

Supplementary materials

Immersion Time Determines Performance of Artificial Habitats in Commercial Harbours by Changing Biodiversity of Colonising Invertebrate Assemblages

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Supplementary materials

Table S1. Surveyed species recorded in Biohut structures in Le Barcarès (BA), Port-Vendres (PV), and Grand Port maritime de Marseille (MA) in 2013 and 2014.

Phylum	Class	Family	Species	Location(s) recorded
Annelida	Polychaeta	-	<i>Polychaeta</i> spp.	BA, MA
Arthropoda	Malacostraca	Alpheidae	<i>Athanas nitescens</i>	BA, MA, PV
Arthropoda	Malacostraca	Carcinidae	<i>Carcinus</i> spp.	BA, PV
Arthropoda	Malacostraca	Galatheididae	<i>Galathea squamifera</i>	MA
Arthropoda	Malacostraca	Grapsidae	<i>Pachygrapsus marmoratus</i>	MA, PV
Arthropoda	Malacostraca	Hippolytidae	<i>Lysmata seticaudata</i>	BA, MA, PV
Arthropoda	Malacostraca	Inachidae	<i>Inachus/Macropodia</i> spp.	BA, MA, PV
Arthropoda	Malacostraca	-	<i>Isopoda</i> spp.	BA, MA, PV
Arthropoda	Malacostraca	Majidae	<i>Maja crispata</i>	BA
Arthropoda	Malacostraca	Majidae	<i>Maja</i> spp.	MA, PV
Arthropoda	Malacostraca	Eriphiidae	<i>Eriphia verrucosa</i>	BA, MA, PV
Arthropoda	Malacostraca	Palaemonidae	<i>Palaemon</i> spp.	BA, MA, PV
Arthropoda	Malacostraca	Palaemonidae	<i>Periclimenes</i> spp.	MA
Arthropoda	Malacostraca	Porcellanidae	<i>Pisidia</i> spp.	BA, MA, PV

Arthropoda	Malacostraca	Xanthidae	<i>Xantho poressa</i>	BA, PV
Echinodermata	Echinoidea	Echinidae	<i>Paracentrotus lividus</i>	BA, PV
Echinodermata	Ophiuroidea	Amphiuridae	<i>Amphipholis squamata</i>	BA
Echinodermata	Ophiuroidea	Ophiocomidae	<i>Ophiocomina nigra</i>	BA
Echinodermata	Ophiuroidea	Ophiocomidae	<i>Ophiopsila aranea</i>	BA
Echinodermata	Ophiuroidea	Ophiidermatidae	<i>Ophioderma longicauda</i>	BA
Echinodermata	Ophiuroidea	Ophiothricidae	<i>Ophiothrix fragilis</i>	BA, PV
Echinodermata	Ophiuroidea	-	<i>Ophiurida</i> spp.	BA, PV
Mollusca	Bivalvia	Anomiidae	<i>Anomia ephippium</i>	MA, PV
Mollusca	Bivalvia	Cardiidae	<i>Acanthocardia</i> spp.	PV
Mollusca	Bivalvia	Cardiidae	<i>Cerastoderma edule</i>	BA, MA, PV
Mollusca	Bivalvia	Limidae	<i>Limaria hians</i>	BA, MA, PV
Mollusca	Bivalvia	Mactridae	<i>Lutraria</i> spp.	BA, MA, PV
Mollusca	Bivalvia	Mytilidae	<i>Modiolarca subpicta</i>	BA
Mollusca	Bivalvia	Ostreidae	<i>Ostrea edulis</i>	MA
Mollusca	Bivalvia	Pectinidae	<i>Lissopecten hyalinus</i>	BA
Mollusca	Bivalvia	Pectinidae	<i>Mimachlamys varia</i>	BA, MA, PV
Mollusca	Cephalopoda	Sepiidae	<i>Sepia officinalis</i>	PV
Mollusca	Gastropoda	Calliostomatidae	<i>Calliostoma zizyphinum</i>	PV
Mollusca	Gastropoda	Cerithiidae	<i>Bittium reticulatum</i>	BA, PV
Mollusca	Gastropoda	Columbellidae	<i>Columbella rustica</i>	BA, MA, PV
Mollusca	Gastropoda	Facelinidae	<i>Cratena peregrina</i>	BA
Mollusca	Gastropoda	Fissurellidae	<i>Diodora graeca</i>	PV
Mollusca	Gastropoda	Littorinidae	<i>Melarhaphe neritoides</i>	MA
Mollusca	Gastropoda	Muricidae	<i>Hexaplex trunculus</i>	BA
Mollusca	Gastropoda	Muricidae	<i>Ocenebra erinaceus</i>	BA, MA, PV
Mollusca	Gastropoda	Muricidae	<i>Ocenebrina edwardsii</i>	BA, PV
Mollusca	Gastropoda	Muricidae	<i>Thophonopsis muricatus</i>	PV
Mollusca	Gastropoda	Nassariidae	<i>Nassarius incrassatus</i>	BA, MA, PV
Mollusca	Gastropoda	Nassariidae	<i>Nassarius</i> spp.	BA, MA, PV
Mollusca	Gastropoda	Plyceridae	<i>Polycera quadrilineata</i>	BA
Mollusca	Gastropoda	Trochidae	<i>Gibbula magus</i>	BA, PV
Platyhelminthes	Turbellaria	Discocelidae	<i>Discocelis tigrina</i>	MA, PV
Platyhelminthes	Turbellaria	Euryleptidae	<i>Pseudoceros maximus</i>	MA

Table S2. Invertebrate species surveyed between 2013 and 2017 in artificial structures (Dock Biohut: D; Pontoon Biohut, P) installed within 21 harbours, in 19 cities in France and Monaco during monitoring (total = 115 spp.).

Phylum	Class	Family	Species	Biohut type
Annelida	Echiura	Bonelliidae	<i>Bonellia viridis</i>	D, P
Annelida	Polychaeta	Arenicolidae	<i>Arenicola</i> spp.	P
Annelida	Polychaeta	Eunicidae	<i>Leodice harassii</i>	P
Annelida	Polychaeta	Eunicidae	<i>Leodice torquata</i>	P
Annelida	Polychaeta	Hesionidae	<i>Hesione pantherina</i>	D, P
Annelida	Polychaeta	Nereidae	<i>Nereis</i> spp.	P
Annelida	Polychaeta	-	<i>Polychaeta</i> spp.	D, P

Arthropoda	Malacostraca	Alpheidae	<i>Alpheus macrocheles</i>	D, P
Arthropoda	Malacostraca	Alpheidae	<i>Athanas nitescens</i>	D, P
Arthropoda	Malacostraca	-	<i>Brachyura</i> spp.	P
Arthropoda	Malacostraca	Carcinidae	<i>Carcinus aestuarii</i>	D, P
Arthropoda	Malacostraca	Carcinidae	<i>Carcinus</i> spp.	D, P
Arthropoda	Malacostraca	Dromiidae	<i>Dromia personata</i>	D, P
Arthropoda	Malacostraca	Galatheididae	<i>Galathea</i> spp.	P
Arthropoda	Malacostraca	Galatheididae	<i>Galathea squamifera</i>	D
Arthropoda	Malacostraca	Gammaridae	<i>Gammarus</i> spp.	P
Arthropoda	Malacostraca	Grapsidae	<i>Pachygrapsus marmoratus</i>	D, P
Arthropoda	Malacostraca	Hippolytidae	<i>Hippolyte</i> spp.	P
Arthropoda	Malacostraca	Hippolytidae	<i>Lysmata seticaudata</i>	D, P
Arthropoda	Malacostraca	Inachidae	<i>Inachus/Macropodia</i> spp.	D, P
Arthropoda	Malacostraca	-	<i>Isopoda</i> spp.	D, P
Arthropoda	Malacostraca	Leucosiidae	<i>Ebalia</i> spp.	D
Arthropoda	Malacostraca	Majidae	<i>Macropodia</i> spp.	P
Arthropoda	Malacostraca	Majidae	<i>Maja crispata</i>	D
Arthropoda	Malacostraca	Majidae	<i>Maja</i> spp.	D, P
Arthropoda	Malacostraca	-	<i>Malacostraca</i> spp.	P
Arthropoda	Malacostraca	Eriphiidae	<i>Eriphia verrucosa</i>	D, P
Arthropoda	Malacostraca	Mysidacea	<i>Mysidacea</i> spp.	P
Arthropoda	Malacostraca	Paguridae	<i>Pagurus anachoretus</i>	D
Arthropoda	Malacostraca	Palaemonidae	<i>Palaemon</i> spp.	D, P
Arthropoda	Malacostraca	Palaemonidae	<i>Periclimenes</i> spp.	D
Arthropoda	Malacostraca	Polybiidae	<i>Liocarcinus</i> spp.	D
Arthropoda	Malacostraca	Porcellanidae	<i>Pisidia longicornis</i>	P
Arthropoda	Malacostraca	Porcellanidae	<i>Pisidia longimana</i>	P
Arthropoda	Malacostraca	Porcellanidae	<i>Pisidia</i> spp.	D, P
Arthropoda	Malacostraca	Porcellanidae	<i>Porcellana platycheles</i>	P
Arthropoda	Malacostraca	Processidae	<i>Processa</i> spp.	D, P
Arthropoda	Malacostraca	Sphaeromatidae	<i>Sphaeromatidae</i> spp.	P
Arthropoda	Malacostraca	Xanthidae	<i>Xantho poressa</i>	D
Echinodermata	Asteroidea	Asteriidae	<i>Marthasterias glacialis</i>	D
Echinodermata	Asteroidea	Asterinidae	<i>Asterina gibbosa</i>	D, P
Echinodermata	Asteroidea	Astropectinidae	<i>Astropecten irregularis</i>	D
Echinodermata	Crinoidea	Antedonidae	<i>Antedon</i> spp.	P
Echinodermata	Echinoidea	Echinidae	<i>Gracilechinus acutus</i>	P
Echinodermata	Echinoidea	Echinidae	<i>Paracentrotus lividus</i>	D, P
Echinodermata	Holothuroidea	Holothuroiidea	<i>Holothuria forskali</i>	P
Echinodermata	Holothuroidea	Holothuroiidea	<i>Holothuria</i> spp.	D, P
Echinodermata	Ophiuroidea	Amphiuridae	<i>Amphipholis squamata</i>	D, P
Echinodermata	Ophiuroidea	Ophiocomidae	<i>Ophiocomina nigra</i>	D
Echinodermata	Ophiuroidea	Ophiocomidae	<i>Ophiopsila aranea</i>	D, P
Echinodermata	Ophiuroidea	Ophiidermatidae	<i>Ophioderma longicauda</i>	D, P
Echinodermata	Ophiuroidea	Ophiothricidae	<i>Ophiothrix fragilis</i>	D, P
Echinodermata	Ophiuroidea	-	<i>Ophiurida</i> spp.	D
Mollusca	Bivalvia	Anomiidae	<i>Anomia ephippium</i>	D, P

Mollusca	Bivalvia	Arcidae	<i>Arca noae</i>	D, P
Mollusca	Bivalvia	-	<i>Bivalvia</i> spp.	P
Mollusca	Bivalvia	Cardiidae	<i>Acanthocardia</i> spp.	D, P
Mollusca	Bivalvia	Cardiidae	<i>Cerastoderma edule</i>	D, P
Mollusca	Bivalvia	Cardiidae	<i>Cerastoderma glaucum</i>	P
Mollusca	Bivalvia	Cardiidae	<i>Parvicardium scriptum</i>	D, P
Mollusca	Bivalvia	Donacidae	<i>Donax</i> spp.	D, P
Mollusca	Bivalvia	Limidae	<i>Lima lima</i>	P
Mollusca	Bivalvia	Limidae	<i>Limaria hians</i>	D, P
Mollusca	Bivalvia	Mactridae	<i>Lutraria</i> spp.	D, P
Mollusca	Bivalvia	Mytilidae	<i>Modiolarca subpicta</i>	D, P
Mollusca	Bivalvia	Ostreidae	<i>Ostrea edulis</i>	D, P
Mollusca	Bivalvia	Ostreidae	<i>Ostreidae</i> spp.	P
Mollusca	Bivalvia	Pectinidae	<i>Lissopecten hyalinus</i>	D
Mollusca	Bivalvia	Pectinidae	<i>Mimachlamys varia</i>	D, P
Mollusca	Bivalvia	Thraciidae	<i>Thracia</i> spp.	P
Mollusca	Bivalvia	Veneridae	<i>Chamalea gallina</i>	P
Mollusca	Bivalvia	Verenidae	<i>Callista chione</i>	P
Mollusca	Cephalopoda	Sepiidae	<i>Sepia officinalis</i>	D
Mollusca	Gastropoda	Buccinidae	<i>Buccinum humphreysianum</i>	D
Mollusca	Gastropoda	Calliostomatidae	<i>Calliostoma zizyphinum</i>	D, P
Mollusca	Gastropoda	Cerithiidae	<i>Bittium reticulatum</i>	D, P
Mollusca	Gastropoda	Cerithiidae	<i>Cerithium vulgatum</i>	D
Mollusca	Gastropoda	Columbellidae	<i>Columbella rustica</i>	D, P
Mollusca	Gastropoda	Dorididae	<i>Doris verrucosa</i>	D
Mollusca	Gastropoda	Epitonidae	<i>Epitonium clathrus</i>	P
Mollusca	Gastropoda	Facelinidae	<i>Cratena peregrina</i>	D, P
Mollusca	Gastropoda	Fissurellidae	<i>Diodora graeca</i>	D
Mollusca	Gastropoda	Flabellinidae	<i>Flabellina</i> spp.	P
Mollusca	Gastropoda	-	<i>Gastropoda</i> spp.	D
Mollusca	Gastropoda	Goniodorididae	<i>Goniodoris castanea</i>	P
Mollusca	Gastropoda	Haliotidae	<i>Haliotis tuberculata</i>	D
Mollusca	Gastropoda	Haminoeidae	<i>Haminoea</i> spp.	D
Mollusca	Gastropoda	Hydrobiidae	<i>Peringia ulvae</i>	P
Mollusca	Gastropoda	Littorinidae	<i>Melarhaphe neritoides</i>	D
Mollusca	Gastropoda	Muricidae	<i>Bolinus brandaris</i>	D
Mollusca	Gastropoda	Muricidae	<i>Hexaplex trunculus</i>	D
Mollusca	Gastropoda	Muricidae	<i>Ocenebra erinaceus</i>	D
Mollusca	Gastropoda	Muricidae	<i>Ocenebrina edwardsii</i>	D, P
Mollusca	Gastropoda	Muricidae	<i>Thophonopsis muricatus</i>	D, P
Mollusca	Gastropoda	Nassariidae	<i>Nassarius corniculum</i>	D, P
Mollusca	Gastropoda	Nassariidae	<i>Nassarius incrassatus</i>	D, P
Mollusca	Gastropoda	Nassariidae	<i>Nassarius</i> spp.	D, P
Mollusca	Gastropoda	Nassariidae	<i>Tritia</i> spp.	D, P
Mollusca	Gastropoda	Naticidae	<i>Euspira</i> spp.	D
Mollusca	Gastropoda	Patellidae	<i>Patella</i> spp.	D, P
Mollusca	Gastropoda	Plyceridae	<i>Polycera hedgpethi</i>	D, P

Mollusca	Gastropoda	Plyceridae	<i>Polycera quadrilineata</i>	D, P
Mollusca	Gastropoda	Trochidae	<i>Gibbula magus</i>	D, P
Mollusca	Gastropoda	Trochidae	<i>Gibbula umbilicalis</i>	D, P
Mollusca	Gastropoda	Trochidae	<i>Jujubinus gravinae</i>	D
Mollusca	Gastropoda	Trochidae	<i>Jujubinus striatus</i>	D, P
Mollusca	Gastropoda	Trochidae	<i>Trochidae</i> spp.	D
Mollusca	Gastropoda	Turritellidae	<i>Turritella communis</i>	D
Platyhelminthes	Turbellaria	Discocelidae	<i>Discocelis tigrina</i>	D, P
Platyhelminthes	Turbellaria	Euryleptidae	<i>Oligocladus sanguinolentus</i>	P
Platyhelminthes	Turbellaria	Euryleptidae	<i>Prostheceraeus moseleyi</i>	P
Platyhelminthes	Turbellaria	Euryleptidae	<i>Pseudoceros maximus</i>	D, P
Platyhelminthes	Turbellaria	Pseudocerotidae	<i>Thysanozoon brocchii</i>	D, P
Platyhelminthes	Turbellaria	Stylocomoplanidae	<i>Comoplana agilis</i>	P

Table S3. Temporal comparisons (with 95% confidence intervals: CI) of invertebrate assemblages in Dock Biohut across harbours (random factor) in Year 1 to Year 2 (linear mixed effects models). Significant metrics shown in bold.

Response	Contrast	Lower CI	Upper CI	Test stat	df	p
Total abundance	1.69	1.08	2.66	2.36	1,42	0.02
Species richness	1.28	1.03	1.58	2.28	1,42	0.02
Shannon (H)	0.14	-0.26	0.54	0.70	1,42	0.48
Pielou's evenness (J)	0.08	0.002	0.16	2.07	1,40	0.04
Malacostraca abundance	3.69	2.06	6.63	4.50	1,42	<0.0001
Bivalvia abundance	1.16	0.60	2.24	0.45	1,42	0.66
Gastropoda abundance	0.99	0.54	1.80	-0.04	1,42	0.97
Ophiuroidea abundance	0.84	0.27	2.66	-0.31	1,42	0.76

Table S4. Mean \pm SE total abundance, biodiversity, and abundance of classes of invertebrates surveyed within Biohut structures in year 1 and year 2 since installation.

	Year 1	Year 2
Total abundance	46.30 \pm 7.93	75.38 \pm 11.25
Species richness	7.20 \pm 0.42	9.13 \pm 1.15
Shannon diversity (H)	1.44 \pm 0.08	1.58 \pm 0.18
Pielou's evenness (J)	0.74 \pm 0.03	0.82 \pm 0.02
Malacostraca abundance	10.97 \pm 1.90	39.00 \pm 5.81
Bivalvia abundance	6.33 \pm 1.53	8.13 \pm 2.07
Gastropoda abundance	13.70 \pm 3.83	17.50 \pm 6.16
Ophiuroidea abundance	14.73 \pm 7.15	7.50 \pm 3.79

Table S5. Temporal comparisons (with 95% confidence intervals: CI) of potentially exploited species surveyed contributing >5% of the total abundance of invertebrate assemblages in surveyed Biohuts in Year 1 and Year 2 (linear mixed effects models) [30].

Response	Contrast	Lower CI	Upper CI	Test stat	df	p
<i>Palaemon</i> spp. abundance	1.81	0.81	4.07	1.49	1,42	0.14
<i>Mimachlamys varia</i> abundance	1.10	0.52	2.31	0.25	1,42	0.80

Table S6. Mean \pm SE total abundance of commercially exploitable species in surveyed Dock Biohut structures in Year 1 and Year 2 [30].

	Year 1	Year 2
<i>Carcinus</i> spp.	0.47 \pm 0.23	0.00 \pm 0.00
<i>Cerastoderma edule</i>	0.17 \pm 0.07	0.00 \pm 0.00
<i>Galathea squamifera</i>	0.13 \pm 0.08	0.19 \pm 0.14
<i>Melarhaphe neritoides</i>	0.03 \pm 0.03	0.00 \pm 0.00
<i>Mimachlamys varia</i>	5.63 \pm 1.50	6.63 \pm 1.70
<i>Ostrea edulis</i>	0.03 \pm 0.03	0.00 \pm 0.00
<i>Palaemon</i> spp.	4.60 \pm 1.50	7.81 \pm 2.00
<i>Paracentrotus lividus</i>	0.30 \pm 0.16	2.63 \pm 1.06
<i>Periclimenes</i> spp.	0.00 \pm 0.00	0.75 \pm 0.44
<i>Polychaeta</i> spp.	0.00 \pm 0.00	0.56 \pm 0.30
<i>Sepia officinalis</i>	0.07 \pm 0.05	0.00 \pm 0.00