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A photographic, taxonomic and environmental dataset of fish eggs and larvae in the south-central Tyrrhenian Sea, 2021–2025

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Abstract

We present a photographic and taxonomically annotated dataset of fish eggs and larvae collected by plankton net tows at three sampling locations in the south-central Tyrrhenian Sea (Campania region): the Cuma stations in the Gulf of Gaeta, the Dohrn transect in the Gulf of Naples, and the Marechiara Long-Term Ecological Research station (LTER-MC). Sampling combined 200, 333 and 500 µm mesh plankton nets across 15 stations spanning coastal, shelf and offshore habitats at bottom depths between 70 and 407 m. The dataset spans June 2021 to March 2025 and comprises 2,376 records corresponding to identified individuals, each linked to a reference photograph. Concurrent conductivity–temperature–depth (CTD) downcast profiles of temperature, salinity, dissolved oxygen, pH and chlorophyll fluorescence are provided. An accompanying egg table contains 3,016 eggs from 165 net tows (2022–2025). A total of 91 taxa across 59 genera, 42 families and 20 orders were recorded. For each individual, we provide capture date and time, station identity and coordinates, gear and flowmeter metadata, taxonomic identification at the finest resolved level, larval abundance normalized by filtered volume and by sea surface area, and a reference photograph. The dataset supports taxonomic training and image-recognition

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applications, ichthyoplankton phenology and biodiversity studies, and long-term comparison with the LTER-MC time series. The dataset is available at https://doi.org/10.6084/m9.figshare.34981408 (Liguori et al., 2026b).

1 Introduction

Seasonality in the reproductive timing of many fish species drives substantial shifts in the abundance and composition of ichthyoplankton assemblages, and these temporal patterns are increasingly affected by climate-driven changes in spawning phenology (Asch, 2015; Sabatés et al., 2007). Spatially, the early life stages of fish carry information on spawning grounds and nursery habitats that is central to understanding recruitment variability (Bergamasco et al., 2023; Patti et al., 2020, 2022). Submarine canyons, in particular, are recognized as hotspots of enhanced planktonic and larval fish activity, owing to their distinctive hydrodynamics, upwelling and retention features (Fernandez-Arcaya et al., 2017; Russo et al., 2024; Skliris and Djenidi, 2006).

The South-Central Tyrrhenian Sea hosts two such systems, the Dohrn and Cuma submarine canyons, together with the Marechiara Long-Term Ecological Research station (LTER-MC), one of the longest-running marine time series in the Mediterranean Sea, monitored continuously since 1984 and part of the global LTER network since 2006 (Carotenuto et al., 2023; Zingone et al., 2019). Despite being among the most productive and heavily fished areas of the Mediterranean, ichthyoplankton assemblages in this region remain comparatively poorly documented (Cataudella and Spagnolo, 2011; Ciannelli et al., 2022; Liguori et al., 2026a).

A major obstacle to filling this gap is taxonomic. The identification of fish eggs and larvae relies on a combination of morphological, meristic and pigmentation characters that change rapidly through ontogeny, so that the same species can look markedly different between the yolk-sac, preflexion, flexion and postflexion stages, while closely related species may be almost indistinguishable at a given stage (Leis, 2015). Identification is further complicated by the damage that specimens commonly suffer during net collection and by the fading of pigmentation in preserved material, and morphological identifications can differ substantially among laboratories, particularly below family level (Ko et al., 2013). The reference literature for the Mediterranean and adjacent Atlantic (Fahay, 2007; Lo Bianco et al., 1956; Re and Meneses, 2008; Richards, 2005; Rodríguez et al., 2017; Russell, 1976; Whitehead et al., 1986) is largely based on line drawings of idealized, intact specimens, often covering only part of the developmental series, and openly

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available photographs of real specimens, showing the natural variability, the range of developmental stages and the typical state of preservation encountered in routine samples, remain comparatively scarce and geographically scattered (Hou et al., 2021). Photographic vouchers linked to an explicit identification and to full sampling metadata therefore have a taxonomic value of their own: they document the characters on which each identification was based, allow identifications to be independently verified and revised as taxonomic knowledge improves, support the training of new taxonomists, and provide the labelled images required to develop and validate automated identification tools (Colas et al., 2018; Irisson et al., 2022; Luo et al., 2018).

This dataset was generated within a PhD research project on the ichthyoplankton of the Cuma and Dohrn canyons and the LTER-MC coastal station, underlying the analyses of seasonal and interannual variability of ichthyoplankton assemblages in the region reported by Liguori et al. (2026a). Here we make available the full underlying photographic and taxonomic archive, including the 2021 pilot sampling season and mesh sizes not used in the community analyses, as a standalone, richly annotated resource. Publishing this photographic and taxonomic material openly serves three purposes: (i) it provides a reusable, quality-controlled reference resource for training and validating both human taxonomists and automated image-classification tools for ichthyoplankton; (ii) it enables independent verification and re-analysis of the taxonomic identifications underlying derived publications; and (iii) it makes the full record of this sampling effort accessible beyond the summary statistics typically published.

This data descriptor accompanies the deposited dataset and describes the sampling design, data processing and technical validation steps applied, so that the dataset can be reused with a clear understanding of its structure, coverage and limitations.

2 Methods

2.1 Study area and sampling design

Samples were collected at 15 stations across three sampling areas in the Gulf of Naples: five coastal stations off Cuma (c1–c5; station c5 is labelled c2b from July 2022 onward), a five-station offshore transect associated with the Dohrn canyon (d1–d5), and the LTER-MC station. An additional pilot station set (st1–st4) was sampled along the Dohrn transect in 2021 before adoption of the standardized d1–d5 scheme. Station locations are shown in Fig. 1, and their coordinates are reported in Table 1. Bottom depth at sampling stations ranged from 70 to 407 m.

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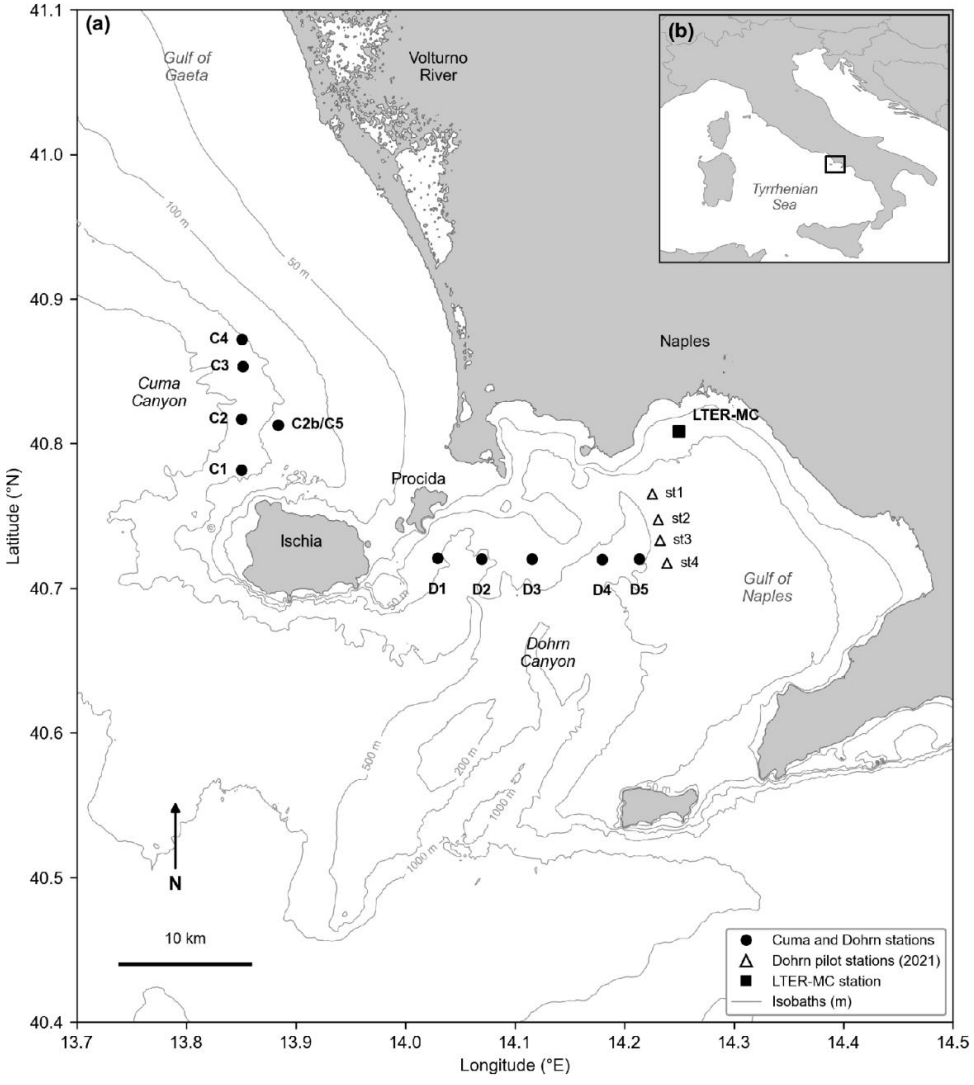

Figure 1. (a) Sampling stations in the Gulf of Naples and off the Cuma canyon (south-central Tyrrhenian Sea): Cuma stations C1–C4 and C2b/C5 (the same station, labelled C5 until March 2022), Dohrn transect stations D1–D5, 2021 pilot stations st1–st4 along the Dohrn transect, and the LTER-MC station. Positions are the mean coordinates of the net tows (Table 1). Isobaths at 50, 100, 200, 500 and 1000 m from the EMODnet Digital Terrain Model. (b) Location of the study area in Italy.

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The Cuma canyon is a topographically complex system off the northern coast of Ischia, comprising a submarine valley reaching about 800 m depth with a southwest–northeast principal axis and several minor branching channels; it receives sediment input from the Volturno and Garigliano rivers and supports locally enhanced upwelling (Pace et al., 2012). Owing to its biodiversity value, notably as a feeding ground for cetaceans (Mussi et al., 1999, 2014; Mussi and Miragliuolo, 2003), the canyon falls within the “Regno di Nettuno” marine protected area. The Dohrn canyon lies in the central Gulf of Naples, a narrow, steep-walled feature incising the continental shelf and slope to approximately 1000 m depth, with a predominantly north–south orientation. The Gulf of Naples itself grades from a more oligotrophic offshore Tyrrhenian regime to a coastal, eutrophic inner gulf, a transition broadly delimited by the islands of Ischia and Procida, with surface circulation predominantly wind-driven (Gifuni et al., 2022; Kokoszka et al., 2022). The LTER-MC station (40°48.5′N, 14°15′E), located about two nautical miles off Naples at approximately 75 m depth, has been monitored for physical, chemical and planktonic variables since January 1984 and is part of the global LTER network since 2006 (Zingone et al., 2019); its proximity to the shallow head of the Dohrn canyon makes it a natural coastal reference point for the two canyon transects (Romillac et al., 2023).

Sampling took place from June 2021 to March 2025. Ichthyoplankton was collected with a Bongo plankton net fitted with two nets of 200 µm and 333 µm mesh size and a mouth diameter of 60 cm. In 2021 and part of 2022, a 500 µm mesh net was additionally used at a subset of stations; the standard paired 200/333 µm Bongo configuration was used consistently from 2023 onward. The net was lowered by winch at a constant speed of 1 m s^{-1} and towed obliquely at a constant angle of 45° between the wire and the vertical, then retrieved at 0.5 m s^{-1} to limit avoidance from the net's pressure wave; maximum wire-out was calculated from the target depth divided by the cosine of the wire angle. A calibrated flowmeter mounted on the net recorded the volume of water filtered at each tow, used to derive the larvae_1000_m3 and larvae_10m2 abundance fields. Collected samples were preserved on board in 70% v/v ethanol for laboratory analysis. At each station, a vertical CTD profile was acquired before or after the net tow with a Sea-Bird Scientific multiparameter probe: an SBE 19plus between June 2021 and July 2022 and an SBE 911plus from December 2022 onward. The probes were equipped with sensors for temperature, conductivity, pressure, dissolved oxygen (SBE 43), pH and chlorophyll fluorescence (Turner Cyclops or WET Labs ECO-AFL/FL), and, depending on the campaign, turbidity (Turner Cyclops), beam

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transmission (WET Labs C-Star), photosynthetically available radiation and oxidation–reduction potential. Raw data were processed with Sea-Bird Data Processing software (data conversion, low-pass filtering, loop editing and bin averaging over 1 m depth intervals, 0.5 m for one campaign), and only the downcast was retained. Salinity and sigma-t were derived from conductivity, temperature and pressure.

In 2021, sampling followed a pilot design restricted to stations c1–c4 at Cuma and to the st1–st4 pilot station scheme along the Dohrn transect; from 2022 onward, sampling was standardized across all three sampling areas under the c1–c5/d1–d5 scheme, with LTER-MC represented in the dataset from 2023 onward. This distinction is preserved in the dataset via the sampling_protocol field (2021_pilot *vs* standardized_2022_2025) so that users can restrict analyses to methodologically homogeneous subsets.

2.2 Sample processing, photography and identification

In the laboratory, samples were sorted and ichthyoplankton isolated under a Leica MZ12 stereomicroscope. Individuals were then photographed under a Leica stereomicroscope equipped with a Leica S9i digital camera, generating the reference images linked to each record via the photo identifier field. Fish eggs and larvae were identified visually to the lowest possible taxonomic level using standard Mediterranean and Atlantic ichthyoplankton identification guides (Fahay, 2007; Lo Bianco et al., 1956; Re and Meneses, 2008; Richards, 2005; Rodríguez et al., 2017; Russell, 1976; Whitehead et al., 1986).

Individuals that could not be assigned to a given taxonomic rank are recorded as “unidentified” (order level) or “nd” (not determined, genus level). Scientific names were matched against the World Register of Marine Species (WoRMS Editorial Board, 2026; accessed October 2026): names are given in their currently accepted form, order and family follow the WoRMS classification (two percomorph groups placed by WoRMS as incertae sedis, Eupercaria and Ovalentaria, are reported in the order field and not counted as orders), and the AphiaID of the most resolved taxon is provided for each identified record.

3 Data records

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The dataset is deposited on Figshare (Liguori et al., 2026b; https://doi.org/10.6084/m9.figshare.34981408) under a Creative Commons Attribution 4.0 (CC BY 4.0) licence and comprises the following files:

- fish_larvae_cuma_dohrn_clean.csv — the tabular dataset described below (2,376 rows × 34 columns).
- fish_eggs_cuma_dohrn_clean.csv — egg count table, one row per counted egg (3,016 rows × 31 columns).
- photos_Cuma.zip, photos_Dohrn.zip and photos_Marechiara.zip — reference photographs, one archive per locality, organised in one folder per sampling date (Locality_DD_MM_YYYY), with egg photographs in an eggs subfolder of each sampling folder; filenames match the photo.identifier field.
- dwca_ichthyoplankton_gulf_of_naples.zip — the same data as a Darwin Core Archive (Event core with Occurrence and Extended Measurement or Fact extensions), with WoRMS identifiers for all taxa and NERC vocabulary terms for measurements and units.
- ctd_profiles.zip and ctd_casts.csv — CTD downcast profiles (temperature, salinity, conductivity, density, dissolved oxygen, pH, fluorescence and, depending on the campaign, turbidity, beam transmission, PAR and ORP), one CSV file per cast in 1 m depth bins, for 98 of the 101 station visits, with a table of cast metadata linking each profile to its station visit.
- README.md — a data dictionary describing every column, station list, and usage notes.

Each row of the tabular dataset corresponds to one identified individual (egg or larva) linked to a reference photograph, or, for 13 records, to a net tow in which no individual was collected. Sampling metadata (date, station, coordinates, gear, mesh size, filtered volume) are repeated across all individuals from the same tow. A full description of every field, including units, is provided in the accompanying README.md.

The egg table records 3,016 eggs from 165 net tows (March 2022 – March 2025): 881 from Cuma, 1,545 from the Dohrn transect and 590 from LTER-MC. Eggs were assigned to four taxa, *Maurolicus muelleri* (972), *Engraulis encrasicolus* (436), *Sardina pilchardus* (405) and *Sardinella*

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aurita (91), while 1,112 eggs (36.9%) remain unidentified. Each row corresponds to one egg and carries the sampling metadata of its tow, with the same fields as the larval table; eggs_1000_m3 and eggs_10m2 give the contribution of each egg to the tow density, so tow-level densities are obtained by summing rows. Eggs are not linked to individual photographs.

Table 1. Sampling stations and mean coordinates (WGS84) of the net tows. Station c5 was relabelled as c2b from July 2022 onward.

Locality	Station	Latitude (°N)	Longitude (°E)
Cuma	C1	40.7818	13.8504
Cuma	C2	40.8168	13.8504
Cuma	C2b/C5	40.8130	13.8838
Cuma	C3	40.8534	13.8514
Cuma	C4	40.8720	13.8506
Dohrn	D1	40.7209	14.0292
Dohrn	D2	40.7203	14.0695
Dohrn	D3	40.7201	14.1156
Dohrn	D4	40.7201	14.1798
Dohrn	D5	40.7202	14.2136
Dohrn	st1 (2021 pilot)	40.7654	14.2252
Dohrn	st2 (2021 pilot)	40.7476	14.2309
Dohrn	st3 (2021 pilot)	40.7333	14.2323
Dohrn	st4 (2021 pilot)	40.7174	14.2387
Marechiara	LTER-MC	40.8083	14.2499

Table 2. Sampling effort (number of net tows) by locality and year: all net tows and net tows in which eggs were counted.

Locality	2021	2022	2023	2024	2025	Total
All net tows						
Cuma	8	30	10	6	10	64
Dohrn	9	29	40	20	10	108
Marechiara	0	0	13	10	2	25

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Locality	2021	2022	2023	2024	2025	Total
Total	17	59	63	36	22	197
Net tows with eggs						
Cuma	0	27	10	6	7	50
Dohrn	0	25	39	18	9	91
Marechiara	0	0	12	10	2	24
Total	0	52	61	34	18	165

192 **Table 3. Number of records by net mesh size and locality in the larval table and in the egg**
193 **table.**

Locality	200 µm	333 µm	500 µm	Total
Larval table				
Cuma	439	258	150	847
Dohrn	586	566	124	1276
Marechiara	122	131	0	253
Total	1147	955	274	2376
Egg table				
Cuma	452	360	69	881
Dohrn	708	677	160	1545
Marechiara	302	288	0	590
Total	1462	1325	229	3016

194 **Table 4. Ten most represented larval taxa in the dataset (by number of records).**

Order	Family	N records
Myctophiformes	Myctophidae	510
Gobiiformes	Gobiidae	307
Stomiiformes	Gonostomatidae	254
Clupeiformes	Engraulidae	174
Clupeiformes	Alosidae	140
Mugiliformes	Mugilidae	123
Eupercaria incertae sedis	Sparidae	82

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Order	Family	N records
Blenniiformes	Blenniidae	60
Pleuronectiformes	Bothidae	59
Scombriformes	Scombridae	30

4 Technical validation and uncertainty

The following checks were performed on the published dataset:

• Completeness of the photo–record link: the photo.identifier field is populated for 2,363 of 2,376 records (99.5%); the remaining 13 correspond to tows with no individuals collected, for which the field is intentionally left empty. Every populated photo.identifier matches a photograph in the archive.

• Taxonomic resolution: 81.6% of records were resolved to family level or below; 414 records (17.4%) remain unidentified and 1,162 (48.9%) are not resolved to genus level, reflecting the condition of the specimens (e.g., damage during capture) rather than data-entry error.

• Filename–station correspondence: photo filename prefixes were checked against the station.name field. In these photographs, larvae are numbered consecutively within each net tow, and a photograph containing several larvae carries the range of their numbers (e.g. larva_0001_0005 for larvae 1–5); a bis suffix marks a second photograph of the same individuals. Prefixes of the remaining photographs are not fully consistent across years and stations (*e.g.*, station c4 photographs are variously prefixed Cuma_, C4_, or c4_), reflecting original file organization by the survey team across different sampling campaigns. The station.name and locality fields, not the filename prefix, are the authoritative station reference and should be used for any spatial analysis.

• Photograph and specimen quality: each photograph linked to larval records was scored by visual inspection on a single four-level scale combining specimen condition and photographic quality (photo.quality.code: 1 = excellent, 2 = good, 3 = poor, 4 = unusable; full definitions in README.md). The code is the worse of the specimen and photograph criteria, and photographs showing several individuals were scored on the individual in the worst condition. All 2,088 larval

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Preprint. Discussion started: 27 November 2026
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220 photographs were scored: 1,273 (61.0%) were scored 1, 595 (28.5%) 2, 198 (9.5%) 3 and 22
221 (1.1%) 4. The score applies to larvae only; egg photographs were not scored.

222 • CTD profiles: each cast was assigned to its station visit by date, station code, cast time and
223 maximum depth. Profiles were inspected for spikes and out-of-range values: a single-level
224 temperature spike (Cuma C4, 28 July 2021, 16 m) and turbidity values above 20 NTU caused by
225 sensor saturation (Dohrn d1–d3, 1 December 2022) were removed, and conductivity recorded in
226 S m−1 (Dohrn d1, 3 December 2024) was converted to mS cm−1. Bad-flag values were set to
227 empty. All corrections are reported in the qc_notes field of ctd_casts.csv.

228 • Sources of uncertainty: larval and egg densities depend on the filtered volume measured by the
229 flowmeter and on the depth reached by the net, which was not measured directly but derived from
230 the wire length paid out and the nominal 45° wire angle. Taxonomic uncertainty is expressed by
231 the level of resolution of each record (unidentified, family, genus or species) rather than by a
232 confidence score; because every identified larva is linked to its photograph and photo.quality.code,
233 identifications can be independently checked and revised.

234

235 **5 Usage notes**

236 Users combining data across the full 2021–2025 period should account for the change in sampling
237 design after 2021 using the sampling_protocol field, particularly when comparing larval densities
238 (larvae_1000_m3, larvae_10m2) between the 2021 pilot phase (200/500 µm nets only) and the
239 standardized period (200/333/500 µm nets).

240 Each photograph can be linked to its full sampling and taxonomic context via the photo.identifier
241 field in the tabular dataset. Records sharing the same photo.identifier value represent multiple
242 individuals captured in a single photograph; their number is given in the n.individuals.photo field.
243 Within such photographs individual records cannot be matched to specific larvae, so only single-
244 individual photographs (n.individuals.photo = 1) provide an unambiguous image–record link, *e.g.*
245 for training image-classification models.

246 Unresolved taxonomic ranks (“unidentified”, “nd”) should be treated as missing data rather than
247 as valid taxonomic categories in diversity analyses.

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The LTER-MC subset may complement the long-term plankton and environmental observations carried out at this station, supporting future comparative analyses as further data become available.

CTD profiles were not acquired simultaneously with the net tows, and cast times are given in different time references depending on the campaign (see the ctd_time_source field in ctd_casts.csv). The set of sensors varied between campaigns, so not all variables are available for every cast, and no profile is available for Dohrn st2–st4 on 20 December 2021. Profiles can be joined to the biological data and to the Darwin Core Archive through the station_visit_eventID field.

6 Data availability

The dataset is publicly available on Figshare at https://doi.org/10.6084/m9.figshare.34981408 (Liguori et al., 2026b) under a Creative Commons Attribution 4.0 (CC BY 4.0) licence. It includes the larval and egg tables, the reference photographs, the CTD profiles, a Darwin Core Archive and a README file describing all fields (Sect. 3).

7 Conclusions

This dataset makes openly available the complete photographic and taxonomic archive of fish eggs and larvae collected between 2021 and 2025 in two submarine canyons and at a long-term coastal station of the south-central Tyrrhenian Sea, a region where ichthyoplankton remains poorly documented. Each larval record is linked to a reference photograph with a quality score and to its sampling context, names are aligned to WoRMS, and the data are provided both as plain tables and as a Darwin Core Archive, together with concurrent CTD profiles. The dataset can support the training of taxonomists and of automated identification tools, the independent verification of published identifications, and comparative studies of ichthyoplankton phenology and diversity in the Mediterranean Sea.

Author contributions

GL, LC, AM and AC carried out the field sampling and the identification of fish eggs and larvae (investigation). GL curated the data, performed the analyses and wrote the original draft (data curation, formal analysis, writing – original draft). LC, DC, YC and GD supervised the work (supervision). All authors reviewed and edited the manuscript (writing – review and editing).

Competing interests

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277 The authors declare that they have no conflict of interest.

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281 and in several of the following ones.

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