

New and confirmed records of a deep-water decapod (family Acanthephyridae), and five deep-sea fishes (families Alepocephalidae, Gonostomatidae, Myctophidae, and Nemichthyidae) from Maltese waters

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ABSTRACT

Recent routine monitoring efforts conducted in 2018 and 2022 under the European Union's Data Collection Multi-Annual Program (DC-MAP) have yielded specimens confirming the presence of six deep-sea species in Maltese waters (FAO GFCM Geographical Sub-Area 15), which were previously either unreported or only dubiously recorded. The first of these species is the decapod crustacean, *Acanthephyra purpurea* A. Milne-Edwards, 1881. The remaining five consist of the teleost fishes: *Alepocephalus rostratus* Risso, 1820; *Gonostoma atlanticum* Norman, 1930; *Ceratoscopelus maderensis* (Lowe, 1839); *Hygophum hygomii* (Lütken, 1892); and *Nemichthys scolopaceus* Richardson, 1848. This contribution, which includes first confirmed national records and verifications of previously questionable reports, provides valuable information about the deep-sea biodiversity of the Central Mediterranean region, underscoring the importance of ongoing monitoring efforts.

KEYWORDS: Malta, Central Mediterranean, MEDITS, trawling, Decapoda, Teleostei

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1. Introduction

Deep-sea ecosystems constitute approximately 70% of the Mediterranean Sea floor (Cartes et al., 2004; Danovaro et al., 2010). While the Mediterranean Sea is one of the most extensively studied marine regions globally in terms of biodiversity, its deep-sea ecosystems remain comparatively underexplored (Danovaro et al., 2010; 2020). This knowledge gap is particularly evident for Maltese waters, where significant substantial deficiencies in scientific understanding persist regarding deep-sea assemblages despite substantial research on the area's shallow-water ecosystems (Evans et al., 2017; Borg et al., 2023; ERA, 2023).

The Maltese archipelago, situated on the southwestern edge of the Malta Plateau, extends from the Sicilian continental shelf and borders the deeper waters of the Gela Basin to the northwest and the Malta Graben to the west and southwest (Drago et al., 2003). The depths in this region vary considerably, from approximately 50–200 m on the eastern and northeastern plateau to depths exceeding 1600 m within the Malta Graben (Drago et al., 2003). This pronounced bathymetric gradient, coupled with the transitional nature between the eastern and western Mediterranean basins, has led to the identification of the deep waters surrounding the Maltese Islands as significant biodiversity hotspots (Evans et al., 2017; Borg et al., 2023).

Deep-sea species, particularly those inhabiting the mesopelagic and bathypelagic zones, are increasingly recognised for their fundamental roles in marine ecosystem functioning. These organisms contribute significantly to global fish biomass and occupy critical positions in mid-trophic levels, playing a pivotal role in linking surface productivity with deep-sea environments

(Clavel-Henry et al., 2020). Despite their ecological significance, data on the presence and distribution of many of these species in the Central Mediterranean remains sparse, hindering efforts to fully understand the structure and functioning of regional deep-sea ecosystems. This study aims to document the first confirmed records on the presence of six deep-sea species from the waters surrounding the Maltese Islands, collected in 2018 and 2022 as part of routine sampling conducted by Aquatic Resources Malta in alignment with EU obligations under the DC-MAP framework. These findings provide new insights into the biodiversity composition and verified distribution of deep-water fauna from understudied areas of the Central Mediterranean, thereby supporting evidence-based conservation and management efforts in the region.

2. Materials and Methods

The specimens discussed here were collected during routine monitoring activities undertaken between the years 2018 – 2022 as part of the European Commission's Data Collection Multi-Annual Program (DC-MAP) which is required for EU member states. Most individuals were caught during the annual International Bottom Trawl Survey in the Mediterranean (MEDITS Working Group, 2017) surveys in Maltese waters, which involve the deployment of a specialized research net as outlined in the MEDITS Handbook to collect fisheries-independent data in accordance with the MEDITS protocol. Some specimens were collected during onboard observations by Aquatic Resources Malta as part of routine monitoring of commercial otter-board trawl fisheries targeting *Aristaeomorpha foliacea*. These observations were conducted using standard commercial trawling gear in accordance with

current regulations and within established trawling grounds. All specimens were collected from the Geographical Subarea (GSA) 15 of the General Fisheries Commission for the Mediterranean (GFCM, 2009). At the time of capture, the geographic coordinates, depth, and date of capture were recorded for each specimen. Each of these was either frozen immediately in a blast freezer and retained in cold storage or kept refrigerated to be analysed or frozen at the laboratory when freezing onboard was not possible. In the laboratory, specimens were identified to species level using standard keys

and manuals, including Zariquiey Alvarez (1968) for the Acanthephyridae, Whitehead *et al.*, (1984) for the Alepocephalidae, Fischer *et al.*, (1987) for the Myctophidae, Smith and Heemstra (1986) for the Gonostomatidae, and Carpenter and De Angelis (2002) for the Nemichthyidae. Most of the species reported on here were collected during MEDITS surveys. The MEDITS protocol only requires the total number and total weight of these species to be recorded, and the measurements reported here were based on the specimens available to us.

Table 1. Summary of collection details for each specimen used for the purposes of this study.

| Species | No. of individuals collected | Length type | Length (millimetres) | Total weight (grams) | Sampling coordinates | Approximate depth (metres) | Date of collection |
|----------------------------------|------------------------------|-------------|----------------------|----------------------|---------------------------------|----------------------------|--------------------|
| <i>Acanthephyra purpurea</i> | 1 | Carapace | 21 | 6.9 | N 36° 05.969', E 13° 58.539' | 570 | 19/09/20 22 |
| <i>Alepocephalus rostratus</i> | 1 | Total | 255 | 111 | N 36° 28.433', E 14° 02.167' | 560 | 09/05/20 18 |
| <i>Gonostoma atlanticum</i> | 1 | Total | 162 | 11.6 | N 35° 13.222', E 14° 14.544' | 610 | 20/09/20 22 |
| <i>Ceratoscopelus maderensis</i> | 1 | Total | 62 | 1.7 | N 35° 09.640', E 14° 25.160' | 605 | 20/09/20 22 |
| | 3 | N/A | N/A | 4.5 | N 35° 13.222', E 14° 14.544' | 610 | 20/09/20 22 |
| | 1 | Total | 73 | 3.3 | N 35° 30.860', E 13° 49.970' | 665 | 21/09/20 22 |
| | 1 | N/A | N/A | 1.6 | N 35° 06.991', E 13° 37.256' | 645 | 21/09/20 22 |
| | 34 | N/A | N/A | 55.5 | N 36° 19.630', E 13° 48.000' | 525 | 24/09/20 22 |
| | 1 | N/A | N/A | 0.6 | N 36° 22.352', E 14° 27.916' | 275 | 29/09/20 22 |
| | 13 | N/A | N/A | 7.9 | N 36° 28.506', E 14° 21.007' | 470 | 29/09/20 22 |
| <i>Hygophum hygomii</i> | 1 | Total | 57 | 2.6 | N 35° 13.222', E 14° 14.544' | 610 | 20/09/20 22 |
| | 1 | Total | 49 | 1.9 | N 36° 28.501', E 14° 21.007' | 475 | 29/09/20 22 |
| <i>Nemichthys scolopaceus</i> | 1 | Total | 584 | 13.4 | N 36° 27.333', E 14° 01.317' | 515 | 14/06/20 22 |

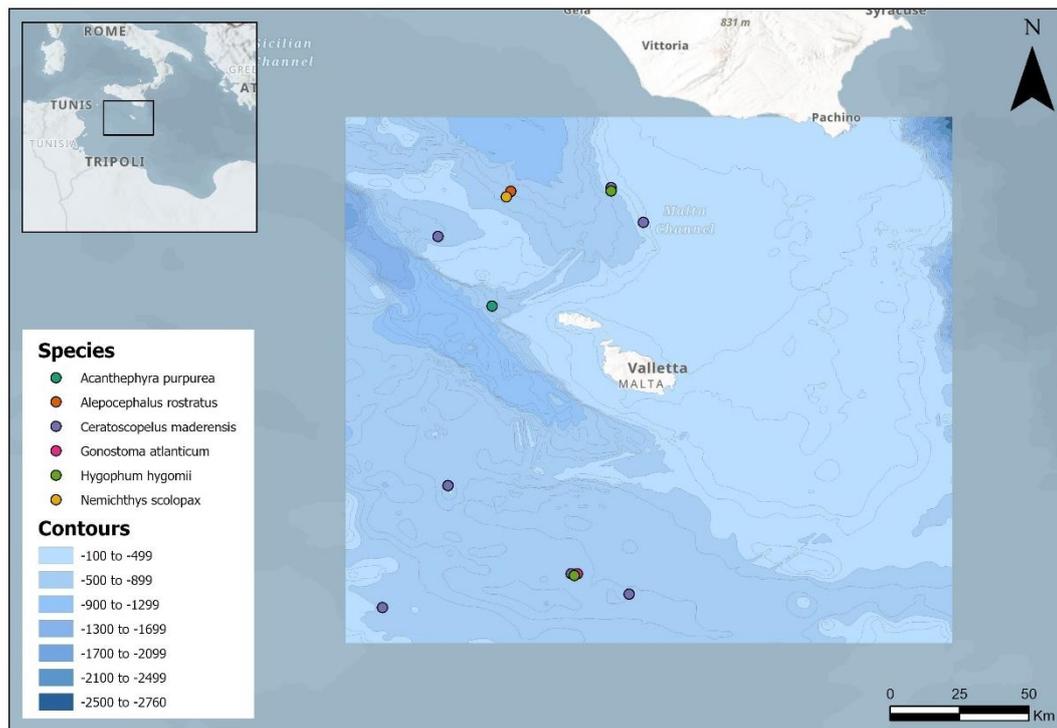


Figure 1. Map of the Central Mediterranean Sea showing the sampling locations from which the specimens reported on here were collected, and the bathymetry.

3. Results

3.1. Family Acanthephyridae

Acanthephyra purpurea A. Milne-Edwards, 1881

A single specimen of this species was collected on September 19, 2022, during the 2022 MEDITS survey, from coordinates N 36° 05.969', E 13° 58.539', at an approximate depth of 570 m.

The specimen exhibited a cylindrical body that narrowed toward the tail, and had a carapace length of 21 mm and weighed 6.9 g. The exoskeleton was tough and semi-translucent, deep red in colouration, with a slightly darker patch above the cephalothorax (Figure 2A). The rostrum was large and well-developed with a slight upward curve. Nine rostral teeth lined the dorsal edge of the rostrum, and a further seven along the

ventral side (Figure 2B). The antennae were relatively short, shorter than the full body length. The pleura of the second abdominal segment overlapped those of the first and third segments, and the last four abdominal tergites each had a short, curved spine at the posterior edge along the dorso-median carina. Four additional pairs of spines were present along the dorsal surface of the telson (Figure 2C).

Although *A. purpurea* has been documented from the Central Mediterranean (Massi et al., 2013), there are no records of its occurrence in Maltese waters (Mifsud, 2017). Therefore, this is the first record from Maltese waters.

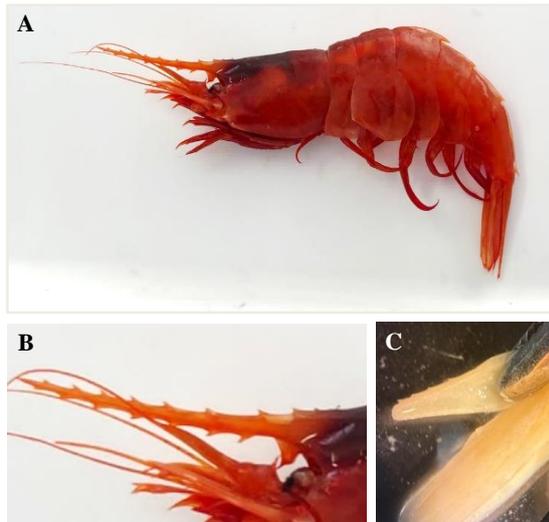


Figure 2. (A) *AcanthePHYRA purpurea* specimen collected during the 2022 MEDITS survey. (B) Close-up view of the rostrum showing the 9 rostral teeth along the dorsal edge and 7 rostral teeth along the ventral edge. (C) Close-up view of the telson showing 4 pairs of spines along the dorsal surface.

3.2. Family Alepocephalidae

Alepocephalus rostratus Risso, 1820

On May 9, 2018, a single specimen of this species was collected during routine onboard observations of otter-board trawling activities from coordinates N 36° 28.433', E 14° 02.167', and a depth of approximately 560 m. The original specimen was no longer available at the onset of this study; however, the species was initially identified at the time of capture and later re-verified based on detailed measurements, descriptions, and photographs retained from the original observation, which together enabled an accurate identification.

The specimen displayed a cylindrical, fusiform body covered in cycloid scales, with a total length of 255 mm and a weight of 111 g. The head and body were black, with a brownish tint toward the posterior half of

the body (Figure 3A). The area between the posterior edge of the operculum and the pectoral fin base was also scaled; however, scales were notably absent from the head (Figure 3C). A total of 53 scales were counted along the lateral line between the head and the forked caudal fin. The eyes were large and well developed, and the robust head tapered sharply to a pronounced rostrum. The dorsal fin origin was located above and slightly anterior to the anal fin origin (Figure 3B), whereas the adipose fin was absent. The body was deepest just above the pectoral fin; however, this was only marginally deeper than the depth of the body between the dorsal and anal fin origins.

This species is listed in Jennings (1996) as having been recorded from Maltese waters; however, this record has been regarded as dubious by Borg et al., (2023) and is considered to be unsubstantiated. Therefore, this record confirms the presence of the species in the Maltese Islands.

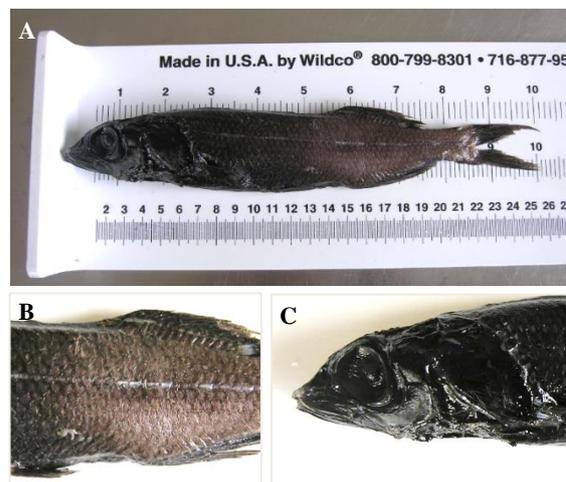


Figure 3. (A) The specimen of *Alepocephalus rostratus* collected during onboard observations aboard a commercial trawler in 2018. (B) Close-up view of the dorsal fin origin positioned above and slightly anterior to the anal fin origin. (C) Close-up view

of the head highlighting the absence of scales.

3.3. Family Gonostomatidae

Gonostoma atlanticum Norman, 1930

A single specimen of this species was collected on September 20, 2022, during the 2022 MEDITS survey, from coordinates N 35° 13.222', E 14° 14.544' and a depth of approximately 610 m.

The specimen had an elongated and laterally compressed body, with a silvery head and a pale, discoloured trunk and tail, likely due to abrasions from the trawl (Figure 4A). The total length of the body was 162 mm and the weight was 11.6 g. The head was large relative to the body and had an equally large mouth, with the cleft extending well behind the eye. The maxilla was curved to overhang the mouth and bore long, exposed, slender, conical teeth along its length. Shorter, closely spaced teeth were interspaced between the long teeth but were only visible under magnification (Figure 4C). Teeth were also present on the vomer (Figure 4B). The eyes were moderately sized and positioned close to the snout, with silvery reflector scales behind the orbit. The dorsal fin was located posteriorly to the middle of the body and directly above the origin of the anal fin, whereas the adipose fin was absent. Photophores were absent from the isthmus; however, a row of photophores was visible along the body's ventral midline, from the head to the tail's base.

The only reference to the presence of Gonostomatidae in Maltese waters is that of *Gonostoma denudatum* in Jennings (1996). *Gonostoma atlanticum* was previously considered a Mediterranean subspecies of the latter but has now been elevated to species status (Froese and Pauly, 2025). However, Borg et al., (2023) considered Jennings's

record to be dubious; therefore, this specimen presents the first confirmed record of *G. atlanticum* from Maltese waters.

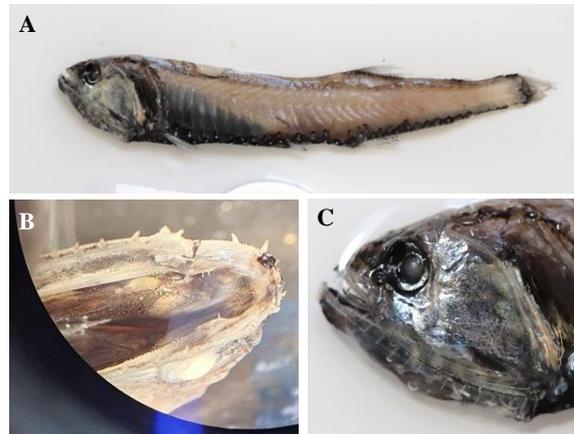


Figure 4. (A) The *Gonostoma atlanticum* specimen collected during the 2022 MEDITS survey. (B) Close-up view of the mouth showing teeth on the vomer. (C) Close-up view of the head showing the interspaced teeth on the maxilla.

3.4. Family Myctophidae

Ceratoscopelus maderensis (Lowe, 1839)

A total of 54 specimens of this species were collected during the 2022 MEDITS survey.

On September 20, 2022, four specimens were collected. The first individual was collected from coordinates N 35° 09.640', E 14° 25.160' (605 m), while the remaining three specimens were collected at N 35° 13.222', E 14° 14.544' (610 m). On September 21, two additional specimens were collected from separate locations, the first of which was collected from N 35° 30.860', E 13° 49.970' (665 m), while the second was collected from N 35° 06.991', E 13° 37.256' (645 m). The largest catch occurred on September 24, when 34 specimens were collected from coordinates N 36° 19.630', E

13° 48.000' (525 m). The remaining specimens were caught on September 29, with one collected from coordinates N 36° 22.352', E 14° 27.916' (275 m), and 13 from N 36° 28.506', E 14° 21.007' (470 m).

All specimens displayed a slender, fusiform body terminating in a forked caudal fin. The head was silvery in colour, whilst the body appeared pale and discoloured, likely due to abrasions from the trawl (Figure 5A). The two specimens available for detailed species identification measured 62 mm and 73 mm total length and had a weight of 1.7 g and 3.3 g, respectively. The head was tapered, with large, well-developed eyes situated toward the snout and a large mouth, whose cleft extended well behind the eye (Figure 5C). No luminous tissue was visible above the eyes, and no white crescent was observed on the posterior half of the eye. Regarding the ventral primary photophores, the fourth pectoral organ (PO₄) was aligned with the other pectoral organs. It was not elevated, while the ventral organs (VO) were aligned in a slight arch. Regarding the lateral primary photophores, four precaudal organs (Prc) were present at the tail base, with the last (Prc₄) located on the lateral line (Figure 5B). Luminous scaliform structures were also found on the dorsal and ventral margins of the caudal peduncle, which lacked a black pigmented border.

Borg et al., (2023) listed this species as one “recorded from Maltese waters whose presence requires confirmation”; we can now verify the occurrence of *C. maderensis* in Maltese waters.

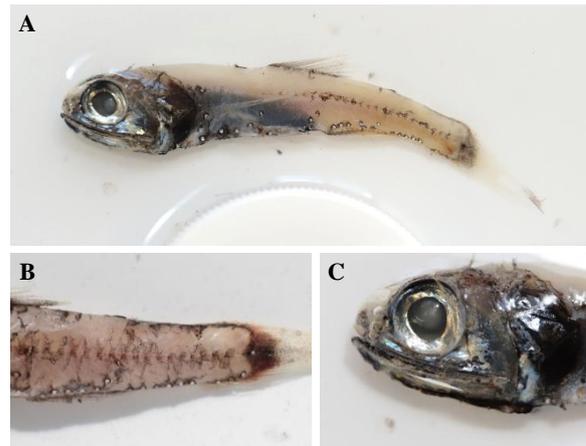


Figure 5. (A) Specimen of *Ceratoscopelus maderensis* collected during the 2022 MEDITS survey from N 35° 30.860', E 13° 49.970'. (B) Close-up view of the body and tail showing the arrangement of the photophores. (C) Close-up view of the head.

3.5. Family Myctophidae

Hygophum hygomii (Lütken, 1892)

Two specimens of this species were collected during the 2022 MEDITS survey. The first was caught on September 20, 2022, at coordinates N 35° 13.222', E 14° 14.544' and at depth of approximately 610 m, while the second was caught on September 29, 2022, at coordinates N 36° 28.501', E 14° 21.007' and a depth of approximately 475 m.

Both specimens displayed a laterally compressed and fusiform body. The head's colouration was black and with silver markings, whereas the body appeared pale and discoloured, again most likely the result of abrasions from the trawl (Figure 6A). The first specimen collected measured 57 mm in total length with a weight of 2.6 g, whilst the second measured 49 mm with a weight of 1.9 g. The head featured a rounded snout and large, well-developed eyes above a large downturned mouth (Figure 6C). The lateral primary photophores were arranged

with two posterolateral organs (Pol) on the body and two precaudal organs (Prc) near the base of the forked caudal fin (Figure 6B). The second precaudal organ (Prc₂) was located on the lateral line. The subpectoral luminous glands (PVO) were arranged diagonally, with the first gland (PVO₁) positioned lower than the second (PVO₂). The supraventral organ (VLO) was situated just below the lateral line.

According to Borg et al. (2023), this species has been recorded from Maltese waters, but its presence needed confirmation. Therefore, the two specimens described here represent the first locally verified records of *H. hygomii*.

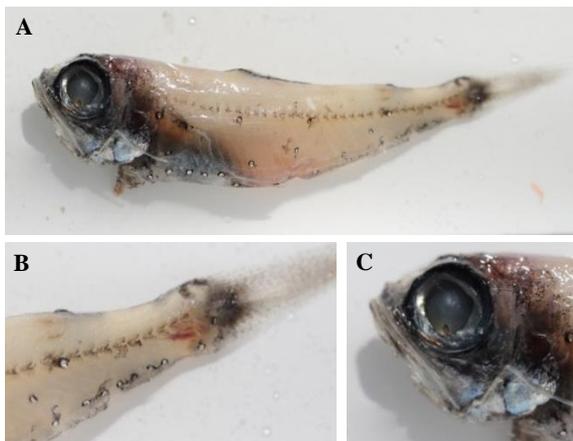


Figure 6. (A) Specimen of *Hygophum hygomii* collected during the 2022 MEDITS survey. (B) Close-up view of the body and tail showing the photophore arrangement. (C) Close-up view of the head.

3.6. Family Nemichthyidae

Nemichthys scolopaceus (Richardson, 1848)

A single specimen of this species was collected during routine onboard observations of otter-board trawling activities on June 14, 2022, from coordinates N 36° 27.333', E 14° 01.317', and a depth of approximately 515 m.

The body was slender, laterally compressed, and filiform, with overall colouration from dull brown to black without markings or patterns (Figure 7A). The specimen measured 584 mm in total length and weighed 13.4 g. The jaws were slightly damaged, and the tail end was missing, likely damaged during the trawl. The narrow jaws were highly elongated and non-occlusible, indicating that the specimen was a juvenile or mature female (Figure 7B). The head was small with relatively large eyes, and the mouth's cleft extended behind the eye. Eight orbital pores were counted behind the eye (Figure 7C), arranged in a staggered pattern, whereas nine preopercular pores were counted behind the head (Figure 7D). The anus was located beneath the pectoral fins, roughly half-way between the base and tip of the pectoral fins.

This species was reported from Malta by Jennings (1996); however, Borg et al. (2023) considered this record unsubstantiated. Therefore, the specimen described here represents the first confirmed record of *N. scolopaceus* from Maltese waters.

4. Discussion

Through the routine activities of the DC-MAP conducted in 2018 and 2022, one species of decapod crustacean (*Acantheephyra purpurea*) and five teleosts (*Alepocephalus rostratus*, *Gonostoma atlanticum*, *Ceratoscopelus maderensis*, *Hygophum hygomii*, and *Nemichthys scolopaceus*) were identified and confirmed in Maltese waters (GSA 15). Four of these species had been previously reported as potentially occurring in Maltese waters, but were not confirmed by a verified specimen. The extensive critical checklist of Maltese fishes produced by Borg et al. (2023) listed *A. rostratus*, *N.*

scolopaceus, *C. maderensis*, and *H. hygomii* as needing confirmation. No prior records of *A. purpurea* and *G. atlanticum* from

local waters were found, making this report the first for both species from the Maltese Islands.

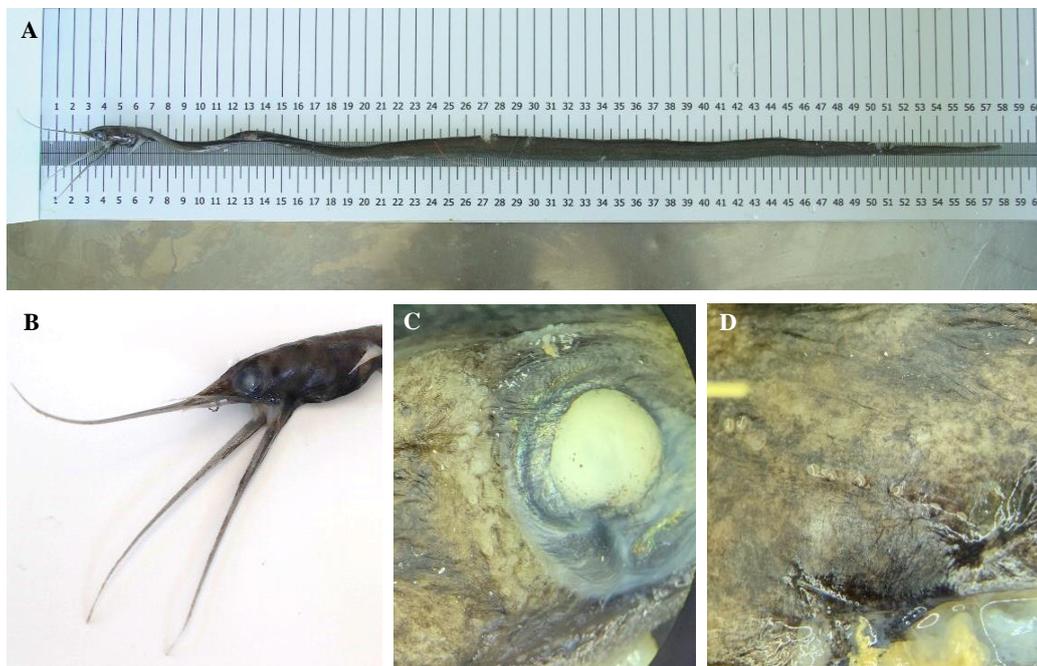


Figure 7. (A) The specimen of *Nemichthys scolopaceus* collected during onboard observations aboard a commercial trawler in 2022. (B) Close-up view of the head displaying elongated, non-occlusible jaws. (C) Close-up view of the eye showing the 8 orbital pores. (D) Close-up view of the head showing the 9 preopercular pores.

Identifying some of the reported species is challenging, especially in the field. For example, *A. purpurea* is very similar in colouration to *Aristaeomorpha foliacea* and *Aristeus antennatus*, and distinguishing a single individual in a catch dominated by the last two commercially targeted species can be hard. As a result, this species may have been previously encountered in both commercial catches and MEDITS surveys but was overlooked.

Although the teleost species reported here have no commercial value, they are of significant ecological importance, playing a fundamental role in the functioning of deep-sea ecosystems and food webs. Investigations into the distribution of megafaunal biomass in the deep sea have shown that *A. rostratus* becomes a key species beyond

900m depth in the western basin of the Mediterranean, even making up over 70% of the total fish biomass at depths between 1300 and 1700 m (Cartes et al. 2004). This high biomass is indicative of the ecological significance of the species in mediating energy transfer and nutrient cycling within the deep-sea ecosystems of the Western Mediterranean. Fish from the families Myctophidae and Gonostomatidae are ubiquitous across the world's oceans and have been identified as the dominant fish taxa inhabiting the mesopelagic zone (Gjøsæter and Kawaguchi, 1980). These species contribute significantly to global fish biomass, and constitute an integral component of pelagic food webs. Through their diel vertical migrations, these mid-level trophic organisms

facilitate the movement of nutrients and energy across the water column, ascending to the surface at night to feed on zooplankton and descending to deeper waters during the day (Clavel-Henry et al. 2020). This migration links primary producers to top predators, thereby promoting trophic connectivity between disparate oceanic zones.

In addition to their ecological roles, the documentation of these species in Maltese waters carries biogeographical significance by expanding the known distributions of several taxa within the Central Mediterranean. From a conservation and management perspective, the presence of mesopelagic and bathypelagic species within areas subject to deep-sea fishing activity underscores the need to better understand their spatial and temporal distribution. Several of these species, though not commercially targeted, are potentially vulnerable to bycatch in bottom trawl fisheries operating in deeper waters. These records provide the first confirmed evidence of the presence of these deep-sea species in Maltese waters, filling key gaps in the documented distribution of deep-water fauna within the Central Mediterranean. By contributing to baseline biodiversity knowledge, they offer a valuable resource for future ecological assessments and marine management efforts. Continued monitoring of these species will be essential to better understand their ecological roles, assess potential vulnerability to anthropogenic pressures, and support the development of informed conservation strategies in deep-sea environments.

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collection of these samples, and to Dr. Athanasios Evangelopoulos for his assistance in decapod crustacean identification.

Compliance with Ethical Standards

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Ethical approval

Ethics committee approval is not required.

Data availability

Not applicable.

Consent for publication

Not applicable.

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