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# The distribution pattern and description of new Sipunculan characteristics in Banda Neira

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**Abstract.** Sipunculans were collected in Banda Neira from October 2019 to February 2020. In this paper, I describe the distribution pattern and characteristics of the Genus *Sipunculus* (*Sipunculus* sp. 1, *Sipunculus* sp. 2), Genus *Thysanocardia* (*Thysanocardia* sp. 1, *Thysanocardia* sp. 2, *Thysanocardia* sp. 3), and Genus *Siphonosoma* (*Siphonosoma* sp. 1). The sampling method was purposive sampling. Two stations were selected as sample locations with squared plot size 60x60 cm, divided into 5 sub-plots, and repeated 3 times. The specimens were dissected, observed, and compared with available morphological literature. The result showed that the distribution pattern of Sipuncula was irregular, the distribution of holes or dwellings at several stations shows a varying distance of 10–30 cm from dwelling to other dwellings around 3 meters. The morphological characteristics of the sipunculan are slightly different, so it is suspected that there are new species in Banda Neira.

**Keywords:** distribution pattern; new characteristics; sipunculan

## 1. Introduction

Sipunculans are non-regenerating, symmetrical, and segmentless marine worms (commonly known as peanut worms) that inhabit a wide variety of benthic substrates in all major ocean basins across poles, temperature, and tropical latitudes. The number of recognized species ranges from 320 species [1], to revisions including the introduction of a new family by Cutler [2] which states that, Sipuncula is a relatively species-poor phylum about 144 of 17 genus, 6 families, 4 orders, and 2 classes in worldwide. Research on the phylum Sipuncula which causes a lack of literacy, so that its distribution is poorly understood and even the possibility of finding new species that have never been identified is normal [5]. Distribution characteristics of this species are largely related to the nature of the sediment or the availability of shelter [3, 4].

Sipuncula is considered ecologically important in the trophic dynamics of various ecosystems, such as the formation and degeneration of coral reefs, as well as ecological indicators for environmental monitoring [2]. Indirectly, Sipuncula is useful as a substitute for protein needs other than fish. The people of Banda, especially Tanah Rata and Walang villages are the ones who use Sipuncula as food and fishing bait. This activity has been carried out for a long time and has been passed down from generation to generation. Sipuncula was caught randomly with local knowledge in an uncertain time.



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Several studies explain that the nutritional content of Sipuncula is quite high, equivalent to fish, the highest protein content is 82.46%, contains complete vitamins, and has medicinal properties [6-7].

Research on the distribution patterns and characteristics of the Sipuncula in Banda Neira is not yet known. Information about distribution patterns can be used as a potential development for the potential to improve community welfare. Therefore, this research was conducted so that information can be obtained about the distribution patterns and types of Sipuncula in Banda Neira.

## 2. Methods

### 2.1. Time and locations

This research was conducted in October 2019-February 2020, located in Banda Neira. Sample identification was carried out in several laboratories. The Macro- and Microbiology, Department of Aquatic Resources Management, IPB University.

### 2.2. Sampling method and data analysis

This study used the transect method squared 60 x 60 cm with purposive sampling and descriptive techniques. At stations 1 and 2, each of the three transects are installed from the highest tide, with a perpendicular position from the coastline to the sea, then a systematic observation plot is placed with a plot size of 5 x 5 meters. 5 plots with a distance between the plots to the other plot are 30 meters, in each plot 3 replications of sampling will be carried out. Identification of the characteristics of Sipuncula based on Cutler's book is supported by related literature.

The data analysis used is descriptive quantitative. To determine the distribution pattern of Sipuncula, the formula is used [8]:

$$Id = \frac{n \sum x^2 - \sum x}{(\sum x)^2 - \sum x} \quad (1)$$

Id = Morisita spread index

n = The number of plots

$\sum x$  = The number of individuals of a species per plot

$\sum x^2$  = The number of individual squares of a species per plot

$$Mu = \frac{x_{0.975}^2 - n + \sum x}{\sum x - 1} \quad (2)$$

$$Mc = \frac{x_{0.025}^2 - n + \sum x}{\sum x - 1} \quad (3)$$

$$Ip = 0.5 + 0.5 \frac{id - Mc}{n - Mc} \quad (4)$$

Mu = Uniform index

Mc = Clumped index

To determine the three distribution patterns above, the standard dispersion Morisita index formula is used. If the results of data analysis get a value of 0, then the distribution pattern occurs randomly (random), but if the value is above 0 then the distribution pattern is clustered (clumped), while the uniform pattern can be seen if the value is below 0 [8]. To prove that the distribution is true in groups or not, then further tested using the chi-square distribution formula:

$$\chi^2 = \left( \frac{n \sum x^2}{N} \right) - N \quad (5)$$

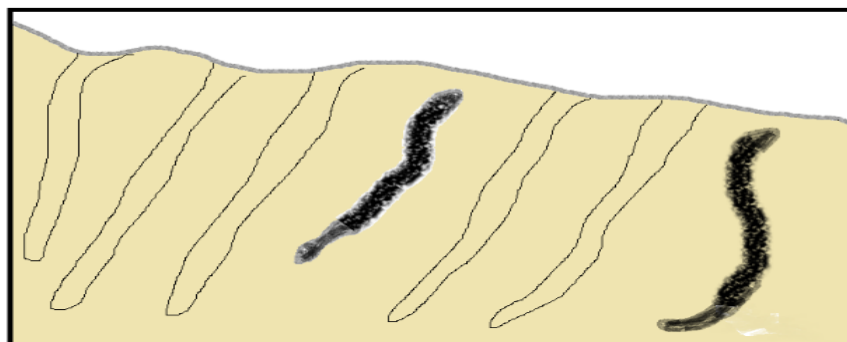
- $\chi^2$  = Statistical test of the chi-square distribution  
 $\sum \chi^2$  = The number of individual squares of a species per plot  
 $n$  = The number of plots  
 $N$  = The total number of individuals obtained

The calculated  $\chi^2$  value is compared with the  $\chi^2$  table value with degrees of freedom ( $df = n - 1$ ). If  $\chi^2 \text{ count} < \chi^2 \text{ table}$ , it can be concluded that the shape of the distribution pattern is not significantly different from the group distribution pattern. If the  $\chi^2 \text{ count} > \chi^2 \text{ table}$ , it can be concluded that the form of the distribution pattern is significantly different from the group distribution pattern [9].

### 3. Results and discussion

#### 3.1. Distribution pattern

The pattern of spread of the Sipuncula is known to be irregular. Based on the observations made, the distribution of holes or dwellings of Sipuncula at stations 1 and 2 shows a varying distance of about 10-30 cm from one dwelling to another, about 3 meters away. According to the experience of local people, Sipuncula or *kariong* usually likes to make many burrows around their dwellings as camouflage or trap shelters. The nest burrows are two to three burrows.



**Figure 1.** Camouflage hole.



**Figure 2.** Catch with hand.



**Figure 3.** How to catch Sipuncula.

This characteristic is thought to be the eating behavior of the Sipuncula, because every Sipuncula that is caught, the contents of the stomach or intestines are always full of food. The people of Banda know that there is a Sipuncula in the hole by looking at the sand grains that have been excavated, Sipuncula likes to move around to hunt for food and make new burrows (old nest holes will be difficult to detect because they have been swept away by the waves). This indicates that the Sipuncula is relatively mobile in the nest hole.

The nest holes of the Sipuncula can be far apart or close together, mostly far apart. If they are far apart, this is beneficial because the fishing process does not disturb other individuals around them. If when close together the catch on the next hole always fails. This is the reason why the Sipuncula is not easily depleted in its habitat [10]. Distribution patterns depend on the physicochemical properties of the environment as well as the biological features of the organism itself. The unlimited diversity of such distribution patterns can be divided into three categories; uniform distribution, random distribution, and group distribution [11]. Below is a table of the results of the analysis of the Sipuncula distribution pattern based on the Morisita distribution index.

**Table 1.** Calculation results with the spread index of the Morisita.

|                | Station    |          |                       |
|----------------|------------|----------|-----------------------|
|                | Tanah rata | Walang   | Tanah rata and Walang |
| Id             | 0.971989   | 1.000301 | 0.998682              |
| $\chi^2$ 0.975 | 0.484419   | 0.484419 | 0.484419              |
| $\chi^2$ 0.025 | 11.14329   | 11.14329 | 11.14329              |
| Mu             | 0.978861   | 0.992014 | 0.994217              |
| Mc             | 1.068431   | 1.025852 | 1.01872               |
| Ip             | 0          | 0.005829 | 0                     |

Based on the table above, it is known that the distribution pattern of Sipuncula in Tanah Rata is random with an Ip value = 0. The distribution pattern of the Walang area is clustered with an Ip value > 0, a further test is carried out with the dispersion morista index to determine whether the distribution is really in groups or not, obtained  $\chi^2$  count >  $\chi^2$  table, it can be concluded that the shape of the distribution pattern of the Sipuncula in Walang is significantly different from the pattern of group distribution. Tests were also carried out or combined station 1 and 2 with Ip = 0, it can be concluded that the Sipuncula distribution pattern is random.

### 3.2. New Characteristics

**3.2.1. Morphometric.** Morphometric measurements were carried out including length and weight based on morphological standards adapted to biota. Morphological measurements of length and weight have authentic evidence that is easiest to identify [12]. The results of morphometric observations from 100 samples with various variations (values\*). This is due to differences in the size (growth) and age of the Sipuncula. The following are the results of morphometric measurements.

**Table 2.** Morphometric measurements.

| Parameters     | Values*  | Unit |
|----------------|----------|------|
| Total length   | 17.1±8.0 | cm   |
| Total weight   | 31.2±8.9 | g    |
| Flesh          | 18.9±6.7 | g    |
| Internal organ | 9.74±7.2 | g    |

The total length of the Sipuncula's body is 17.1 cm with a minimum length value of 8.0 cm. The average weight 31.2 g with a minimum average weight of 8.9 g. The proportion of flesh is 18.9 g and

internal organ is 9.74 g. It is best if biota morphometric measurements are carried out fresh. When preserved the Sipuncula flesh will be reduced by half of its initial weight. Therefore, the weight of flesh and internal organs that were weighed in this study was fresh when it was caught. The Sipuncula that has been caught at stations has a volume of intestine filled with food, especially at low tide during the day or evening. Meanwhile, the intestinal volume tends to be small and empty at low tide or catching up in the morning. This indicates that the feeding time of these organisms is estimated at noon to late afternoon. Measurement of environmental parameters includes pH, temperature, and salinity. Measured in the hole of the Sipuncula nest. The values can be seen in the table below.

**Table 3.** Environmental parameters.

| Parameters  | Station             |                                       |
|-------------|---------------------|---------------------------------------|
|             | Tanah rata          | Walang                                |
| Temperature | 30 °C               | 28 °C                                 |
| Salinity    | 34-35‰              | 33-35‰                                |
| pH          | 7                   | 7                                     |
| Substrate   | sand, seagrass, mud | Sand, rock, coral fragments, seagrass |

The table above shows the temperature in the burrows in Banda waters ranging from 28<sup>0</sup> Celcius-30<sup>0</sup> Celcius. In Bangka Belitung, Sipuncula lives at temperatures between 29-30<sup>0</sup> Celcius and this range is the optimal temperature [10]. The high burrow temperature in Tanah Rata is thought to be influenced by the composition of the substrate consisting of sand, stone, coral fragments, and seagrass. Meanwhile, the burrow temperature in the village of Walang is thought to be influenced by the growth of seagrass which is mostly intertidal. The pH measurement results of the burrow are 7. These conditions are at normal pH. The salinity of the burrows ranges from 33-35 ‰.

**3.2.2. Identification and description.** In distinguishing the genus *Sipunculus* from others is to identify papillae by shape, size, LMBs (Longitudinal muscle bands), morphology of nephridia, location of the anus, brain morphology, and diameter or protractor. Meanwhile, to distinguish the genus *Siphonosoma* from other genera is to look at introvert hooks, shape, size, presence/ absence, origin of the retractor, CVV (Contractile vessel villi) morphology, Rectal caecum (but this structure is difficult to see in small biota and is not always present, some authors do not mention its presence, but not means nothing). Identification results that determine the class, order, family, and genus of the phylum Sipuncula by observing the shape of the tentacles, Nephridia (N), Dorsal Retractor Muscle (DRM), Longitudinal Muscle Bands (LMB), Cerebral ganglion (CG), and hooks [2].

### 3.3. Genus *Sipunculus*

To determine which specimens belong to the genus *sipunculus* are 20-50 separate and well-defined LMBs. The CMBs are also distinct and separate. Oblique muscle strands are present between the two layers. The pores open into longitudinal canals, one canal between each pair of LMBs. Each canal has numerous pores along its length, opening into it between each pair of CMBs. One species (*S. longipapillosus*) has slender, digitate papillae as extensions of these canals in the mid-trunk region. In the posterior end of the trunk (the glans region), the circular layer is continuous and the LMBs may change. In some species the LMBs become a continuous layer; in others, each band subdivides into two; and in a few species, the LMBs continue as single units [2]. The genus found in Tanah rata and walang is a genus of *sipunculus* with characteristics close to that of the *Sipunculus nudus* and *Sipunculus robustus kaferstein*. The species *Sipunculus nudus* and *Sipunculus robustus* look very similar, it is very difficult to distinguish them, so surgery is needed to see any differences. The *Sipunculus nudus* have a total length of 13-15 cm, The maximum width is 9-11 mm; The skin is thick and dull brown. Longitudinal bands of muscle numbering 31-33 fuse anteriorly in the introverted region; ventral and

dorsal retractors emerge from the longitudinal muscle bands by 2-6 and 8-12, respectively. Convolution of the intestine 19 and attached to the body wall by several muscle attachments; rectal diverticulum is present. The proximal quarter of nephridia is attached to the body wall [13]. The following is a table of characters from the (Genus\*) Sipuncula found in Banda Neira. *Sipunculus* sp. 1, 2: *Sipunculus* sp. 2, 3: *Thysanocardia* sp. 1, 4: *Thysanocardia* sp. 2, 5: *Thysanocardia* sp. 3, 6: *Siphonosoma* sp. 1.

**Table 4.** Morphometric measurements.

| Characteristics                  | Genus* |   |   |   |   |   |
|----------------------------------|--------|---|---|---|---|---|
|                                  | 1      | 2 | 3 | 4 | 5 | 6 |
| Trunk length of adult            |        |   |   |   |   |   |
| 10 – 41 mm                       | -      | - | + | + | + | - |
| >41 mm                           | +      | + | - | - | - | + |
| Trunk shape                      |        |   |   |   |   |   |
| Elongate/vermiform               | +      | + | + | + | + | + |
| Spindle/tapered                  | -      | - | + | + | + | - |
| Longitudinal muscle bands (LMBs) | +      | + | - | - | - | + |
| Habitat                          |        |   |   |   |   |   |
| Sand or mud                      | +      | + | + | - | + | + |
| Rock                             | +      | - |   | + | - | - |
| Depth                            |        |   |   |   |   |   |
| <10 m                            | +      | + | + | + | + | + |
| 10 – 250 m                       | +      | + | - | - | - | + |
| 250 – 2000 m                     | +      | + | - | - | - | - |

*Sipunculus* sp.1 found in Banda Neira has almost the same characteristics as the *Sipunculus nudus*, the difference being the total length 12-17 cm, maximum width 9-12 m, thick skin dark brown with a thin line extending. This *sipunculus* is not only found in sand or mud habitats but also in rocky habitats with the longitudinal muscle bands (LMB) continue to the tip as single and each LMB divides into two units. The figure shows how the body of *Sipunculus* sp.1 like a spring, so difficult to flex. The intestines full of food, have thick skin, LMBs are visible.



**Figure 4.** *Sipunculus* sp. 1 found in rocky areas.



**Figure 5.** *Sipunculus* sp. 1.

*Sipunculus robustus* comes from the same class as *Sipunculus nudus*, Sipunculidea, but *S. robustus* is of the order Golfingiida. Even though it is the same genus, it has its own characteristics. *S. robustus* has a total length of 14-16.5 cm., A maximum width of 3.2-3.5 cm; introvert one-third of the body length; flesh-colored skin, bearing papilla triangular scales, elongated muscle bands 26-28; ventral and dorsal retractors originating from 2-5 and 9-12 longitudinal muscle bands respectively; intestinal convolution consists of 14-16 spirals and is fixed in the body wall by many binding muscles; organs such as tufts and rectal diverticulum are present; nephridia are short and hang freely into the body cavity [13]. *Sipunculus* sp. 2 has several differences; total length up to 180 mm, LMBs 25-28, slightly thin skin with white mixed with pink, another pattern is thin white transparent so that the internal organs of the *sipunculus* can be seen.



**Figure 6.** *Sipunculus* sp.2.

### 3.4. Genus *Siphonosoma*

The next genus found in Banda Neira was *Siphonosoma*. The results of the specimen identification were close to the characteristics of *Siphonosoma australe-australe*. The taxonomy of this species; the phylum Sipuncula, class Sipunculidea, order Sipunculiformes, family Sipunculida, genus *Siphonosoma* and species *Siphonosoma australe-australe*. Research shows that these organisms live in sandy areas with seagrass on the intertidal. This animal immerses its body into the sand with a depth of 20-70 cm from the bottom of the substrate with a salinity of 35 ppt. This well-known species can exceed 200 mm in length or more than 20 cm, has large, dark, simple hooks as high as 190-210  $\mu\text{m}$ . The muscular body wall is often visible through the skin (15-20 LMB), and the intestinal muscles may have up to three branches [2]. Simple contractile and anal villi. Distribution; including Indonesia. Found in Banda Neira with total length of 23 cm.



**Figure 7.** *Siphonosoma* sp. 1.

A characteristic similar to that of *S. australe* is rectum without numerous caecae. The genus *Siphonosoma* in Banda Neira present with Multiple Rectal Caecae (MRC) is slightly different from that

described by Cutler in the notes. The little literature that at the Sipuncula taxon level makes specimens with almost the same characteristics as well as different is potentially present.

### 3.5. Genus *Thysanocardia*

The distribution of the specimens *Thysanocardia* sp. 1, *Thysanocardia* sp. 2, and *Thysanocardia* sp. 3 are 1-120 meters to the sea. Pigmentation is present in most of the specimens but can fade to brown in preserved specimens. Color usually appears on individual tentacles, either as a circular patch on small specimens or as an elongated band on larger worms. The retractor muscle originates 53-76% of the distance to the posterior end of the body. Small size, long introverts, and short body make the specimen not easily dissected.

The difference between the three specimens in the image below is the line pattern on the body, spots on the body or papillae, circular color on the hooks, skin color, hooks shape, posterior shape and papillae.



**Figure 8.** *Thysanocardia* sp. 1.



**Figure 9.** *Thysanocardia* sp. 2.



**Figure 10.** *Thysanocardia* sp. 3.



**Figure 11.** *Siphonosoma* sp.1 fresh.



**Figure 12.** *Sipunculus* sp. 1. fresh.



**Figure 13.** *Sipunculus* sp. 2. fresh.

The posterior shape of the Sipuncula has variations, it can be seen in the picture above that one of the Sipuncula has a parasite that is attached and lives in the posterior area. The parasite is a type of gastropod that reaches and attaches posterior. Based on the results in the field, the parasite was found in Sipuncula ranging from 9 cm to 23 cm.

#### 4. Conclusion

The spread pattern of Sipuncula in Banda Neira at Tanah Rata and Walang stations is random by testing the Morisita index. The genera found in Banda Neira are from the Sipunculidea class, the *Siphonosoma*, and the *Thysanocardia*. It takes a long identification effort and process in determining the taxon from the genus above to the species level. The morphological characteristics of the sipunculan are slightly different, so it is suspected that there are new species in Banda Neira.

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