Ecobiology of gonggong conch *Laevistrombus turturella* in Madong Bay, Tanjungpinang for culture effort

[1,3]Muzahar, [2]Ani Suryanti, [3,4]Lily Viruly

[1] Department of Aquaculture, Faculty of Marine Sciences and Fisheries, Raja Ali Haji Maritime University, Riau Islands, Indonesia; [2] Faculty of Marine Science and Fisheries, Jenderal Soedirman University, Purwokerto, Indonesia; [3] Environmental Science Department, Faculty of Marine Sciences and Fisheries, Raja Ali Haji Maritime University, Riau Islands, Indonesia; [4] Department of Fisheries Product Technology, Faculty of Marine Sciences and Fisheries, Raja Ali Haji Maritime University, Riau Islands, Indonesia. Corresponding author: Muzahar, muzahar@umrah.ac.id

Abstract. Intensive exploitation of gonggong conch *Laevistrombus turturella* to meet market demand threatens the sustainability of these conchs. Cultivation efforts need to be made to protect the population in nature. Information on the gonggong conch ecobiology is still limited. This study aims to analyze the type of substrate, organic matter content, inorganic substrate and water from the gonggong conch habitat and its reproductive biology aspects for cultivation efforts. The substrate was analyzed by the Rifardi method and Wenthwort criteria. Water quality was measured according to SNI No. 06-2412 and laboratory manuals. Reproductive biology studied aspects were the sex ratio and maturity index of the gonggong conch gonads. The results showed: 1) the types of substrate habitat for the gonggong conch are sandy mud and muddy sand, 2) macrobentos which is commonly found is polychaeta, 3) the phytoplankton generally is Bacillariophycea especially *Chaetoceros* sp., *Thalassiothrix* sp., and zoooplankton from Crustaceans, especially *Nauplius* sp., *Neocalanus* sp. and Cilliata, (*Leprotintinnus* sp. and *Tintinnopsis* sp.), 4) the levels of organic and inorganic substances in the substrate and water vary and are still in the appropriate category for marine biota, 5) the sex ratio between male and female gonggong conch is 0.61:0.39, 6) gonado somatic index (GSI) conchs are 15.44-16.72. The data and information obtained from this research can be used as a reference to start cultivating gonggong conchs.
Key Words: conch, ecology, GSI, reproductive biology, substrate type.

Introduction. The type of sea conch that is most favored by the people of Tanjungpinang City, Riau Islands Province (Kepri) because its delicious taste and high protein content of around 38.91-46.65% is the gonggong conch *Laevistrombus turturella* (Muzahar & Viruly 2013). The gonggong conch is an icon of Tanjungpinang City. There are five morphological variations of the gonggong conch that live in the Madong Bay, Tanjungpinang (Muzahar et al 2018). As the population of Tanjungpinang City increased from 233,896 people in 2023 to 237,580 people in 2024 (BPS Kota Tanjungpinang 2024), the demand for gonggong conch is estimated to continue to increase. The increase in demand for gonggong conch encourages intensive exploitation so that their stock in the wild is expected to shrink. Gonggong conch catchers complain about the decrease in the number and size of the conchs that are caught (Muzahar & Hakim 2018).

Knowledge of the ecological and reproductive biology aspects of the gonggong conch determines the success of its cultivation efforts. These aspects can be manipulated for gonggong conch rearing in a culture environment. The quality and quantity of water affect the reproductive activity of aquatic biota. The needs for water quality and the basic substrate required by each aquatic biota are different. The provision of quality cultivation media is the result of a combination of physico-chemical and biological parameters that support optimal life for cultivated biota, including gonggong conch. Information on the use of plankton communities as biological indicators related to water quality in aquaculture systems, especially in marine environments is still limited (Widigdo & Wardiatno 2013).

The *Strombus canarium* conch (the closest relative of the gonggong conch) feeds on algae, plankton, detritus and seagrass (Nasution 2011). *S. canarium* conchs are dioceus because they have separate genitals between male and female individuals. Male *S. canarium* have a penis and females have oviducts (Cob et al 2008a). Information on the ecology and reproductive biology of the gonggong conch is limited.

The purpose of this study was to analyze the type of substrate, the content of organic matter, inorganic substrate and water from the habitat of the gonggong conch and several aspects of its reproductive biology for cultivation.

Material and Method

Description of the study sites. This research was conducted in August-November 2025 in the Madong Bay, Tanjungpinang with coordinates 0.9827N-0.9835N and 104.43425E-104.4637E as shown in Figure 1. Sampling was carried out at ten stations. The ten stations are included in the shaded area in the research area in Figure 1. Analysis of substrate types and biology of gonggong conchs was carried out at the Marine Biology Laboratory, Raja Ali Haji Maritime University. Analysis of the content of organic and inorganic substrates, and water parameters was carried out at the Aquatic Environment and Productivity Laboratory IPB University.

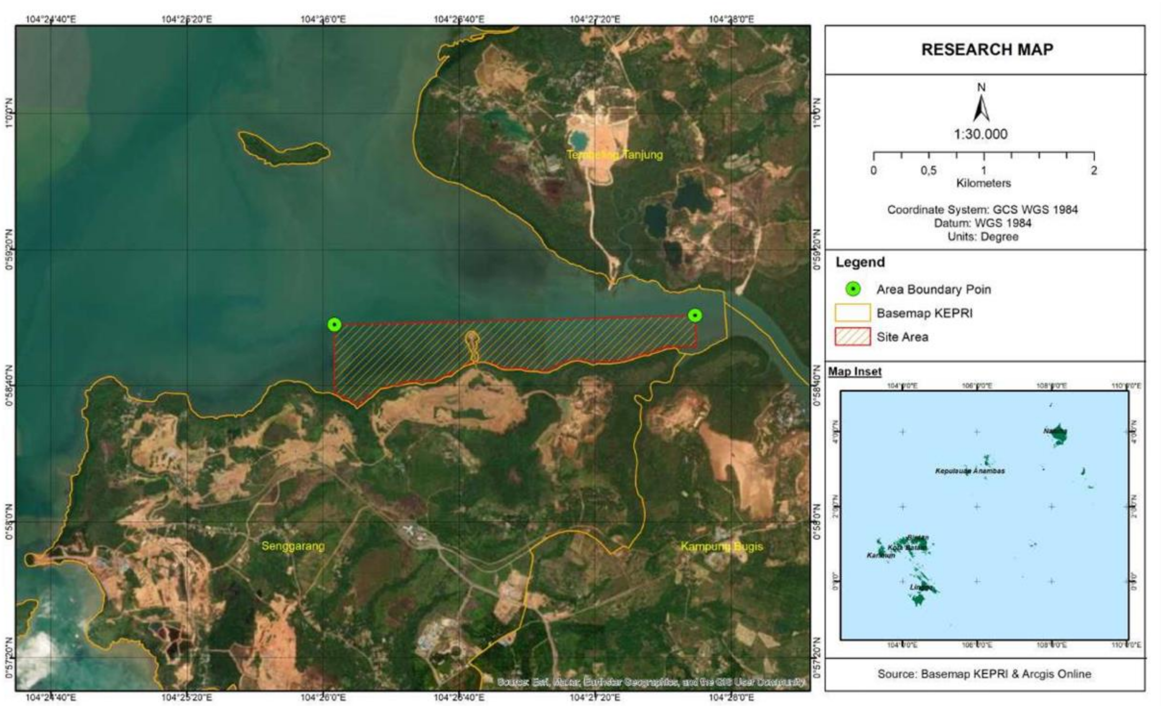

Figure 1. Ecobiology research location of the gonggong conch (in the shaded area) at Madong Bay.

Analysis of substrate types, organic and inorganic materials, and water parameters. A total of 500 g substrate samples were taken with Ekman Grab from each location. The substrate sample was put in a coded plastic bag. The substrate sample was sieved by the dry sieving method and analyzed according to Rifardi (2012). The grain size of the resulting sediment was classified according to Wenthwort criteria. This system is used to classify sediments based on their grain size. Wentworth Criteria divides sediment grain size into several classes, namely: 1) boulder: > 256 mm; 2) cobble: 64-256 mm; 3) pebble: 4-64 mm; 4) granule: 2-4 mm; 5) sand: very coarse sand: 1-2 mm, coarse sand: 0.5-1 mm, medium sand: 0.25-0.5 mm, fine sand: 0.125-0.25 mm, very fine sand: 0.063-0.125 mm; 6) sandy mud/silt: 0.004-0.063 mm; 7) mud/clay: < 0.004 mm.

The determination of substrate texture and type follows the value categories defined in the Shepard triangle. Shepard (1954) categorized sediment substrate types based on the percentage ratio of mud and sand into four groups: (1) mud, (2) sandy mud, (3) muddy sand, and (4) sand.

Measurement of water quality parameters was carried out in situ (temperature, pH and salinity) based on the Indonesian National Standard No. 06-2412-1991, and ex situ (abundance of phytoplankton and zooplankton, content of organic and inorganic materials, density of macrobenthos) according to the laboratory manual. Water samples for plankton observation were taken as follows: seawater was taken with a bucket with a capacity of 10 L filtered with a plankton net mesh size of 40 μL. Water samples were stored in 500 mL sample bottles and added 5-10 drops of 5% Lugol (the color of the water changes like tea water). Water samples for chemical parameters analysis were given 5-10 drops 10% H_2SO_4 preservative and pH < 2 were put into amber bottles, while water samples that were not given preservatives were directly added to the sample bottles. All samples were stored in cold boxes that have been given ice and then taken to the laboratory.

To assess the water quality of Madong Bay, Tanjungpinang, measurements of plankton abundance in the water column, macrobenthos abundance in the substrate, and their ecological indices were conducted. The formulas for calculating the ecological indices and community abundance are presented below:

- diversity index (Shannon–Wiener): $H' = -\sum_{i=1}^{S} (\frac{n_i}{N}) \ln (\frac{n_i}{N})$

- evenness index (Pielou): $E = \frac{H'}{\ln (S)}$

- dominance index (Simpson): $D = \sum_{i=1}^{S} (\frac{n_i}{N})^2$

- abundance of plankton or macrobenthos: $A = \frac{n}{V}$*(plankton per unit volume)* or $A = \frac{n}{A_s}$*(macrobenthos per unit substrate area)*

where: n_i = number of individuals of species *i*;
N = total number of individuals;
S = total number of species;
n = total number of organisms collected;
V = volume of water filtered (for plankton);
A_s = area of substrate sampled (for macrobenthos).

Observation of gender, sex ratio and gonadosomatic index (GSI). Handling of gonggong conch samples refers to the method of Cob et al (2008a), namely by removing the mud and adhering organisms from the shell, then breaking the shell carefully with a hammer so as not to damage the internal organs. The sex of the gonggong conch is known by looking at the presence of secondary sex organs. The sex ratio of male and female gonggong conch was calculated using the equation below:

$$X = \frac{M}{F}$$

where: x = sex ratio of gonggong conch; M = number of male gonggong conch; F = number of female gonggong conch.

Gonadosomatic index (GSI) or gonad maturity index (GMI) is the relative ratio between the gonad weight and the overall soft body weight of the gonggong conch. The soft body of the gonggong conch was carefully taken out, then measured and weighed. The gonads of the gonggong conch were separated from the soft body and weighed. GSI values were calculated using the formulation of Marentette & Corkum (2008):

$$GSI = \frac{Wg}{Wt} \times 100$$

where: Wg = gonad weight (g) and Wt = total soft body weight (g).

Data analysis. The data on physical and chemical water parameters, plankton abundance, and ecological indices were analyzed using Principal Component Analysis (PCA). The sex ratio and gonadosomatic index (GSI) data were analyzed descriptively.

Results

Type of substrate, content of organic materials, inorganic substrate and water parameters. The results of the substrate type analysis of the gonggong conch habitat in the Madong Bay, Tanjungpinang are shown in Table 1. Data on the content of organic matter (macrobenthos density) in the substrate are presented in Table 2, the types of plankton in the waters are presented in Table 3 and Table 4. The levels of content of inorganic and organic matter in the base substrate and in the seawater of the gonggong conch habitat are shown in Table 5 and Table 6.

Table 1

Type of gonggong conch habitat substrate in the Madong Bay, Tanjungpinang

No.	*Sampling location code*	*Coordinate*	*Substrate type*
1	A5	104°44'42" E, 0°97'84" S	Sandy mud
2	B1	104°44'35" E, 0°98'43" S	Sandy mud
3	B2	104°44'41" E, 0°98'23" S	Muddy sand
4	B3	104°44'36" E, 0°98'20" S	Muddy sand
5	B4	104°44'38" E, 0°97'35" S	Mud
6	B5	104°44'33" E, 0°98'30" S	Muddy sand
7	C5	104°44'44" E, 0°98'51" S	Sandy mud
8	C9	104°44'49" E, 0°98'51" S	Muddy sand
9	C12	104°44'43" E, 0°98'71" S	Muddy sand
10	C13	104°44'61" E, 0°98'48" S	Sandy mud

The habitat types for the gonggong conch in the Madong Bay, Tanjungpinang are generally sandy mud and muddy sand based on the above criteria of Rifardi (2012).

Table 2

Density of macrobenthos (ind m^{-2}) in substrate from gonggong conch habitat

Organism	*PS. 119-1*	*PS. 119-2*	*PS. 119-3*	*PS. 119-4*	*PS. 119-5*
	Station A5	*Station B1*	*Station B2*	*Station B3*	*Station B4*
POLYCHAETA					
Scoloplos sp.	0	57	0	0	0
Nephtys sp.	0	57	0	0	0
Notomastus sp.	0	57	0	0	0
Ophelia sp.	0	57	0	0	0
Lumbrineris sp.	0	0	57	0	0
Paralacidonia sp.	0	0	57	0	0
Total taxa	0	4	2	0	0
Abundance (ind m^{-2})	0	228	114	0	0
Diversity index	-	2.00	1.00	-	-
Uniformity index	-	1.00	1.00	-	-
Dominance index	-	0.25	0.50	-	-

Organism	PS. 119-6	PS. 119-7	PS. 119-8	PS. 119-9	PS. 119-10
	Station C5	Station C6	Station C9	Station C12	Station C13
POLYCHAETA					
Scoloplos sp.	0	57	0	0	0
Lumbrineris sp.	0	57	0	0	57
Prionospio sp.	0	0	0	0	285
Ancistrosyllis sp.	0	0	0	0	57
CRUSTACEAE					
Gropsidae	0	0	0	0	57
Total taxa	0	2	0	0	4
Abundance (ind m^{-2})	0	114	0	0	456
Diversity index	-	1.58	-	-	1.55
Uniformity index	-	1.00	-	-	0.77
Dominance index	-	0.33	-	-	0.44

Note: PS.119-1 to PS.119-10 represent the sample codes of the gonggong conch habitat substrate collected from each sampling station.

Macrobenthos in the substrate are mostly Polychaeta (worms). The abundance of macrobenthos (ind m^{-2}) in six of the ten observation stations had a low ecological index of zero and the diversity index varied between 1 and 2, the uniformity index of 0.77-1, and the dominance index of 0.25-0.50.

Table 3

Abundance of phytoplankton (cells m^{-3}) in water from the gonggong conch habitat

Organism	PS. 119-1	PS. 119-2	PS. 119-3	PS. 119-4	PS. 119-5
	Station A5	Station B1	Station B2	Station B3	Station B4
BACILLARIOPHYCEA					
Coscinodiscus sp.	5,484	26,049	10,968	4,113	13,710
Pleurosigma sp.	23,307	13,710	6,855	0	10,968
Chaetoceros sp.	104,196	525,093	292,023	176,859	601,869
Thalassiothrix sp.	80,889	170,004	39,759	42,501	146,697
Bacteriastrum sp.	24,678	233,070	109,680	91,857	215,247
Thalassionema sp.	6,855	34,275	2,742	0	0
Biddulphia sp.	4,113	16,452	4,113	1,371	16,452
Amphora sp.	1,371	2,742	0	0	0
Rhizosolenia sp.	4,113	37,017	5,484	1,371	24,678
Cyclotella sp.	10,968	0	0	0	0
Surirella sp.	1,371	0	0	0	0
Lauderia sp.	4,113	15,081	9,597	2,742	16,452
Bacillaria sp.	31,533	19,194	0	0	0
Ditylum sp.	4,113	1,371	2,742	1,371	4,113
Guinardia sp.	1,371	0	4,113	1,371	2,742
Nitzschia sp.	2,742	21,936	13,710	4,113	6,855
Corethron sp.	1,371	2,742	0	0	0
Hemiaulus sp.	0	16,452	4,113	2,742	65,808
Cerataulina sp.	0	1,371	0	0	1,371
Diploneist sp.	0	1,371	0	1,371	0
Hemidiscus sp.	0	2,742	0	0	4,113
Asteromphalus sp.	0	1,371	0	0	0
Climacodium sp.	0	4,113	0	0	0
Leptocylindrus sp.	0	0	0	2,742	13,710
Navicula sp.	0	0	0	0	1,371
DINOPHYCEAE					
Ceratium sp.	6,855	9,597	1,371	1,371	6,855
Peridinium sp.	4,113	4,113	0	0	1,371
CYANOPHYCEAE					
Trichodesmium sp.	42,501	212,505	0	0	85,002

Total taxa	20	23	14	14	19
Abundance (cells m^{-3})	366,057	1,372,371	507,270	335,895	1,239,384
Diversity index	2.20	1.94	1.40	1.31	1.71
Uniformity index	0.73	0.62	0.53	0.50	0.58
Dominance index	0.16	0.22	0.39	0.37	0.29

Organism	*PS. 119-6*	*PS. 119-7*	*PS. 119-8*	*PS. 119-9*	*PS. 119-10*
	Station B5	*Station C5*	*Station C9*	*Station C12*	*Station C13*
BACILLARIOPHYCEA					
Coscinodiscus sp.	13,710	16,452	32,904	24,678	12,339
Pleurosigma sp.	549,771	427,752	1,813,833	797,922	5,484
Chaetoceros sp.	71,292	333,153	122,019	353,718	159,036
Thalassiothrix sp.	80,889	224,844	120,648	255,006	31,533
Bacteriastrum sp.	0	108,309	24,678	95,970	42,501
Thalassionema sp.	10,968	157,665	87,744	204,279	97,341
Biddulphia sp.	0	2,742	5,484	19,194	2,742
Amphora sp.	35,646	24,678	23,307	21,936	2,742
Rhizosolenia sp.	5,484	27,420	17,823	54,840	8,226
Cyclotella sp.	0	5,484	0	0	0
Surirella sp.	38,388	43,872	167,262	80,889	5,484
Lauderia sp.	9,597	12,339	32,904	34,275	6,855
Bacillaria sp.	0	34,275	0	0	0
Ditylum sp.	1,371	0	1,371	0	0
Guinardia sp.	0	4,113	1,371	0	0
Nitzschia sp.	117,906	111,051	223,473	207,021	39,759
Corethron sp.	0	0	0	0	0
Hemiaulus sp.	0	8,226	5,484	12,339	6,855
Cerataulina sp.	0	0	2,742	0	0
Diploneis sp.	57,582	21,936	60,324	28,791	5,484
Hemidiscus sp.	0	0	0	2,742	0
Climacodium sp.	0	0	6,855	0	0
Leptocylindrus sp.	0	27,420	23,307	0	5,484
Navicula sp.	65,808	17,823	124,761	47,985	9,597
Campylodiscus sp.	1,371	1,371	2,742	4,113	0
Cocconeis sp.	6,855	0	5,484	4,113	1,371
Triceratium sp.	2,742	1,371	0	0	0
Diatoma sp.	13,710	0	0	0	0
Amphiprora sp.	0	1,371	0	0	0
Gyrosigma sp.	0	0	0	0	1,371
DINOPHYCEAE					
Ceratium sp.	0	0	0	0	1,371
Peridinium sp.	0	0	1,371	0	0
CYANOPHYCEAE					
Trichodesmium sp.	382,509	127,503	722,517	680,016	85,002
Total taxa	18	23	24	19	20
Abundance (cells m^{-3})	1,465,599	1,741,170	3,630,408	2,929,827	530,577
Diversity index	1.91	2.31	1.75	2.14	2.16
Uniformity index	0.66	0.74	0.55	0.73	0.72
Dominance index	0.23	0.14	0.30	0.16	0.17

Note: PS.119-1 to PS.119-10 represent the sample codes of the gonggong conch habitat substrate collected from each sampling station.

The many phytoplankton found are a group Bacillariophycea especially *Chaetoceros* sp. and *Thalassiothrix* sp.

Table 4

Abundance of zooplankton (ind m^{-3}) in water from the gonggong conch habitat

Organism	PS. 119-1	PS. 119-2	PS. 119-3	PS. 119-4	PS. 119-5
	Station A5	Station B1	Station B2	Station B3	Station B4
CRUSTACEAE					
Nauplius sp.	19,194	28,791	8,226	9,597	15,081
Oithona sp.	1,371	8,226	1,371	4,113	12,339
Microsetella sp.	0	1,371	0	0	1,371
Neocalanus sp.	0	34,275	27,420	1,371	42,501
Acartia sp.	0	1,371	0	0	0
Penaeidae (larva)	0	1,371	0	0	0
Balanus sp.	0	1,371	1,371	0	0
Macrosetella sp.	0	1,371	0	0	1,371
Oncaea sp.	0	0	1,371	0	0
Euterpina sp.	0	0	0	0	4,113
CILIATA					
Favella sp.	1,371	1,371	0	0	0
Leprotintinnus sp.	2,742	8,226	5,484	1,371	8,226
Tintinnopsis sp.	1,371	1,371	2,742	6,855	1,371
Codonellopsis sp.	0	1,371	1,371	1,371	1,371
Amphorellopsis sp.	0	0	0	0	1,371
POLYCHAETA (larva)					
Larvae (sp. 1)	0	1,371	0	0	0
GASTROPODA (larva)					
Larvae (sp. 1)	1,371	0	0	0	0
Total taxa	6	13	8	6	10
Abundance (ind m^{-3})	27,420	91,857	49,356	24,678	89,115
Diversity index	1.08	1.67	1.43	1.50	1.61
Uniformity index	0.60	0.65	0.69	0.84	0.70
Dominance index	0.51	0.26	0.35	0.27	0.29
Organism	PS. 119-6	PS. 119-7	PS. 119-8	PS. 119-9	PS. 119-10
	Station C5	Station C6	Station C9	Station C12	Station C13
CRUSTACEAE					
Nauplius sp.	0	23,307	12,339	4,113	9,597
Oithona sp.	8,226	9,597	16,452	37,017	5,484
Neocalanus sp.	0	0	4,113	12,339	0
Macrosetella sp.	1,371	0	0	0	0
Oncaea sp.	0	0	0	1,371	2,742
Euterpina sp.	0	0	0	1,371	2,742
Tigriopus sp.	0	4,113	0	0	0
Corycaeus sp.	0	0	0	2,742	0
Paracalanus sp.	0	0	0	1,371	0
Eucalanus sp.	0	0	0	1,371	0
CILIATA	0	0	0	0	0
Favella sp.	1,371	0	1,371	1,371	0
Tintinnopsis sp.	8,226	16,452	27,420	30,162	5,484
Codonellopsis sp.	0	4,113	1,371	0	1,371
Epistylis sp.	0	0	0	1,371	0
Total taxa	4	5	6	11	6
Abundance (ind m^{-3})	19,194	57,582	63,066	94,599	27,420
Diversity index	1.10	1.40	1.38	1.60	1.62
Uniformity index	0.80	0.87	0.77	0.67	0.90
Dominance index	0.38	0.28	0.30	0.28	0.23

Note: PS.119-1 to PS.119-10 represent the sample codes of the gonggong conch habitat substrate collected from each sampling station.

Zoooplankton which were mostly found were crustaceans especially the *Nauplius* sp., *Neocalanus* sp. and the Cilliata group including *Leprotintinnus* sp. and *Tintinnopsis* sp.

Table 5

Content of inorganic and organic matter in the base substrate of the gonggong conch habitat

No.	Code sample	*Parameter*				
		Calcium (mg kg⁻¹)	*Magnesium (mg kg⁻¹)*	*Total P (%)*	*Total N (%)*	*C-organic (%)*
1	St. A5	52,276.94	5,872.71	0.66	1.25	1.87
2	St. B1	3,129.12	7,286.17	1.25	2.19	3.42
3	St. B2	10,533.35	7,708.67	1.21	2.14	3.34
4	St. B3	4,497.60	7,107.39	1.11	1.98	3.07
5	St. B4	4,088.31	6,987.21	0.82	1.51	2.29
6	St. C5	819.89	4,428.31	1.23	2.16	3.38
7	St. C6	1,325.60	4,647.80	1.24	2.17	3.39
8	St. C9	798.80	4,627.37	1.18	2.08	3.24
9	St. C12	1,204.00	4,668.93	1.19	2.10	3.28
10	St. C13	826.55	3,923.75	1.59	2.75	4.35
Average		7,950.016	5,725.831	1.148	2.033	3.163
Method		APHA, ed. 22, 2012, 3111-B, 3030-H	APHA, ed. 22, 2012, 3111-B, 3030-H	Kjeldahl	Kjeldahl	Walkey & Black

Table 6

Content of organic and inorganic matter in seawater from gonggong conch habitat

No.	Sample code	*Parameter*						
		Total organic matter (mgKMnO4 L⁻¹)	*Silica (mg L⁻¹)*	*Calcium (mg L⁻¹)*	*Magnesium (mg L⁻¹)*	*Ammonia (mg L⁻¹)*	*Nitrate (mg L⁻¹)*	*Ortho phosphate (mg L⁻¹)*
1	St. A5	7.58	1.113	182.644	517.649	0.194	0.093	0.010
2	St. B1	9.48	0.965	168.126	501.579	0.273	0.079	0.014
3	St. B2	8.85	1.045	178.772	543.128	0.189	0.085	0.009
4	St. B3	8.57	0.976	177.136	503.538	0.197	0.081	0.012
5	St. B4	10.11	1.014	180.999	577.267	0.206	0.091	0.011
6	St. B5	8.85	1.018	197.647	608.408	0.210	0.073	0.010
7	St. C5	8.22	1.303	196.098	562.862	0.268	0.076	0.009
8	St. C9	9.48	1.006	179.644	607.159	0.201	0.087	0.006
9	St.C12	10.74	1.033	194.743	612.571	0.236	0.106	< 0.002
10	St.C13	10.11	1.678	161.737	531.888	0.247	0.078	< 0.002
Average		9.27	1.23	182.27	562.50	0.22	0.085	0.008
Method		SNI-06-6989.22-2004	APHA, ed. 22, 2012, 4500-SiO2-D	APHA, ed. 22, 2012, 3111-B	APHA, ed. 22, 2012, 3111-B	APHA, ed. 22, 2012, 4500-NH3-F	APHA, ed. 22, 2012, 4500-NO3-E	APHA, ed. 22, 2012, 4500-PE

The levels of organic and inorganic matter in the substrate at the ten observation stations had various values, the highest and the lowest, respectively, were: calcium 52,276.94 mg kg^{-1} (st. A5) and 798.80 mg kg^{-1} (st. C9); magnesium 7,708.67 mg kg^{-1} (st. B2) and 3,923.75 mg kg^{-1} (st. C13); total P 1.59% (st. C13) and 0.66% (st. A5); total N 2.75% (st. C13) and 1.25% (st. A5), and C-organic 4.35% (st. C13) and 1.87% (st. A5).

The levels of organic and inorganic matter in seawater in the habitat of the Madong Bay, Tanjungpinang gonggong conch varied across all observation stations, with the highest and lowest values respectively: total organic matter (mg $KMnO_4$ L^{-1}) 10.74 (st. C12) and 7.58 (st. A5); silica (mg L^{-1}) 1.678 (st. C13) and 0.965 (st. B1); calcium (mg L^{-1}) 197.647 (st. C5) and 161.737 (st. C13); magnesium (mg L^{-1}) 608.408 (st. C5) and 501.579 (st. B1); ammonia (mg L^{-1}) 0.273 (st. B1) and 0.189 (st. B2); nitrate (mg L^{-1}) 0.106 (st. C12) and 0.073 (st. C5), and orthophosphate (mg L^{-1}) 0.014 (st. B1) and < 0.002 (st. C12, C13).

Sex and sex ratio of gonggong conch. A total of 278 gonggong conch s were collected, consisting of 170 males and 108 females. Morphometric comparisons between male and female individuals are presented in Table 7.

Table 7

Morphometric comparison between mature male and female gonads

Morphometric	*Male (mm)*	*Female (mm)*
Shell length	60.36±5.20	64.46±6.41
Shell width	36.66±3.36	38.35±5.27
Shell depth	26.87±2.32	29.94±3.28
The length of the shell opening	46.47±4.38	48.58±5.69
Shell lip thickness	1.98±1.32	1.54±1.36
Total weight	21.25±6.55	26.00±10.02
Total number	170 tails	108 tails
Sex ratio	0.6115	0.3884

All morphometric values of female gonggong conch have greater values than male conchs, except for shell lip thickness. The sex ratio between male and female is 0.6115:0.3884.

Gonadosomatic index (GSI). The GSI and gonad maturity stage (GMS) values of gonggong conch are presented in Table 8. The value of the GSI of immature and ripe gonad conch is relatively the same, namely 15.44-16.72.

Table 8

GSI values for gonggong conch

Classification	*GSI value*
Green - gonads are not ripe	15.44
GMS 1 - gonads begin to mature	15.86
GMS 2 - mature gonad	16.72
GMS 3 - gonads are ready for ovulation	15.74

Discussion. Generally, the substrate for the gonggong conch in the Madong Bay, Tanjungpinang is sandy mud and muddy sand. These results are consistent with Amini (1986) and Cob et al (2008b) who stated that the gonggong conch inhabit tidal areas with a muddy sand substrate and prefer soft areas with mud sediments. Jailani & Nur (2012) stated that the ability of gastropods to survive in a certain environment is caused by environmental conditions such as the type of substrate and the relatively high content of organic matter. The organic material content of the substrate is needed as a source of food for certain organisms, especially macrobenthos (Putro 2007), as well as organic material on the substrate in the habitat of the gonggong conch which is a source of food for these conch and other benthic detrivores. The high value of organic matter in the habitat is due to the large amount of material run off from the land because it is a river mouth and a mangrove forest environment which supplies nutrients from the results of litter decomposition. Manengkey (2010) found high levels of organic matter in the bay and estuary areas.

The types of macrobenthos (Table 2) found in the bottom substrate mostly come from the polychaeta (worm) group supported by the results of Izzah & Roziaty (2016), and Zahidin (2008) that the dominant group of organisms that make up macrofauna on the bottom of the waters usually consists of 4 groups namely Polychaeta, Crustacea, Bivalvia and Gastropoda. Macrozoobenthos can be used as a bio-indicator of water quality because changes in population are strongly influenced by the aquatic environment (Maula 2018). Benthic animals have a role in the process of decomposition and mineralization of organic material in waters, and occupy several tropical levels in the food chain (Odum 1993).

The types of phytoplankton that are widely found in the Madong Bay, Tanjungpinang are group Bacillariophycea especially *Chaetoceros* sp. and *Thalassiothrix* sp. Widigdo & Wardiatno (2013) found six phytoplankton classes consisting of the Bacillariophyceae, Dinophyceae, Cyanophyceae, Chlorophyceae, Euglenophyceae, and Chrysophyceae, with the general dominance of the Bacillariophyceae class in the waters around shrimp farms in Lampung. The abundance of phytoplankton in the aquatic environment has a strong correlation with dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphate (DIP) as shown in Table 5. DIN is the sum of ammonia, nitrate and nitrite, and DIP is orthophosphate. Pirzan & Pong-Masak (2008) state that an ecosystem composed of several communities, such as phytoplankton, will interact with abiotic factors to form a balance for the sustainability of the ecosystem. The existence of organisms or biota is closely related to aquatic environmental factors.

Zooplankton which are abundant in the Madong-Tanjungpinang sea are the crustacean group especially the *Nauplius* sp., *Neocalanus* sp., and Cilliata group including *Leprotintinnus* sp. and *Tintinnopsis* sp. Zooplankton is an important component in the food chain related to the productivity of an ecosystem because it has a dual role as a first or second level consumer, and is a link between plankton and nekton (Pratono et al 2005). Zooplankton abundance is highly dependent on phytoplankton abundance, because phytoplankton is food for zooplankton, thus the abundance of zooplankton will be high in waters with high phytoplankton content (Arinardi et al 1997). Zooplankton abundance is closely related to changes in the aquatic environment, both physical, chemical and biological (Ardiansyah et al 2023). Zooplankton can only live and develop well in suitable water conditions (Junaidi et al 2018).

The levels of calcium, magnesium, total P, total N and C-organic in the base substrate varied from the ten observation stations. Minerals in aquatic animals play a role in physiological processes. Calcium is directly related to the development and maintenance of the skeleton system and participates in various physiological processes in the body. Calcium requirements in fish are influenced by water chemistry, phosphorus levels in feed and fish species (Lall 2003). Magnesium is indispensable in body metabolism, including energy metabolism, glucose use, protein synthesis, fatty acid synthesis and breakdown, muscle contraction, all ATPase functions, almost all hormonal reactions and maintaining cellular ionic balance and the Na/K-ATPase pump. Magnesium deficiency causes an increase in intracellular sodium and extensive movement of potassium out of and into the extracellular compartment. This condition leads to hypokalaemia in the cells, which can only be treated through magnesium administration (Gums 2004). Phosphorus is a macromineral directly associated with the development and maintenance of the skeletal system, as well as various physiological processes in the organism's body. In most fish species, phosphorus deficiency results in slow growth, poor feed efficiency, poor bone mineralization, high body lipid content and low ash content (Lall 2003). Calcium and phosphorus are synergistic minerals (Zainuddin 2012) and, in the form of hydroxyapatite, contribute to the formation of bone crystals (Ye et al 2006).

A nutrient that also plays an important role in the growth of phytoplankton or algae, which are commonly used as indicators of water fertility, is nitrogen (Fachrul et al 2005). Nitrogen and phosphorus are two very influential parameters in marine life. Nitrous elements that can be utilized are nitrite and nitrate, while phosphorus is in the form of orthophosphate compounds (Jones-Lee & Lee 2005). Organic compounds are generally derived from naturally occurring carbon compounds. There are two types of organic carbon, namely organic carbon material from land carried by rain or river runoff, and from the oceans in the form of the production of marine organisms (biogenous) such as biogenic carbonates from forams or mollusks (Permanawati et al 2016).The ocean contains carbon mostly in the form of bicarbonate ions. Inorganic carbon, that is, carbon compounds without carbon-carbon or carbon-hydrogen bonds, are important in their reactions in water. This carbon exchange is important in controlling the pH in the ocean.

The levels of organic and inorganic matter in seawater in the habitat of the Madong Bay, Tanjungpinang gonggong conch varied in all observation stations (Table 6). The highest and lowest total organic matter / TOM (mg $KMnO_4$ L^{-1}) values were 10.74 (st. C12) and 8.22 (st. C6), respectively. TOM is all deposited organic material (detritus, phytoplankton or other biota excretions) which can be decomposed by micro-organisms that are around the waters. TOM dissolved in water bodies by physical and chemical processes will be deposited on the bottom of the waters and form organic content in the sediments. The high value of TOM can be caused by high human activity and the possibility of entry of organic matter from rivers (Rustam et al 2018).

An element that is also important in marine waters is silica. Dissolved silica is an important nutrient for primary productivity (Papush & Danielsson 2006), and acts as a regulator for phytoplankton competition, with diatoms always dominating phytoplankton populations at high silicate concentrations (Egge & Aksnes 1992). The highest silica content in this study was 1,678 mg/L (C13 station) and the lowest was 0.965 mg/L (B1 station). The distribution of SiO_2 in coastal waters is generally higher than in the open sea due to river runoff (Risamasu & Prayitno 2011). Dissolved silicate concentrations in the surface layer of sea waters are generally lower than those at the bottom, except in areas that experience upwelling (Millero 1996).

The orthophosphate values in these waters ranged between < 0.002% (st. C12) and 0.01% (st. B4). This content is lower than the seawater quality standard for marine biota, which is 0.015 mg L^{-1} (MENLH 2004). This condition can not encourage a phytoplankton population explosion and does not lead to the dominance of certain phytoplankton species. Phosphate (PO_4-P) is an essential element for metabolism and protein formation. In marine waters, phosphate is in the form of inorganic and dissolved organic and particulate phosphate (Affan 2010). Phosphates are needed for the growth and metabolism of phytoplankton and other marine organisms. The amount of phosphate in the waters is unstable because it is easy to undergo a process of erosion, weathering and dilution (Kadim et al 2017).

The largest and smallest Nitrate levels in this study were 0.106 mg L^{-1} (C12 station) and 0.073 mg L^{-1} (C5 station). These two values are greater than the quality standard for marine biota, namely 0.008 mg L^{-1}. Nitrate (NO_3-N) is the main form of nitrogen in natural waters. Nitrate is one of the important nutrient compounds in animal and plant protein synthesis. High concentrations of nitrate in water can stimulate the growth and development of aquatic organisms. Nitrification, which is the process of oxidizing ammonia to nitrite and nitrate, is an important process in the nitrogen cycle and takes place in aerobic conditions. The oxidation of ammonia to nitrite is carried out by nitrosomonas bacteria, while the oxidation of nitrite to nitrate is carried out by Nitrobacter. Nitrates in water bodies can come from diffusion by the atmosphere, fixation, the results of degradation of organic matter and waste of organic waste due to human activities (Effendi 2003). Nitrates and phosphates in water naturally come from the decomposition of plants and animals, domestic waste, industry, agriculture and livestock (Ulqodry et al 2010). If the rate of nitrogen use by phytoplankton is fast and not proportional to the rate of use of phosphate, the N/P ratio will decrease (Aininnur et al 2015)

The highest ammonia content (mg L^{-1}) was 0.273 (station B1) and the lowest was 0.189 (station B2). This value is classified as feasible because it is lower than the quality standard of 0.3 mg L^{-1} stipulated in the Quality Standard based on the Minister of Environment Decree 51 of 2004 Annex III (For Marine Biota). Ammonia (NH_3) is a water-soluble inorganic nitrogen. This compound comes from nitrogen which becomes NH4 at low pH and is called ammonium. Ammonia in water comes from urine and feces, oxidation of organic substances microbiologically and from industrial wastewater and community activities (Putri et al 2019). High concentrations of ammonia in waters can cause a decrease in dissolved oxygen which can cause disturbances in physiological and metabolic functions such as respiration (Zhang et al 2013).

The shell size of the female gonggong conch (*L. turturella*) is bigger than the male conch the same as other Strombidae conchs such as *Strombus gigas* (Avila-Poveda & Baqueiro-Cardenas 2006) and *S. canarium* (Cob et al 2008a). The sex ratio between male and female gonggong conch s is 0.6115:0.3884, meaning that the number of conchs of each sex is relatively balanced. This sex ratio value is similar to the results of Widyastuti & Aji (2016) on *Lambis lambis* conchs on the coast of Yenusi waters, Biak which has a male and female sex ratio of 1.0:1.2. The sex ratio of male and female gonggong conch between stations (Table 7) in the coastal waters of Dumai City is relatively the same, with an average of 1:1.12 (Efriyeldi et al 2012).

The value of gonado somatic index (GSI) of immature and ripe gonad conchs is relatively the same, namely 15.44-16.72. Pratiwi et al (2019) found that the gonad maturity index value of male and female pokea shells was 13.99 for male shells and 14.89 for female shells. Efriyeldi et al (2012) reported that the average value of gonado somatic index sepetang shellfish every month during the study ranged from 6.66 to 11.88%.

Figure 2a) showed the positive axis 1 (F1) had the characteristics of habitat could be interpreted that the correlation circles tend to cluster called Mg, NO_3, Ca and TOM. The relative abundance (F), ∑ Taxa, dominance index (e) and diversity index found on the same axis with intensity parameters, such as Mg, NO_3, Ca and TOM, as clumped, approached the X axis. These parameters have been shown to have a considerable effect on the relative abundance, ∑ Taxa, dominance index (e) and diversity index of natural feed. On the other hand, other parameters such as Si, PO_4 and NH_3 content were no correlation to abundance (F), ∑ Taxa, dominance index (e) and diversity index.

Figure 2b illustrated the results of the analysis were represented using two principal axes that would account for 57.38% of the total variance. Data consists of the main components of 33.70% and 23.68% for the second element, respectively. The interpretation of PCA had been considered to represent a state that occurs without reducing the information from the data obtained.

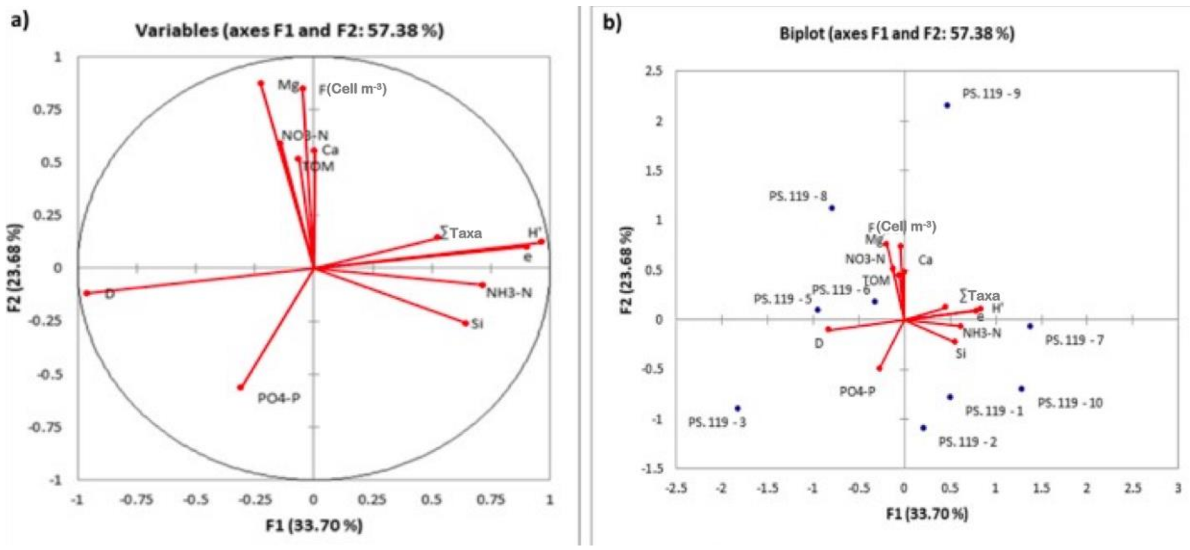

Figure 2. a). PCA variables with physical and chemical parameters and relative abundance, ∑ Taxa, dominance and diversity index; b). PCA Biplot with physical and chemical parameters and relative abundance at the research station.

Habitat characteristics are shown in the positive axis one clearly that contributed these parameters negatively to the shaft 2. Dominance index was on the same axis with Mg, NO_3, Ca and TOM. The four parameters have an important role to the relative abundance (F), ∑ Taxa, dominance index (e) and diversity index.

Conclusions. The habitat for the gonggong conch in the Madong-Tanjungpinang sea is sandy mud and muddy sand. The most common types of macrobenthos are Polychaeta (worms). The types of phytoplankton that are commonly found are Bacillariophycea especially *Chaetoceros* sp. and *Thalassiothrix* sp. The levels of organic and inorganic materials in the substrate and water varied and were still in the proper category for marine life. The sex ratio between male and female gonggong conch is 0.6115:0.3884. Score gonadosomatic index (GSI) immature gonads and ripe conchs were 15.44-16.72. The findings of this study have great potential to support the success of gonggong conch aquaculture, particularly in (1) determining the male-to-female ratio of gonggong conchs for spawning, and (2) providing artificial habitats for this species.

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Authors:
Muzahar, Department of Aquaculture Faculty of Marine Sciences and Fisheries, Raja Ali Haji Maritime University, Riau Islands, street Politeknik Senggarang PO.BOX 155 – Tanjungpinang 29111, Indonesia, e-mail: muzahar@umrah.ac.id
Ani Suryanti, Faculty of Marine Science and Fisheries, Jenderal Soedirman University, Purwokerto 53123, Indonesia, e-mail: ani.suryanti@unsoed.ac.id.
Lily Viruly, Department of Fisheries Product Technology, Faculty of Marine Sciences and Fisheries, Raja Ali Haji Maritime University, Riau Islands, street Politeknik Senggarang PO.BOX 155 – Tanjungpinang 29111, Indonesia, e-mail: lilyviruly@umrah.ac.id

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