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SEA SPIDERS (PYCNOGONIDS) IN AND AROUND MILFORD HAVEN (South West Wales)

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ABSTRACT

Thirteen of the 19 British species of Pycnogonids (sea spiders) have been recorded in and around Milford Haven in southwest Wales. The sites from which each species has been recorded are listed and maps are provided for the more widely distributed. The influence of salinity and other estuarine factors affecting their penetration into the Daucleddau (the joint estuary of the Eastern and Western Cleddau rivers) is discussed.

INTRODUCTION

THE Pycnogonida are a group of marine arthropods often referred to as sea spiders. Their general biology has been reviewed by Thompson (1909), Helfer and Schlottke (1935), Fage (1949) and King (1973). Their distribution in the British Isles recorded by Hodge (1864), Thompson (1909), Hodgson (1910), Halhed (1896), Carpenter (1905, 1912), Bruce, Colman and Jones (1963), King, Wyer and Jarvis (1971) and King (1972, 1976). Species occurring in Pembrokeshire were recorded by Crothers (1966) and King and Crapp (1971). Since that time the list has been extended and further studies have suggested some changes in the relationship and validity of some species (Fry, 1978). King (1986) has revised the earlier keys and summarised the current position on taxonomy and nomenclature. The present study updates the pycnogonid records for Pembrokeshire and describes in more detail their distribution in Milford Haven.

DISTRIBUTION IN WEST WALES

King and Crapp (1971) listed eleven species from Pembrokeshire (now part of Dyfed). Since that time two more have been added, *Endeis charybdaea* and *Anoplodactylus petiolatus*. Thus, 13 of the 19 British species have been recorded in the area. Using the classification and terminology of King (1986), the records of pycnogonid distribution in Pembrokeshire are as follows:

Family NYMPHONIDAE *(Fig. 3)*

Nymphon gracile Leach (1814)	Milford Haven, Daucleddau, West Angle, Freshwater East, Martin's Haven, Skokholm, Solva, Cwm-Eglys.
Nymphon brevirostre Hodge (1863)	Dale Fort Beach, Black Rock (Dale), Tenby, Ramsey Haven.

Family ACHELIIDAE *(Fig. 4)*

Achelia echinata Hodge (1864)	Sandy Haven, West Blockhouse Point, Dale Point, Watwick Bay, West Angle Bay in Milford Haven; Skokholm-Hog Bay and Peter's Bay, Skomer, Cwm-Eglys, Fishguard, St Brides Bay, Manorbier, Lydstep Point, Caldy Island, Tenby, Freshwater West, Ramsey.

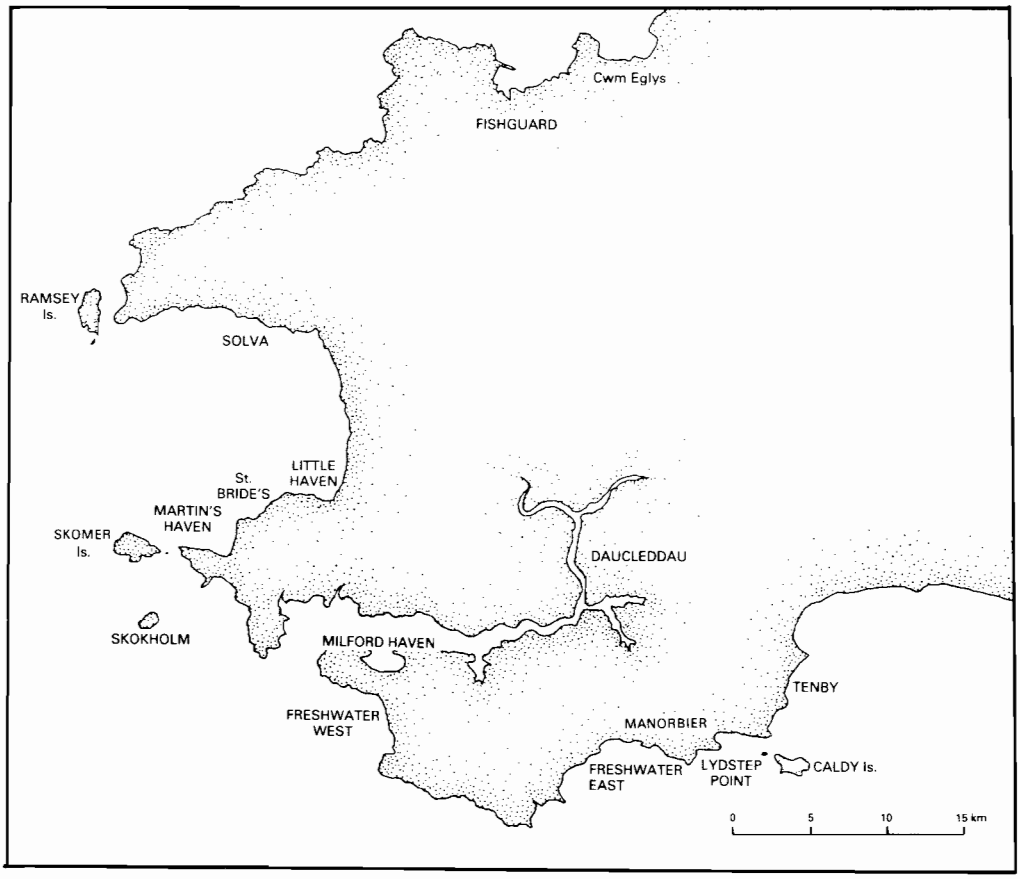

FIG. 1.
The sites from which sea spiders have been recorded in the old county of Pembrokeshire, outside Milford Haven.

A. longipes Hodge (1864)	Solva, Little Haven, St Brides, Watwick, West Angle, Freshwater East, Lydstep Point, Caldy Island, Tenby.
A. laevis Hodge (1864)	Caldy Island.
Family AMMOTHEIDAE	
Phoxichilidium femoratum (Rathke, 1799)	Castlebeach Bay, Gann Flat, Skomer.
Family ENDEIDAE (Fig. 5)	
Endeis spinosa (Montagu, 1808)	Gann Flat, Musselwick Point, Dale Point, Watwick, Martin's Haven, North Skomer, Mew Stone, Cwm Eglys, Fishguard, Ramsey, Solva St Brides, Manorbier, Caldy Island, Tenby.
Endeis charybdaea (Dohrn, 1881)	Martin's Haven, Skomer.
Family PYCNOGONIDAE	
Pycnogonum littorale (Ström, 1762)	Slip Pier Beach (Dale), Sandy Haven, West Dale Bay, Skokholm.

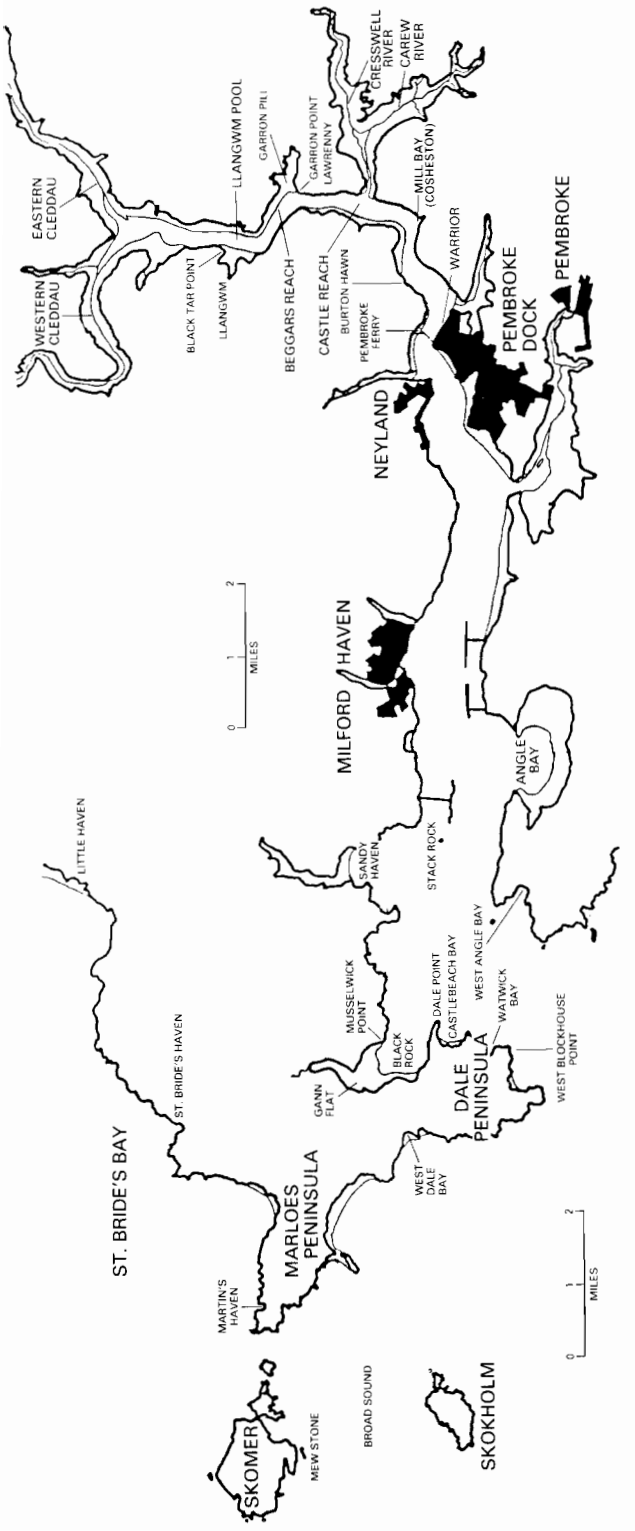

FIG. 2.
The sites from which sea spiders have been recorded inside Milford Haven (based on maps in Crothers, 1966).

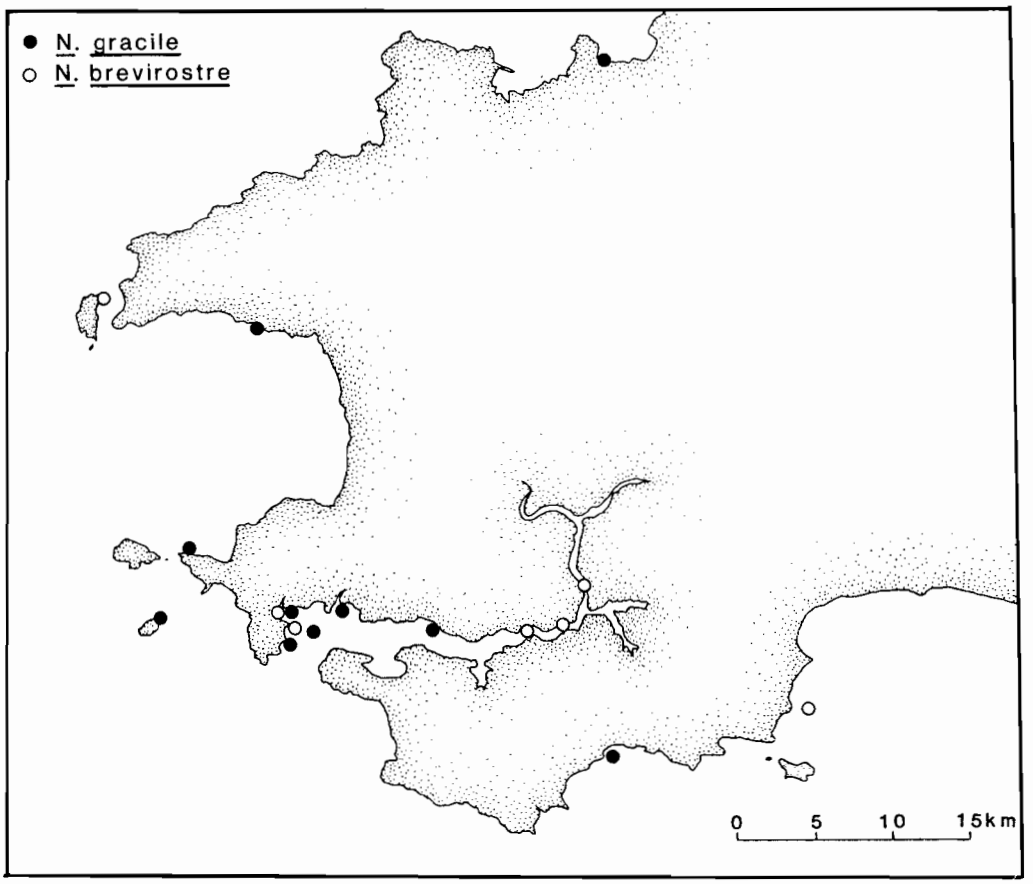

FIG. 3.
Records of *Nymphon gracile* and *N. brevirostre*.

Family CALLIPALLENIDAE

Callipallene brevirostris (Johnston, 1837) Ramsey Haven.

Family ANOPLODACTYLIDAE (Fig. 6)

Anoplodactylus angulatus (Dohrn, 1881) Pembroke Ferry, Slip Pier Beach (Dale), Sandy Haven, St Brides, West Angle.

Anoplodactylus pygmaeus (Hodge, 1864) Stack Rock, Sandy Haven, Black Rocks Flat (Dale), Tenby, Cwm-Eglys.

Anoplodactylus petiolatus (Kröyer, 1884) Milford Haven.

Distribution within Milford Haven

Pycnogonids occur over a wide bathymetric range, though species occurring in the littoral zone are subjected to greater fluctuations of temperature and salinity than those from greater depths. Species vary in their ability to tolerate these conditions, as shown for *Achelia echinata* and *Nymphon gracile* (El-Hawawi and King, 1978). The distribution of species within estuaries indicates the range of tolerances, though availability of food and a

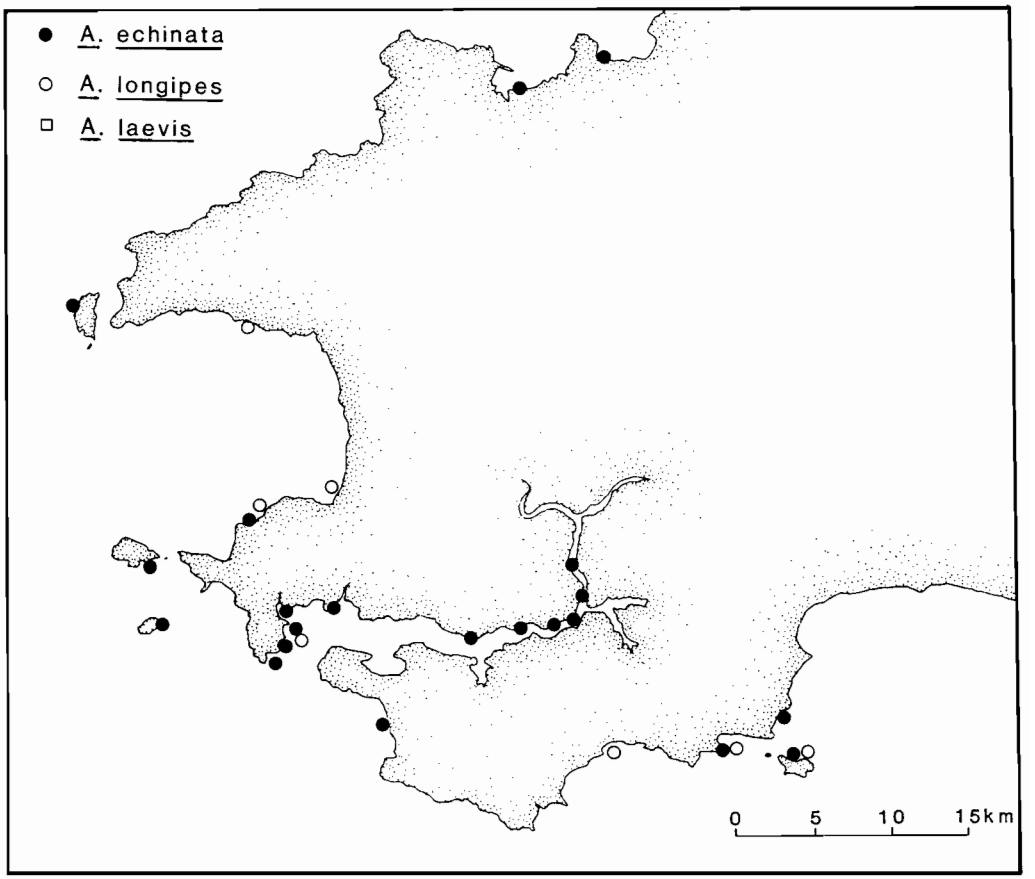

FIG. 4.
Records of *Achelia echinata*, *A. longipes* and *A. laevis*.

suitable substratum must also be considered. Little work on this aspect of pycnogonid distribution has been published. Wolff (1976) described the distribution of pycnogonids in the estuarine area of the south-western part of the Netherlands. No detailed study of the distribution within the Haven has been made and since data regarding the environment are available (Nelson-Smith, 1965; Williams and Jolly, 1975) it was considered of interest to investigate the distribution in this estuary. Records in the present study have been augmented from Crothers (1966) and King and Crapp (1971).

Littoral collections were made during summer months of 1972 and 1974 during spring tides at a number of sites within Milford Haven and along the Daucleddau. Circa-littoral collections were made at different depths by diving, mainly in the Daucleddau, during 1977 and 1978 (Fig. 7).

Callipallene brevirostris

Not previously recorded in Milford Haven. Daucleddau specimens were recovered from Neyland upstream to Castle Reach. Wolff (1976) observed greater numbers in the littoral than sublittoral zone in the Oosterschelde estuary but in British waters the converse

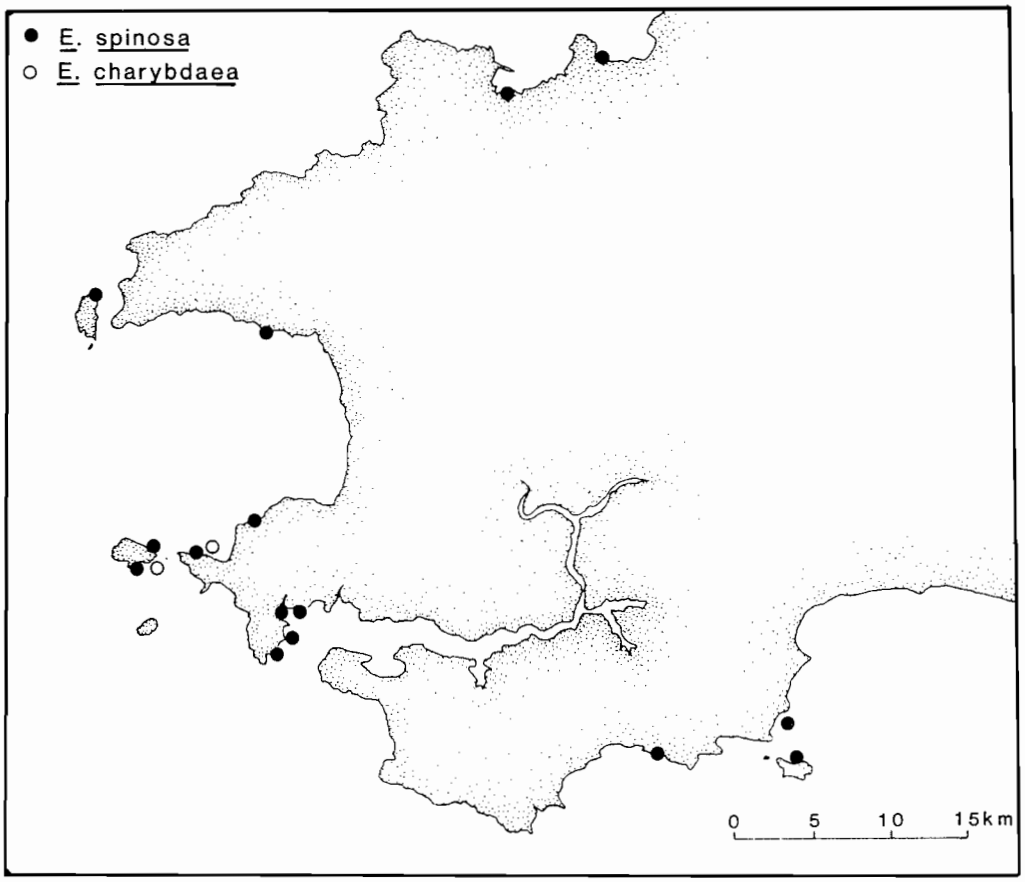

FIG. 5.
Records of *Endeis spinosa* and *E. charybdaea*.

is usually true (King, 1974). The distribution shown in Table 1 indicates a sublittoral distribution in the Daucleddau, typically below the algal belt. Specimens were not numerous (13) but males carrying eggs were collected at Bridge (12.10.77), Warrior (8.6.78) and Cosheston (8.7.78).

Achelia echinata (Fig. 8)

The most abundant species recorded, though it showed no depth preference. Their distribution is shown in Fig. 8. They occur further up the Daucleddau in deeper water than in the littoral zone. Wyer and King (1974) recorded them feeding on detritus trapped in moribund areas of *Bugula* colonies. Species of *Bugula* occur regularly in the Daucleddau. King (1974) reported this species in association with the hydroid *Dynamene pumila* and the bryozoan *Flustra foliacea*. *F. foliacea* does not occur in the Daucleddau and *D. pumila* rarely occurs sublittorally other than on algal substrates, which suggests an alternative food source. Specimens were collected associated with poriferans: *Dysidea fragilis, Halichondria panicea, Haliclona oculata, Raspailia hispida, Stelligera stuposa*; coelenterates: *Hydrallmania falcata, Nermertesia antennina, Nermertesia ramosa*;

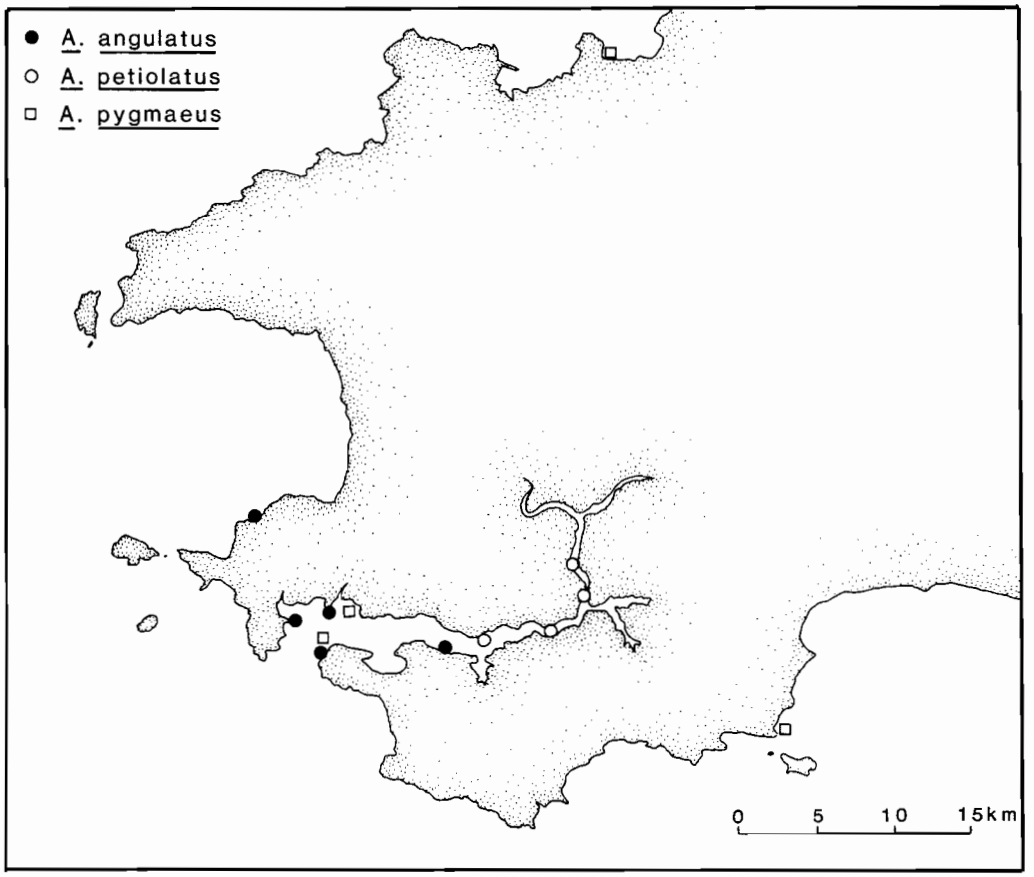

FIG. 6.
Records of *Anoplodactylus angulatus*, *A. petiolatus* and *A. pygmaeus*.

Table 1. *Vertical distribution of* Callipallene brevirostris *in the Daucleddau*

Metres	Bridge	Warrior	Cosheston	Castle R
0		X		
5	XX			
7.5				X
10	XXXXX	X	X	
12.5			X	
15			X	

molluscans: *Ostrea edulis*; bryozoans: *Bugula plumosa*, *Alcyonidium* cf. *gelatinosum* and tunicates: *Dendrodoa grossularia*, *Styela clava*. Some of which may provide a suitable food source.

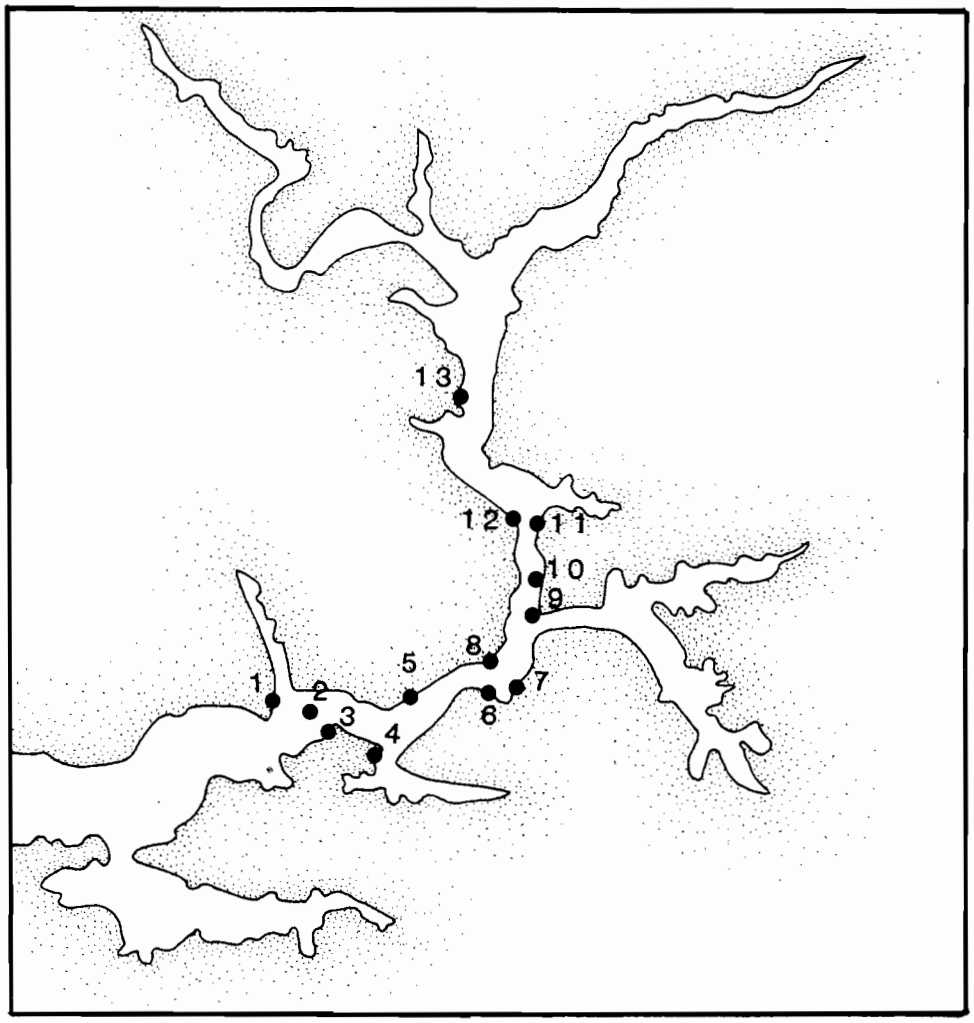

FIG. 7.

The 1972 and 1974 collection sites within Milford Haven and the Daucleddau. Neyland (1), Bridge (2), Pembroke Ferry (3), Warrior (4), Burton-Cliff (5), Cosheston (6), Mill Bay (7), Whalecum (8), Lawrenny (9), Castle Reach (10), Garron Point (11), Beggars Reach (12), and Black Tar (13).

Nymphon gracile and ***Nymphon brevirostre*** (Fig. 9)

During the summer months this species migrates on shore, particularly males carrying eggs on their ovigers, which may account for its absence in the sublittoral above Pembroke Ferry. *N. brevirostre* was recorded between Neyland and Black Tar at all depths and particularly below the algal belt. King (1974) recorded this species in association with tubularians, *Halichondria panicea* and *Nermertesia* sp. Each of these was present in the Daucleddau samples, often occurring together in the same faunal assemblage.

Anoplodactylus pygmaeus, Anoplodactylus angulatus and ***Anoplodactylus petiolatus*** (Fig. 10)

A. pygmaeus has been recorded at the mouth of the Haven. *A. angulatus* penetrates further with a specimen collected from Pembroke Ferry (Crothers, 1966). In the present

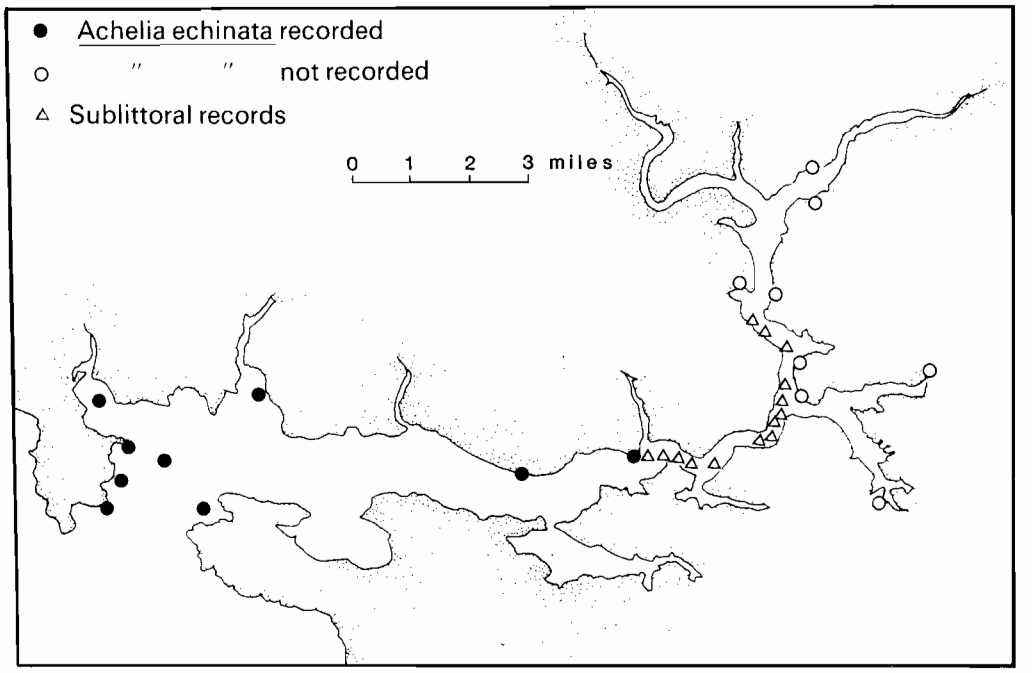

FIG. 8.
Littoral and sublittoral records of *Achelia echinata* in Milford Haven and the Daucleddau.

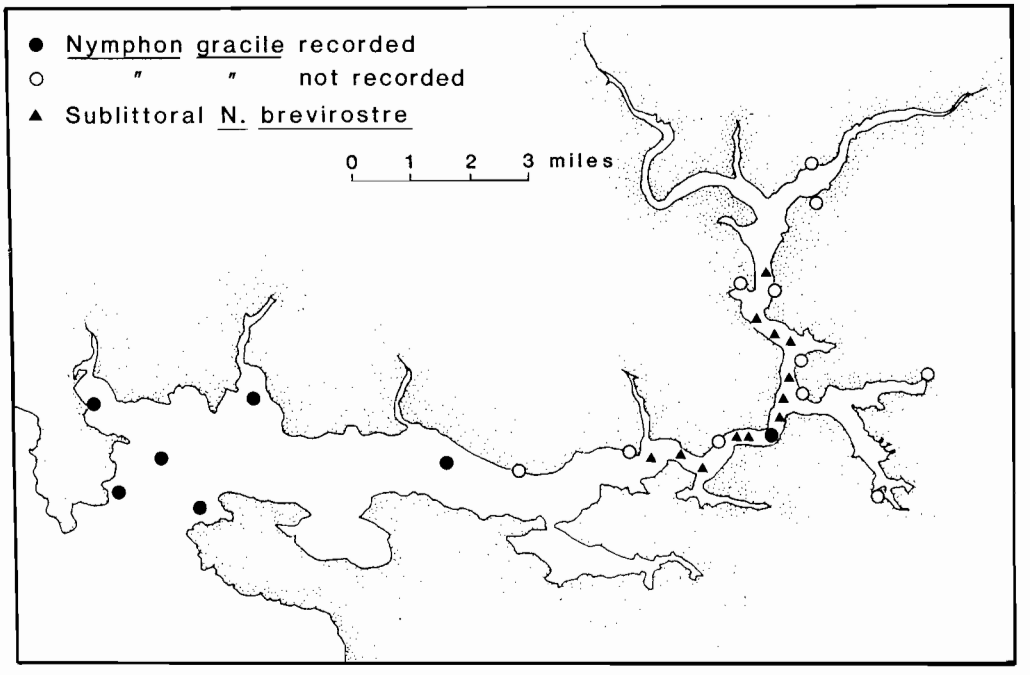

FIG. 9.
Littoral and sublittoral records of *Nymphon gracile* and *Nymphon brevirostre* in Milford Haven and the Daucleddau.

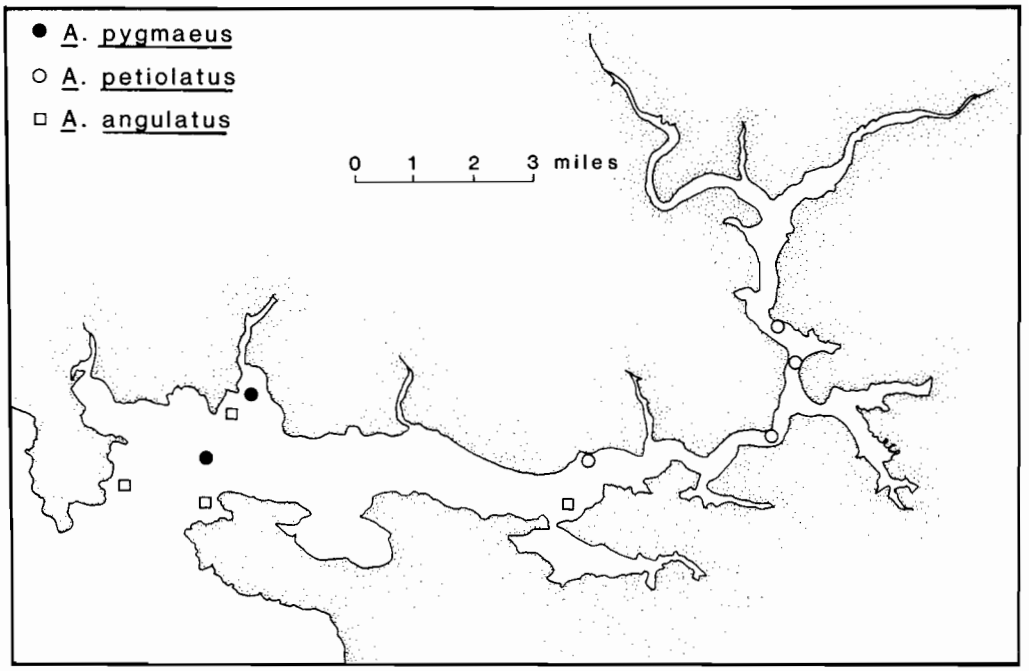

FIG. 10.
Records of *Anoplodactylus* species in Milford Haven and the Daucleddau.

study specimens of *A. petiolatus* were collected as far upstream as Beggar's Reach in the Daucleddau. This suggests that within this genus there is a difference in the degree of tolerance to environmental stresses. *A. pygmaeus* and *A. angulatus* were collected in the littoral zone but *A. petiolatus* from sublittoral samples, where it may avoid adverse salinities.

Although information is incomplete, *A. petiolatus*, with a recorded distribution from Norway to the Mediterranean, may be better suited to the temperatures in the Haven than *A. angulatus* with a more southerly distribution. El-Hawawi and King (1978) showed the effects of temperature and salinity tolerance in pycnogonids.

Endeis spinosa and ***Pycnogonum littorale*** occur in the mouth of the Haven.

There is considerable confusion arising from the available salinity data for the Daucleddau and their interpretation. It is apparent that the general mixing of fresh water and sea water, and the greatest fluctuations in surface salinities, occur well above the confluence of the Eastern and Western Cleddau. Data on vertical stratification have been recorded by Nelson-Smith (1965) and Williams and Jolly (1975) in waters between Lawrenny and Landshipping (Fig. 11). Maximum stratification occurs at low water of an ebb neap tide, particularly between Cosheston and Garron Point. Evidence suggests that the estuary is well mixed for the first sixteen kilometres from the mouth, which is defined by a line drawn between St Ann's Head and Studdock Point. Upstream of this there is a steepening longitudinal (horizontal) salinity gradient between Neyland and Landshipping. In the present study salinity readings were taken between Pembroke Ferry and Llangwm

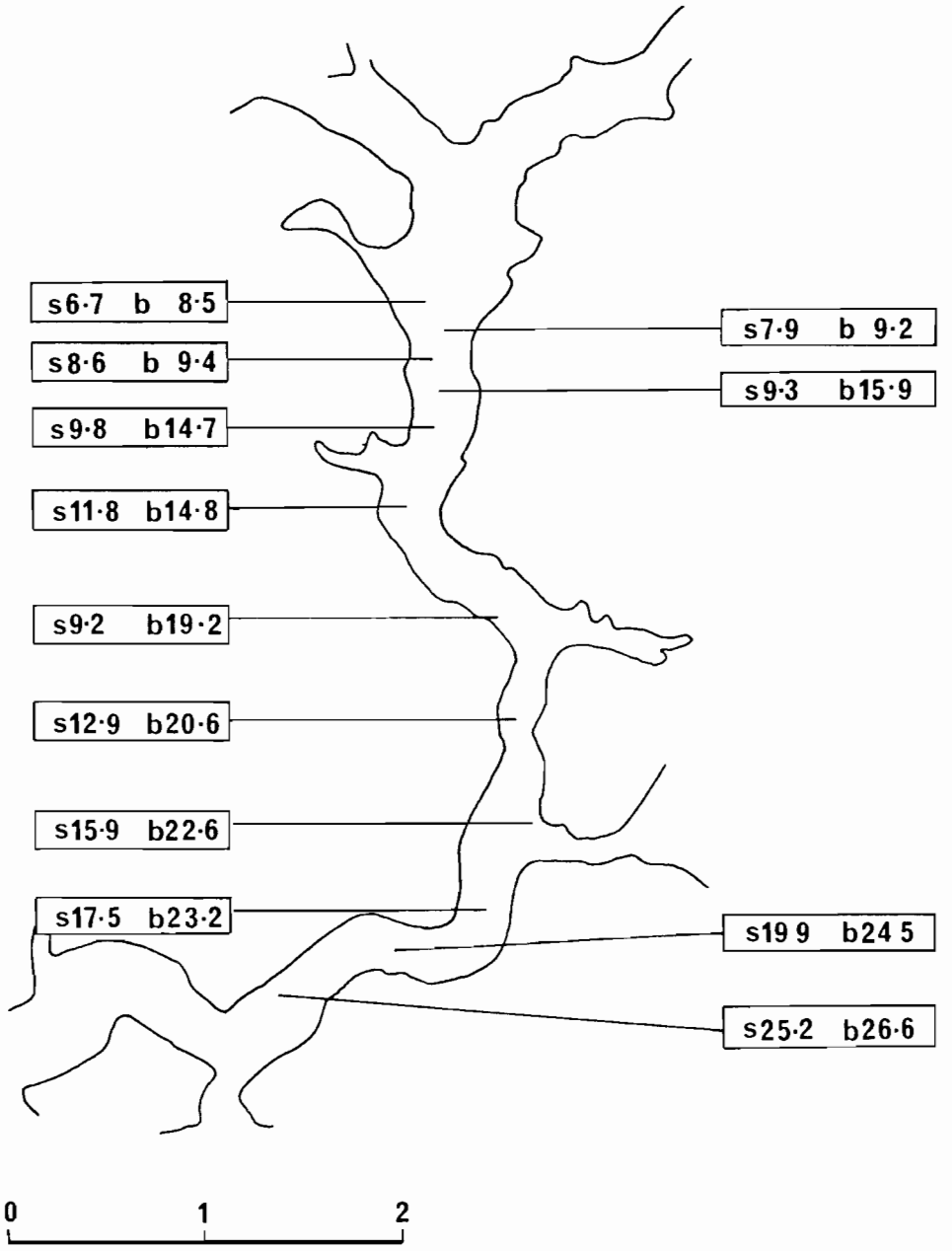

FIG. 11.

Range of surface and bottom salinities (‰ NaCl) in the upper reaches of Milford Haven and the Daucleddau obtained during the present study. Scale in miles.

during March 1978 using a N10 MC5 salinometer-conductivity cell. This period coincided with large spring tides, a generally wet winter and recent heavy precipitation. Hence the salinity values were lower than those of both Nelson-Smith (1965) and Williams and Jolly (1975) (Fig. 11).

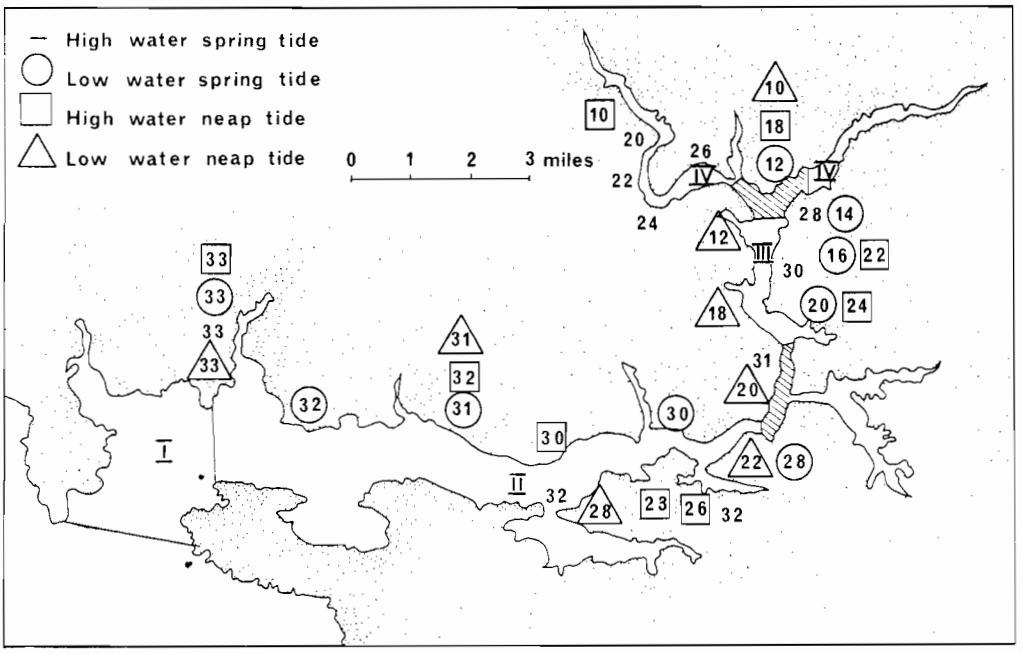

FIG. 12
Salinities at different tide levels and zones within Milford Haven and the Daucleddau (Nelson-Smith, 1965).

Wolff (1976) stated that *A. petiolatus, C. brevirostris* and *A. echinata* occur at salinities in excess of 15‰. During low water neap tides in Daucleddau, at the limit of penetration by this species, the surface isohaline is 17‰ though the bottom may be 8‰ higher (Nelson-Smith, 1965). Values obtained by Williams and Jolly (1975) were somewhat lower than this. The figure obtained in the present study at the deepest point of penetration agreed with the findings of Wolff (1976) who noted that *N. brevirostre* penetrates further upstream than all other species and apparently tolerates salinities of 11–12‰. This is in general agreement with the findings in this study. In the laboratory *A. echinata* has been exposed to a range of salinity and temperature combinations and has shown negligible tolerance to constant exposure to salinities of 17‰, particularly at higher temperatures.

Nelson-Smith (1965) divided the Haven into four ecological zones, with each zonal boundary forming a critical region in the distribution of marine plants and animals up the estuary (Fig. 12). Zone 1 is oceanic with sandy or rocky substrata. Zone II is marine-polyhaline with mixed substrata, Zone III marine-mesohaline with rocky substrata and Zone IV polyhaline-mesohaline with muddy substrata. Zones I–III have substrata suitable for pycnogonids.

E. spinosa, P. littorale and *A. pygmaeus* do not penetrate beyond Zone I. In Zone II, *A. echinata* and *N. gracile* reach the limit of their littoral penetration and *A. angulatus* in the sublittoral. In Zone III no species have been recorded from the littoral but *N. brevirostre, C. brevirostris, A. echinata* and *A. petiolatus* penetrate in the sublittoral. These species utilise the deep tongue of higher salinity water.

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REFERENCES

BRUCE, J. R., COLMAN, J. S. and JONES, N. S. (ed.) (1963). *Marine fauna of the Isle of Man.* Liverpool University Press.

CARPENTER, G. H. (1905). The marine fauna of the coast of Ireland, part 6. Pycnogonida. *Scientific Investigations of the Fisheries Board for Ireland*, **4,** 1–8.

CARPENTER, G. H. (1912). Pycnogonida. Clare Island survey. *Proceedings of the Royal Irish Academy*, **31,** 1–4.

CROTHERS, J. H. (ed) (1966). Dale Fort Marine Fauna (2nd edn). *Field Studies*, **2** (suppl.) 169 pp.

EL-HAWAWI, A. S. N. and KING, P. E. (1978). Salinity and temperature tolerance by *Nymphon gracile* (Leach) and *Achelia echinata* (Hodge) (Pycnogonida). *Journal of experimental marine biology and ecology*, **33,** 213–222.

FAGE, L. (1949). *Traité de Zoologie, 6. Classe des Pycnogonides.* Masson: Paris.

FRY, W. G. (1978). A classification within the pycnogonids. *Zoological Journal of the Linnean Society*, **63,** 35–59.

HALHED, W. B. (1896). Report of the marine zoology, botany and geology of the Irish Sea. List of the Pycnogonida. *Report of the British Association for the Advancement of Science*, **442**.

HELFER, H. and SCHLOTTKE, E. (1935). Pantopoda. *Bronn's Kl. Ordn. Tierreichs*, **5,** (4), (2).

HODGE, G. (1864). List of the British Pycnogonidae, with descriptions of several new species. *Annals and Magazine of Natural History*, **13,** series 3, 113–117.

HODGSON, T. V. (1910). The Pycnogonida of Devonshire. *Report of Transactions, The Devon Association*, **42,** 425–439.

KING, P. E. (1972). The marine flora and fauna of the Isles of Scilly. Pycnogonida. *Journal of Natural History*, **6,** 621–624.

KING, P. E. (1973). *Pycnogonids.* Hutchinson & Co., London, 1–144.

KING, P. E. (1974). *British sea spiders (Arthropoda = Pycnogonida). Keys and notes for the identification of the species.* Linnean Society Synopses of the British Fauna No. 5, 68 pp.

KING, P. E. (1976). The Marine Fauna of Lundy. Pycnogonida (Sea Spiders). *Report of the Lundy Field Society*, **27,** 1–3.

KING, P. E. (1986). Sea Spiders. A revised key to the adults of littoral Pycnogonida in the British Isles. *Field Studies*, **6,** 503–526.

KING, P. E. and CRAPP, G. B. (1971). Littoral Pycnogonids of the British Isles. *Field Studies*, **3,** 455–480.

KING, P. E., WYER, D. and JARVIS, J. H. (1971). Littoral Pycnogonids of Galway Bay. *Irish Naturalist's Journal*, **17,** No. 3, 78–85.

NELSON-SMITH, A. (1965). Marine Biology of Milford Haven: the physical environment. *Field Studies*, **2,** 155–188.

THOMPSON, D'ARCY W. (1909). *The Cambridge Natural History*, Vol. 4, *Pycnogonida*, Cambridge University Press: Cambridge.

WILLIAMS, D. J. A. and JOLLY, R. (1975). *Milford Haven: survey of pollution and mathematical modelling of pollutant distribution and transport.* Department of Chemical Engineering, University College, Swansea.

WOLFF, W. J. (1976). Distribution of Pantopoda in the estuarine area in the southwestern part of the Netherlands. *Netherlands Journal of Sea Research*, **10**(4), 472–478.

WYER, D. and KING, P. E. (1974). Feeding in British Littoral Pycnogonids. *Estuarine and Coastal Marine Science*, **2,** 177–184.