

Sea pen (Pennatulacea) aggregations on the northern Spanish shelf: distribution and faunal assemblages

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Supplementary material

Table S1. – Pennatulacea occurring in the southern sector of the Bay of Biscay (off Spain) south of the 44°N parallel and Galicia after a review of the literature contrasting with our results in the study area from 1995-2010 (* data collected from 2008-2014). Only references with the shallow-most and deep-most data included.

Species	Depth range (m)	References	Depth range (m) Present study
Suborder Sessiliflorae Kükenthal, 1915			
<i>Anthoptilum grandiflorum</i> (Verrill, 1879)	1400	Louzao et al. (2010)	
<i>Cavernularia pusilla</i> (Philippi, 1835)	25-100	Rallo et al. (1988), Altuna et al. (2008)	
<i>Funiculina quadrangularis</i> (Pallas, 1766)	100-468	Altuna (1994), Louzao et al. (2010)	84-793
<i>Kophobelemnion stelliferum</i> (Müller, 1776)	151-1005	Rallo et al. (1993), Altuna (1994)	
<i>Protoptilum thomsoni</i> Kölliker, 1872	790-1200	Louzao et al. (2010)	
<i>Umbellula lindahli</i> Kölliker, 1874	896-2320	Gourret (1906), Thomson (1927)	
<i>Veretillum cynomorium</i> (Pallas, 1766)	15-75	Thomson (1929), Altuna (1994)	50-373
Suborder Subselliiflorae Kükenthal, 1915			
<i>Pennatula aculeata</i> Danielssen, 1860	161-1225	Gourret (1906), Louzao et al. (2010)	793-811*
<i>Pennatula grandis</i> Ehrenberg, 1834	1228-1980	Grasshoff (1982), unpublished data	
<i>Pennatula phosphorea</i> Linnaeus, 1758	112-135	Grasshoff (1982), Paulmier (1997)	133-366*
<i>Pteroeides spinosum</i> (Ellis, 1764)	60-208	Thomson (1927), Urgorri et al. (2011)	50-296
<i>Virgularia mirabilis</i> (Müller, 1776)	3.7-468	Cacabelos et al. (2009), Louzao et al. (2010)	
<i>Virgularia tuberculata</i> Marshall, 1883	No data		

Table S2. – Species composition of the aggregations of *F. quadrangularis* on circalittoral and upper bathyal soft bottoms and of *Pennatula* spp. on circalittoral soft bottoms. Taxon: A, ascidian; C, cnidarian; CR, crustacean; E, echinoderm; M, mollusc, P, polychaete worm; S, sponge. Species: * species that occur in the aggregations of *F. quadrangularis* on circalittoral soft bottoms but not in the upper bathyal soft bottoms; ** species that occur in the aggregations of *F. quadrangularis* on bathyal soft bottoms but not on circalittoral soft bottoms; *** species that occur in the aggregations of *Pennatula* spp. on circalittoral soft bottoms but not in the aggregations of *F. quadrangularis* on circalittoral soft bottoms. %: percentage of frequency of occurrence (occurs in 81-100% of the samples (•••••), 61-80% (••••), 41-60% (•••), 21-40% (••) and 1-20% (•)). D: density (col/haul): A (>1000/haul), C (100-999/haul), F (10-99/haul) and O (1-9/haul). Abbreviations used in Figure 4 appear in brackets after the species name.

<i>F. quadrangularis</i> on circalittoral			<i>F. quadrangularis</i> on upper bathyal			<i>Pennatula</i> spp. on circalittoral					
Taxon	Species	%	D	Taxon	Species	%	D	Taxon	Species	%	D
C	<i>Funiculina quadrangularis</i> (Fqua)	••••	C	C	<i>Funiculina quadrangularis</i> (Fqua)	••••	F	C	<i>Pennatula</i> spp. (Penn)	••••	F
CR	<i>Macropodia longipes</i> (Mlon)	••••	O	M	<i>Rossia macrosoma</i> (Rmac)	••••	O	E	<i>Astropecten irregularis</i> (Airr)	••••	F
E	<i>Astropecten irregularis</i> (Airr)	••••	F	E	<i>Astropecten irregularis</i> (Airr)	••••	F	M	<i>Eledone cirrhosa</i> (Ecirr)	••••	F
M	<i>Eledone cirrhosa</i> (Ecirr)	••••	O	CR	<i>Munida sarsi</i> (Msar)	••••	A	M	<i>Sepia elegans</i> (Sele)	••••	O
C	<i>Actinauge richardi</i> (Aric)	••••	O	M	<i>Eledone cirrhosa</i> (Ecirr)	••••	O	CR	<i>Liocarcinus depurator</i> (Ldep)	••••	O
CR	<i>Pagurus prideaux</i> (Ppri)	••	F	CR	<i>Macropipus tuberculatus</i> (Mtub)	••••	C	M	<i>Sepiolo sp.</i> (Sepi)	••••	F
CR	<i>Liocarcinus depurator</i> (Ldep)	••	F	CR	<i>Macropodia longipes</i> (Mlon)	••••	O	M	<i>Sepia orbignyana</i> (Sorb)	••	O
M	<i>Sepia elegans</i> (Sele)*	••	O	E	<i>Ophiura ophiura</i> (Ooph)	••	F	M	<i>Calliostoma granulatum</i> (Cgran)	••	O
E	<i>Ophiura ophiura</i> (Ooph)	••	O	M	<i>Sepietta oweniana</i> (Sowe)	••	O	CR	<i>Munida intermedia</i> (Mint)	••	O
E	<i>Parastichopus regalis</i> (Preg)	••	O	C	<i>Actinauge richardi</i> (Aric)	••	O	CR	<i>Pagurus prideaux</i> (Ppri)	••	F
M	<i>Rossia macrosoma</i> (Rmac)	••	O	CR	<i>Liocarcinus depurator</i> (Ldep)	••	O	M	<i>Octopus vulgaris</i> (Ovul)	••	O
E	<i>Leptometra celtica</i> (Lcel)	••	F	CR	<i>Pontophilus spinosus</i> (Pspi)	••	O	E	<i>Parastichopus regalis</i> (Preg)	••	O
C	<i>Hydrozoa</i> (Hydr)	••	O	M	<i>Scaphander lignarius</i> (Slig)	••	O	M	<i>Scaphander lignarius</i> (Slig)	••	O
M	<i>Octopus salutti</i> (Osall)	••	O	CR	<i>Munida intermedia</i> (Mint)	••	O	M	<i>Sepietta oweniana</i> (Sowe)	••	O
M	<i>Sepia orbignyana</i> (Sorb)	••	O	CR	<i>Nephrops norvegicus</i> (Nnor)	••	O	CR	<i>Macropodia longipes</i> (Mlon)	••	O
CR	<i>Munida intermedia</i> (Mint)	••	F	M	<i>Octopus salutti</i> (Osall)	••	O	M	<i>Neptunea contraria</i> (Ncon)	••	O
CR	<i>Munida sarsi</i> (Msar)	••	O	E	<i>Parastichopus regalis</i> (Preg)	••	O	CR	<i>Pagurus excavatus</i> (Pexc)	••	O
CR	<i>Scalpellum scalpellum</i> (Scal)	••	O	M	<i>Sepiolo sp.</i> (Sepi)	••	F	CR	<i>Pagurus alatus</i> (Pala)**	••	O
M	<i>Calliostoma granulatum</i> (Cgran)	••	O	E	<i>Anseropoda placenta</i> (Apla)	••	O	CR	<i>Pontophilus spinosus</i> (Pspi)	••	O
E	<i>Ophiotrix fragilis</i> (Ofra)	••	O	M	<i>Bathypolipus sponsalis</i> (Bspo)**	••	O	P	<i>Aphrodita aculeata</i> (Aacu)**	••	O
M	<i>Sepiolo sp.</i> (Sepi)	••	O	M	<i>Neptunea contraria</i> (Ncon)	••	O	M	<i>Charonia lampas</i> (Clam)	••	O
E	<i>Gracilechinus acutus</i> (Gacu)	••	O	CR	<i>Pagurus alatus</i> (Pala)**	••	O	CR	<i>Galathea intermedia</i> (Gint)	••	O
CR	<i>Macropipus tuberculatus</i> (Mtub)	••	O	E	<i>Parastichopus tremulus</i> (Ptrt)**	••	O	E	<i>Leptometra celtica</i> (Lcel)	••	F
C	<i>Pennatula</i> spp. (Penn)*	••	O	CR	<i>Philocheras equinulatus</i> (Pech)**	••	O	M	<i>Euspira fusca</i> (Efus)	••	O
E	<i>Anseropoda placenta</i> (Apla)	••	O	M	<i>Ranella olearium</i> (Role)	••	O	CR	<i>Nephrops norvegicus</i> (Nnor)	••	O
CR	<i>Pagurus excavatus</i> (Pexc)*	••	O	E	<i>Asteronyx loveni</i> (Alov)**	••	O	E	<i>Ophiura ophiura</i> (Ooph)	••	O
M	<i>Scaphander lignarius</i> (Slig)	••	O	M	<i>Buccinum</i> sp. (Bucc)**	••	O	M	<i>Rondeletiola minor</i> (Rmin)	••	F
M	<i>Galeodea rugosa</i> (Grug)	••	O	M	<i>Calliostoma granulatum</i> (Cgran)	••	O	M	<i>Rossia macrosoma</i> (Rmac)	••	O
M	<i>Euspira fusca</i> (Efus)*	••	O	M	<i>Colus gracilis</i> (Cgra)**	••	O	C	<i>Actinauge richardi</i> (Aric)	••	O
CR	<i>Nephrops norvegicus</i> (Nnor)	••	O	A	<i>Diazona violacea</i> (Dvio)**	••	O	A	<i>Corella parallelogramma</i> (Cpar)	••	O
M	<i>Octopus vulgaris</i> (Ovul)*	••	O	C	<i>Epizoanthus incratus</i> (Einc)**	••	F	E	<i>Echinus melo</i> (Emel)**	••	O
CR	<i>Pontophilus spinosus</i> (Pspi)	••	O	CR	<i>Galathea intermedia</i> (Gint)	••	O	C	<i>Funiculina quadrangularis</i> (Fqua)	••	O
M	<i>Sepietta oweniana</i> (Sowe)	••	O	M	<i>Galeodea rugosa</i> (Grug)	••	O	CR	<i>Goneplax rhomboides</i> (Grho)	••	O
A	<i>Corella parallelogramma</i> (Cpar)*	••	O	E	<i>Gracilechinus acutus</i> (Gacu)	••	O	E	<i>Gracilechinus acutus</i> (Gacu)	••	O
CR	<i>Galathea intermedia</i> (Gint)	••	O	C	<i>Hydrozoa</i> (Hydr)	••	O	P	<i>Hyalinoecia tubicola</i> (Htub)	••	O
S	<i>Phakelia ventrilabrum</i> (Pven)*	••	O	CR	<i>Inachus dorsettensis</i> (Idor)**	••	O	CR	<i>Macropipus tuberculatus</i> (Mtub)	••	O
M	<i>Ranella olearium</i> (Role)	••	O	E	<i>Leptometra celtica</i> (Lcel)	••	O	CR	<i>Munida sarsi</i> (Msar)	••	O
M	<i>Rondeletiola minor</i> (Rmin)	••	O	CR	<i>Munida iris</i> (Miri)	••	O	M	<i>Octopus salutti</i> (Osall)	••	O
M	<i>Sepia officinalis</i> (Soff)*	••	O	E	<i>Ophiotrix fragilis</i> (Ofra)	••	O	S	<i>Phakelia ventrilabrum</i> (Pven)	••	F
P	<i>Hyalinoecia tubicola</i> (Htub)*	••	O	CR	<i>Pagurus prideaux</i> (Ppri)	••	O	S	<i>Alcyonium palmatum</i> (Apal)**	••	O
CR	<i>Inachus leptochirus</i> (Idor)*	••	O	M	<i>Rondeletiola minor</i> (Rmin)	••	O	CR	<i>Cancer pagurus</i> (Cpag)	••	O
E	<i>Luidia ciliaris</i> (Lcil)*	••	O	CR	<i>Scalpellum scalpellum</i> (Scal)	••	O	C	<i>Caryophyllia smithii</i> (Csmi)	••	O
E	<i>Luidia sarsi</i> (Lsar)*	••	O	M	<i>Sepia orbignyana</i> (Sorb)	••	O	E	<i>Echinocardium cordatum</i> (Ecor)	••	O
CR	<i>Munida iris</i> (Miri)	••	O					M	<i>Galeodea rugosa</i> (Grug)	••	O
M	<i>Neptunea contraria</i> (Ncon)	••	O					CR	<i>Homarus gammarus</i> (Hgra)**	••	O
M	<i>Neopygnodonte cochlear</i> (Ncoc)*	••	O					CR	<i>Inachus dorsettensis</i> (Idor)**	••	O
E	<i>Brissopsis lyrifera</i> (Blyr)*	••	O					CR	<i>Inachus leptochirus</i> (Ilep)	••	O
CR	<i>Cancer pagurus</i> (Cpag)*	••	O					E	<i>Luidia sarsi</i> (Lsar)	••	O
C	<i>Caryophyllia smithii</i> (Csmi)*	••	O					E	<i>Marthasterias glacialis</i> (Mgla)	••	O
M	<i>Charonia lampas</i> (Clam)*	••	O					M	<i>Ranella olearium</i> (Role)	••	O
C	<i>Dendrophyllia cornigera</i> (Dcor)*	••	O					CR	<i>Scalpellum scalpellum</i> (Scal)	••	O
E	<i>Echinocardium cordatum</i> (Ecor)*	••	O								
CR	<i>Goneplax rhomboides</i> (Grho)*	••	O								
E	<i>Marthasterias glacialis</i> (Mgla)*	••	O								
CR	<i>Polycheles typhlops</i> (Ptyp)*	••	O								
M	<i>Pseudosimnia carnea</i> (Pcar)*	••	O								

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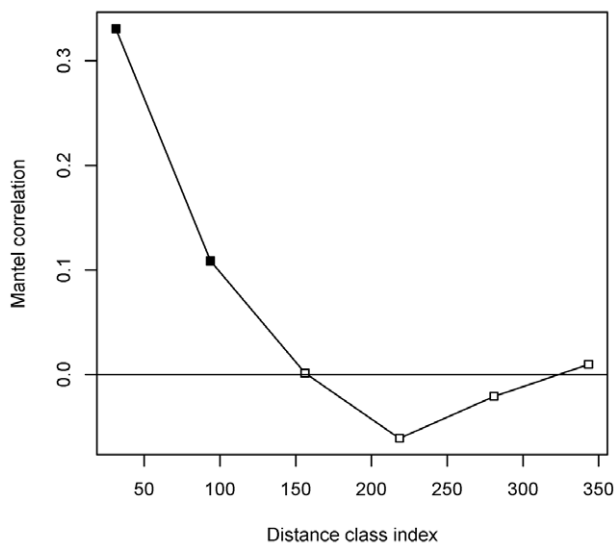


Fig. S1. – Mantel correlogram for the abundance data of aggregations as a function of the geographic distance classes among the study locations. The black squares indicate significant spatial correlation.

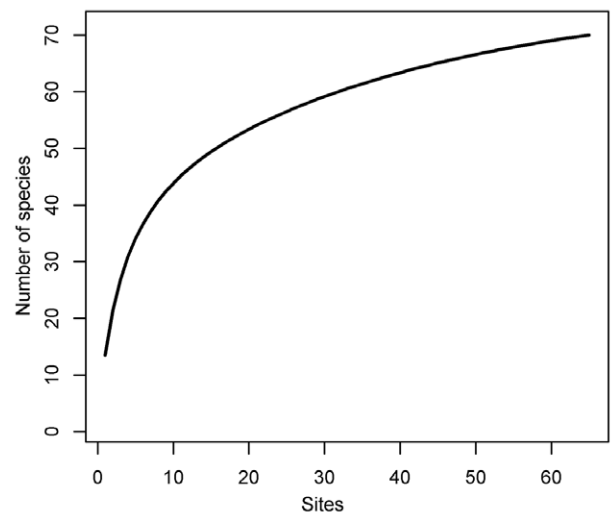


Fig. S2. – Species accumulation curve for the locations with density at or above the threshold 10.5 sea pens/haul of *F. quadrangularis* and *Pennatula* spp.