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Data Article

Relative abundances of benthic foraminifera in response to total organic carbon in sediments: Data from European intertidal areas and transitional waters

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A B S T R A C T

We gathered total organic carbon (%) and relative abundances of benthic foraminifera in intertidal areas and transitional waters from the English Channel/European Atlantic Coast (587 samples) and the Mediterranean Sea (301 samples) regions from published and unpublished datasets. This database allowed to calculate total organic carbon optimum and tolerance range of benthic foraminifera in order to assign them to ecological groups of sensitivity. Optima and tolerance range were obtained by mean of the weighted-averaging method. The data are related to the research article titled "Indicative value of benthic foraminifera for biomonitoring: assignment to ecological groups of sensitivity to total organic carbon of species from European intertidal areas and transitional waters" [1].

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Specifications Table

Subject	Ecology
Specific subject area	Environmental Monitoring
Type of data	Tables and Figures
How data were acquired	Data available with peer-reviewed journal articles and unpublished data. The weighted-averaging (WA) optimum and tolerance approach was used [2,3] using the optimos.prime R package [4]; as well as the AMBI formula [5]. Statistics were done with the statistical language R version 3.6.3 [6].
Data format	Primary data Secondary data
Parameters for data collection	The aim was to collect data on total organic carbon (TOC) and benthic foraminifera in order to classify benthic foraminifera in ecological groups of sensitivity to TOC [5]. Studies had to fulfill the following criteria: 1) coming from the English Channel, the French, Spanish and Portuguese Atlantic coasts and the Mediterranean Sea, 2) sampled from intertidal areas and transitional waters (TWs), 3) based on living foraminifera, 4) TOC sample must come from the same site at the same date as foraminiferal sample, 5) only samples containing >50 living stained specimens were considered. If only organic matter content (%) was provided, it was converted to TOC using the following formula: LOI (loss-on-ignition) = ~2 TOC [7,8]. When foraminiferal raw counts or abundances were available, there were transformed to relative abundances.
Description of data collection	Primary data – Data from unpublished studies (studies 1, 3, 6, 7, 8, 9, 10) were provided by their authors. When the raw data were not published with the peer-reviewed publication (studies 13, 33 and 41), the authors were contacted to provide us with the raw data.

(*continued on next page*)

	Secondary data – When available, relative abundances data were downloaded from online sources where the study was published. When only raw counts or abundances were published, foraminiferal data were transformed to relative abundances. We standardized species names according to the World Registry of Marine Species (WoRMS). All data processing and analysis was done in the open-source software R.
Data source location	Secondary data sources: The full list of data sources is available at https://data.mendeley.com/datasets/stjfr9xvxg/1
Data accessibility	The database is available on Mendeley: Bouchet, Vincent; Frontalini, Fabrizio; Francescangeli, Fabio; Sauriau, Pierre-Guy; Geslin, Emmanuelle; Martins, Virginia; Almogi-Labin, Ahuva; Avnaim-Katav, Simona; Di Bella, Letizia; Cearreta, Alejandro; Coccioni, Rodolfo; Costelloe, Ashleigh; Dimiza, Margarita; Ferraro, Luciana; Haynert, Kristin; Martinez-Colon, Michael; Melis, Romana; Schweizer, Magali; Triantaphyllou, Maria; Tsujimoto, Akira; Wilson, Brent; Armynot du Châtelet, Eric (2021), "Living foraminifera relative abundances and total organic carbon in European Atlantic intertidal and transitional areas", Mendeley Data, V1, http://dx.doi.org/10.17632/stjfr9xvxg.1 http://dx.doi.org/10.17632/stjfr9xvxg.1
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Value of the Data

- The data of relative abundances of living benthic foraminifera in European intertidal areas and transitional waters allows assessing the response of the species to total organic carbon contained in the sediment over a large geographical scale.
- The assignment of benthic foraminiferal species to ecological groups of sensitivity to total organic carbon have further implication for environmental monitoring.
- In the present study database, foraminiferal species names and data format were standardised to species concept from the World Register of Marine Species and to relative abundances, respectively.
- These data might be re-used to further assess and improve our understanding of the biogeographical distribution patterns of benthic foraminifera in European intertidal areas and transitional waters over a large latitudinal range.

1. Data Description

The present study database (available in Mendeley: http://dx.doi.org/10.17632/stjfr9xvxg.1), composed of primary and secondary data, summarizes the total organic carbon content in sediment (%) and the relative abundances (%) of benthic foraminiferal species in European intertidal areas and transitional waters (French coast of the English Channel, European Atlantic Coast and the Mediterranean Sea) extracted from 35 primary peer-reviewed articles and seven unpublished grey literature that met the inclusion criteria for the related meta-analysis [1] (see meta-data in Table 1). In the English Channel/European Atlantic Coast, selected study sites included eight classical estuaries, four coastal freshwater/brackish water plumes, two artificial water bodies and two Rias (Fig. 1; see definition of each body type in Table 1 in [1] according to [9,10]). In the Mediterranean Sea, one delta, six lentic non-tidal lagoons, four lentic tidal lagoons, one artificial water body, seven semi-enclosed bays and one classical estuary were considered (Fig. 1).

This database was built to assign benthic foraminiferal species to ecological groups of sensitivity to total organic carbon (see [1] for more details). Because of the particular characteristics of foraminiferal habitats and communities, we decided to present the database split in two: one for the English Channel/European Atlantic and one for the Mediterranean region. The overall aim of this paper is to provide foraminiferal ecologists with a ready-to-use database detailing foraminiferal species relative abundances and total organic content (%) in the studied sampling sites to be used for ecological, biogeographical and environmental monitoring purposes.

Table 1
Meta-data of the different selected studies. Full details of primary and secondary data sources are available at https://data.mendeley.com/datasets/stjfr9xvxg/1.

Dataset	Region	Country	Local study area	Related foraminiferal study	Related Total Organic Carbon study	Sample code description	Tidal condition	Year of sampling	Time of the year	Foram size fraction	TOC method	Data available with original publication	Sediment layer	Sampling device
1	English Channel	France	Grand-Fort Philippe	Francescangeli (2017)-PhD thesis	same	A-J-O-F: April, June, October, February; FP: Fort-Philippe; 1–2–3: replicates	Intertidal	2014–2015	4 seasons	> 63 µm	CHN Elemental analyser	Unpublished	0–1 cm	Corer (diameter: 85 µm)
2	English Channel	France	Liane estuary	Armynot du Châtelet et al. (2011)	same	BL: Boulogne sur Mer; a-b-c: replicates	Intertidal and subtidal	2008	April	> 63 µm	CHN Elemental analyser	Yes, relative abundances	0–1 cm	Van Veen grab
3	English Channel	France	Boulogne sur Mer Harbor	Francescangeli (2017)-PhD thesis	same	A-J-O-F: April, June, October, February; BL: Boulogne-sur-Mer; 1–2–3: replicates	Intertidal	2014–2015	4 seasons	> 63 µm	CHN Elemental analyser	Unpublished	0–1 cm	Corer (diameter: 85 µm)
4	English Channel	France	Canche estuary	Francescangeli et al. (2017)	same	T: transect; P: sampling point; A,B,C: replicates	Intertidal	2012–2013–2014	September	> 63 µm	CHN Elemental analyser	Yes, Raw counts	0–1 cm	Corer (diameter: 85 µm)
5	English Channel	France	Canche estuary	Armynot du Châtelet et al. (2018)	same	CE: Canche estuary transept cross shore; D: samples in a square meter	Intertidal	2007 (CE) and 2017 (D)	April	> 63 µm	CHN Elemental analyser	Yes, relative abundances	0–1 cm (CE) and 0–2 cm (D)	Van Veen grab (CE), scraping (D)
6	English Channel	France	Canche estuary	Francescangeli (2017)-PhD thesis	same	A-J-O-F: April, June, October, February; CA: Canche Estuaryr; 1–2–3: replicates	Intertidal	2014–2015	4 seasons	> 63 µm	CHN Elemental analyser	Unpublished	0–1 cm	Corer (diameter: 85 µm)
7	English Channel	France	Authie estuary	Francescangeli (2017)-PhD thesis	same	A-J-O-F: April, June, October, February; AU: Authie Esturie; 1–2–3: replicates	Intertidal	2014–2015	4 seasons	> 63 µm	CHN Elemental analyser	Unpublished	0–1 cm	Corer (diameter: 85 µm)
8	English Channel	France	Somme estuary	Francescangeli (2017)-PhD thesis	same	A-J-O-F: April, June, October, February; SO: Somme Estuary; 1–2–3: replicates	Intertidal	2014–2015	4 seasons	> 63 µm	CHN Elemental analyser	Unpublished	0–1 cm	Corer (diameter: 85 µm)
9	English Channel	France	Bay of Veys	Bouchet (unpublished)	same	Ref: reference station outside the influence of the oyster farming area; Transect from oyster farming area (0 m) to 50, 100, 200 and 400 m away	Intertidal	2006	October	> 63 µm	CHN Elemental analyser	Unpublished	0–1 cm	Spoon (pseudoreplication method)
10	Atlantic	France	Crouesty harbor	Armynot du Châtelet (2003)-PhD thesis	same	Numbers: stations	Subtidal	2002	July	> 63 µm	LOI	Unpublished	0–1 cm	Van Veen grab
11	Atlantic	France	Loire estuary	Mojtahid et al. (2016)	same	A-B-L: outer estuary-lower inner estuary-middle inner estuary; according to station number	Intertidal and Subtidal	2012	September	> 150 µm	LECO–CS200® analyser	Yes, abundances	0–1 cm	Subtidal: Van Veen grab; Intertidal: scraping off
12	Atlantic	France	Aiguillon bay	Armynot du Châtelet et al. (2009)	same	According to station number	Intertidal	2001	October	> 63 µm	LOI	Partly, relative abundances	0–1 cm	Van Veen grab
13	Atlantic	France	Aiguillon Bay/Ré Island	Bouchet et al. (2009)	same	C: control station outside oyster farm; OZ: in the oyster zone; OFZ: oyster free zone under the influence of the oyster farming area	Intertidal	2004	October, 29	> 63 µm	LOI	No	0–1 cm	Corer (diameter: 95 µm)
14	Atlantic	France	Ronce Perquis	Bouchet et al. (2007)	same	According to station number	Intertidal	2004	April 22, May 25, June 9 and 22, August 4	> 63 µm	LOI	Partly, abundances	0–1 cm	Spoon (pseudoreplication method)
15	Atlantic	Spain	Plentzia estuary	Cearreta et al. (2002)	same	According to sampling station name	Intertidal	1997	Sping and Autumn	> 63 µm	Walkey method	Partly, relative abundances	0–1 cm	Corer (diameter: not specified)
16	Atlantic	Spain	Ria de Vigo	Diz et al. (2006)	same	According to station number and month of sampling	Subtidal	1998	January and September	> 63 µm	LECO–CS200® analyser	Yes, raw counts	0–1 cm	Box corer
17	Atlantic	Portugal	Ria de Aveiro	Martins et al. (2015)	same	According to station number	Subtidal	2011	Summer	> 63 µm	LOI	Yes, relative abundances	0–1/2 cm	Adapted Petit Ponnar sampler (with two openings
18	Atlantic	Portugal	Ria de Aveiro	Martins et al. (2013)	same	According to station number	Subtidal	2006–2007	Spring/ Summer	> 63 µm	LOI	Yes, relative abundances	0–2 cm	Adapted Petit Ponnar sampler (with two openings
19	Atlantic	Portugal	Ria de Aveiro	Martins et al. (2010)	same	According to station number	Subtidal	2006	March and April	> 63 µm	LOI	Yes, relative abundances	0–5 cm	Adapted Petit Ponnar sampler (with two openings

(continued on next page)

Table 1 (*continued*)

Dataset	Region	Country	Local study area	Related foraminiferal study	Related Total Organic Carbon study	Sample code description	Tidal condition	Year of sampling	Time of the year	Foram size fraction	TOC method	Data available with original publication	Sediment layer	Sampling device
20	Atlantic	Portugal	Ria de Aveiro	Martins et al. (2016)	same	C1-C8: stations number; 1–4: Sampling season (1: Autumn, 2: early winter, 3: early spring, 4: late winter)	Subtidal	2009 to 2011	Autumn, early winter, early spring, late winte	> 63 µm	LOI	Yes, relative abundances	0–1 cm	Box-corer
21	Atlantic	Portugal	Guadiana estuary	Camacho et al. (2014)	same	According to station name and season of sampling	Intertidal	2010	Winter and Summer	> 63 µm	CHN Elemental analyser	Yes, relative abundances	0–1 cm	Corer (diameter: 50 µm)
22	Mediterranean Sea	Spain	Ebro delta	Benito et al. (2016)	same	According to station number and date of sampling	Intertidal	2012–2013	November, April and August	> 63 µm	LOI	Yes, relative abundances	0–1 cm	Corer (diameter: 57 µm)
23	Mediterranean Sea	France	Bagès-Sigean lagoon	Foster et al. (2012)	same	According to station number	Subtidal	2010	September	> 125 µm	CHN Elemental analyser	Yes, relative abundances	0–1 cm	Shallow-water surface sediment sampler
24	Mediterranean Sea	Italy	Sardinia island	Schintu et al. (2015)	same	According to sampling zone (PT: Porto Torres, PS: Portoscuso, LM: La Maddalena Archipelago) and station number	Subtidal	2010 (PT and PS) and 2011 (LM)	May (PT and PS) and June (LM)	> 63 µm	LOI	Yes, relative abundances	0–3 cm	Van Veen grab
25	Mediterranean Sea	Italy	Santa Gilla	Frontalini et al. (2009)	Aztori (2013)-PhD thesis	According to station number	Subtidal	2006	October	> 63 µm	CHN Elemental analyser	Yes, relative abundances	0–2 cm	Van Veen grab
26	Mediterranean Sea	Italy	Orbetello	Frontalini et al. (2010)	Specchiulli et al. (2010)	According to station number	Subtidal	2003	October	> 63 µm	CHN Elemental analyser	Yes, relative abundances	0–2 cm	Van Veen grab
27	Mediterranean Sea	Italy	Naples harbor	Ferraro et al. (2006)	same	According to sampling zone (DL: Levante dock, DG: Granili dock) and station number	Subtidal	N.D.	N.D.	> 125 µm	CHN Elemental analyser	Yes, relative abundances	0–20 cm	Hydraulic vibro-corer (diameter: 100 µm)
28	Mediterranean Sea	Italy	Varano lake	Frontalini et al. (2013)	same	According to station number	Subtidal	2012	March	> 125 µm	CHN Elemental analyser	Yes, relative abundances	0–2 cm	Van Veen grab
29	Mediterranean Sea	Italy	Lesina lagoon	Frontalini et al. (2010)	Borja et al. (2011)	According to station number	Subtidal	2004	March	> 63 µm	CHN Elemental analyser	Yes, relative abundances	0–2 cm	Van Veen grab
30	Mediterranean Sea	Italy	Venice lagoon	Coccioni et al. (2009)	Secco et al. (2005)	According to station number	Subtidal	2002	June	> 63 µm	CHN Elemental analyser	Yes, relative abundances	0–2 cm	Van Veen grab
31	Mediterranean Sea	Italy	Marano and Grado lagoon	Melis (unpublished data)	same	VN: Valle Noghere, according to station number	Intertidal	2015	May and July	> 63 µm	CHN Elemental analyser	Unpublished	0–2 cm	Corer (diameter: 56 µm)
32	Mediterranean Sea	Greece	Saronikos gulf	Portela (2017)-MSc thesis	same	S: distance from the point source of the effluents	Subtidal	2016	February	> 125 µm	CHN Elemental analyser	Unpublished	0–1 cm	Stainless steel box-corer
33	Mediterranean Sea	Greece	Saronikos gulf	Dimiza et al. (2016)	same	S: distance from the point source of the effluents	Subtidal	2012	February	> 125 µm	CHN Elemental analyser	No	0–1 cm	Stainless steel box-corer
34	Mediterranean Sea	Greece	Evoikos gulf	Goreija (2013)-MSc thesis	same	N: According to station number	Subtidal	2011	November	> 125 µm	CHN Elemental analyser	Unpublished	1 to 2 cm	Van Veen grab
35	Mediterranean Sea	Greece	Kavala bay	Delliou (2013)-MSc thesis	same	according to the sampled geographical sites	Subtidal	2012	November	> 125 µm	CHN Elemental analyser	Unpublished	1 to 2 cm	Bowser-corer
36	Mediterranean Sea	Turkey	Gulf of Izmir	Bergin et al. (2006)	same	According to station number	Subtidal	2002	November	> 250 µm	Hach method	Yes, relative abundances	0–1 cm	Van Veen grab
37	Mediterranean Sea	Israel	Timsah pond	Flako-Zaritsky et al. (2011)	same	According to date of sampling	ground water-surface water interaction pond	2002 and 2003	November and February	> 63 µm	CHN Elemental analyser	Yes, raw counts	0–4 cm	Corer (diameter: 35 µm)
38	Mediterranean Sea	Israel	Betzet, Naaman, Poleg, Lachish estuaries	Avnaim-Katav et al. (2016)	same	Three replicates. Sample names at each estuary include a capital letter representing sampling season (S —summer; A —autumn;W— winter; W*) and numerals representing the E–W gradient away from the stream mouth: 1 being the closet to the river mouth and 3 the most inland one.	Intertidal	2012–2013	3 seasons: summer: May 30, June 6, June 27, July 11; autumn: October 25;winter: January 17 (shortly after a major winter storm event), March 19	> 63 µm	CHN Elemental analyser	Yes, raw counts	0–1 cm	Corer (diameter: 54 µm)
39	Mediterranean Sea	Egypt	Abu-Qir bay	Elshanawany et al. (2011)	same	According to station number and date of sampling	Subtidal	2005	May and November	> 63 µm	LECO–CS200® analyser	Yes, relative abundances	0–1 cm	Grab
40	Mediterranean Sea	Tunisia	Djerba lagoon	El Kateb et al. (2018)	same	According to station number	Subtidal	2014	July	> 63 µm	CHN Elemental analyser	Yes, relative abundances	0–1 cm	Grab
41	Mediterranean Sea	Tunisia	Monastir bay	Damak et al. (2019)	same	According to station number	Subtidal	2015	August	> 125 µm	Walker and Black method	No	0–1 cm	Scraping
42	Mediterranean Sea	Tunisia	Bizerte lagoon	Alves Martins et al. (2015)	same	Stations number	Subtidal	2013	March	> 63 µm	Perkin Elmer (Waltham, MA, USA) PE 2400 CHN system	Yes	0–2 cm	Box-corer

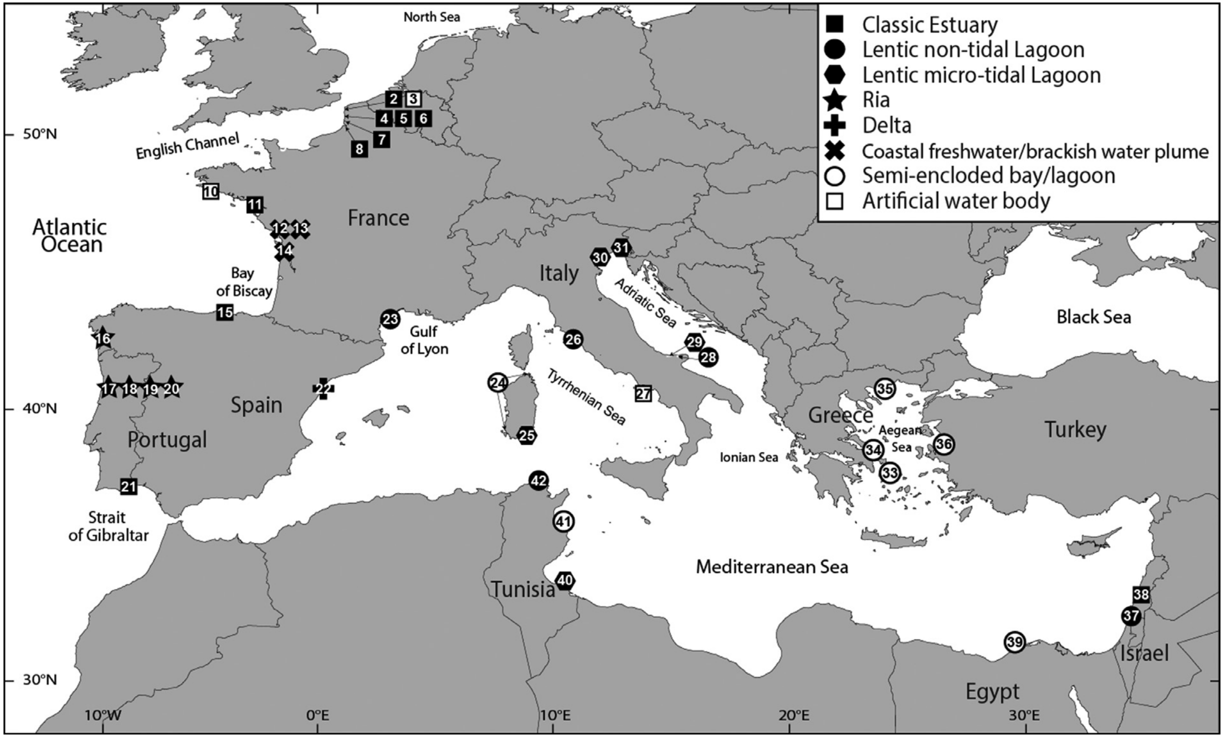

Fig. 1. Map showing the geographical distribution of the 42 studies according to the water body type (see definition of each body type in Table 1 in [1] according to [9] and [10]) used to assign the species from the English Channel/European Atlantic coast and the Mediterranean Sea intertidal and TWs. Numbers are the same as in Table 1.

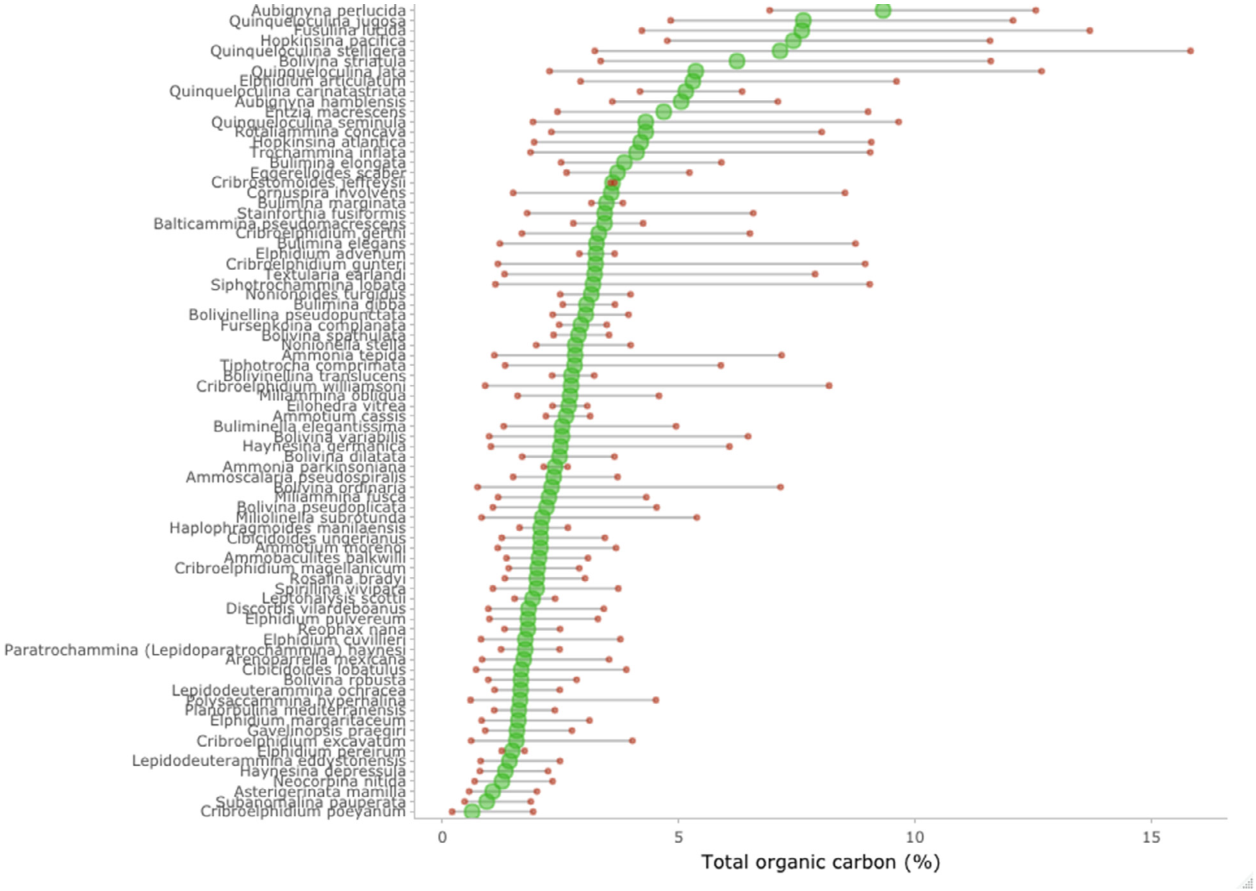

Fig. 2. Caterpillar plot showing the optimum (green dots) and tolerance range (bars) to TOC of benthic foraminiferal species in the English Channel/European Atlantic intertidal areas and transitional waters.

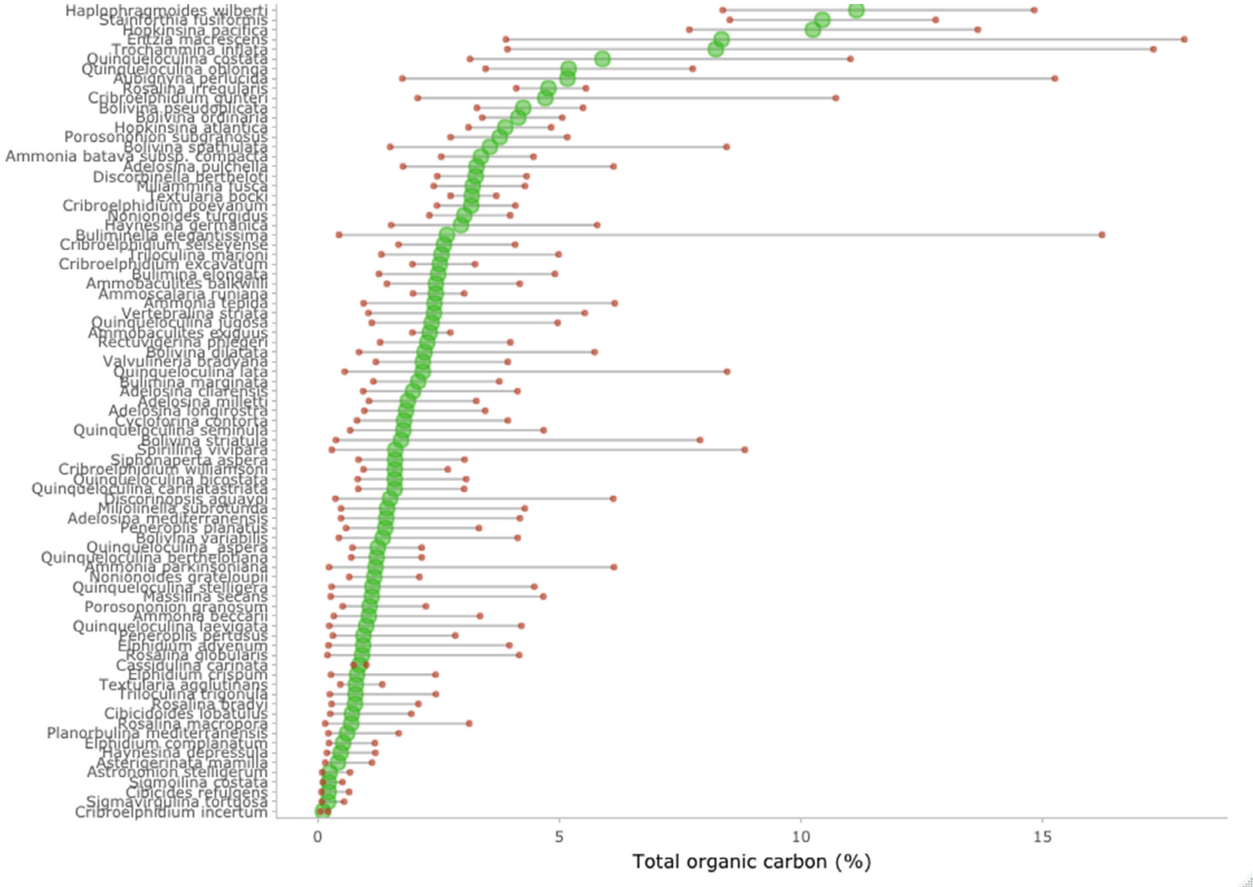

Fig. 3. Caterpillar plot showing the optimum (green dots) and tolerance range (bars) to TOC of benthic foraminiferal species in the Mediterranean Sea intertidal areas and transitional waters.

2. Experimental Design, Materials and Methods

Data acquisition: Data of benthic foraminifera relative abundances and related TOC contents (%) in the sediment are mainly from published literature, obtained from data tables in the publication or provided by the authors if not published (database available in Mendeley: http://dx.doi.org/10.17632/stjfr9xvxg.1). To select the relevant studies, the following criteria scheme was followed: only studies on living foraminifera (not dead neither total assemblages), only samples with >50 living specimens and contemporaneous TOC and foraminifera sampling. In total, it was possible to include in the data 587 samples from the English Channel/European Atlantic Coast and 301 from the Mediterranean Sea.

Data computation: When raw counts or abundances were provided, we standardised it to relative abundances. The optimos.prime R package [4] was used to calculate the weighted averaging optimum and tolerance level [2,3] of each species to TOC (Figs. 2 and 3).

In order to illustrate the typical response of species from each ecological group along the TOC gradient, a locally weighted scatterplot smooth line (LOESS) was fitted through each scatter plot (see Fig. 5–6 in [1]). Marginal plots were added to each scatter plot to show the frequency of distribution of occurrences along the TOC gradient. The median of the distribution of the occurrences was also computed. The R code (supplementary materials) includes the following packages: ggpubr, ggExtra, cowplot, mgcv.

CRediT Author Statement

Vincent M.P. Bouchet: Conceptualization, Supervision, Investigation, Data curation, Formal analysis, Visualization, Writing – original draft; **Fabrizio Frontalini:** Investigation, Writing – Review & Editing; **Fabio Francescangeli:** Visualization - Writing – Review & Editing; **Pierre-Guy Sauriau:** Formal analysis, Writing – Review & Editing; **Emmanuelle Geslin:** Supervision, Writing – Review & Editing; **Virginia Martins:** Investigation, Writing – Review & Editing; **Ahuva Almogi-Labin:** Writing – Review & Editing; **Simona Avnaim-Katav:** Investigation, Writing – Review & Editing; **Letizia Di Bella:** Writing – Review & Editing; **Alejandro Cearreta:** Investigation, Writing – Review & Editing; **Rodolfo Coccioni:** Writing – Review & Editing; **Ashleigh Costelloe:** Writing – Review & Editing; **Margarita D. Dimiza:** Writing – Review & Editing; **Luciana Ferraro:** Investigation, Writing – Review & Editing; **Kristin Haynaert:** Writing – Review & Editing; **Michael Martínez-Colón:** Writing – Review & Editing; **Romana Melis:** Investigation, Writing – Review & Editing; **Magali Schweizer:** Writing – Review & Editing; **Maria V. Triantaphyllou:** Investigation, Writing – Review & Editing; **Akira Tsujimoto:** Writing – Review & Editing; **Brent Wilson:** Writing – Review & Editing; **Eric Armynot du Châtelet:** Supervision, Investigation, Writing – Review & Editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported in this article.

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Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2021.106920.

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