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The arrival of the Piscicolidae leech Trachelobdella lubrica (Grube, 1840) (Annelida: Clitellata: Hirudinea) in the northeastern Atlantic: could these parasites indicate changes in climate?

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Abstract

Emergent, conspicuous parasites on commercially valuable fishes have become an increasing concern for fisheries because they can impair host condition and markedly reduce marketability. Since 2022, fishermen and veterinary inspection services have reported a rising frequency of leeches attached mainly to the branchial cavity of fish in Galician waters (NW Spain), with a particularly high impact on the sedentary, shallow-water ballan wrasse *Labrus bergylta*, a key coastal fishery resource in the region. This study aimed to document and confirm the identity and biogeographic significance of these infestations and to provide molecular reference data for the causative taxon. Records were compiled through an informal fisheries information network using photographs and videos, and four *L. bergylta* specimens were examined. Parasites were identified as *Trachelobdella lubrica* (Grube 1840) based on the diagnostic characters described for the species. This constitutes the first confirmed record of *T. lubrica* in Galician waters and the northernmost confirmed Atlantic record, extending beyond previously Mediterranean-restricted European occurrences. The COI-5P sequence obtained from the *T. lubrica* sample is unparalleled in the BOLD and GenBank molecular repositories, representing the first barcode of this species publicy available to the scientific community. Given the species' affinity for warm–temperate waters and documented regional sea-surface warming trend, the northward appearance of *T. lubrica* may indicate climate-linked distributional change. Targeted monitoring is recommended to track infestation dynamics, mitigate potential economic losses, and improve molecular resources for marine leech surveillance.

INTRODUCTION

The increasing presence of visible parasites in commercially valuable fish species has become a pressing issue in fisheries and seafood industries, significantly affecting both biological and economic aspects (Llarena-Reino et al. 2013). Although these parasites may not pose direct health risks to human consumers, their impact on the regular development of hosts and marketability of fish is profound. The aesthetic degradation caused by parasite infestations reduces consumer appeal, leading to diminished market value and economic losses for fishers and aquaculture producers. This concern underscores the necessity for comprehensive understanding and management of parasitic infections in fish populations to safeguard industry sustainability.

Leeches, belonging to the subclass Hirudinea, represent a diverse group of segmented worms inhabiting a wide range of ecosystems, from marine and estuarine to freshwater and moist terrestrial environments (Moser et al. 2016). With over 700 species described, leeches exhibit remarkable evolutionary adaptations in their habitat preferences, feeding strategies, and morphology (Phillips et al. 2020). Among these, the family Piscicolidae comprises jawless leeches primarily parasitizing freshwater and marine fishes. These parasites attach to various external surfaces of their hosts, including the skin, mouth, gill cavities, and cloaca, using specialized mouthparts designed for prolonged attachment and blood-feeding. Their lack of strict host specificity allows them to infest multiple fish species, complicating control efforts (Sağlam et al. 2003). The parasitic behavior of piscicolid leeches results in significant

physiological damage to their hosts. Their blood-feeding activity induces local hemorrhages, swelling, tissue necrosis, and epidermal tissue loss, which can impair fish health and growth (Bulguroglu et al. 2015). Beyond direct physical harm, these leeches act as vectors for pathogenic protozoans (Celik and Aydin 2006; Hayes et al. 2006). Thus, freshwater and marine fish leeches are known to transmit haemoflagellates such as *Trypanosoma* and *Cryptobia* species, as well as intracellular haemogregarines and piroplasmae to their fish hosts (Burreson 1995). The transmission of these pathogens exacerbates the negative effects on fish populations, potentially leading to increased morbidity and mortality. Consequently, the combined impact of leech infestation and pathogen transmission poses a multifaceted threat to both wild and cultured fish stocks.

Despite their relevance, marine fish leeches remain understudied, particularly regarding their diversity, host interactions, and epidemiology. Recent observations in Galician waters (NW Spain) have drawn attention to the rising incidence of parasitic infestations in fish of commercial interest, notably the ballan wrasse (*Labrus bergylta* Ascanius, 1767). These reports, initially from fishermen and later by veterinary inspection services, highlight an emerging challenge for regional fisheries and aquaculture. The identification of *Trachelobdella lubrica* in this area marks a significant extension of the known geographic range of marine fish leeches, representing the northernmost record of the species in the Atlantic Ocean.

The confirmation of *T. lubrica*'s presence in Galician waters was achieved through detailed morphological analysis, supplemented by the generation and public deposition of the species' first COI-DNA sequence. This molecular data provides a valuable resource for future taxonomic verification and ecological research, facilitating more accurate monitoring and identification of parasitic leeches in marine environments. Prior to this finding, only three piscicolid species—*Branchellion torpedinis* Savigny, 1822, *Calliobdella lophii* (Leigh–Sharpe, 1914), and *Pontobdella muricata* (Linnaeus, 1758) (Besteiro et al. 2018)—had been documented in the region, underscoring the novelty and potential ecological implications of this discovery.

Given the economic importance of affected fish species and the potential for parasite-induced losses, there is a critical need to advance research on marine fish leeches. Enhanced surveillance, combined with studies on host specificity, life cycles, and pathogen transmission dynamics, will inform effective management strategies. Such efforts are essential to mitigate the impact of these parasites on fisheries and aquaculture sustainability, ensuring the long-term viability of these industries in regions like Galicia and beyond.

MATERIALS & METHODS

The primary source of data for this study was an informal fisheries information network that has long facilitated communication between the fishing sector and researchers. This network enables fishermen to promptly and efficiently contact researchers with enquiries. Since 2022, a growing number of consultations have concerned the detection of parasites in the gills of commercially important fish species. As reports increased, numerous records were collected, including photographs, videos, and four

specimens of the ballan wrasse (*Labrus bergylta*) which were loaned for detailed parasitological examination and identification.

Three fish specimens were preserved by freezing and transported to the laboratory, while one specimen was fixed in 70% ethanol (ETOH) for preservation. Following an external examination and parasite enumeration, several parasite individuals were collected for detailed morphological study. After measurement and morphological studies, most specimens were donated to the Biobank Technical Unit (UTB) of the Ecobiomar Research Group (Marine Research Institute, Spanish National Research Council, IIM-CSIC), for storage and preservation. A subset of these specimens was also preserved in 70% ethanol for subsequent molecular analyses.

Morphological analysis of the parasites was conducted using a Leica M205C stereomicroscope (Wetzlar, Germany) equipped with an MC170 HD camera to document key diagnostic features.

DNA and Molecular taxonomic analysis

For molecular taxonomic analysis, DNA was extracted from parasite tissue fragments using the E.Z.N.A. Tissue DNA Kit (Omega-biotech), following the manufacturer's protocol. The mitochondrial cytochrome c oxidase subunit I (COI) gene barcode region (COI-5P) was amplified using universal primers 1490 and 2198 (Folmer et al. 1994). Polymerase chain reaction (PCR) amplifications were performed with Taq DNA Polymerase Master Mix (2X) from Canvax. Sequencing reactions were carried out bidirectionally using BigDye Terminator v3.1 chemistry (Thermo Fisher Scientific), and sequences were resolved on a SeqStudio genetic analyzer.

The resulting trace files were analyzed with MEGA X software (Kumar et al. 2018) to generate a consensus sequence approximately 650 nucleotides in length. This consensus sequence was queried against the Barcode of Life Data System (BOLD) Identification System (Ratnasingham and Hebert 2007) and the National Center for Biotechnology Information (NCBI) BLASTn tool (Morgulis et al. 2008) for preliminary taxonomic assignment.

For phylogenetic analyses, the consensus sequence was aligned with closely related sequences retrieved from public databases using the MUSCLE algorithm (Edgar 2004) implemented in MEGA X. The best fitting nucleotide substitution model was selected based on the corrected Akaike information criterion (AICc) using MEGA X model selection tools (Posada and Buckley 2004). A Neighbor-Joining (NJ) phylogenetic tree was constructed to infer relationships, and the resulting cladogram was visualized and edited using the Interactive Tree of Life (iTOL) online platform (Letunic & Bork 2021).

RESULTS

The macroscopic examination of the *Labrus bergylta* specimens revealed a notable infestation by leeches predominantly attached within the branchial cavity (Figure 1). The intensity of infestation varied among hosts, with one fish harboring as many as 20 leeches, another with five, and two others each

hosting a single specimen. All parasites were morphologically identified as *Trachelobdella lubrica*, belonging to the family Piscicolidae Johnston, 1865 and subfamily Piscicolinae Caballero, 1956, based on distinctive morphological characteristics observed during the study.

Optical microscopy study

A total of 27 leeches were recovered and subjected to detailed morphological analysis. The specimens exhibited considerable variation in size, influenced both by inherent individual differences and by their contracted or extended state at the time of fixation (in frozen samples, as all specimens preserved in alcohol were contracted). Length measurements ranged from a minimum of 6.0 mm to a maximum of 23 mm, while widths varied between 1.5 mm and 8 mm. The mean length and width for 24 measured specimens were 10.0 ± 4.2 mm and 3.1 ± 1.5 mm, respectively. All specimens were adults, characterized by a distinct club-shaped enlargement of the posterior region. Morphologically, the body was clearly divided into two main regions: the slender trachelosome and the inflated, blood-filled urosome (Figure 2A).

Prominent paired pulsatile vesicles were observed along the body, with the first three to four pairs being especially conspicuous (Figures 2B and 2C). The oral sucker was well-developed, facilitating firm attachment to the host, while no eyespots were detected (Figures 2D, 2E and 2F). The posterior sucker was relatively small, bell-shaped, and lacked ocelli. Living specimens displayed a brown to dark green coloration, lighter in the trachelosome region (Figure 2A). These morphological features, including size, coloration, and body segmentation, were consistent with previous descriptions of *T. lubrica* by Burreson (2020), Burreson et al. (2006), Noël and Sittler (2021), and Ramdani (2023), confirming species-level identification.

Molecular taxonomic analysis

Molecular taxonomic analysis was conducted by sequencing the mitochondrial cytochrome c oxidase subunit I (COI) gene barcode region. The COI-5P sequence obtained from the putative *T. lubrica* specimen demonstrated a maximum similarity of 90.78% with a Piscicolidae sp. sequence (GenBank accession MW278767). Other closely related sequences from the same family showed similarity values below 90%, including those assigned to genera such as *Myzobdella*, *Piscicola*, and *Platybdella*. This molecular evidence supports the morphological identification and provides a genetic reference for *T. lubrica* in public databases.

Phylogenetic relationships were inferred using a Neighbor-Joining tree constructed from partial COI sequences of the most closely related Piscicolidae species retrieved via BLASTn. The resulting cladogram, clustered the study specimens within a well-supported clade consistent with the genus *Trachelobdella*. Bootstrap values above 70 reinforced the robustness of the inferred relationships, underscoring the reliability of the combined morphological and molecular approach in accurately identifying the parasite species.

These findings represent the first confirmed occurrence of *T. lubrica* in this region, highlighting an expansion of the known geographic distribution of marine fish leeches in the Atlantic Ocean. The documented infestation levels and detailed morphological and genetic characterization provide a foundation for further ecological and epidemiological studies aimed at understanding the impact of this parasite on commercially important fish species and informing management strategies in fisheries and aquaculture.

Remarks

The morphological study presented some difficulties. The specimens obtained from frozen samples, although with a more relaxed body and a colour closer to live leeches (see supplementary material, videos 1, 2 and 3), showed poor preservation, with some alterations in the body surface. Furthermore, in all frozen samples there were far fewer specimens than reported by the fisherman who had caught the fish, and even in the videos they sent before the samples. The 20 specimens obtained from the only *L. bergylta* preserved in alcohol seems to be better preserved, and some leeches were recovered from the liquid in the container. But those specimens fixed using alcohol showed evidence of body contraction and colour alteration. Specimens of *T. lubrica* are usually attached on the gills of the live host, but they have been also observed externally, probably as initial attachment before moving to the preferred site on the gills (Williams et al. 1994). The mature leeches leave the fish to lay eggs, after which they die (Sawyer 1986; Williams et al. 1994). It has been described that attachment and feeding sites of *T. lubrica* showed frayed fins, abdomen, and haemorrhages of the gills and swelling of the host skin (Sağlam et al. 2003). Unfortunately, fixation procedures of the samples (freezing/alcohol) did not allow pathological studies of the tissues.

No ocelli or eyespots were observed on the oral or caudal suckers. Although some authors have indicated the presence of these eyespots on the oral sucker in *T. lubrica* (Sağlam et al. 2003; Allegra and Castriota 2020; Noël and Sittler 2021), Sawyer et al (1975), in their key to identify marine leeches, stated as a distinctive feature of genus *Trachelobdella* eyespots absence (or one diffusely pigmented pair). No ocelli were observed on the oral or caudal suckers in any of the studied samples. Epshtein et al. (1994) also mentioned that eyes, segmental ocelli or eye-like spots could be present or absent in the caudal sucker of Piscicolinae (subfamily including genus *Trachelobdella*), but not ocelli or eyespots appeared in oral sucker. Burreson's (2020) description of the species states that lacks eyespots, but included this feature in the dichotomous key that led to the species *T. lubrica*. No images of those eyespots in any of the mentioned references could be seen.

Even so, the observed morphological characteristics corresponded to those described by other authors for *T. lubrica* (Sawyer et al. 1975; Sağlam et al. 2003; Öktener and Utevsky 2010; Allegra and Castriota 2020; Burreson 2020).

Table 1 compiles the bibliographic records of *T. lubrica* reported in European waters, including the host parasites, the affected organs and localities.

DISCUSSION

The increasing incidence of *Trachelobdella lubrica* in Galician waters has become a matter of growing concern for the coastal fishing industry due to its potential ecological and economic implications. This species, traditionally considered to have a circumglobal distribution in warm and temperate seas (Sağlam et al. 2003; Öktener and Utevsky 2010) and with preference for shallow waters (Noël and Sittler 2021; Gabel et al. 2022), has now been recorded at its northernmost limit in the Atlantic Ocean. Such an extension challenges earlier assumptions about the species' geographic range, which was thought to be largely confined to warmer waters, and sets the stage for further expansion into European waters. It has been previously found on marine fishes from the west coast of Africa, South Africa, Arabian Sea, Australia, Caribbean, Gulf of Mexico, South Carolina and near the Hawaiian Islands (Sawyer 1986; Burreson 2020). In the Atlantic Ocean, it has been reported from both sides of the ocean, with records on fishes from Puerto Rico and adjacent regions (Williams 1982; Ramos-Ascherl et al. 2015) and in various coastal environments of Canary Islands, although not fixed to any fish host (Burreson et al. 2006). Within European coasts, the presence of the species is considered to be restricted to the Mediterranean Sea (see Table 1), with even one published record on the same host, *L. bergylta*, from Turkey (Öktener and Utevsky 2010). Additionally, Howson and Picton (1997) reported the only previously known record in the Atlantic European coasts, although they qualified that as a "doubtful record". Therefore, no confirmed records of the presence of this species at such high latitudes are known to date. The presence of *T. lubrica* in the Galician cooler, temperate waters is surprising and suggests that recent environmental changes, particularly those related to climate warming, are facilitating the poleward expansion of marine parasites and their hosts.

The ongoing rise in sea surface temperatures (SST) in the Galician upwelling system is well documented, with satellite data indicating an increase of approximately 0.78°C in oceanic and 0.32°C in coastal waters over the past four decades (Bañón et al. 2024). Climate models predict further warming of between 1.4 and 2.4°C by the end of the 21st century (Philippart et al. 2011), creating conditions conducive to the northward migration of thermophilic species. This phenomenon, often referred to as tropicalization, is reshaping coastal fish communities in the NE Atlantic (Horta e Costa et al. 2014) including the Macaronesian archipelagos, the Mediterranean Sea and the European continental shelves, from the Iberian Peninsula up to the North Sea (Afonso et al. 2013). In Galicia, nearly 50 fish species have been documented for the first time as a consequence of an expansion of their distribution ranges northward, with 15 species reaching in this area a new northern distribution limit (Bañón et al. 2024). The arrival of *T. lubrica* aligns with these broader biogeographic shifts, highlighting the interconnectedness of climatic drivers, host distribution, and parasite ecology.

The biology and ecology of *T. lubrica* further facilitate its successful colonization of new habitats. Its broad host range, encompassing diverse teleost families such as Lutjanidae, Pomacentridae, Priacanthidae, Serranidae, Sciaenidae, Scorpaenidae, among others (Sağlam et al. 2003; Burreson et al. 2006; Öktener and Utevsky 2010), increases its chances of encountering suitable hosts in novel environments. *Trachelobdella lubrica* has been described in multiple species (including *L. bergylta*), some

of them with a wide distribution range, which might then favour its expansion toward northern locations. Additionally, as an ectoparasite dependent on external attachment to fish gills and body surfaces (Sağlam et al. 2003), T. *lubrica* is particularly sensitive to ambient temperature changes, which influence its development, reproduction, and survival rates (Brazenor et al. 2020). Warmer waters can accelerate its life cycle, potentially leading to higher infestation intensities and increased transmission (Brazenor et al. 2020).

Within European waters, a total of 874 non-indigenous species were documented by December 2020, including 22 species of parasites and pathogens (Zenetos et al. 2022). Distribution and diversity of marine parasite species could also be affected directly by climate change, modifying transmission rates and virulence, but also through changes in their hosts' distribution and abundance (Palm 2011; Rodriguez et al. 2019). Changes could be even enhanced if we consider that introduction of only one fish into a new ecosystem can imply the introduction of a far higher number and species diversity when we consider the parasite fauna (Rodríguez et al. 2019). Similar examples of shifts in distribution expanding from the Mediterranean Sea to the NE Atlantic have been observed in other parasite species. A well-known example is found in the two sibling species of the nematode genus *Anisakis* clade 1: *Anisakis simplex* (s. s.) (Rudolphi, 1809) Dujardin, 1845 and *Anisakis pegreffii* Campana-Rouget & Bioca, 1955, that have been reported so far in several European fishing areas and in multiple intermediate and definitive hosts. *Anisakis pegreffii* was signalled some decades ago as the Mediterranean species, whilst *A. simplex* was considered as the Atlantic one, with a sympatric area found in the South Atlantic Ocean (Mattiucci et al. 1997, 1998). However, since Abollo et al. (2001, 2003) reported mixed infections and hybrids of both species in Galician waters (NE Atlantic), there were increasing reports of *A. pegreffii* in northern locations. Recently, Ramilo et al. (2023) have found that *A. pegreffii* was the most prevalent species of *Anisakis* in viscera from European hake (*Merluccius merluccius*) captured in ICES areas VIII and IX. Again, this expansion toward northern locations could be also facilitated in anisakids, parasites with host ranges as broad as *T. lubrica* .

Morphological and molecular analyses conducted in this study provide additional support on the species' identity, with the first COI barcode sequence for *T. lubrica* made publicly available. This molecular resource is critical for advancing taxonomic resolution and facilitating future ecological and epidemiological research. However, the relatively moderate sequence similarity to other Piscicolidae species underscores the necessity for expanded genetic sampling within this family to better understand intraspecific variation and phylogenetic relationships.

From a fisheries management perspective, the infestation of economically valuable species such as the ballan wrasse (*Labrus bergylta*) by *T. lubrica* raises significant concerns. While the parasite does not pose a direct threat to human health, its presence can reduce the commercial value of fish by causing visible damage and reducing consumer appeal. Moreover, the blood-feeding behavior of *T. lubrica* can impair host health, potentially affecting growth rates and increasing susceptibility to secondary infections. Given that *L. bergylta* is a sedentary, shallow-water species and a key component of Galician fisheries

(Villegas-Ríos et al. 2013), the parasite's establishment could lead to notable economic losses if infestation levels increase unchecked.

The findings emphasize the importance of integrating parasitological surveillance with broader environmental monitoring to anticipate and manage emerging threats to marine fisheries and aquaculture. Proactive research into the life cycle, host specificity, and pathogen vector potential of *T. lubrica* will be essential for developing effective mitigation strategies. Collaborative efforts involving fishers, researchers, and regulatory bodies can enhance early detection and response capabilities, reducing the risk of widespread parasite outbreaks.

In conclusion, the detection of *Trachelobdella lubrica* in Galician waters represents both a biological indicator of ongoing climatic and ecological shifts and a practical challenge for fisheries sustainability. Continued monitoring, supported by molecular tools and stakeholder engagement, will be vital to understanding the dynamics of this parasite-host system and safeguarding the economic viability of local fisheries in the face of environmental change.

Declarations

Competing interests

The authors have no relevant financial or non-financial interests to disclose

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Authors contributions

All authors contributed to the study conception and design, and performed different parts of: material preparation, data collection and analysis. The first draft of the manuscript was written by Helena Rodríguez and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript

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Data availability

GenBank accession code *Trachelobdella lubrica* COI: MW278767. All data supporting the findings of this study are available within the paper and its Supplementary Information. Specimens of *T. lubrica* were preserved at UTB-IIM-CSIC facilities (https://iim.csic.es/servicio/biobank-technical-unit/, contact at utb@iim.csic.es)

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Table

Table 1 Bibliographical survey of *T. lubrica* European records

Fish host	Affected organs	Locality	Reference
Lagocephalus sceleratus	Skin (under pectoral fin)	Israeli Mediterranean Coast (Lessepian migration species)	Gabel et al. (2022)
Symphodus tinca	?	Lagoon of Bizerte (Tunisia)	Ben Ahmed et al. (2015)
Labrus bergylta	Gill cavity	Bosphorus, Marmara Sea	Öktener & Utevsky (2010)
Scorpaena porcus	Base of pectoral, pelvic fin; gills	Aegean Sea	Sağlam et al. (2003)
Scorpaena scrofa	Base of pectoral, pelvic fin; gills	Aegean Sea	Sağlam et al. (2003)
Diplodus vulgaris	Mouth, gill cavity	Aegean Sea	Öktener & Utevsky (2010)
Epinephelus aereus	Body surfaces	Aegean Sea	Öktener & Utevsky (2010)
Sciaena umbra	Skin	NE Aegean Sea	Akmirza (2014)
Dicentrarchus labrax	?	Po River delta, Adriatic Sea	Ghion et al. (1982)
Serranus cabrilla	Branchiostegal membrane	Strait of Sicily, Central Mediterranean	Allegra & Castriota (2020)
Fistularia commersonii	Gills and mouth	Sardinia and North Africa (Mediterranean Sea)	Merella et al. (2016)
Sparus aurata	Gills	Gulf of Bejaia (Algeria)	Ramdani 2023
?	?	North Sea (doubtful record).	Howson & Picton (1997)
Labrus bergylta	Body surface, gills	Galician coast (NW Spain)	This work

Figures

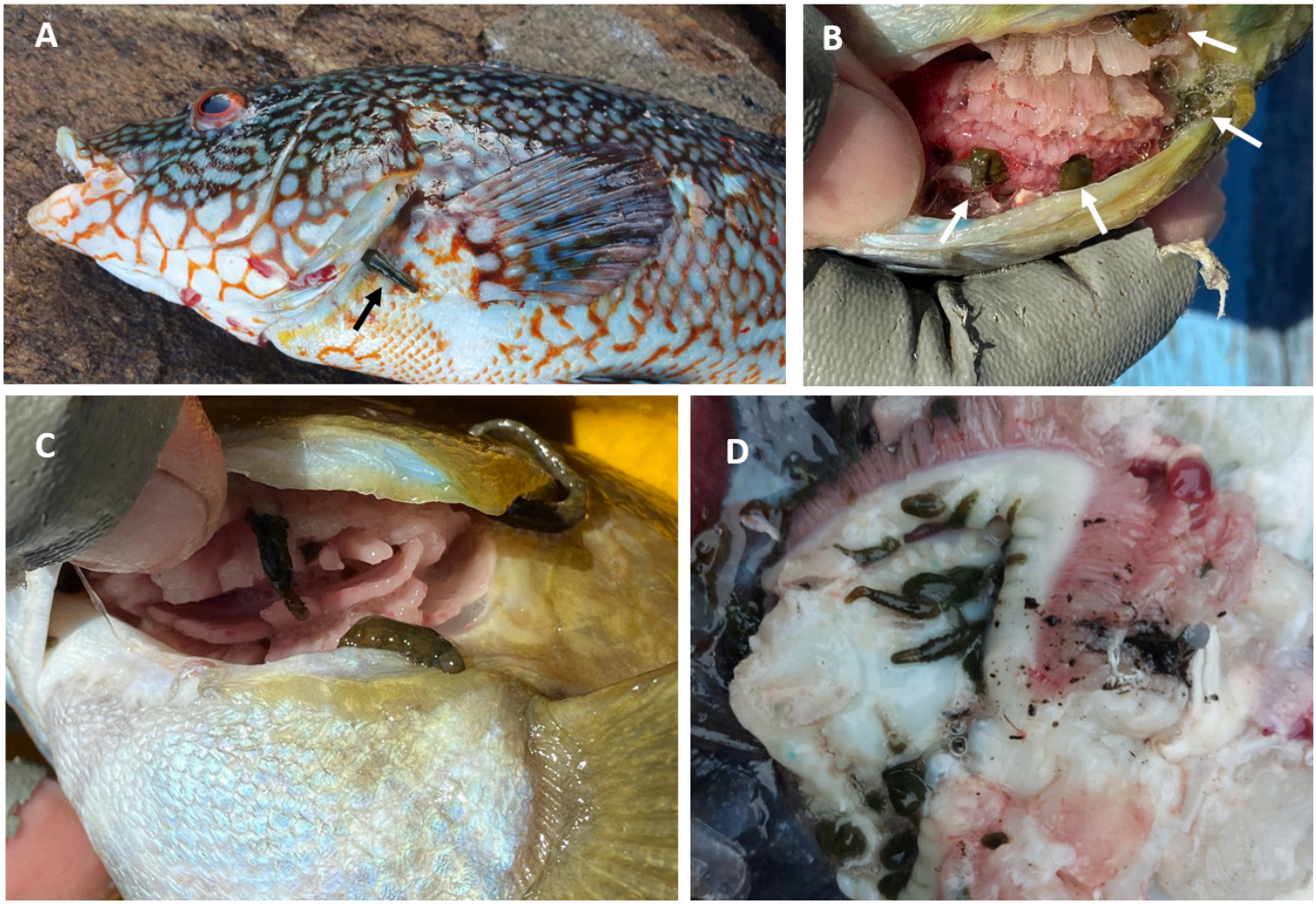

Figure 1

Different photos obtained by fishermen, showing different individuals of the ballan wrasse *Labrus bergylta* with live leeches. **A** *Trachelobdella lubrica* specimen (arrow) emerging from the gill cavity. **B-C** *Trachelobdella lubrica* (arrows) on the gill surface. **D** Large number of leeches on the gill cavity

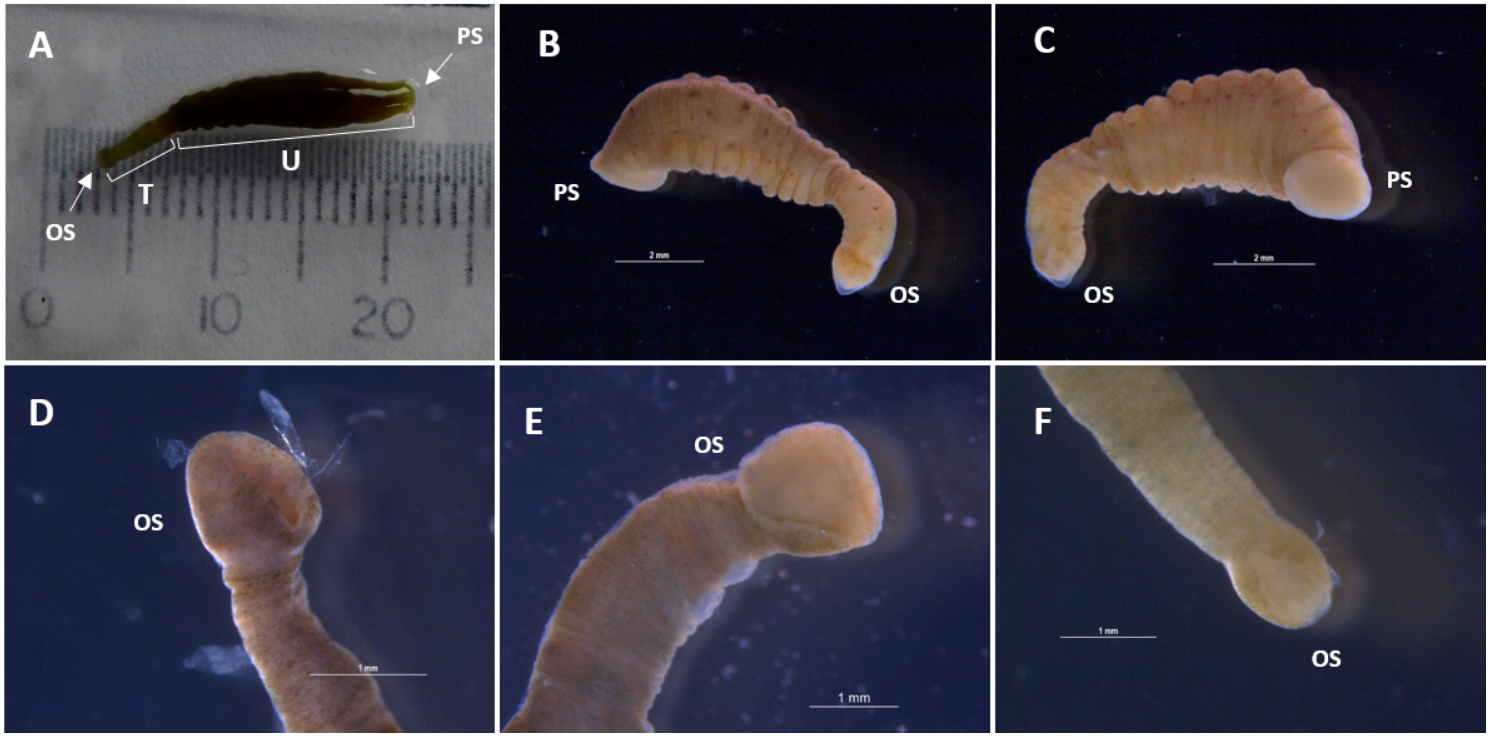

Figure 2

Photographs of the morphological study of *T. lubrica* isolated from *L. bergylta*. **A, B and C** Leech body, showing trachelosome (T) and urosome (U) and the oral (OS) and posterior (PS) suckers. **D, E y F** oral suckers from different *T. lubrica* specimens

A, D, E y F: frozen specimens. B and C: alcohol fixed

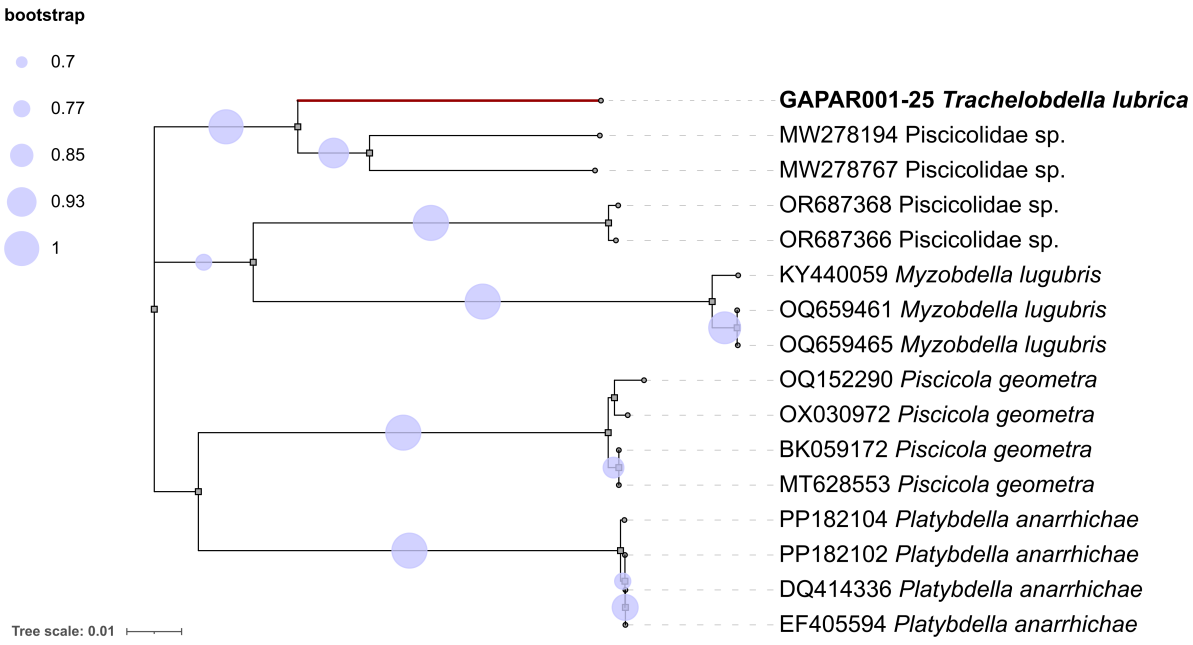

Figure 3

Neighbor-Joining phylogenetic tree based on partial COI sequences of the most closely related sequences of the Piscicolidae family according to the BLASTn analysis. Numbers on the branches represent bootstrap values; only bootstrap values > 70 are included

Supplementary Files

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