

Short Communication: New record of a primitive brachiopod, *Lingula* sp. in Lubuk Damar, Indonesia

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Manuscript received: 3 May 2017. Revision accepted: 10 September 2017.

Abstract. Darmarini AS, Wardiatno Y, Prartono T, Soewardi K. 2017. Short Communication: New record of primitive brachiopod, *Lingula* sp. in mangrove ecosystem of Lubuk Damar, Aceh Tamiang, Indonesia. *Biodiversitas* 18: 1438-1444. This study reports the occurrence of the primitive brachiopod, *Lingula* in mangrove ecosystem as a new record in Indonesia. Specimens were collected from the mangrove sediment at a depth of between the sediment surface and 20 cm beneath. *Lingula* has a glossy shell and oval-ovate shell shape. The color of shell is brownish or greenish. In posterior a point where pedicle occurs is found. The pedicle is a prolongation of the body like an anchor, with varying length, rough, hard and striped texture. Pedicle has soft transparent layer and the edges are covered by the substrate. The inside body of *Lingula*, there is a lophophore, which is the characteristic of this species. The total length of the brachiopod ranges from 3-122 mm. The texture of habitat consists of 39.67% sand, 50.95% silt, and 11.45% clay.

Keywords: Benthos, living fossil, Malacca Strait, marine biodiversity, soft sediment

INTRODUCTION

As an ecosystem, mangrove has been revealed to play ecological function as the center of marine biodiversity by supplying habitat for various organisms (Robertson and Alongi 1992; Field et al. 1998; Wei-dong et al. 2003; Lee et al. 2014). For Indonesia, recent studies related to marine biodiversity have been focused mainly on the occurrence of edible marine invertebrate species, such as lobsters (e.g. Wardiatno et al. 2016a,b,c; Wahyudin et al. 2016; 2017a,b), hippoid crabs (e.g. Wardiatno 2015a,b; Mashar et al. 2014, 2015; Ardika et al. 2015). Information on the occurrence and distribution of non-edible marine organisms such as brachiopods are limited.

Brachiopoda are components significant of the early Cambrian marine faunas (Carlson 2016) and was initially included in the class of mollusk, which was then at the end of the 19 century was removed from the mollusk group (Emig 2008). Hutchins et al. (2003) mention grouping this fauna an exclusively marine group of lophophorate animals. They are called "inarticulated" because their shells lack articulation. Nonarticulate lampshells are also known as inarticulated brachiopods.

Brachiopoda is one phylum of Lophophorates (Pechenik, 2010) and the lophophore, an essential organ of the Brachiopoda (Zhang et al. 2003). Grouping Lophophorates be based animals take possession of a lophophore (Carlson 2016) and as it related to a way of eating that is using lophophore (Emig 1992; Samanta et al.

2014a, b; Carlson 2016), but is morphologically similar to the mollusk with two shells (Sundaram and Deshmukh 2011; Samanta et al. 2014). Additionally, the brachiopoda are differentiated from the mollusk because their shells have anteroposterior symmetry. One common genus of brachiopods is *Lingula* and received appellation as a living fossil (Mudjiono and Suparman 1992; Emig 2003). According to Emig (1997), various types of inarticulate brachiopods spread over coastal waters at bathyal zone until abyssal and are found many in the intertidal zone.

The area of study in Lubuk Damar Aceh Tamiang is located along the coast of Malacca Strait with about ± 3 km beach length. The dominant vegetation is real mangrove vegetation consisting of several species such as *Sonneratia* sp., *Bruguiera sexangula*, *Scyphiphora hydrophyllaceae*, *Avicennia alba*, and *Rizophora stylosa*. The study was aimed to report the occurrence of *Lingula* sp. in a mangrove ecosystem in Province Aceh as a new record of Indonesia.

MATERIALS AND METHODS

Lingula sp. specimens were collected from mangrove ecosystem in Lubuk Damar, Aceh Tamiang, Province Aceh, Indonesia (Figure 1) on January 2017 during low tide at three stations. Sampling was carried out by using core with the area 0.0133 m² at 300 sampling points and 74 individuals were obtained from 0-20 cm sediment depth.

Collected specimens were stored in 70% ethanol after being fixed in 10% formaldehyde and sorting. Laboratory works were conducted in Biomicro Laboratory, Department of Aquatic Resources Management, Faculty of Fisheries and Marine, Bogor Agricultural University, West Java, Indonesia. Substrate analysis was conducted in Soil Laboratory, Faculty of Agriculture, University of Syiah Kuala, Banda Aceh, Indonesia. Morphological picture of the specimens was taken by the dinolite Pro 2 and macro camera of Canon Power Shot D30. Description of the specimens was based on morphology descriptions by Emig (2003), Lee and Campbell (1987), and Yugan et al. (1982).

RESULTS AND DISCUSSION

Systematics

Phylum Brachiopoda Duméril 1806; subphylum linguliformea Williams, Carlson, Brunton, Holmer &

Popov, 1996; Class Lingulata Gorjansky and Popov 1985; Order Lingulida Waagen 1885; Superfamily Linguladea Menke 1828; Family Lingulidae Menke 1828; Genus *Lingula* Bruguière, 1797; Species *Lingula* sp. (Lee and Campbell 1987) (see Figure 2).

Description and biology

Shell shape is oval-ovate with a glossy shell. Its different size on dorsal and ventral valve *Lingula* (Figure 2.D) is representing the dissimilar color of the shells, brownish or greenish (Figure 2.A, D, H). In posterior a point where pedicle occurs is found (Figure 2.G). The pedicle is a prolongation of the body like anchor. Pedicle length varies with striped texture, rough and hard, the colors a light brown to creamy. Pedicle has a sort of a transparent layer (cuticle) and the top part wrapped by the substrate. The sample was found to have two types of pedicle that are stubby and elongated.

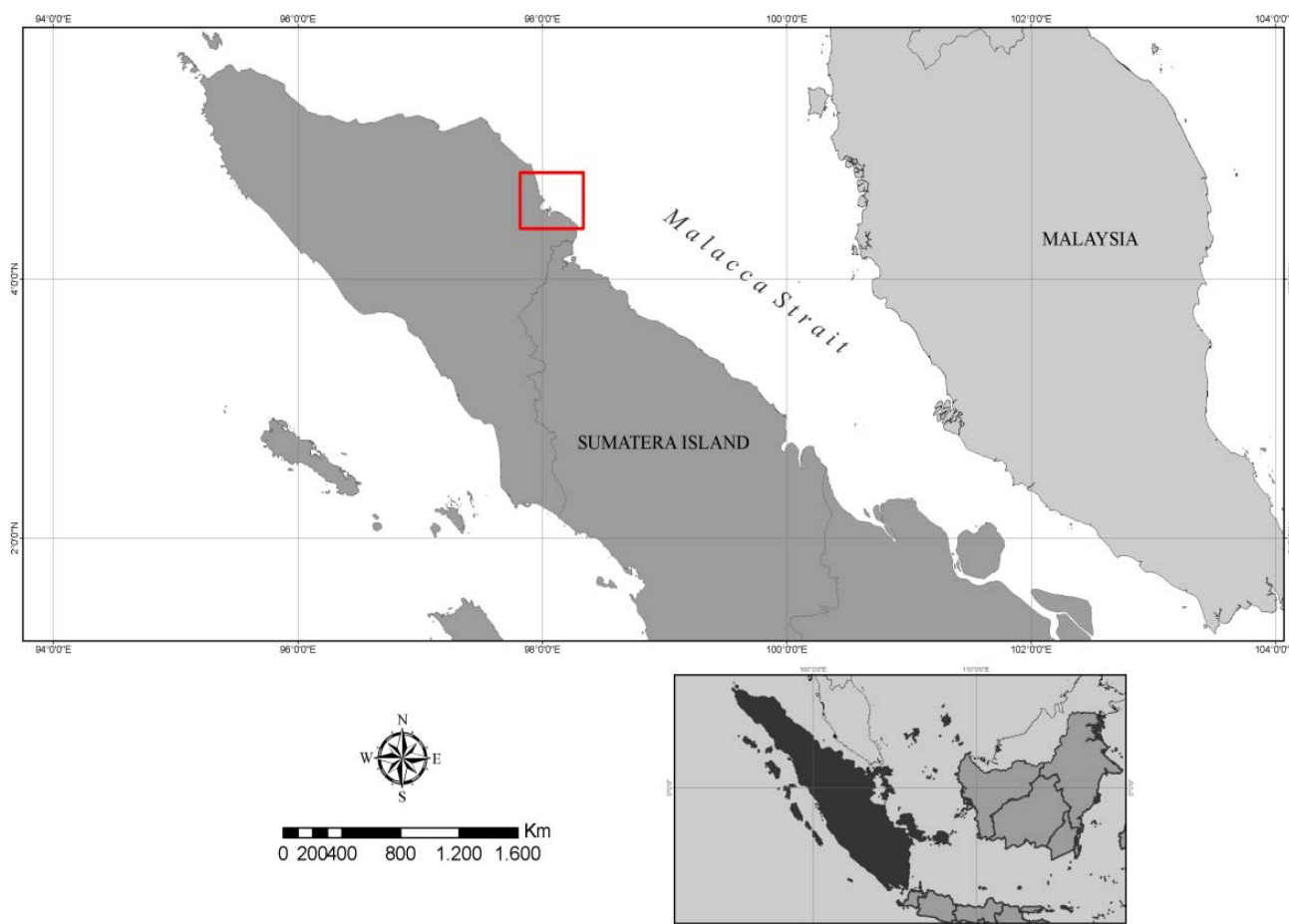


Figure 1. Research location showing the collection site of the brachiopod in the mangrove ecosystem of Lubuk Damar, Aceh Tamiang, Province Aceh-Indonesia. The red square indicates the sampling site

In each valve has a mantle with chaeta throughout shell (Figure 2.A, H). On the anterior have chaeta a longer, functioning as an inhalant and exhalant pseudo siphon (Figure 2.H). In the sampling locations small size *Lingula* was found too (Figure 2.C) and chetae on juvenile is evident. The inside of the body is lophophore which is the distinctiveness of this species (Figure 2.B, E). In this study, 74 individuals of *Lingula* sp. were obtained, and the total length, shell length, width of a shell and pedicle length ranged from 1-122 mm, 1-39 mm, 0.2-19 mm and 2-99 mm, respectively. While the weight ranged between 0.0001-6.543 g.

Shell

The size of *Lingula* sp. in the mangrove ecosystem of Lubuk Damar, Aceh was very diverse and bigger (3 mm-122 mm), if compared with the size of *Lingula* found in other studies, e.g. 22.5 mm-38.5 mm (Emig 1984), 45 mm-58 mm (Sundaram and Deshmukh 2011), 27.5 mm (Hutchins et al. 2003), and 24.84 ± 2.98 mm (Printrakoon et al. 2014). Shells of *Lingula* discovered in the mangrove ecosystem mostly had a light to dark green color (Figure 2.A, H) as in *Lingula anatina* reported from Subarnarekha estuaries, India (Mitra and Pattanayak 2013), but few specimens showed light brown to greenish color; similar to those found in New Caledonia (Bitner 2010) and in Ratnagiri, Maharashtra, India (Sundaram and Deshmukh 2011). Shell color distinction is probably an indication of species and environmental conditions. Observations also showed that the shell consists of two distinct parts. The anterior valve widens and posteriorly narrows which culminate in the appearance of the pedicle. The shape of shell reveal is oblong-elongate, (Figure 2.A, H) and smooth surface and *Lingula* sp. shells are thin and fragile, the shell divide by a dorsal and ventral valve. The ventral valve is more taper than dorsal on the posterior part. Clarke and Wheeler (1915) found that the brachiopod fell into two chemically distinct groups; one is calcareous and the other is highly phosphatic.

Emig (1979, 1984) and Samantha et al. (2014) explored the characteristics of the shell of *Lingula anatina* in West Bengal-Odisha coast, India, and they found their specimens had two dissimilar valves which emerge to be oblong-ovate, elongate, bilaterally symmetrical, endowed with parallel lateral margins, sharp beaks, and straight edges. Emig (2003) pursuant to genus *Lingula* characteristic from Sumatra is shell lengthen oval or subrectangular in broad outline, lateral margins subparallel, anterior margin amply spherical to lank.

Surface of the two valves was mostly found to be smooth but indicating growing process lines (Emig 1978, 1979; Hutchins et al. 2003). The outer of shell depicts flimsy growth lines (Figure 2.H). These shells have a ventral and a dorsal valve. Anterior valves have setae, two inhalant and one exhalant pseudo siphon (Emig 2003). *Lingula* has three low-siphonal ribs extend from beak to

anterior margin of the shell (Emig 1979; Hutchins et al. 2003). Inhalant-exhalant pseudosiphon is shown in Figure 2H.

Pedicle

All of the *Lingula* sp. in the study site had longer pedicle size (1-2 times and more) than the shell length. The pedicle length on location is 2 mm-99 mm. Some juvenile sample length of the pedicle more than 3 times of the shell and some few completely lost of a pedicle. The length of pedicle size was found to be one and a half until 2 times the shell length similar (Emig 1978; 1979). The color of the pedicle is creamy to whitish (Figure 2.F) and substantially similar as described in Emig (1984). The pedicle described is fleshy in *L. anatina* (Emig 1979; 1984).

During the observation, some *Lingula* sp. position showed the pedicle on the bottom and shell upstairs in their habitat. This evidence is similar to the common findings that *Lingula* is a vertically digging brachiopod in soft sediments with shell position at the top of their burrows (Emig 1997, 2003; Hutchins et al. 2003). Yugan et al. (1991) mentioned that the pedicle of extant lingulids was composed of a deltoidal section banded to the pedicle valve, a cylindrical primary trunk, and a desolate bulb-like end anchored by a mucous secretion to the bottom of the burrow. The isolated bulb of the pedicle (foot like base of the organism) is firmly anchored into the substrate at the bottom of the burrow and is bestead by a mass of sand and organic particles take hold of together by sticky mucus. The pedicle of brachiopods is described attachment of generally accomplished tool of a stalk (Pechenik 2010), a stalk-like structure appearing between the two valves of most brachiopod, make easier attachment to a tough substrate but not for hard substrate (Carlson 2016).

Lophophore

Lophophore is a characteristic of *Lingula* (Figure 2.E, B), and is described as muscle endowed spiral feeding structure of ciliated tentacles around the mouth (Samantha et al. (2014a). The position of lophophore is on the anterior valve and/or on the open out shell. The shape is like a snail's dwelling, in white and has a tentacle at the edges (Figure 3.A, B). It is composed of two, right and left (Figure 2.E, 3.A). Lophophore consists of two long arms the circle to form a spiral (Figure 3.A), the detail part of lophophore (Figure 3.B). Emig (1976) showed lophophore as oval shaped round the mouth with a single line of tentacles, therefore the functions may be associated to feeding, respiratory, and protection. Emig (1976, 1992) stated that the lophophore had increasingly advantage than just being considered as a feeding mechanism absorbing alimentary particles and soluble nutrients. Its primary function is a water flow model that also acts as a respiratory organ.

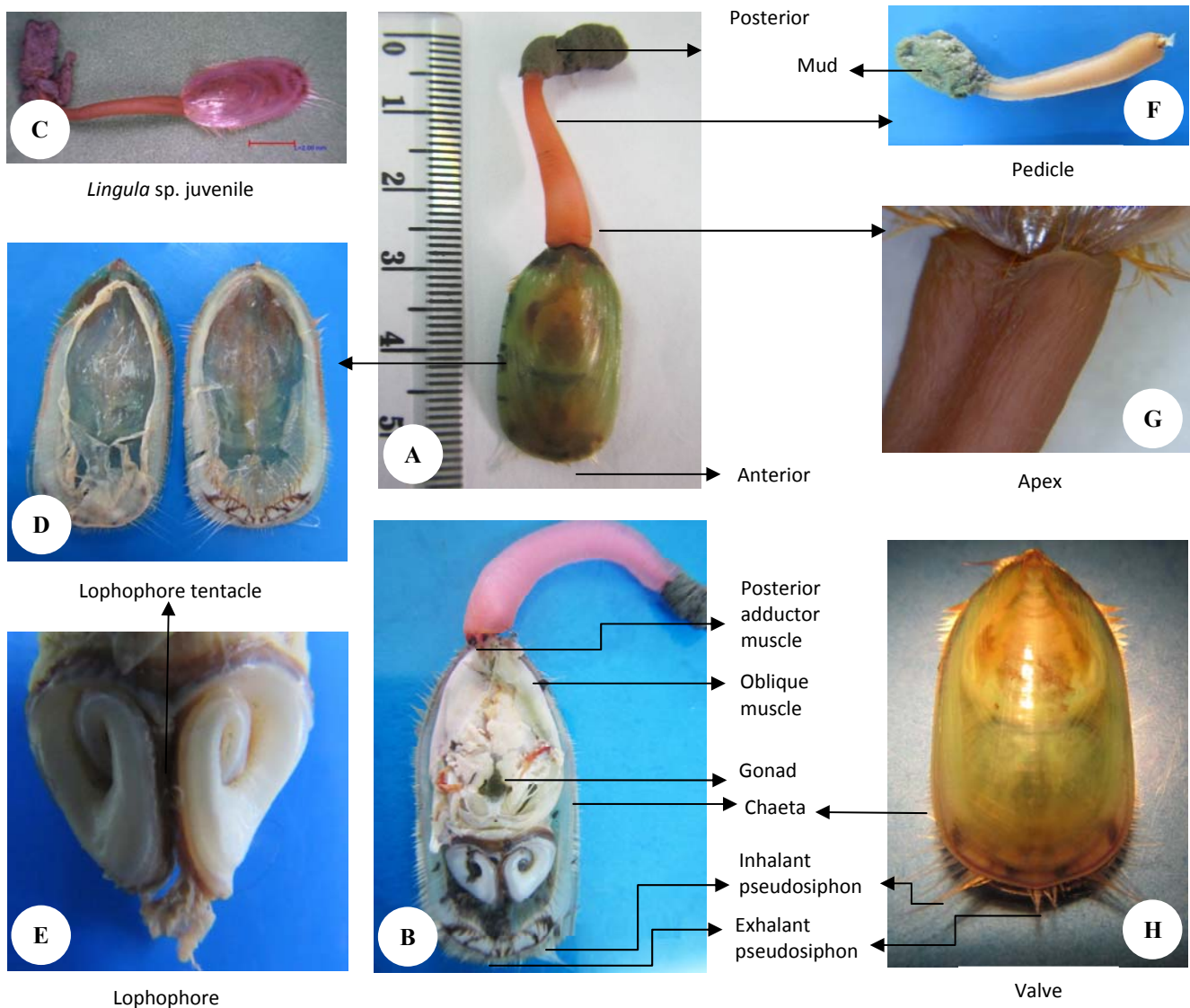


Figure 2. Morphology and anatomy of *Lingula* sp. collected from mangrove ecosystem in Lubuk Damar, Aceh Tamiang, Province Aceh, Indonesia. A. Body of *Lingula*, B. *Lingula* dissection, C. Juvenile, D. Valve, E. Lophophore, F. Pedicle, G. Apex, H. Shell.

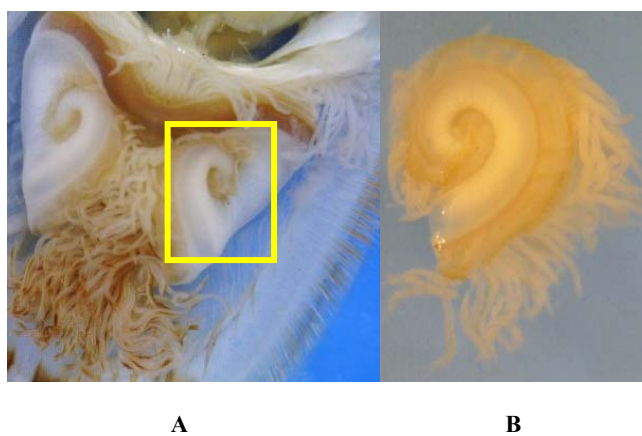


Figure 3. Lophophore. A. Lophophore coiling, B. The coiling part of lophophore

The lophophore is an organ of two arms that endure ciliated tentacles get used to filter feeding and respiration (Carlson 2016). Lophophore is characterized by the presence of muscle crease helical with ciliated tentacles (Samanta et al. 2014a), the function of cilia (tiny hair-like structures) produce a unidirectional current of water through the mantle cavity, extracting oxygen and food particles and transporting them to the mouth (Carlson 2016). According to LaBarbera (1981) the lophophore establishes a perpetual, laminar water flow, induced by rows of lateral cilia on the tentacles. Their movement draws water through the tight cleft between tentacles. There is no internal mixing and no recirculation of filtered exhalant current. Gametes and cesspool products are discarded from the mantle cavity by the same process (Carlson 2016). The spirolophore is characteristic of all alive inarticulate (Emig 1992; Hutchins et al. 2003).

Habitat

Observations conducted in areas of study acquired *Lingula* sp. of the distance from the highest tide-lowest tide was 0-500 m, from the mangrove canopy area until the beach. Substrate texture in location was muddy with 39.67% sand, 50.95% silt and 11.45% clay. Habitat of *Lingula* was reported with evenly density present on intertidal areas (Emig and Hammod 1981; Bitner et al. 2012; Samanta et al. 2014), which is partially exposed in middle intertidal muddy area during low tide. Superfamily Linguloidea was reported to share an infaunal way of life (Emig 1984, 2003), and were found in sandy loam regions (Samanta et al. 2015). The variance found in this so that could be found on the substrate of silt up to coral (Savazzi 1991), in shallow waters by a depth of 20 m or more (Samanta et al. 2014).

The similar condition to the habitat of *Lingula* sp. in Subarnarekha India is that the substrate in most cases was soft muddy area, but black soil (decomposed) and sand mixed mud were believed to be preferential for the living. Juvenile's bed was established in fine soft mud (Mitra and Pattanayak 2013). On Fangchenggang mangrove in China *Lingula* occurred from areas with fine sand (>68%) with sediment particles on sandy loam and loamy sand (Printrakoon et al. 2014). In accordance with Hutchins et al. (2003), Lingulidae is exclusively infaunal (living in the sediment at the bottom of the ocean) in soft substrates from the intertidal zone.

In the study area, some other macrozoobenthos were also discovered, such as polychaetes (*Glycera*, *Maldane*, *Pista*, *Pistella*, *Sternapsis*, *Onuphis*, etc.), sipunculans, pelecypods (*Tellina*, *Siliqua*, *Anadara*, *Gastrana*, etc.), gastropods (*Solen*, *Cepridula*, *Dentalium*), crustaceans (*Pagurus*, *Uca*, *Scylla*, *Penaeus*, *Alpheus*), and many more (Darmarini 2017; unpublished data). This finding is similar with Mitra and Pattanayak (2013). There is probably indirect and direct relationships in habitat among those benthic animals with the brachiopod. Goto (2014) revealed a symbiotic relationship between the *Lingula anatina* and *Koreamia setouchiensis*. This mollusk embedded on the anterior part of the shell, perhaps to make use of water flow created by the host for filter feeding, estimation this bivalve may prefer to use exhalant by *Lingula*.

Feeding ecology and diet

Feeding habit of *Lingula* based on gut content analysis indicated the presence flake of mangrove leaves, planktonic materials, and detritus in the gut (Samanta et al. 2015). According to Hutchins et al. (2003) the food items of brachiopods include phytoplankton as diatom, superficial meiobenthos, colloidal organic matter. Therefore, the brachiopod can be included in suspension feeder (Emig 1984; Hutchins et al. 2003; Samanta et al. 2015; Temereva and Tsitirin 2015).

Distribution

Brachiopods live in all oceans (Emig 1997; Emig et al. 2013), and are greatly dispersed geographically at depths ranging from intertidal down to more than 5000 m (Emig et al. 2013). They are distributed considerably in Indo-West

Pacific area (Emig 1997). *Lingula* has a widely distribution in Asia, Australia, Europe, Africa (Williams et al. 2000; Mitra and Pattanayak 2013), such as in Ambon, Indonesia (Jackson and Stiasny 1937), Singapore Island (Chuang 1961), Hokkaido Japan (Hayasaka and Hatai 1956), Mutsu Bay, Northern Japan (Emig 1984), Korea (Park et al. 2000; Hong et al. 2007), mangrove area in Ratnagiri Maharashtra, India (Sundaram and Deshmukh 2011), estuary Subarnarekha (Mitra and Pattanayak 2013), Thailand (Printrakoon and Kamlung-ek 2013), north-east coast of India (Samanta et al. 2014), China seas (Ricardson et al. 1989), Fangchenggang mangrove, China (Printrakoon et al. 2014), Nhatrang Bay, Vietnam (Temereva and Tsitirin 2015), Kaneohe Bay, Oahu, Hawaii, USA (Hunter et al. 2008), Atlantic (Williams et al. 2000), Spain (Marques-Aliaga et al. 1999), France (Emig et al. 2007), South Germany (Bitner et al. 2009), New Zealand (Allan. 1936), Australia (Kenchington and Hammod 1977), New Caledonia, New Zealand (Bitner 2010), Madagascar (Emig 1977), Western Indian Ocean (Bitner and Logan 2016).

ACKNOWLEDGEMENTS

This paper is a part of a doctoral study of the first author. The first author is thankful to Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences Bogor Agricultural University, for supporting laboratory. This study is funded by BPPDN Scholarship from Ministry of Research, Technology and Higher Education of the Republic of Indonesia. Constructive comments of two reviewers to improve the earlier MS are appreciated.

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