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The population of *Solen* sp. (Bivalvia: Solenidae) from Pamekasan, Indonesia

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ABSTRACT

Solen is one of the genera found in the Solenidae. In Indonesia, as in other Southeast Asian countries, *Solen* species are widely used by local communities, both for consumption and trade. The coastal water of Madura Island and the Northern shores of East Java are well known as the centre of biodiversity of *Solen*. *Solen* from Pamekasan, which is located at the southern shores of Madura, reveals some differences compared than other *Solen* found in East Java. This research is aimed to describe the population structure of *Solen* from Pamekasan, Indonesia. The samples were collected from two research stations in Pamekasan, namely Candi Polagan and Kotasek and one of research station located out of Pamekasan, namely Kenjeran. In each research station, the samples were collected from ten samplings quadrant sized 1x1 m. The samples were preserved in 70% alcohol. The density of the population was examined and the morphometric parameters of the shell were measured using a caliper. The results showed that the population density of *Solen* in Candi Polagan was 15.4 idv/m^2, while the population density of *Solen* in Kotasek was 13.2 idv/m^2. This population density decreased compared to previous year. The most abundant group size in Candi Polagan was 15-25 mm, while the most abundant group size in Kotasek was 31-35 mm. *Solen* from Pamekasan was significantly smaller than other *Solen* reported from Indonesia. The average length of the shell from Candi Polagan was 12.20-36.35 (21.64±4.057) mm, meanwhile the average length of the shell from Candi Polagan was 12.20-36.35 (21.64±4.057) mm. Hence, further detailed study on this taxon is urgently needed.

Key words: *Population structure, Bivalves, Solen, Madura Island*

Introduction

The genus *Solen* has characteristics: elongated shells, shaped like a knife, very equivalvis, thin shells, thin periostracum, umbo terminal, prosogyrate, opisthodetic ligament, short palial sinus (Linnaeus, 1758; Willan, 1998, Lamprell and Healy, 1998; Huber, 2010) The anterior and posterior margins of the shell, the shell pattern, the palial sinus shape, the adherence of the posterior and anterior adductor muscles, the periostracum and the color of the shell become distinct species (Lamprell and Healy, 1998; Huber, 2010). Anatomy of *Solen*, for example the anterior palial tentacle is also an important feature because it is only owned by certain species (Morton, 1998; Cosel, 2002; Saeedi *et al.,* 2013).

In Southeast Asia, *Solen* species are found in several locations, for example in Vietnam, namely *Solen sloani, S. thaci, Solen vagina* (Thanch, 2005); in Thailand found *Solen curtus, Solen correctus, Solen timorensis* (Swennen *et al.,* 2001; Sanpanich, 2011). In Malaysia found *Solen Sarawakensis* and *Solen*

regularis. In Singapore, *Solen brevissimus, Solen delesserti, Solen linearis, Solen pseudolinearis* (Tan and Low, 2011), *Solen brevis* (Morris and Purchon, 1981; Tan *et al.,* 2011) were found. According to Cosel (2002) the Indo-Pacific region is the center of biodiversity of Solenidae.

In Indonesia, as in other Southeast Asian countries (Poutiers, 1998), *Solen* species are widely used by local communities, both for consumption and trade (Trisyani, 2017; Wahyurini and Zahro, 2017; Trisyani, 2018). In the western region of Java, *Solen* shells are known as knife shells (Subiyanto *et al.* 2013), in East Java, known as bamboo shells or lorjuk (Trisyani and Irawan, 2008; Trisyani and Hadimarta, 2013; Abida *et al.,* 2014; Wahyurini and Zahro, 2017) in the South Kalimantan region known as kerang pisau. In the eastern region of Indonesia, namely in Merauke, the *Solen* species is known as kerang mumu.

Although it is widely used by the community, there is no exact record of the *Solen* species in Indonesia. Cosel (2002) also states that the genus *Solen* is not widely known and tends to be ignored. Dharma (2005) who described molluscs in Indonesia, only reported one *Solen* species, namely *Solen truncata*. Some local publications mention the existence of the *Solen* species. Trisyani *et al.,* (2016) reported the existence of *Solen regularis* on the East Coast of Surabaya. Arbi (2016) reports the existence of *Solen grandis* in Lamong Bay, East Java. Some publications also noted the existence of *Solen* species on the coast of Madura Island, for example Wahyuni *et al.,* (2016); Wahyuni, Insafitri *et al.,* (2017) who reported the existence of *Solen* species in several coastal Madura, for example Bangkalan, Sampang, Pamekasan, and Sumenep. Ahyar *et al.,* (2017) reported *Solen lamarckii* from the Madura Strait waters. Several publications revealed that the waters of the eastern part of Java Island and Madura Island have high biodiversity of *Solen*.

Pamekasan is well known as the center of *Solen* biodiversity in Madura Island. The *Solen* comes from this region is smaller compared to another *Solen* from East Java. However, the consistence of the size among the population needs to be reviewed. Trisyani *et al.* (2016) tested the *Solen's* relationship found on the East Coast of Surabaya and Pamekasan Beach based on the CO1 gene and found that the two *Solen* were closely related and were *Solen regularis*. However, there were no morphological and anatomical records of the samples tested. This research is aimed to to describe the population structure of *Solen* from Pamekasan, Indonesia.

Materials and Methods

The samples were collected from two research stations in Pamekasan, namely Candi Polagan (S7°23.307′ E112°50.513′) and Kotasek (S7°23.307′ E112°50.513′) and one of research station located out of Pamekasan, namely Kenjeran (S7°22.521′ E112°78.817′), which is located at the eastern coast of Surabaya (Fig. 1).

In each research station, the samples were collected from ten samplings quadrant sized 1x1 m by digging the substrate using cowbar. The samples were preserved in 70% alcohol for species identification and morphometric analysis. The density of the population was examined. The sampling in two research stations of Pamekasan were conducted in September 2018 and August 2019, meanwhile the sampling in Kenjeran was carried out in August 2019.

The morphometric parameters of the shells were measured using a caliper. Shell length (SL) was defined as the perpendicular distance between the anterior and posterior ends of the shells. Shell height (SH) was measured from the highest part of the dorsal side to the lowest part of the ventral side of the shells. Shell width (SW) was defined as the distance between the most prominant parts of the lateral side of the two shells.

The data of population density and morphometric parameters were analyzed descriptive quantitatively.

Fig. 1. Research stations; A: Candi Polagan; B: Kotasek; C: Kenjeran

Results and Discussion

The population density of *Solen* sp. in Pamekasan was about 9-26 individual/m^2. This population density tends to decrease during 2018 to 2019. The population of Solen in Candi Polagan was denser than the population of Solen in Kotasek. The average population density of the former was 15.4 individual/m^2, while the population density of the latter was 13.2 individual/m^2. However, the density of these two locations was higher than the density of Solen in Kenjeran, Surabaya (Table 1).

Table 1. Population density of *Solen* sp.

Year	Research Station	Population Density (Individual/m^2)	
		Range	Average
2018	Candi Polagan	11-21	16.1
	Kotasek	15-26	19.3
2019	Candi Polagan	10-24	15.4
	Kotasek	9-17	13.2
	Kenjeran	1-10	2.6

Table 2. Morphometry of *Solen* sp. from Pamekasan, Madura

Parameter of Morphometry	2018	2019
Research Station: Kotasek		
Number (n)	184	120
Shell Length (mm)	17.95-38.15 (28.11±4.26)	15.15-38.65 (29.28±5.06)
Shell Width (mm)	2.25-6.45 (4.39±0.74)	1.90-6.35 (4.41±0.92)
Shell Height (mm)	3.90-8.30 (6.10±0.82)	3.85-8.00 (6.53±0.97)
SL : SH Ratio	4.6:1	4.5:1
Research Station: Candi Polagan		
Number (n)	152	144
Shell Length (mm)	15.35-38.70 (25.75±3.67)	12.20-36.35 (21.64±4.057)
Shell Width (mm)	1.85-6.55 (3.99±0.73)	1.40-5.65 (3.21±0.81)
Shell Height (mm)	2.75-18.00 (5.98±1.82)	3.15-9.85 (5.06±0.89)
SL : SH Ratio	4.3:1	4.3:1
Research Station: Kenjeran		
Number (n)		26
Shell Length (mm)		15.00-49.55 (29.29±9.45)
Shell Width (mm)		2.00-7.75 (4.43±1.56)
Shell Height (mm)		3.00-10.65 (6.29±4.43)
SL : SH Ratio		4.7:1

The population density of *Solen* sp. in Pamekasan recorded in this study was lower than previous report. Wahyuni *et al.,* (2016) reported that the density of *Solen* sp in Shorthen coast of Bangkalan, Madura ranged 8-10 individual/cm^2. The same condition was also applicable to the population of *Solen* in Kenjeran, which is located at the east coast of Surabaya. This study found that in situ sampling in August 2019 revealed that the population density of *Solen* sp. in this area was 1-10 individual/m^2. Meanwhile, the previous study about *Solen vaginalis* in East Coast of Surabaya found that the population density of this bivalve ranged from 10-104 individual/m^2 (Trisyani and Irawan, 2008). Some factors can affect the decrease of the population of *Solen*, for example the sampling period. Although according to Trisyani and Irawan (2008), during August up to September, the population density of *Solen* was high. Another factor that can influence the population of *Solen* was the fishing activities of this bivalve. This bivalve has been collected regularly by local communities as reported by some studies (Haryatik *et al.,* 2013; Trisyani, 2017; Trisyani *et al.,* 2016;

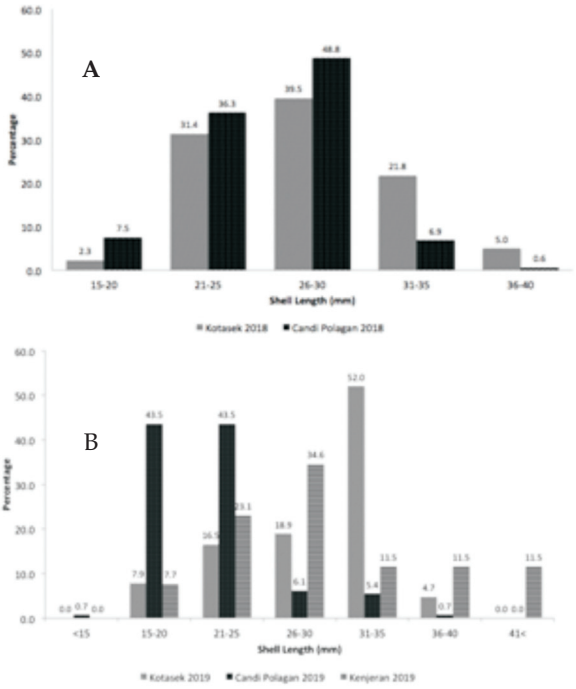

Fig. 2. **A:** Population structure of *Solen sp.* in two locations in Pamekasan (September 2018); **B:** Population structure of *Solen sp.* in two locations in Pamekasan and Kenjeran, Surabaya (August 2019)locations in Pamekasan and Kenjeran, Surabaya (August 2019)

Trisyani and Irawan, 2008; Wahyurini and Zahro, 2017).

The population of *Solen* in Candi Polagan dan Kotasek revealed similar pattern. Medium group size dominated the population in these areas, meanwhile the population of Solen in Kenjeran was dominated by larger group size (Fig. 2). In 2018, the most abundant group size of *Solen* was 21-25 and 26-30 mm. In 2019, the smaller *Solen* tended to dominate the population, although the most abundant was 21-25 mm (Fig.2B)

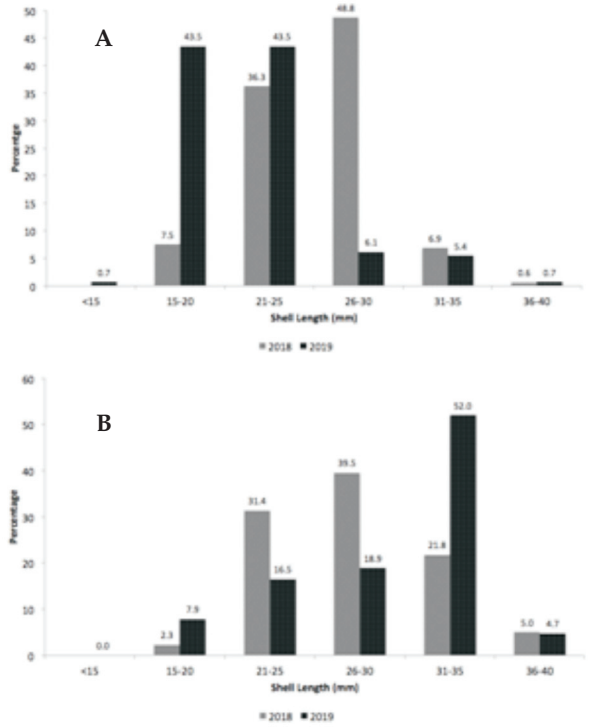

Fig. 3.A: Population structure of *Solensp.* in Candi Polagan, Pamekasan; **B:** Population structure of *Solen* sp. in Kotasek, Pamekasan.

Middle size group dominated the population structure of *Solen* in Candi Polagan, Madura. In 2018, the most abundant shell was 26-30 mm, while in 2019 the group size of 15-20 and 21-25 mm was the most abundant shell (Fig. 3). On the other hand, the population of *Solen* in Kotasek had quite different pattern. In 2018, the dominant group size was 26-30 mm, while in 2019, the most dominant group was 31-35 mm (Fig. 4). Hence, the shell of *Solen* found in Kotasek was relatively bigger than the ones found in Candi Polagan. The substrate of these locations were similar, they were muddy sand. Local communities of these beaches also have been collecting these shells regularly.

Solen collected from coastal waters of Candi Polagan and Kotasek were smaller than the *Solen* collected from Kenjeran, Surabaya (Table 2, Fig.4). The average length of the shell from Candi Polagan was 12.20-36.35 (21.64±4.057) mm, meanwhile the average length of the shell from Kotasek was 12.20-36.35 (21.64±4.057) mm (Table 2).

Generally, *Solen* from Pamekasan was smaller than the ones collected from Kenjeran. Previous study also reported that *Solen* from Pamekasan was smaller than other *Solen* found in this region. Abida *et al.* (2014) stated that *Solen* from Pamekasan was samller that other *Solen*. In addition, some references such as (Cosel, 2002; Huber, 2010; Lamprell and Healy, 1998) mentioned that the member of *Solen* genera have elongate shape, the length of the shell more than 50 mm and can reach more than 100 mm. This convinced us that the *Solen* from Pamekasan belonged to different species from *Solen*. However, Trisyani (2018) argued that the fishing technique and environmental factors affecting the size of *Solen* s. in Indonesian coast.

Solen collected from Pamekasan was also had different pattern. The posterior end of *Solen* from Madura was truncate, while the posterior end of *Solen* from Kenjeran was straight. This pattern was consistent among small, middle, and large group size. In addition, the pattern of pallial line and pallial sinus of *Solen* from Pamekasan and Solen from Kenjeran were different. Hence, they could be belonging to different species.

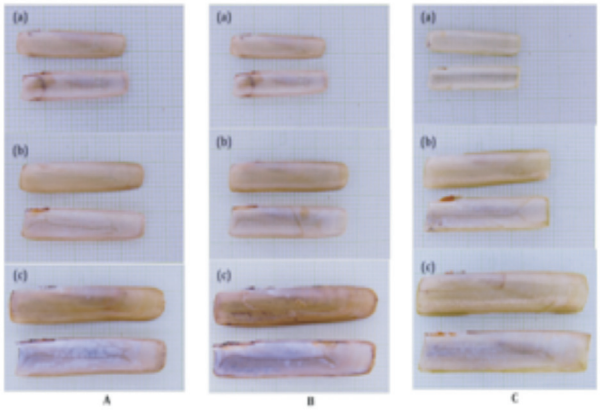

Fig. 4. The shell of *Solen* spp. collected from Pamekasan and Kenjeran, Surabaya; A: Solen collected from Candi Polagan, Pamekasan, B: Solen collected from Kotasek, Pamekasan; C: Solen collected from Kenjeran Surabaya.

Conclusion

The population density of *Solen* in Candi Polagan was 15.4 idv/m^2, while the population density of Solen in Kotasek was 13.2 idv/m^2. This population density decreased compare to previous year. The most abundant group size in Candi Polagan was 15-25 mm, while the most abundant group size in Kotasek was 31-35 mm. *Solen* from Pamekasan was significantly smaller than other *Solen* reported from Indonesia. The average length of the shell from Candi Polagan was 12.20-36.35 (21.64±4.057) mm, meanwhile the average length of the shell from Kotasek was 12.20-36.35 (21.64±4.057) mm. Hence, further detail study on this taxon is urgently needed.

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