipes* échantillonnés aux stations A-E sur les fonds de Creixell en 1991-1992. * : mâles larvigères (surface échantillonnée chaque mois et à chaque station : 50 $m^2$).

| | A | B | C | D | E | TOTAL |
|---|---|---|---|---|---|---|
| M | 3 | 5 | 2* | 0 | 0 | 10 |
| m | 1 | 6 | 7 | 2 | 8 | 24 |
| F | 1 | 4 | 3 | 4 | 4 | 16 |
| f | | 5 | 1 | 2 | 1 | 9 |
| J | 12 | 16 | 32 | 22 | 22 | 104 |
| PL | 1 | 3 | 4 | 2 | 0 | 10 |
| TOTAL | 18 | 39 | 49 | 32 | 35 | 173 |

**Table 4**. Species of the Pycnogonids reported from interstitial shore habitats over the world.
**Tableau 4**. Espèces de pycnogonides signalées dans les habitats interstitiels du monde entier.

| SPECIES | AUTHOR | LOCATION | DEPTH (m) |
|---|---|---|---|
| *Ascorhynchus arenicola* Dohrn, 1881 | Arnaud & Bamber, 1987; Chimenz & Cottarelli, 1986 | Naples Marseille Salerno | 6-30 |
| *Ascorhynchus simile* Fage, 1942 | Stock & Soyer, 1965 | Naples Banyuls-Sur-Mer | 5-95 |
| *Anoplodactylus petiolatus* (Kroyer, 1844) | Arnaud, 1973b; Sorbe, 1984; | Bay of Biscay | 2-180 |
| | Chimenz & Cottarelli, 1986 | Salerno | 24 |
| *Anoplodactylus insigni*s (Hoek, 1881)<br>*A. lentus* Wilson, 1878<br>*Pallenopsis schmitti* Hedgpeth, 1943<br>*Achelia sawayai* Marcus, 1940 | Child, 1992a | Mexican Gulf | 6-18 |
| *Pycnogonum nodulosum* Dohrn, 1881<br>*Ammothella biunguiculata* (Dohrn, 1881)<br>*Nymphonella tapetis* Ohshima, 1927<br>*Anoplodactylus petiolatus*<br>*Rhynchothorax alcicornis* Krapp, 1973<br>*R. anophthalmus* Arnaud, 1973<br>*Ascorhynchus arenicola*<br>*A. simile* | Arnaud, 1988 | Mediterranean | < 20 |
| *Achelia langi* Dohrn, 1881<br>*Anoplodactylus petiolatus*<br>*Ascorhynchus simile*<br>*Callipallene phantoma* (Dohrn, 1881)<br>*Rhynchothorax mediterraneus* Costa, 1861<br>*R. alcicornis* | Chimenz et al. 1993 | Apulian coasts | 6-28 |
| *Paranynphon spinosum* Caullery, 1896 | Sorbe, 1984; Chimenz & Cottarelli, 1986 | Bay of Biscay Salerno | 0-180 15 |
| *Nymphonella tapetis* | Ohshima, 1927<br>De Haro, 1978<br>Le Calvez, 1950 | Japan<br>Garraf (Barcelona)<br>Marseille | 0-10 |
| *Nymphonella lambertensis* Stock, 1959 | | South Africa | 15 |
| *Anoplodactylus arescus* du Bois-Reymond Marcus, 1959 | Arnaud, 1973a | Madagascar | 1-5 |
| *A. tarsalis* Stock, 1968 | Stock<br>Arnaud 1973a<br>Müller 1990 | Philippines<br>Madagascar<br>Kenya | 0-0.5 |
| *Rhynchothorax philopsammum* Hedgpeth, 1951 | Arnaud & Krapp, 1990 | California Açores, Marseille | 0-77 |
| *Endeis spinosa* (Montagu, 1808) | Chimenz, 1990 | Policastro | 2-30 |
| *Hedgpethius interstitialis* Stock, 1989<br>*Rhynchothorax arenicolus* Stock, 1989 | | Curaçao<br>" | Shallow waters |

pycnogonids were recorded at Hendaya beach (southern zone of the Bay of Biscay), sampled with a similar method over a three-months study (San Vicente & Sorbe, 1993b) and only 90 specimens belonging to three species

(unpublished data), were found on 13 Catalan beaches (Munilla et al., 1998).

Comparison of *Ammothella longipes* data from the Creixell beach (soft substratum, between 0.5 and 3.5 m depth, 1991) with the results from an earlier study (Munilla, 1980) carried out in 1975, on hard substratum (*Halopteris* sp., S. Françésc cove, Gerona, between 1 and 3 m depth) is shown in Table 5.

In general, it can be said that densities, biomass (Figs 3, 4) and adult percentage are higher on hard substratum than on soft-bottoms, because the algal rocky biotopes offer a better protection and more food than sandy beaches.

In view of the comparative results presented in Table 5, some questions must be considered: 1) if only two species, *Nymphonella tapetis* Ohshima, 1927 and *Anoplodactylus petiolatus* (Hodge, 1864) (see Arnaud, 1988) are generally found in coastal sands, why do we find ten species on Creixell beach? 2) why are these species so scarce (in number of individuals) compared with the pycnogonid community on hard substratum? 3) why do we find, in the *Ammothella longipes* population of the Creixell beach, a proportion of 2/3 juveniles plus postlarvae and 1/3 adults, whereas the opposite proportion is found in hard substratum?

The most adequate explanation seems to be that at Creixell beach there is a *Posidonia oceanica* meadow located at 500 m off the coast, which provides mainly juvenile pycnogonids to the beach (104 out of 173 specimens of *A. longipes* and 16 out of 21 of *Tanystylum conirostre*). No rocky bottoms were detected near the beach. Moreover, all the species living on the beach were already recorded by Munilla (1981) in *Posidonia* rhizomes, except *Nymphonella tapetis* and *Anoplodactylus petiolatus*. A passive attempt of the specimens is carried out to find new habitats and more food. This mainly occurs during the recruitment periods and with the help of currents. In this context, in the nocturnal superficial plankton of stations A and B (June 1991), two postlarvae and six juvenile forms of *A. longipes* and one male of *T. conirostre* were found, precisely the two most abundant species of the beach taxocoenosis. This fact suggests, at least, postlarval and juvenile dispersion.

The annual evolution of the shore population (Fig. 3) is a reminder of the cycle that occurs in the *Posidonia* meadow. The juvenile and adult maxima rates of abundance in spring and autumn (see Fig. 3a) would be due to the breeding explosions which occur during the biological cycle of the species located in the phanerogam meadow. The specimens sampled on the beach must be considered as a migrant fraction from the meadow population, searching more food and new suitable biotopes for clinging.

Finally, the distribution gradient of pycnogonids on the beach seems to be exclusively related to hydrodynamic conditions (Munilla et al., 1998) as it occurs in other groups (Brown & McLachlan, 1990). Two zones have been detected on the beach: station A, the surf and more stressed zone, with only two species, and a second relatively more stable zone containing the remaining stations, where ten species and greater densities have been collected. The sediment characteristics do not influence this distribution, since all the stations have over 80% of fine sand (median between 125 and 250 micrometers). The same occurs with organic matter, with concentrations oscillating between 4 and 7.6 %.

**Table 5**. Comparison of biology and ecology of *Ammothella longipes* collected on different substrata of the Catalan coast. *modified from Munilla, 1980.

**Tableau 5**. Comparaison des caractéristiques biologiques et écologiques du pycnogonide *Ammothella longipes* récolté dans différents substrats de la côte Catalane. *modifié d'après Munilla, 1980.

| | Hard substratum * S.Françesc cove-, 1975 | Soft Substratum Creixell beach, 1991 |
|---|---|---|
| Surface sampled-(in $m^2$) | 13 | 3250 |
| Nº of individuals | 863 | 172 |
| Adults (%) | 70.92 | 33.70 |
| Males (%) | 44.96 | 18.60 |
| Females (%) | 25.96 | 15.10 |
| Juveniles (%) | 29.11 | 60.50 |
| Postlarvae (%) | ? | 5.80 |
| ♂♂/♀♀ | 1.73 | 1.23 |
| Max. density (ind 100 $m^{-2}$) | 16100 | 13.6 |
| Mean density (ind 100 $m^{-2}$) | 6338 | 5.29 |
| Min. density (ind 100 $m^{-2}$) | 1200 | 0.8 |
| Mean biomass (mg wet weight 100 $m^{-2}$) | 2836 | 2 |
| Recruitment periods per year | 2 | 2 |

**Acknowledgements**

I wish to express my gratitude to the referees, Drs. F. Arnaud and J.C. Sorbe, for their suggestions and comments which improved the manuscript and to A. Morton for English corrections.

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