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RESEARCH ARTICLE

Variations Observed in the Muscle Scars of Left Valve of *Pododesmus patelliformis* (Linnaeus, 1761) [Bivalvia: Anomiidae]

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Abstract: This study investigates the unusual muscle scars observed in some specimens of *Pododesmus patelliformis* (Linnaeus, 1761). Materials were collected between 1964 and 1977 from 18 stations across the Sea of Marmara and the Aegean Sea. In only 49 out of the 85 specimens examined (57,7%), the muscle scars were distinctly separated from each other as described in the general literature. Thirty-six specimens (42,3%) exhibited muscle scars that differed from the known pattern. These atypical muscle scar types were categorized into five types, explained, photographed, and illustrated in this study.

Anahtar kelimeler:

Bivalvia
Anomiidae
Pododesmus patelliformis

Pododesmus patelliformis (Linnaeus, 1761) [Bivalvia: Anomiidae]'in Sol Kapağının Kas İzlerinde Görülen Varyasyonlar

Öz: Bu çalışma *Pododesmus patelliformis* (Linnaeus, 1761)'in bazı örneklerinde gözlenen sıra dışı kas izlerini ele almaktadır. Materyaller 1964-1977 yılları arasında Marmara Denizi ve Ege Denizi'ndeki 18 istasyondan elde edilmiştir. İncelenen 85 örneğin sadece 49'unda (%57,7) kas izleri literatürde belirtildiği gibi belirgin bir şekilde birbirinden ayrılmıştır. Otuz altı örnekte (%42,3) bilinen modelden farklı kas yara izleri vardı. Bu farklı kas yara izi tipleri bu çalışma ile beş sınıfa ayrılmış, açıklanmış, fotoğraflanmış ve şekli çizilerek gösterilmiştir.

Introduction

Cox et al. (1969) described Anomiidae as follows: "Shells irregular in outline, mostly sessile, slightly to markedly inequivalve. Byssus present in young stages, later modified in most to become pluglike, horny, passing through embayment or foramen in lower valve (normally RV). Adductor muscle scar subcentral, with one or more pedal and byssal retractor muscle scars above it, best seen on LV, opposite to foramen.". Members of the family Anomiidae inhabitate hard substrates, by attaching themselves with a calcified byssus passing inside of the left valve through a hole, called as foramen or byssal aperture, in the right valve. This family can be readily identified by semi-transparent lower (right) valve with a foramen. However, species level identification is challenging due to the valves often mimicking the shape of the hard substrate on which they reside. The shape and number of muscle scars in the upper (left) valve are the primary diagnostic features used in species identification within the family (Poppe & Goto, 1993; Tebble, 1966).

The Anomiidae family is represented by five species [*Anomia ephippium* Linnaeus, 1758, *Isomonia alberti* (Dautzenberg & H. Fischer, 1897), *Heteranomia squamula* (Linnaeus, 1758), *Pododesmus patelliformis* (Linnaeus, 1761) and *Pododesmus squama* (Gmelin, 1791)] in the European Marine Mollusca (MolluscaBase eds., 2024). *A. ephippium*, *H. squamula*, *P. patelliformis* and *P. squama* are found in the Mediterranean basin and Atlantic coasts of European countries, whereas *I. alberti* is restricted to the North Atlantic coasts of Europe (WoRMS eds., 2024). In the seas surrounding Türkiye, *A. ephippium* and *P. patelliformis* are distributed along the coasts of Black, Marmara, Aegean and Levantine Seas. Conversely, *H. squamula* and *P. squama* are known only from Marmara and Aegean coasts, and *I . alberti* has not been reported from Turkish seas (Albayrak, 2011; Uysal et al., 2008).

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Anomia ephippium is distinguished from other species by having three muscle scars. The other four species each exhibit two muscle scars within the left valves. *P. patelliformis* and *P. squama* are separated from other species in the family by having byssal and adductor muscle scars which feature radiating furrows (Fig. 1). In *P. patelliformis*, the two muscle scars are clearly separated and distinct, whereas in *P. squama* they merge to form one continuous scar (Poppe & Goto, 1993; Tebble, 1966). Moreover, the external sculpture of left valve in *P. patelliformis* displays approximately thirty radiating ribs, as opposed to the very fine and numerous striae found in *P. squama* (Bucquoy et al., 1887-1898; Forbes & Hanley, 1853; Tebble, 1966).

In 2010, emeritus Prof.Dr. Muzaffer Demir brought to our attention the unusual muscle scars in *P. patelliformis* specimens obtained from the Sea of Marmara and the Aegean Sea. These variations did not align with the existing literature. The significance of the subject inspired us to prepare this article even though it comes years after his passing. This study aims to present the different muscle scar patterns observed in *P. patelliformis*.

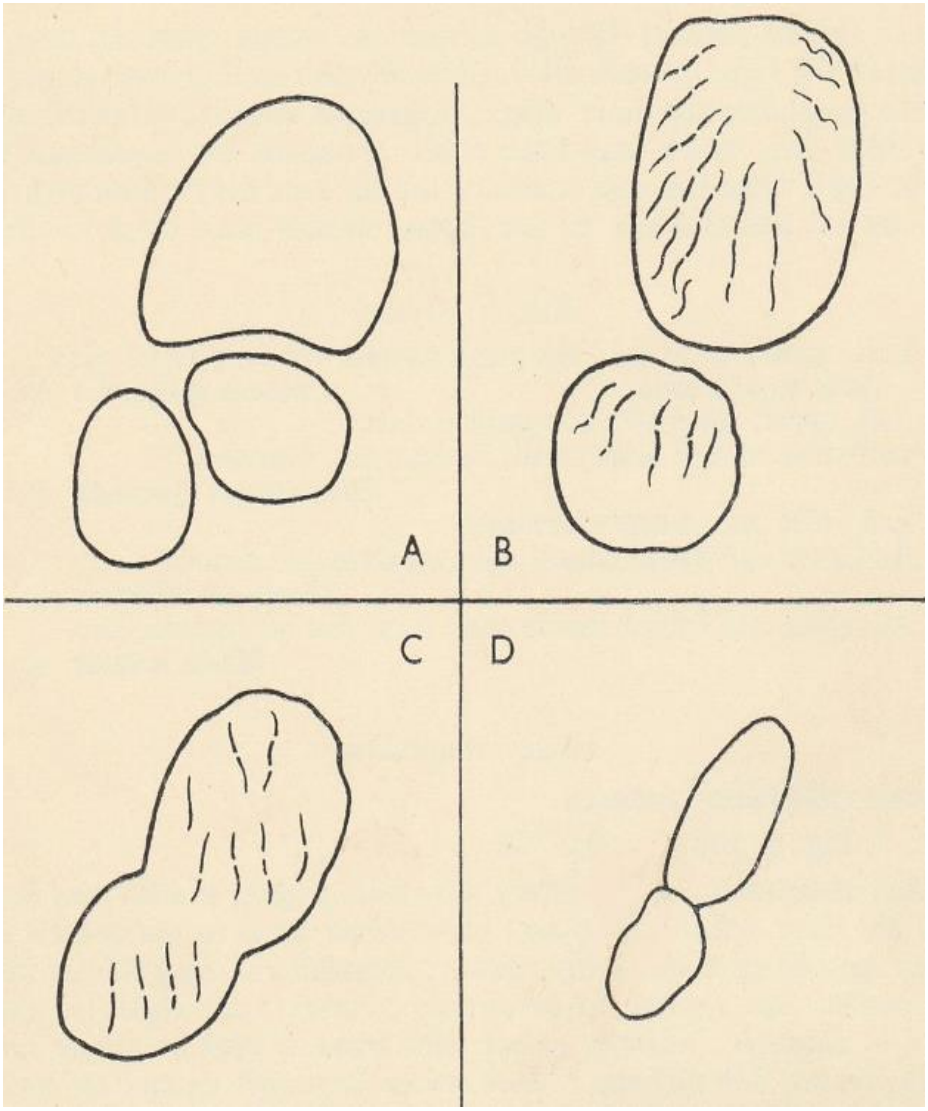


Figure 1. Muscle scars in the Anomiidae family after Tebble (1966). A) *Anomia ephippium*, B) *Pododesmus patelliformis*, C) *Pododesmus squama*, D) *Heteranomia squamula*

Material and Methods

The material for this study was collected between 1964 and 1977 from 18 stations, 10 in the Sea of Marmara and 8 in the Aegean Sea by trawlers (Fig. 2, Tab. 1).

A total of 85 *P. patelliformis* individuals, 62 from the Sea of Marmara and 23 from the Aegean Sea, were selected. Photographs were taken with a digital camera connected to a stereomicroscope and later illustrations were also carried out. After being examined and photographed in the laboratory, all the samples were taken back by Prof. Demir. Unfortunately, the materials could not be found by his family after his passing. Thus, the materials examined in the present study are not part of the Hydrobiology Collection of Department of Biology, Faculty of Science, the University of Istanbul.

Table 1. Locations and depths of sampling stations

Station	Location	Depth (m)
1	Tuzla	30
2	Kınalıada	30
3	Küçükçekmece	25
4	Ambarlı	40
5	M. Ereğlisi	25
6	İmralı	20
7	Bandırma	35
8	Erdek	55
9	Şarköy	80
10	Çanakkale	20
11	Kabatepe	70
12	Gökçeada	15
13	Bozcaada	45
14	Altınoluk	35
15	Behramkale	65
16	Foça	30
17	Çeşme	45
18	Bodrum	30

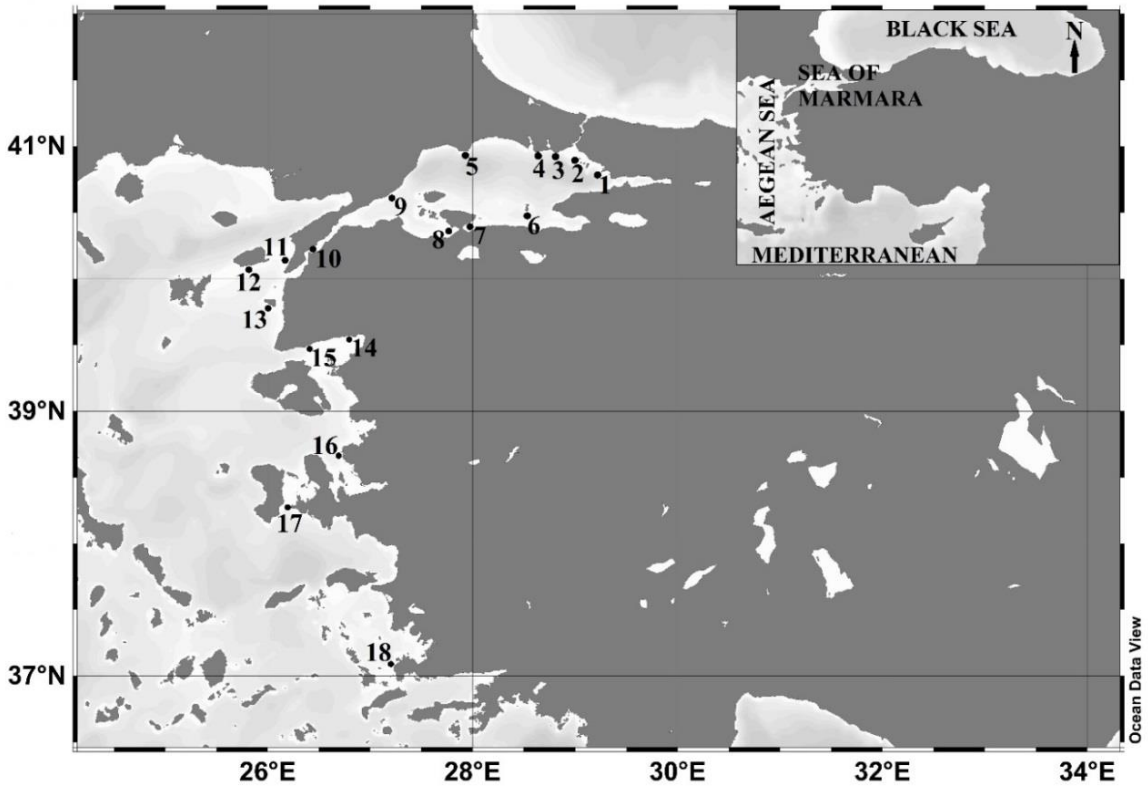


Figure 2. Sampling stations in the coasts of Marmara and Aegean Seas in Türkiye

Results

Although muscle scars are widely used as a primary character for species identification in the Anomiidae family, here we used exterior sculpture of the left valve to distinguish *P. patelliformis* from *P. squama*, both of which differ from other species in the family by having muscle scars with radiating furrows, as some variations in the muscle scar were observed in *P. patelliformis*. Based on definitions by Forbes & Hanley (1853) and Tebble (1966), individuals with approximately thirty radial ribs on the exterior surface of the left valve were identified as *P. patelliformis* (Fig. 3a), while individuals with very fine and numerous striae were identified as *P. squama* (Fig. 3b).

Six different muscle scar patterns were observed in *P. patelliformis* individuals, one of which was consistent with the literature.

Type I: Muscle scars were contiguous across their width (Fig. 4) in 19 (22,4 %) out of 85 individuals from Stations 1, 2, 3, 5, 6, 8, 9, 10, 11, 16 and 18. These individuals were found at depths of 20, 25, 30, 55, 70 and 80 meters.

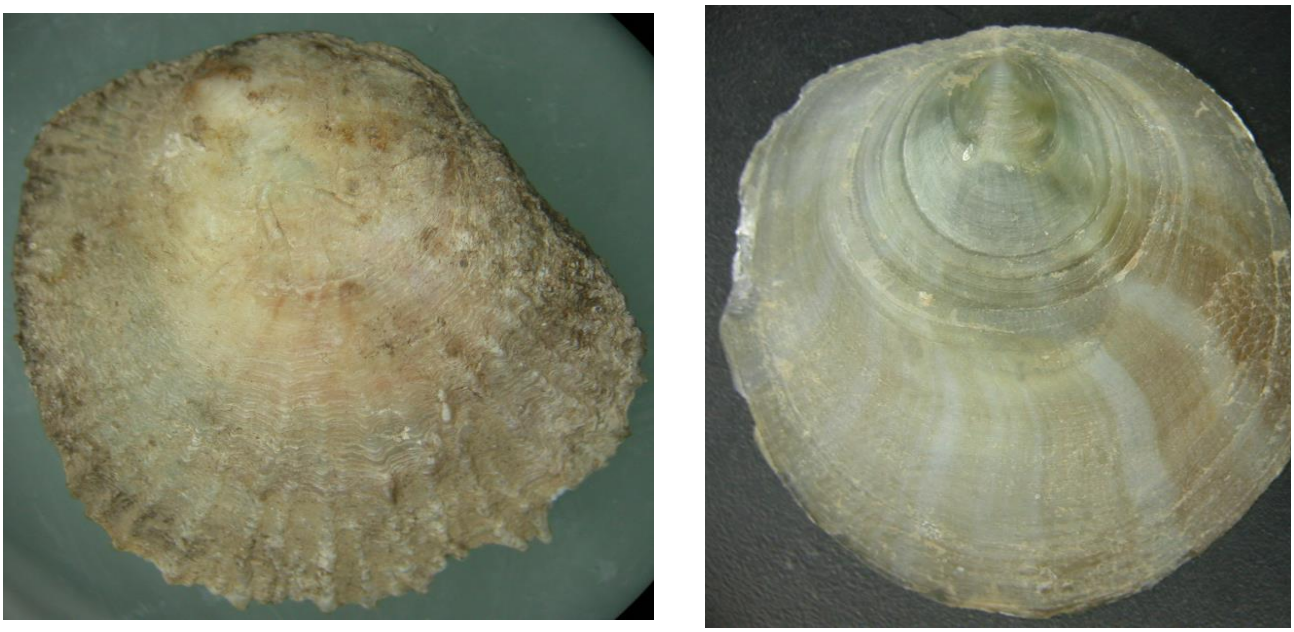
Type II: Muscle scars were adjacent to each other with a wide and short cervix (Fig. 5) in 6 individuals (7 %) from Stations 2, 6, 7, 11 and 18. This type of muscle scar is somewhat similar to *P. squama*, however, they are joined together to form one continuous scar in *P. squama*. These individuals were found at depths of 20, 30, 35 and 70 meters.

Type III: Muscle scars were connected by a narrow and short cervix (Fig. 6) in 5 individuals (5,9 %) from Stations 7 and 13. These individuals were found at depths of 35 and 45 meters.

Type IV: Muscle scars were connected by a thin and long cervix (Fig. 7) in 3 individuals (3,5 %) from Stations 8 and 12. These individuals were found at depths of 15 and 55 meters.

Type V: There was a narrow and long cervix between muscle scars, but, this cervix did not reach to upper scar (Fig. 8) in 3 individuals (3,5 %) from Stations 6 and 11. These individuals were found at depths of 20 and 70 meters.

Type VI: Muscle scars were clearly separated from each other (Fig. 9) just as described in the general literature in 49 individuals (57,7 %) from Stations 1, 2, 3, 4, 6, 7, 8, 9, 12, 14, 15, 17 and 18. These individuals were found at depths of 15, 20, 25, 30, 35, 40, 45, 55, 65 and 80 meters.



a b

Figure 3. Exterior surfaces of a) *Pododesmus patelliformis*, b) *Pododesmus squama*

Figure 4. Photograph and illustration of muscle scars belonging to type I

Figure 5. Photograph and illustration of muscle scars belonging to type II

Figure 6. Photograph and illustration of muscle scars belonging to type III

Figure 7. Photograph and illustration of muscle scars belonging to type IV

Figure 8. Photograph and illustration of muscle scars belonging to type V

Figure 9. Photograph and illustration of muscle scars belonging to type VI

Discussion

The shape and number of muscle scars in Anomiid species have either not been mentioned or inadequately defined in earlier works (Bucquoy et al., 1887-1898; Carus, 1889-1893; Forbes & Hanley, 1853; Locard, 1892). The byssal and adductor muscle scars of *Pododesmus patelliformis* were described in the literature as distinctly separated from each other which serves as a key descriptive character (Nordsieck, 1969; Poppe & Goto, 1993; Tebble, 1966). Contrary to this general pattern, Parenzan (1974) illustrated a muscle scar type with adjacent scars and HABITAS (online) provided photograph of another type with connected muscle scars.

This study identifies six different muscle scar patterns of *P. patelliformis*. These patterns can be grouped into three categories: adjacent, connected and separated.

Of the 85 specimens examined, 25 specimens (29,4 %), corresponding to type I and type II in this study, had adjacent muscle scars. *Isomonia alberti* and *Heteranomia squamula* also exhibit adjacent byssal and adductor muscle scars. However, *I. alberti* can be easily distinguished from other Anomiid species by its dorsal margin with auricles similar to those of Pectinidae family (Cox et al., 1969) and *H. squamula* can be distinguished from *P. patelliformis* by the absence of radiating furrows on the scars (Tebble, 1966). Additionally, the diameters of the examined *P. patelliformis* specimens exceeded 19 mm while *H. squamula* reaches only up to 12,7 mm in diameter (Nordsieck, 1969).

Eight specimens (9,4 %), corresponding to type III and type IV in this study, had connected muscle scars. *Pododesmus squama* within the Anomiidae family also has joined and furrowed muscle scars (Poppe & Goto, 1993; Tebble, 1966). However, the exterior of left valve of *P. squama* is sculptured with very fine and numerous striae countable only under a microscope whereas *P. patelliformis* has approximately thirty radiating ribs countable with the naked eye (Bucquoy et al., 1887-1898; Forbes & Hanley, 1853; Tebble, 1966). Left valve sculpture proved that all of the examined 85 specimens belonged to *P. patelliformis*.

Muscle scars were separated from each other in 52 specimens (61,2 %), corresponding to the type V and type VI in this study. Although type VI matched the general literature description, a residue of cervix was present in type V.

Specimens with type I muscle scars were found in 11 stations at depths of 20-80 m, whereas those with type II muscle scars were found in 5 stations at depths of 20-70 m, type III in 2 stations at depths of 35-45 m, type IV in 2 stations at depths of 15-55 m, type V in 2 stations at depths of 20-70 m and type VI in 13 stations at depths of 15-80 m. As seen, specimens with different types of muscle scars were not confined to a narrow depth range. Moreover, specimens with various muscle scar types were found in the same stations. Station 6 hosted four different types: I, II, V and VI; Station 11 hosted three different types: I, II, V; Stations 2 and 18 hosted three different types: I, II and VI ; Station 7 hosted three different types: II, III and VI; Station 8 hosted three different types: I, IV and VI; Stations 1, 3 and 9 hosted two different types: I and VI; Station 12 hosted two different types: IV and VI. These findings indicated that muscle scars did not vary depending on depth. We were unable to comment on the effects of other environmental factors due to the lack of data. However, it is likely that differential gene expression patterns due to intraspecific genetic variations and/or epigenetic modifications may have caused the different types of muscle scars.

In conclusion, the shape of muscle scars did not conform the literature in about 39 % of the examined specimens. The study identified different patterns, beginning with adjacent, continuing with connected by different cervix types and finally becoming separated. It is advised that other diagnostic features, in addition to muscle scars, should be carefully examined when identifying Anomiid species.

Acknowledgements

We commemorate Prof.Dr. Muzaffer Demir with deep gratitude for his invaluable contributions to the marine biology research in Türkiye and extend our heartfelt thanks to him for providing the samples used in this study.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Author Contributions

Serhat Albayrak and Senem Çağlar have planned and designed this study and contributed to the preparation of the final manuscript.

Ethics Approval

No ethics committee approval is required for this study that involves post hoc examination of bivalve shells collected in earlier studies between 1964-1977.

References

Albayrak, S. 2011. *The Marine Bivalvia (Mollusca) of Turkey*. İstanbul Üniversitesi Press, Yayın No: 5030, İstanbul. ISBN: 978-975-404-905-3.

Bucquoy, E., Dautzenberg, P., & Dollfus, G. (1887-1898). *Les mollusques marins du Roussillon. Tome II, Pelecypodes.* J.-B. Bailliere et Fils. Paris.

Carus, J.V. (1889-1893). *Prodromus faunae Mediterraneae. Vol. II, Brachiostomata, Mollusca, Tunicata, Vertebrata*. E. Schweizerbart'sche Verlagshandlung. Stuttgart.

MolluscaBase eds. (2024). *MolluscaBase. Anomiidae Rafinesque, 1815*. European Register of Marine Species, Costello, M.J.; Bouchet, P.; Boxshall, G.; Arvanitidis, C.; Appeltans, W. (2024). Accessed on: 2024-02-20, http://www.marbef.org/data/aphia.php?p=taxdetails &id=214

Cox, L.R., Newell, N.D., Branson, C.C., Casey, R., Chavan, A., Coogan, A.H., Dechaseaux, C., Fleming, C.A., Haas, F., Hertlein, L.G., Keen, A.M., LaRocque, A., McAlester, A.L., Perkins, B.F., Puri, H.S., Smith, L.A., Soot-Ryen, T., Stenzel, H.B., Turner, R.D., & Weir, J. (1969). Treatise on invertebrate paleontology. Part N, Vol.1-2, Mollusca 6, Bivalvia. In: Moore, R.C. (Ed.), *Systematic descriptions*. Geological Society of America, Boulder & University of Kansas, Lawrence: N225-N907.

Forbes, E., & Hanley, S. (1853). *A history of British Mollusca, and their shells*. *Vol. II*. Samuel Bentley and Co. Bangor House, Shoe Lane, London.

HABITAS (The Web Site of the Ulster Museum Sciences Division). Accessed on: 11 January 2024, http://www.habitas.org.uk/marinelife/photo.asp?item=5279d.

Locard, A. (1892). *Les coquilles marines des cotes de France*. Librairie J.-B. Bailliere et Fils. Paris.

Nordsieck, F. (1969). *Die europaischen meeresmuscheln (Bivalvia)*. Gustav Fischer Verlag. Stuttgart.

Parenzan, P. (1974). *Carta d'identita delle conchiglie del Mediterraneo. Vol. II, Bivalvi.* Prima Parte. Ed. Bios Taras, Taranto.

Poppe, G.T., Goto, Y. (1993). *European seashells. Vol. II, (Scaphopoda, Bivalvia, Cephalopoda)*. Verlag Christa Hemmen. Wiesbaden.

Tebble, N. (1966). *British bivalve seashells*. Trustees of the British Museum (Natural History), London.

Uysal, Z., Latif, M.A., Özsoy, E., Tuğrul, S., Kubilay, N., Beşiktepe, Ş.T., Yemenicioğlu, S., Mutlu, E., Ediger, D., Beşiktepe, Ş., Ediger, V., Örek, Y.A., Örek, H., Demirel, M., Tunç, Ş.Ç., & Terbıyık, T. (2008). *Kilikya Baseni Kıyısal Ekosisteminde Dolaşım, Taşınım ve Ötrofikasyon Araştırmaları*. The Scientific and Technical Research Council of Turkey (TÜBİTAK) 104Y277 p. 523.

WoRMS Editorial Board (2024). *World Register of Marine Species*. Available from https://www.marinespecies.org at VLIZ. Accessed on: 2024-05-02. doi:10.14284/170