










Two New Records of Eunicidae (Annelida, Errantia) Along the Makran Coast of Pakistan, Northern Arabian Sea

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Abstract

The Makran coast of Pakistan in the Northern Arabian Sea is a region of high biodiversity yet remains relatively under-studied in terms of polychaete fauna. In this study, we presented detailed morphological and taxonomical analyses of two newly discovered species of Eunicidae polychaetes, *Eunice indica* and *Lysidice ninetta*, collected during low tide from the intertidal zone of two stations along the Makran coast: Shamal Bandar, Pasni dated 31st January 2022 and Taak Beach, Ormara, dated 31st January 2022. Before our study, only 12 species of Eunicidae were known to occur in Pakistan. The identification and description of *E. indica* and *L. ninetta* provide important information about the distribution and taxonomy of Eunicid polychaetes on the Makran coast. These findings emphasize the need for further investigations and highlight the potential for discovering additional species within the region.

Keywords:

Eunicid polychaetes, polychaeta, eunice, lysidice, balochistan, Indian Ocean

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Introduction

Eunicidae is one of the largest Polychaetae families. Currently, it includes 460 species and 33 genera that have been described (11 of which have been taxonomically identified) (Read & Fauchald, 2021). Polychaeta species belonging to the family Eunicidae (Berthold, 1827) inhabit

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diverse marine environments worldwide (Read & Fauchald, 2021), but reveal higher species variety in warm waters (Fauchald, 1992).

They live in both hard and soft substrates such as reefs, rocks, or sand (Rouse & Pleijel, 2001), but a larger variety of species can originate in the latter, where they live in the rock clefts and other biogenic edifices (Fauchald, 1992), primarily as free-living animals and only sporadically in undying tubes (Carrera-Parra, 2009).

Eunicids have well-developed and complicated jaw apparatus and are primarily carnivores predated on different invertebrates, or omnivores (Jumars et al., 2015); scavenging and herbivorous and other specialized feeding behaviours are also documented (Rouse & Pleijel, 2001).

According to Hartmann-Schröder & Zibrowius (1998), certain species have been described as correlating with other stalkless invertebrates, primarily soft corals, and sponges, while others are experts at boring seagrass fronds (Gambi et al., 2003). Eunicids operate as relating to ecology destructors of coral blocks and play a significant part in the bioerosion processes; they are recognized for drilling the calcareous skeleton of hard corals using their intricate and incredibly hard jaw apparatus (Hutchings, 1986). This family differs from closely related groups in the order Eunicida due to the existence of five prostomial appendages (three antennae and two lateral palps) without annuli at the base and asymmetric maxillae (right maxilla III is lacking) (Zanol et al., 2021).

The specific characteristics of the maxillae, prostomial appendages, peristomial cirri, branchiae, and forms of chaetae can be used to classify these 11 valid taxa. The only genus with three prostomial appendages is *Lysidice* (Lamarck, 1818), whereas all other genera have five appendages. Recent taxonomic investigations have subdivided the most representative and speciose taxa in the family, *Marphysa quatrefages*, 1866, and *Eunice* Cuvier, 1817, based on specific morphological traits and genetic links (Zanolet et al., 2010; 2014; Molina-Acevedo & Carrera-Parra, 2017; Molina-Acevedo, 2018).

Family Eunicidae is widely distributed in the Indian Ocean. Previous reports of eunicid worms from the Indian and Arabian seas were made by Fauvel (1953), Day (1967), Misra & Chakraborty (1983), Wehe & Fiege (2002), Selim (2009), Al-Omari (2011), Sivaleela & Venkataraman (2012), Veeramuthu et al. (2012), Bonyadi-Naeini et al. (2018), Al-Kandari et al. (2019), Sekar et al. (2019), Sivadas & Carvalho (2020). Studies on Eunicid polychaetas from Pakistan have only been conducted by Aziz (1938), Mustaqim (2000), and Mushtaq & Mustaqim (2006), even though the ecology, and taxonomy. Ali et al. (2023) reported the distribution of polychaetae worms from several stations of the Makran coast, there was little information available on the polychaeta fauna of the Makran coast. So, before our study only 12 species of Eunicidae belonging to 5 genera (*Leodice*, *Eunice*, *Marphysa*, *lysidice*, and *Palola*) were known to occur in Pakistan (Kazmi, 2022).

Hence, we have found two new records of the family Eunicidae species from the Makran coast. In this work, we assessed the specific parapodia, chaetae, branchia, and maxillae morphological and taxonomic characteristics of the recently identified species. The current article makes yet another addition to the expansion of Eunicidae species.

Materials and Methods

Worms were collected during low tide from the intertidal zone of 2 stations along the Makran coast i.e. Shamal Bandar, Pasni ($25^{\circ}14'11''\text{N}$, $63^{\circ}04'38''\text{E}$) on dated 31 January 2022 (-0.013, 3:35pm) and Taak Beach, Ormara ($25^{\circ}14'46''\text{N}$, $64^{\circ}28'35''\text{E}$) dated 2 February 2022 (-0.01, 5:10 pm). Water temperature ($^{\circ}\text{C}$), salinity ($\%$), and pH were measured simultaneously. The collected specimens were preserved in 5% formaldehyde and then cleaned, organized, and kept in 70% alcohol for further analysis. Photographs and measurements of the specimens were taken. Samples were dissected and studied under the stereo-zoom microscope (Wild 181300, Switzerland) at 10x50 magnification for identification. Parapodia temporary mounts were made, and they were examined using an upright microscope. With the use of several drawing tube microscopes, the desired parts were shown (Nikon LABOPHOT-2) at 10x4, and 10x10 magnifications. Using the available literature, the specimens were recognized up to the species level (Fauvel, 1953; Day, 1967; Miura, 1986; Martin, 1987; Fauchald 1992). Study area map developed by Mr. Abrar Ali, Marine Reference Collection and Resource Centre, University of Karachi (Figure 1). Specimens *Eunice indica* (MRC&RC-UOK-POL-EUN-05) and *Lysidice ninetta* (MRC&RC-UOK-POL-EUN-27) were deposited in repository museum of Marine Reference Collection and Resource Centre University of Karachi.

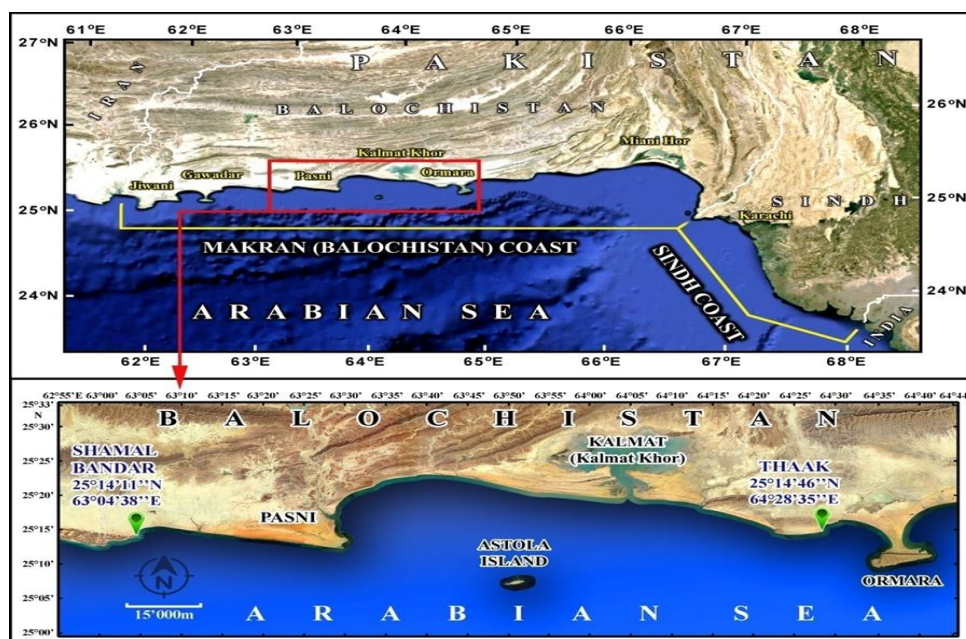


Fig. 1. Map showing the collection sites Shamal Bandar, Pasni and Taak Beach, Ormara.

Results

The physicochemical parameters water temperature (25°C), salinity (37‰), and pH (8.2) were recorded from Shamal Bandar, Pasni, dated 31 January 2022 and temperature (23°C), salinity (38‰), and pH (8.2) were recorded from Taak Beach, Ormara dated 2 February 2022 (-0.01, 5:10 pm).

In this study, we present a comprehensive examination of the morphological and taxonomical characteristics of two Eunicidae polychaetes *Eunice indica* and *Lysidice ninetta* described for the first time in the Makran Coast of Balochistan.

Eunice indica (Kinberg, 1865) (Figure 2 and Figure 3)

Systematic

Order: Eunicida

Family: Eunicidae (Berthold, 1827)

Genus: *Eunice* (Cuvier, 1817)

Species: *Eunice indica* (Kinberg, 1865)

Type locality: Bangka Island (Indonesia)

Habitat: Rocky shores, found under rocks

Material Examined: 2 specimens, Shamal Bandar, Pasni (25°14'11''N, 63°04'38''E), intertidal rocky shore, 31-01, 2022, collectors, Dr. Qadeer Mohammad Ali, and Ms. Hafsa Qazi, catalog no: MRC&RC-UOK-POL-EUN-05.

Description: The length of preserved specimens was 11.7-12.3 cm, with 76-83 chaetigers (Figure 2A), fresh color of the specimens was reddish brown, the prostomium shorten and alienated into two lobes and smaller than the peristomium, about as broad as peristomium. The peristomium is reddish brown. Prostomium faintly jagged anteriorly, with 2 eyes and 5 small occipital antennae. Prostomial antennae and peristomal tentacles are extended, flat, or unevenly furrowed. Middle three antennae expand to setigers 7-8 and external pair to setiger 1 (Figure 3A). Mandibles calcified on the frontal rim. Maxillary formula: Mx. I = 1 + 1; Mx. II = (9-1) + (8-11); Mx. III = (8-11) + 0; Mx. IV = (7-10) + 13 (Figure 3B-C). The first branchia occurs for eternity at chaetiger. The first branchia particularly filament; all other branchia pectinates; rise to a maximum of 10 to 15 filaments and originate only on the frontal third of the body (Figure 3D-E). The aciculum is almost straight yellow and blunt. Acicular chaetae yellow, numerous (4-5), boldly tridentate, and occurs as a transverse series parapodium. Each pectinate seta has five to six inner teeth and lateral asymmetrical extensions. Compound falcigers bidentate with long pointed guard striated one margin (Figure 3F-G). The pygidium has two long dorsal and two short ventral anal cirri. Sexes unknown. Distribution: Japan, New Caledonia, Gambier Islands, Indonesia, India, Indian Ocean, Persian Gulf and Red Sea.

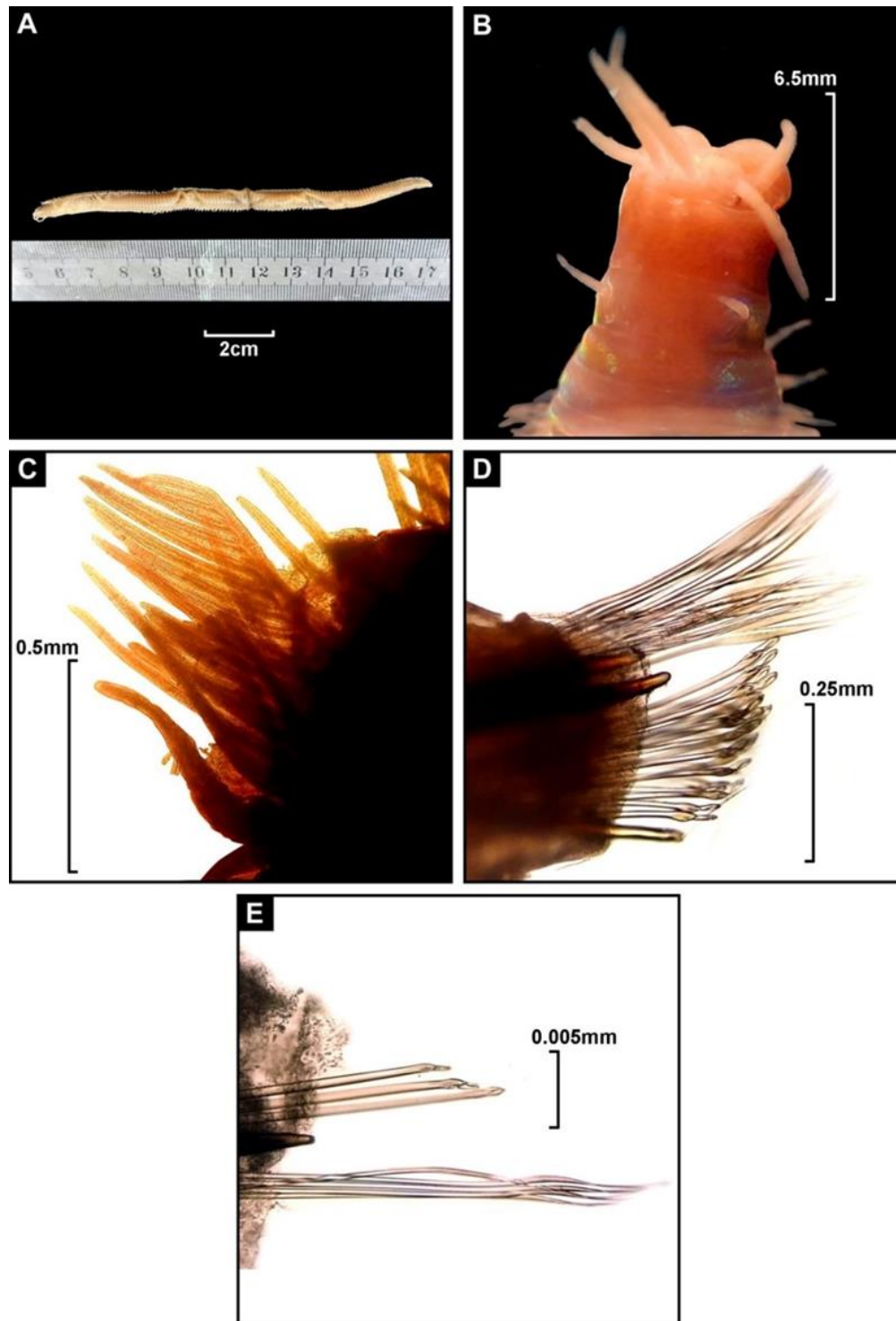


Figure 2. A: *Eunice indica*, B: Anterior end, dorsal view, C- D: Parapodia, E: Compound falciger (Size, 832x741 198 KB 300dpi 24 bit).

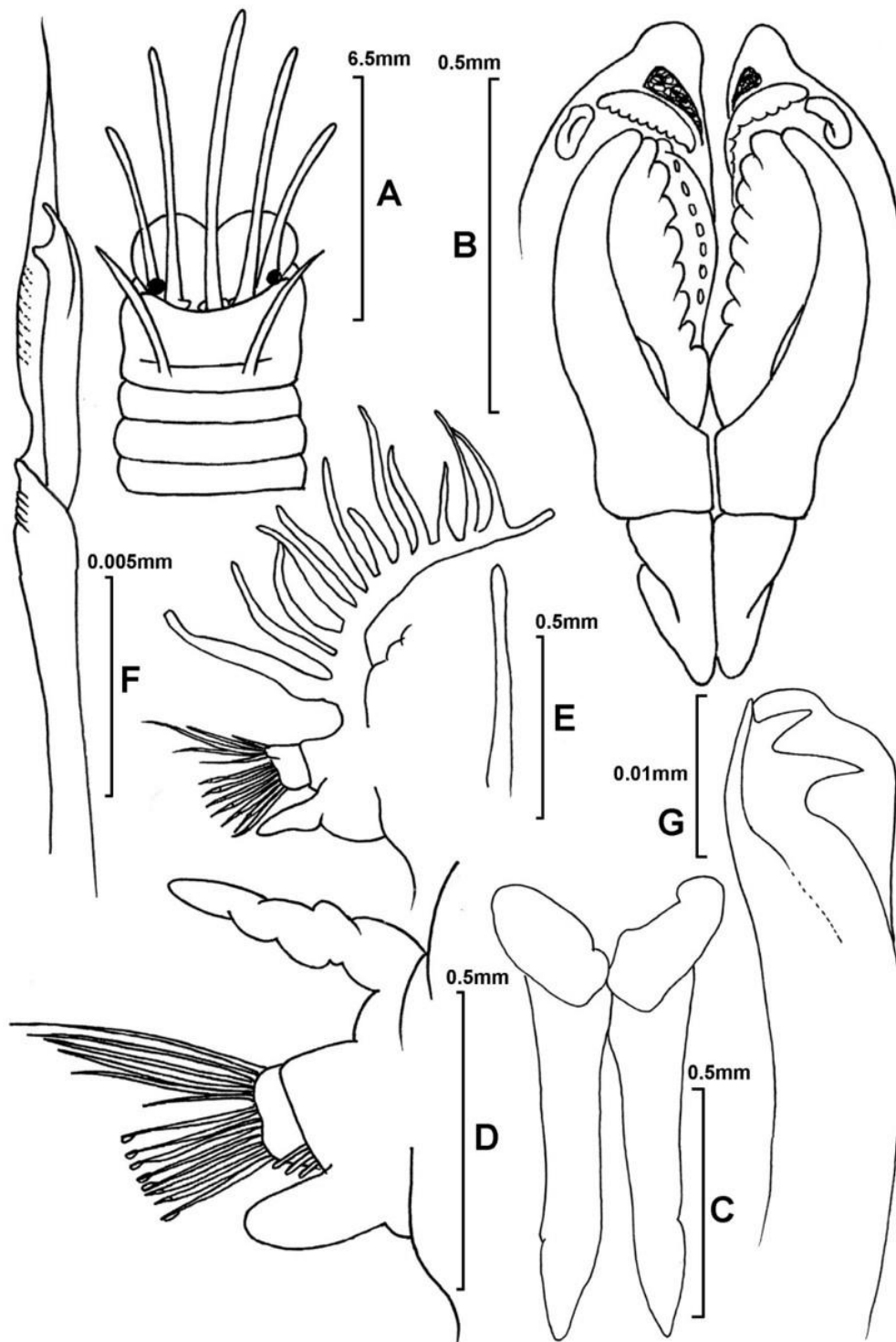


Figure 3. *Eunice indica*, A: Anterior end, dorsal view, B: Maxillae, C: Mandibles, D– E: Parapodia, F: Compound falciger, G: subacicular hook.

Lysidice cf. ninetta* Audouin & H Milne Edwards, 1833 (Figure 4 and Figure 5)**Systematic******Order:*** Eunicida***Family:*** Eunicidae (Berthold, 1827)***Genus:*** *Lysidice* (Lamarck, 1818)***Species:*** *Lysidice cf. ninetta* Audouin & H Milne Edwards, 1833***Type locality:*** France***Habitat:*** Rocky shores, found under rocks***Distribution:*** Red Sea, Indo-West Pacific, North Atlantic, North Carolina, Mediterranean Sea, Angola, India.***Material examined:*** 2 specimens, Taak Beach, Ormara (25°14'46''N, 64°28'35''E), intertidal rocky shore, 2-02-2022, collectors, Dr. Quratulan Ahmed, Ms. Shumaila Mubarak and Mr. Kashif Jameel, catalogue no: MRC&RC-UOK-POL-EUN-27.***Description:*** Length of preserved specimens 3.5-3.8 cm, with 84-88 chaetigers, generally more or less completely colourless or light brown in preservation, with still traces of white spots and white bar on setiger 2 and 5 (Figure 4A). The frontal edge of the prostomium bilobed. Three occipital antennae, sub-equal in length and the same length as the prostomium. Eyes large, black, and typically elliptical (Figure 5A). Mandibles are weighty and scratch-like, H-shaped with two black horny plates on their outside. The maxillary carriers are long and relatively narrow. Maxillary formula: Mx. I = 1 + 1; Mx. II = 4 + 4; Mx. III = 4 + 0; Mx. IV = 4 + 4; Mx. V = 1+1 or are chitinised patches (Figure 5B-C). Parapodia uniramous and lack branchia. Dorsal cirri are long and cylindrical in the first few parapodia or short and conical in the posterior parapodia. The ventral cirri are also long in anterior parapodia and short with a proximal pad in posterior ones. The acicula is dark with blunt tips (Figure 5D). Dark subacicular hooks are bidentate and hooded from chaetiger 22 onwards. The compound setae are in subacicular positions and are bidentate and hooded (Figure 5E). Each pectinate chaetae has nearly symmetrical lateral extensions and more than ten inner spines. The pygidium has two extended dorsal and two small ventral anal cirri.

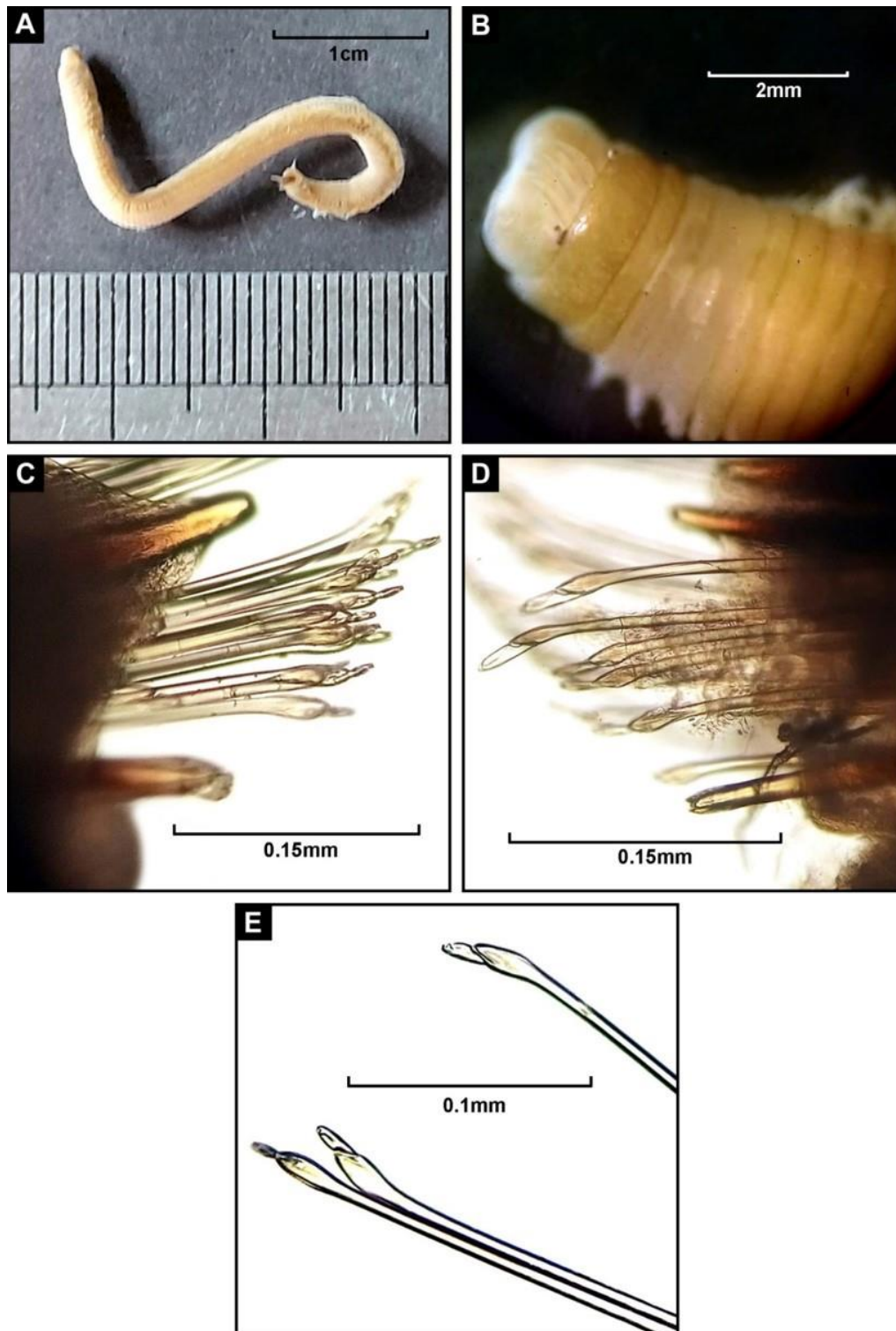


Figure 4. A: *Lysidice cf. ninetta*, B: Anterior end, dorsal view, C-D: Parapodia, E: Compound falciger.

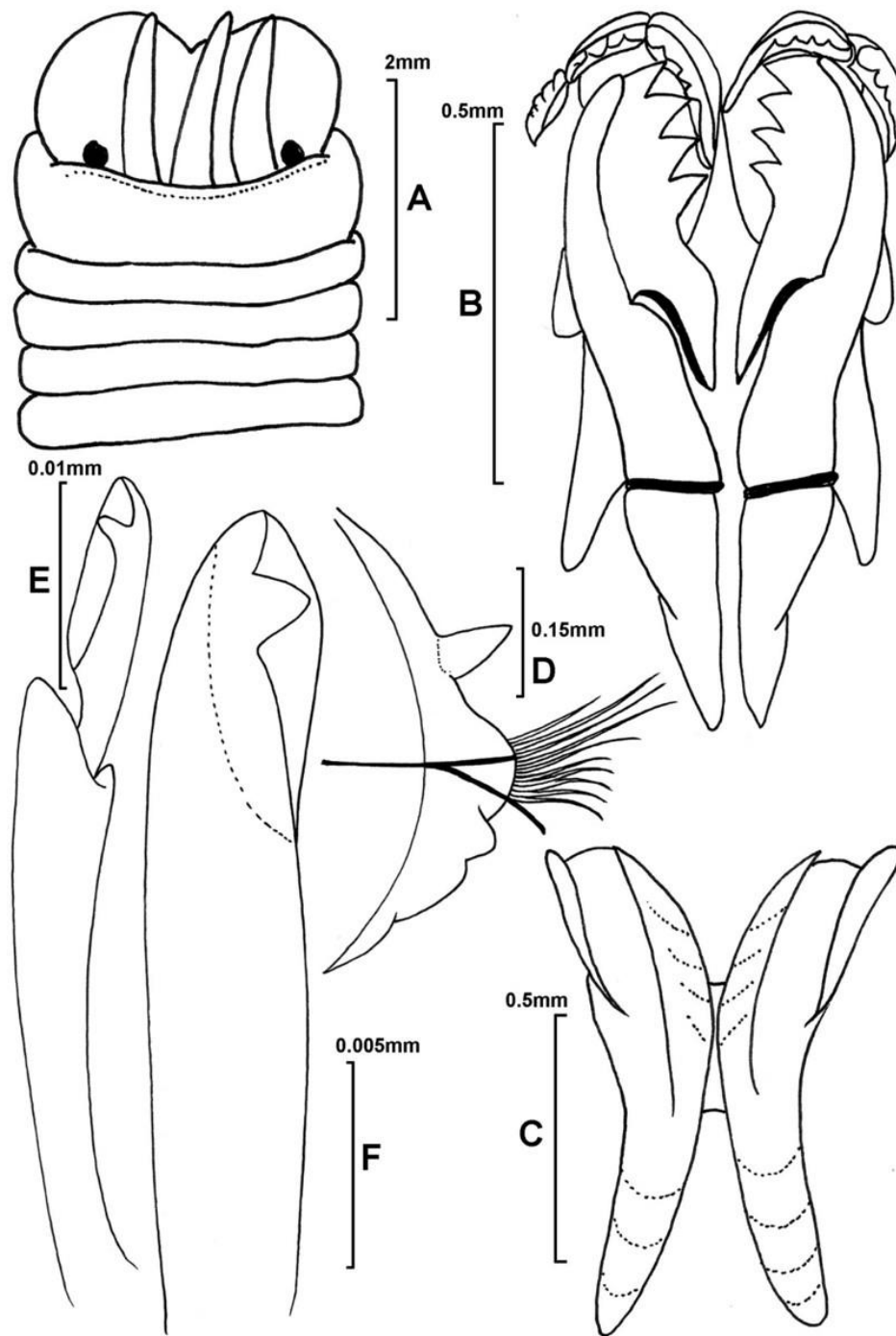


Figure 5. *Lysidice cf. ninetta*, A: Anterior end, dorsal view, B: Maxillae, C: Mandibles, D: Parapodia, E: Compound falciger, F: subacicular hook.

Discussion

Eunicida constituent is one of the most prominent, morphologically distinct polychaetes clades (Struck et al., 2006; Zanol et al., 2007). The present study indicated the first records of eunicid

polychaetes (*Eunice indica* and *Lysidice ninetta*) and their taxonomic accounts, from two rocky shores of Makran coast, Pakistan, which are particularly recorded from the Indian Ocean and Arabian Sea.

According to Fauchald, *Eunice indica* has been widely reported from the Indian Ocean and western Pacific Ocean; several similar species have been reported from this area. From Pakistan only two species of genus *Eunice* were reported e.g. *Eunice australis* and *Eunice manorae* (Aziz, 1938). The distribution of *E. indica* proper must be considered unsettled and the type locality of *E. indica* is the Bangka Island (Indonesia). The studied specimens fit well with the descriptions for *E. indica* Fauchald, (1992) description based on the holotype by Kinberg (1865), about prostomial lobes that are frontally rounded, and dorsally flattened; the shape of the antennae which are long, smooth, or irregularly crumpled (Day, 1967; Miura, 1986); other characters such as the occurrence of branchia from setiger 3, increasing to maximum of 10 filaments (Fauvel, 1953; Day, 1967). Similar to *E. tentaculata* and *E. vittata*, *E. indica* possesses several subacicular hooks in most setigers. However, *E. tentaculata* differs by the first branchia on six setiger and *Eunice indica* and *E. vittata* both have the first branchia on three setiger (Fauchald, 1992). *Eunice indica* can be distinguished from *E. vittata* by the guards on the composite falciger. *E. indica* has the acerous guards on the compound falcigers while *E. vittata* has distantly dulled guards, and concerning aciculae and subacicular hooks, aciculum is almost straight yellow and blunt, acicular chaetae yellow, boldly tridentate and occurs as a transverse series parapodium and compound falcigers bidentate with long pointed guard, agreed with earlier descriptions of (Fauvel, 1953; Day, 1967; Miura, 1986; Fauchald, 1992; Fernando & Rajasekaran, 2007; Veeramuthu et al., 2012). The holotype of *E. indica* lacks jaws but Day, (1967) gave a detailed analysis of the jaw of the specimens from Cape, Mocambique, and Madagascar which are similar to our analyzed specimens. The dorsal cirri of *E. indica* are quite small compared with the other species of the genus and occasionally creased.

From Pakistan, only two species of genus *Lysidice* were reported e.g., *Lysidice collaris* (Aziz, 1938; Mustaqim, 2000) and *Lysidice natalensis* (Mustaqim, 2000). *Lysidice cf. ninetta* is a polychaete linked with various vegetated habitats (Martin, 1987) and widely distributed in Atlantic Ocean, Indo-Pacific, and the Mediterranean Sea although there aren't many features that may be used to differentiate it from other species, therefore different specimens may come from various places (Salazar-Vallejo & Carrera-Parra, 1997). *Lysidice cf. ninetta* was originally described by Audouin and Milne Edwards (1833) and the type locality of *Lysidice cf. ninetta* is France. Their description is brief, and non-informative generally based on basic morphology. The morphological accounts of *L. ninetta* by Gath (1984) incorporated some characteristics of *Lysidice collaris*, but Fauchald (1970) contemplates it as synonymous with *L. ninetta*. *Lysidice ninetta* is a warm temperate and temperate water polychaete (George & Hartmann-Schröder 1985; Cantone 1993) and its congener. *L. collaris* a tropical species (Ben-Eliahu 1972). In the Mediterranean and South Africa, these two species of *Lysidice* are clearly distinguished by both morphological (Day, 1967; Martin, 1987) and genetic outcomes based on both nuclear (ITS1) and mitochondrial (COI) data (Iannotta et al., 2007; Talia, 2001).

The studied specimens agree well with Day (1967) from South Africa and Miura (1977) from Japan's earlier account of *L. ninetta* regarding the three occipital antennae which are sub-equal in length and shorter than the prostomium and follow the maxillary formula described by (Day, 1967; Miura, 1977). The shape of the eyes is a distinguishing characteristic which is large, black, and characteristically oval (Day, 1967; Şahin & Çınar, 2009). The parapodia lack branchia, acicula is dark with blunt tips. Higher setae are limbate capillaries and comb setae and lower setae are compound falcigerous and have bidentate blades found like the descriptions of (Day, 1967; Miura, 1977; Gathof, 1984; Martin, 1987; Veeramuthu et al., 2012; Sekar et al., 2019).

Coloration variation in *L. ninetta* was described by (Gambi et al., 2003; Iannotta et al., 2009; Şahin & Çınar, 2009). Two morphotypes (Dark morph and light morph) of *L. ninetta* were described (Iannotta et al., 2009). The prostomium and first anterior segments of the dark morph were characterized by a dark brownish coloration with fine white spots whereas in the light morph, the prostomium and first segments show greatly lightening coloration and greater pale spots. Our specimens of *Lysidice cf. ninetta* are much like the light morph of (Iannotta et al., 2009) with light brown colour and traces of white spots.

These findings emphasize the need for further investigations and highlight the potential for discovering additional species within the region. Ultimately, this study enhances our understanding of the biodiversity and ecological dynamics of the Northern Arabian Sea, emphasizing the importance of preserving and conserving this unique marine ecosystem.

In conclusion, primary objective of this research endeavor was to document new records of *Eunicidae polychaetae* inhabiting previously unexplored areas along the Makran coast. As a result of this comprehensive study, a valuable compilation of data has been generated regarding the distribution and composition of polychaeta fauna within the Makran coast region, marking a significant milestone. This pioneering document not only represents the first-time disclosure of eunicid polychaetae fauna distribution on the Makran coast but also stands as a crucial resource poised to benefit forthcoming biologists and researchers in their investigations and analyses of this particular ecosystem. In essence, this study not only broadens our understanding of the hidden diversity along the Makran coast but also bequeaths a vital tool to the scientific community. As a pioneering endeavor, it paves the way for future investigations and endeavors, providing a solid foundation upon which researchers can build to unravel the complexities of polychaeta fauna and their role in the intricate web of marine life.

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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 paper.

Author Contributions

All authors performed all the experiments and drafted the main manuscript text.

References

- Ali, Q. M., Ahmed, Q., Kurt, G., Bat, L., Mubarak, S., Qazi, H., Baloch, A., Shaikh, I., Baloch, A., Aziz, N., Ahmed, S., Ali, A., Ahmed, I., Ghalib, A. (2023). First report on distribution of Polychaetes (Annelida: Polychaeta) along the Makran coast of Pakistan, Northern Arabian Sea. *Journal of Materials and Environmental Science*, 14 (3), 277- 292.
- Al-Kandari, M., Sattari, Z., Hussain, S., Radashevsky, V. I., Zhadan, A. (2019). Checklist of intertidal polychaetes (Annelida) of Kuwait, Northern part of the Arabian Gulf. *Regional Studies in Marine Science*, vol. 32, pp. 100872, <https://doi.org/10.1016/j.rsma.2019.100872>
- Al-Omari, N. H. A. (2011). A guide to polychaetes (Annelida) in Qatar marine sediments. Qatar University Environmental Studies Center, 98p.
- Aziz, N. D. (1938). Fauna of Karachi, 2 Polychaetes. *Memoirs of Department of Zoology, Punjab University, Lahore*, 19-52.
- Ben-Eliahu, M. N. (1972). *Littoral polychaeta* from Cyprus. *Tethys*, 4(1), 85-94.
- Bonyadi-Naeini, A., Rastegar-Pouyani, N., Rastegar-Pouyani, E., Glasby, C. J., Rahimian, H. (2018). Intertidal polychaetes from Abu Musa Island, Persian Gulf, with a new species from the *Perinereiscultrifera* species complex (Annelida: Nereididae). *Journal of the Marine Biological Association of the United Kingdom*, 98 (8), 1965-1976. <https://doi.org/10.1017/S0025315417001564>.
- Cantone, G. (1993). Censimento dei policheti dei mari italiani: Eunicidae Berthold, 1827. *Atti della Società toscana di scienze naturali residente in Pisa. Memorie. Serie B*.
- Carrera Parra, L. (2009). F. Eunicidae Berthold, 1827. *Poliquetos (Annelida: polychaeta) de México y América TropicalI*, 167-181.
- Day, J. H. (1967). A monograph on the polychaeta of southern Africa. Pt. 1.
- Fauchald, K. (1992). *A review of the genus Eunice (Polychaeta: Eunicidae) based upon type material*.
- Fauvel, P. (1953). *Annelida Polychaeta. The fauna of India, including Pakistan, Ceylon, Burma, and Malaya*, pp. 1-507.
- Fernando, O. J., & Rajasekaran, R. (2007). Benthic Polychaetes of Tamil Nadu coast. In: *Conservation and Valuation of Marine Biodiversity*, pp. 67.
- Gambi, M. C., van Tussenbroek, B. I., Brearley, A. (2003). Mesofaunal borers in seagrasses: world-wide occurrence and a new record of boring polychaetes in the Mexican Caribbean. *Aquatic Botany*, 76(1), 65-77. [https://doi.org/10.1016/S0304-3770\(03\)00031-7](https://doi.org/10.1016/S0304-3770(03)00031-7).

- Gathof, J. M. (1984). Family Eunicidae Savigny, 1818. In: *Atlas of the Polychaetes of the Northern Gulf of Mexico*, Barry Victor and Associates, 1–31.
- George, J. D., (1985). In: *British Amphinomida, Spintherida and+ & Eunicida: Keys and Notes for the Identification of the Species*, Brill Archive.
- Hartmann-Schröder, G., & Zibrowius, H. (1998) *Polychaeta associated with antipatharia (Cnidaria: Anthozoa): description of Polynoidae and Eunicidae*. Mitteilungen aus dem Hamburgischen zoologischen Museum und Institute.
- Hutchings, P. A. (1986). Biological destruction of coral reefs: a review, *Coral Reefs*, 4, 239-252. <https://doi.org/10.1007/BF00298083>.
- Iannotta, M. A., Patti, F. P., Ambrosino, M., Procaccini, G., Gambi, M. C. (2007). Phylogeography of two species of *Lysidice* (Polychaeta, Eunicidae) associated to the seagrass *Posidonia oceanica* in the Mediterranean Sea. *Marine Biology*, 150, 1115-1126. <https://doi.org/10.1007/s00227-006-0405-2>.
- Iannotta, M. A., Gambi, M. C., Patti, F. P. (2009). Molecular evidence of intraspecific variability in *Lysidice ninetta* (Polychaeta: Eunicidae) in the Mediterranean Sea. *Aquatic Biology*, 6, 121-132. <https://doi.org/10.3354/ab00160>.
- Jumars, P. A., Dorgan, K. M., Lindsay S.M. (2015). Diet of worms emended: an update of polychaete feeding guilds. *Annual Review of Marine Science*, 7, 497-520. <https://doi.org/10.1146/annurev-marine-010814-020007>.
- Kazmi, Q. B. (2022). Marine Faunal Diversity of Pakistan Inventory and Taxonomic Resources. *Zoological Society of Pakistan*, pp. 721.
- Martin, D. (1987). Anélidospoliquetos asociados a las concreciones de lagascales de litoral Catalán. *Miscel·lània Zoològica*, 11, 61-75.
- Misra, A., Chakraborty, R. K. (1983). Further records of polychaetes from Gujarat coast. *Records of the Zoological Survey of India*, 81(1-2), 69-75. <https://doi.org/10.26515/rzsi/v81/i1-2/1983/161253>.
- Miura, T. (1977). *Eunicid polychaetous annelids from Japan*. II. La mer, vol. 15, no. 2, pp. 61-81.
- Miura, T. (1986). Japanese polychaetes of the genera Eunice and Euniphysa: Taxonomy and branchial distribution patterns. *Publications of the Seto Marine Biological Laboratory*, 31(3-6), 269-325.
- Molina-Acevedo, I.C. (2018). Morphological revision of the subgroup 1 Fauchald, 1970 of *Marphysa* de Quatrefages, 1865 (Eunicidae: Polychaeta). *Zootaxa*, 4480(1), 1-125. <https://doi.org/10.11646/ZOOTAXA.4480.1.1>.
- Molina-Acevedo, I.C., Carrera-Parra, L.F. (2017). Revision of *Marphysa* de Quatrefages, 1865 and some species of *Nicidion* Kinberg, 1865 with the erection of a new genus (Polychaeta: Eunicidae) from the Grand Caribbean. *Zootaxa*, 4241 (1), 1-62. <https://doi.org/10.11646/zootaxa.4241.1.1>.
- Mushtaq, S., & Mustaqim J. (2006). New records of polychaetous annelid (Order: Eunicida) from the coastal waters of Karachi. In 26th Pakistan Congress Zoology, Zoological Society of Pakistan.

- Mustaquim, J. (2000). Six new records of intertidal polychaetes from Pakistan. *Pakistan Journal of Marine Sciences*, 9, 97-106.
- Read, G. (2021). In: *World Polychaeta Database. Eunicidae Berthold, World Register of Marine Species*. Available online.
- Rouse, G., & Pleijel, F. (2001). *Polychaetes*. Oxford University Press.
- Salazar-Vallejo, S. I., & Carrera-Parra, L. F. (1997). Eunícidos (Polychaeta) del caribe mexicano con claves para las especies del Gran Caribe: Fauchaldius, Lysidice, Marphysa, Nematoneis y Palola. *Revista de Biología Tropical*, 45(4), 1481-1498.
- Sekar, V., Rajasekaran R., Balakrishnan S., & Raguraman R. (2019). Taxonomical keys for morphological identification of coral-associated Polychaetes from Great Nicobar Islands. *Natural Resources Management and Biological Sciences*, 1-33.
- Selim, S.A. (2009). Polychaete fauna of the Northern part of the Suez Canal (Port-Said–Toussoum). *Egyptian Journal Aquatic Research*, 35 (1), 69-88.
- Sivadas, S.K., & Carvalho R. (2020). Marine Annelida of India: taxonomy and status evaluation and an updated checklist. *Journal of Threatened Taxa*, 12(12), 16647-16714. <https://doi.org/10.11609/jott.5357.12.12.16647-16714>.
- Sivaleela, G., & Venkataraman K. (2012). Distribution of Marine Polychaetes of India. *Records of the Zoological Survey of India*, 112(4), 113-126.
- Struck, T.H., Purschke G., & Halanych K.M. (2006). Phylogeny of Eunicida (Annelida) and exploring data congruence using a partition addition bootstrap alteration (PABA) approach. *Systematic Biology*, 55 (1), 1-20. <https://doi.org/10.1080/10635150500354910>.
- Şahin, G. K., & Çınar M. E. (2009). Eunicidae (Polychaeta) species in and around Iskenderun Bay (Levantine Sea, Eastern Mediterranean) with a new alien species for the Mediterranean Sea and a re-description of Lysidice collaris. *Turkish Journal of Zoology*, 33(3), 331-347. <https://doi.org/10.3906/zoo-0806-19>.
- Talia, M. (2001). Filogeografia comparata nell'ecosistema a Posidonia oceanica (L.) Delile: la pianta e gli organismi scavatori. M.Sc. Thesis, University Federico II, Napoli, pp. 119 (in Italian).
- Veeramuthu, S., Ramadoss, R., Subramaniyan, B., Jeyaram, S., Fernando, O.J. (2012). Abundance of the boring polychaetes of Eunicidae (Annelida) in Great Nicobar Islands. *Our Nature*, 10 (1), 76-88.
- Wehe, T., & Fiege, D. (2002). Annotated checklist of the polychaete species of the seas surrounding the Arabian Peninsula: Red Sea, Gulf of Aden, Arabian Sea, Gulf of Oman, Arabian Gulf. *Fauna of Arabia*, 19, 7-238.
- Zanol, J., Fauchald, K., Paiva, P. C. (2007). A phylogenetic analysis of the genus Eunice (Eunicidae, polychaete, Annelida). *Zoological Journal of the Linnean Society*, 150 (2), 413-434. <https://doi.org/10.1111/j.1096-3642.2007.00302.x>.
- Zanol, J., Halanych, K. M., Struck, T. H., & Fauchald, K. (2010). Phylogeny of the bristle worm family Eunicidae (Eunicida, Annelida) and the phylogenetic utility of noncongruent 16S,

COI and 18S in combined analyses. *Molecular Phylogenetics and Evolution*, 55(2), 660-676. <https://doi.org/10.1016/j.ympev.2009.12.024>

Zanol, J., Halanych, K. M., & Fauchald, K. (2014). Reconciling taxonomy and phylogeny in the bristleworm family Eunicidae (polychaete, Annelida). *Zoologica Scripta*, 43(1), 79-100. <https://doi.org/10.1111/zsc.12034>.

Zanol, J., Carrera-Parra, L. F., Steiner, T. M., Amaral, A. C. Z., Wiklund, H., Ravara, A., & Budaeva, N. (2021). The current state of Eunicida (Annelida) systematics and biodiversity. *Diversity*, 13(2), 74. <https://doi.org/10.3390/d13020074>.