Anatomical respiratory organ of *Solen* sp

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Abstract. Respiratory organs are important to investigate in *Solen* sp. due to the fact that literacy is hard to find beside unclear data information. Excellent knowledge of the respiratory organs in biota has become one of the impact factors for knowing its potential in adaptability and ecology. This study aimed to describe the anatomical respiratory organ by analyzing *Solen* sp. in the Madura Strait, which applied morphological and histological analysis at the Laboratory of Molecular Biology at the State University of Surabaya. The environmental parameters (temperature, pH, salinity, and substrate) and sample of *Solen* sp. was measured and collected around the Modung district, Bangkalan regency during July – August, 2023. The results showed conditions are within the range of environmental parameters and are reasonable and appropriate for the environment. The shape and structure of the respiratory organs *Solen* sp. described the shape of the folds with a fresh red color, as are generally of the normal and health gills. The relationship between environmental parameters and anatomical organ of *Solen* sp. should be concerning for the future research to protect *Solen* sp. from the overfishing.

1 Introduction

Bivalve is the second-most dominant class in the phylum Mollusc (1). Due to the industry's high degree of interest in this particular category of shellfish as well as their notable morphological deviations from conventionally accepted species, razor clams (Solen sp.) have been specifically chosen for this study. Razor clams, sometimes known as razor shells, are bivalve mollusks that belong to the Solenidae family (2). The shells in this category were given that name because they resemble the classic cutthroat razor used by barbers. They feature an extended rectangular shape, with a length that is roughly four to five times greater than a width. The three species of Ensis siliqua, E. arcuatus, and E. ensis are those that are currently of commercial importance. The E. siliqua and E. arcuatus species were the focus of these trials, with the former being the species having the greatest commercial interest in England.

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Razor clams can be found in all waters surrounding the British Isles where there is a suitable substrate of fine to medium sand. They live in the low intertidal zone down to depths of 40 meters. They breathe through projecting short, fused siphons that are employed for foraging at the top of their deep, vertical burrows. The employment of a muscular foot helps with burrowing, and it has also been seen to allow for some horizontal mobility of the animal down the seafloor through lateral "flicking" movements. The burrows themselves may be up to 1 meter in depth. The ecology of razor clams, especially *Solen* sp., has a specific character. The anatomy of Solenoidea was felt to be interesting to study since it is hard to find information about some species. *Solen* sp. have specialized bodies in which the body has a long shell and a big muscular foot, which are different from bivalve molluscs (3,4). The respiratory organ of *Solen* sp. as a filter-feeding organism must be in direct contact with an abiotic factor or environment parameters. The changes in environment (i.e. heavy metal (cadmium and other) will have effects on biotic factors, such as microanatomy of the filament tissue of gills (5). The objective of these study is to investigate the condition of the anatomical respiratory of Solen sp. around the Modung coastal area at the Bangkalan Regency (**Fig. 1**)

2 Materials and methods

Samples of *Solen* sp. were collected from Modung district (Bangkalan, Madura Island), as shown in **Figure 1**, in July and August 2023. Here, we are using histological and morphological analysis, histological analysis used histopathology procedures in the Laboratory of Molecular Biology at the State University of Surabaya and continued to microscope the Olympus CX31 Camera DP21. Morphological analysis has been done in the Biological Laboratory, University of Trunojoyo, Madura. Surface water and sediment were sampled at the same time using physics parameters supported to explain the relationship between biotic and abiotic factors. Temperature, pH, salinity, and substrate have been measured. Water sampling uses seawater and a grab sampler. Sediment substrate are analyzed to estimate the grain size used the granulometric method (6, 7). Grain size separation was carried out. with sieves sized: >2; 1.4; 1; 0.5; 0.250; 0.150; 0.090; 0.063; and <0.063mm. Grain size classification is done by classification (8). Type determination sediment based on classification Shepard's Triangle Diagram (9).

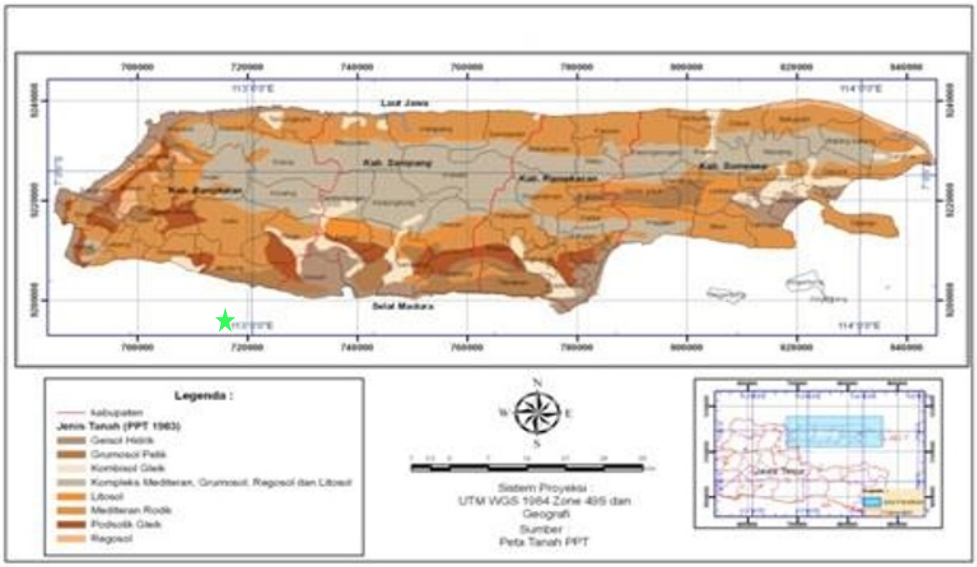

Fig 1. Research Location (green star)

3 Result and Discuss

In contrast to the Ensis genus, the Solenoidea family is primarily tropical and subtropical and is primarily found in the Indo-Pacific area. Organisms in the Solenidae family are long and compressed laterally. The shell of this bivalve is made up of three layers, stacked one on top of the other, with the mantle acting as a separator between the layers. A diagonal line can be seen dividing the outermost layer, or "periostracum," into two distinct areas: the dorsal, with horizontal lines, and ventral, with vertical lines. The "prismatic layer," calcimed with a matte color, and the "nacreous layer," calcimed but shiny, are also present (2). The results of the morphology analysis were shown in Figure 2 as a compact and full organ distribution.
On either side of the soft portions is a region known as the pallial cavity. The internal mantle epithelium serves as its boundary, while the siphons serve as its means of connection with the outer world. The area of the pallial cavity where the gills are found is known as the gill chamber. On either side of the gill chamber, Solenidae have two gill lamellae (inner and outer). The inhalant siphon allows particles to enter, which are then selected by gills and transported to the labial palps, where they are further selected and transferred to the mouth. Behind the gills are two sets of labial palps, one on each side of the foot base. They have a triangle shape with a smooth and a rough surface. The smooth sides of each pair face away from one another, whereas the rough surfaces are opposite one another. Selected particles in suspension pass via the oral groove formed at the base of the labial palps to reach the mouth.

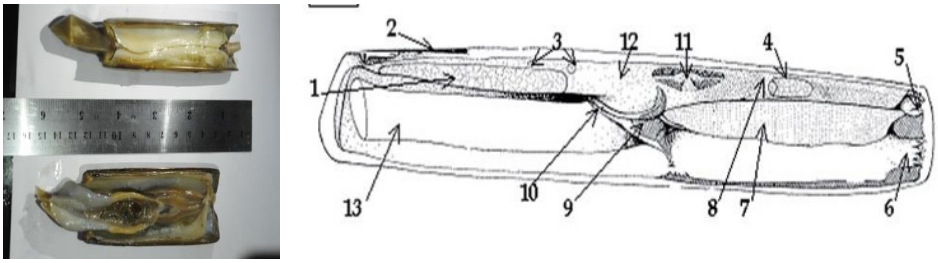

Fig 2. Diagram of organ distribution. 1: Anterior adductor muscle; 2: Ligament; 3: Anterior retractor muscle of the foot; 4: Posterior adductor muscle; 5: Exhalant siphon; 6: Inhalant siphon; 7: **Gills**; 8: Posterior retractor muscle of the foot; 9: Labial palps; 10: Mouth; 11: Heart; 12:Digestive gland; 13: Foot.

Histology analysis showed that the gills of *Solen sp.* lived in Bangkalan, Madura, in good categories. Based on **Fig. 3**, which compares with *Ensis arcuatus* (2), *Solen sp. is* in good arrangement in organ tissue. Five levels of gill distribution, such as edema, hyperplacya, fusion of lamela, hyperplacya in secunder lamella, and necrosis-atropy of the filament of gills, disappeared in this investigation. There are different types of Ensis *arcuatus* and *Solen* sp. *E. arcuatus has an* oval-type tissue organ, and *Solen* sp. shows a little square and is sharp (**Fig. 3**).

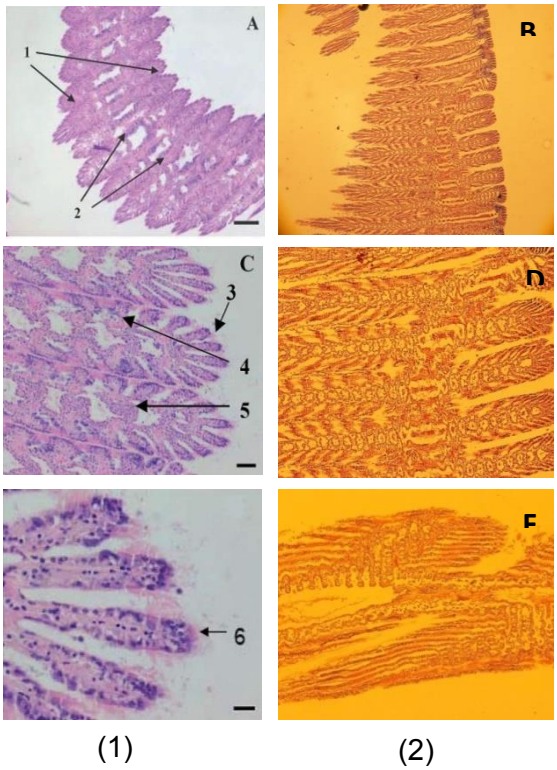

Fig 3. Histological section of *E. arcuatus* gills (1) (Darriba, 2011) and *Solen* sp gills (2). B, A1, A2 Pleated lamellae, interlamellar tisue bridges; D=C3 Lamellar folds consisting of ordinary filaments (in the main filaments), C4 crests, C5 interfilamellar bridges, E6 Detail of ordinary filaments with ciliated cells. (400x)

The environmental parameters (temperature, salinity, pH, and substrate) had an impact on organisms, such as *Solen* sp. Temperature manages the changing of the form of the environment, the solubility of natural substances and pollutants, the stability of contaminants, and the metabolism of organisms (11). On the other hand, acidity degree (pH) describes the degree of acidity and base in sea water. pH = 7 showed a negative condition; water pH < 7 showed an acidic condition; and water pH > 7 showed a base condition (12). Substrate as habitat for some marine organisms is important to protect from other pollutant or dangerous material attacks (13). The investigation showed that the environmental parameters in Modung district, Madura, were at a good level for *Solen* sp. (**Table 1**) (14).

Table 1. Physical Parameters in Modung district, Bangkalan – Madura in 2023.

Time	Weeks	Temperature (°C)	Salinity (ppt)	pH	Substrate
July 2023	1	29	33	8.0	Muddy Sand
	2	29	32	8.1	
	3	30	33	8.0	
	4	30	32	8.0	
August 2023	1	30	32	8.0	
	2	29	32	8.1	
	3	28	33	8.1	
	4	28	32	8.1	

4 Conclusion

In summary, the range of environmental parameters and conditions is reasonable and appropriate for the environment of *Solen* sp. (temperature 28–30 °C, pH 8.0–8.1, salinity 32–33 ppt). The anatomical respiratory organs of *Solen* sp. shows the shape of the folds with a fresh red color, as are generally the gills on water biota. According to the in-situ measurement, the condition is quite good (14). We highly suggest to analysis the relationship between the environmental parameters and the anatomical organ of *Solen* sp. as the preliminary result to assess the possibilities of heavy metal concentration (both in the environmental and *Solen* sp.).

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