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Zooplankton seasonal dynamics in Ambon Bay, Maluku

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Abstract. A seasonal study of zooplankton was conducted to understand the abundance and diversity of zooplankton in related to oceanographic condition in Ambon Bay, Maluku. The research was conducted in four months (March, April, July, and October) which represented the various seasons in Ambon Bay in the year of 2016. The abundance of zooplankton was determined from NORPAC net (mesh size 0.33 mm) with depth varied from 10m to surface. The samples were taken in 18 stations which 7 stations located in Inner Ambon Bay, 1 station in the sill, and 8 stations in Outer Ambon Bay. All samples were preserved in bottle containing 4% formaldehyde and then analyzed using microscope. We also used CTD equipment to measure the vertical and horizontal distribution of temperature and salinity from the surface into 10m depths. The result showed that the distribution of temperature and salinity in Ambon Bay were varied following the season. The total abundance of zooplankton in Ambon Bay was fluctuated between 403-42097 ind./m^3 following the season. The highest average abundance of zooplankton occurred in March (northwest monsoon) where the temperature was higher than other season. The lowest average abundance occurred in April (transition) where the salinity was lower than other season. The number of Copepods from genus *Acrocalanus* and *Eucalanus* were presented in all season. In southwest monsoon, spawning of Annelida and Echinoderm larvae were the most indicated larvae. Meanwhile, in southeast monsoon we indicated that the Copepod eggs and larvae as the most abundance in the waters.

1. Introduction

Plankton communities in coastal ecosystem have a major importance in food webs. Zooplankton is the secondary producers in the coastal area which have the crucial function between the primary producers, phytoplankton [1, 2] and other marine organisms in the higher thropic levels such as the relationship between zooplankton and juvenile chum salmon, which the highly abundance of zooplankton have the positive impact for chum salmon *Oncorhynchus keta* growth during early stage in the sea [3]. Further, Mianzan *et al*. (2001) explained that the important of gelatinous zooplankton as prey item for anchovies *Engraulis anchoita* [4]. There are many intensive study have been conducted according to plankton food web in coastal area eg. The Coliumo Bay, Chile [5], in the coastal water off Usujiri Southwestern Hokkaido [1], and in the Sagami Bay [6].

Ambon Bay is a semi enclosed bay located in Ambon Island (eastern part of Indonesia). This bay was separates into two parts by narrow and shallow sill and known as Inner Ambon Bay (IAB) and Outer Ambon Bay (OAB). IAB and OAB have different characteristic where IAB has neritic characteristic while OAB has an open seas characteristic. Some investigation had been done in this location such as hydrological aspect [7, 8], water mass dynamics [9], primary productivity [10], zooplankton [11, 12] blooming of red tide *Pyrodinium bahamense* [13, 14], the abundance of marine Cladoceran [15], Annelida worm [16], and meroplankton [17, 18]. While previous investigations have described the density and abundance of zooplankton in Ambon Bay, for the first time in this paper we epxlain the seasonal dynamics abundance of zooplankton in Ambon bay with notes of outbreak of annelida larvae during Southwest monsoon.

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2. Methodology

This research was conducted in Ambon Bay on March, April, July, and October 2016. Each month was represented different of season that occurred in Ambon Bay in order to study the zooplankton abundance seasonal dependent. The samples were taken in 18 stations which 7 stations located in Inner Ambon Bay, 1 station in the sill, and 8 stations in Outer Ambon Bay (figure 1). The abundance of zooplankton was determined by NORPAC net (mesh size 0.33mm) with depth varied from 10m to surface. All samples were preserved in bottle containing 4% formaldehyde and then analysed using Wickstead method [19]. We used some zooplankton identification books to classify the samples [20, 21, 22]. The number of zooplankton was counted in ind/m3 unit. In this observation, we also measured vertical and horizontal variability data of temperature and salinity by using CTD equipment from surface to 10m depth and processed using ODV (Ocean Data View) [23] and Surfer software.

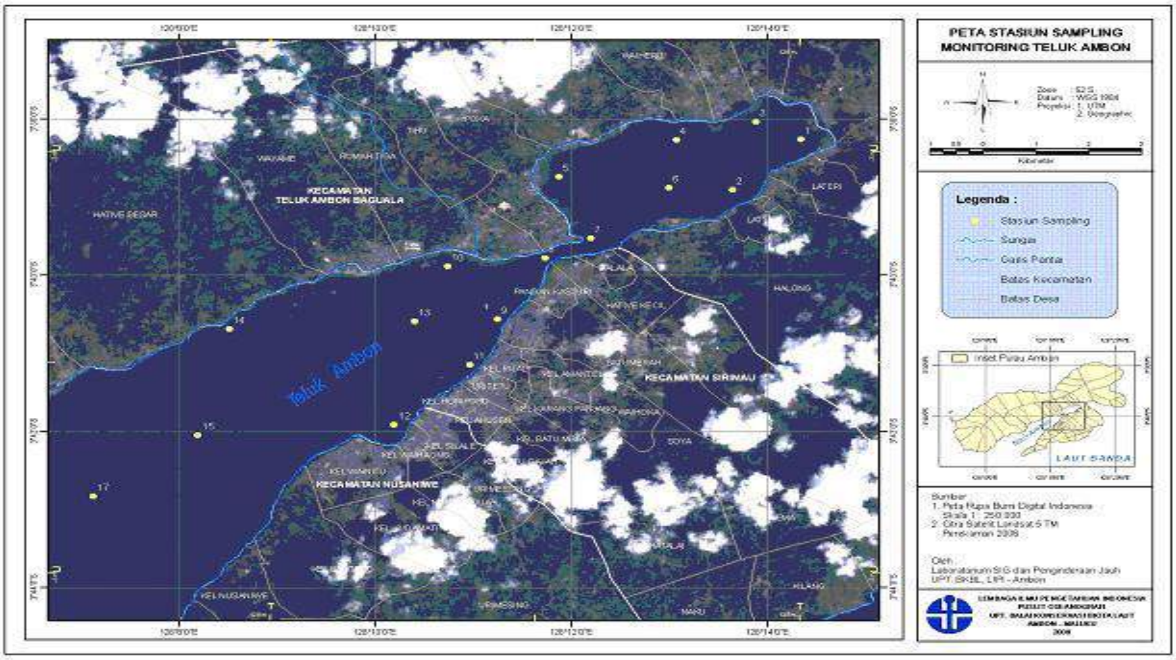


Figure 1. Map of observation location

3. Result and Discussion

3.1. Physical oceanography

The oceanographic condition in Ambon bay was represented using temperature and salinity data from the surface into 10m depths. Each months of observation represented different season occurred in Ambon Bay; March (northwest monsoon), April (transition I), July (southeast Monsoon), and October (transition II). The horizontal distribution of temperature known as sea surface temperature (SST) for each month was obtained from average temperature between 0-1m depths. The result showed that SST in Ambon Bay was changed following the season. In northwest monsoon, the temperature was higher than other season and then reduced when entering the transition I. In southeast monsoon the temperature was lower than other season which predicted due to upwelling phenomena in Banda Sea[1,2] and then the temperature raised again in Transition II (Figure 2).

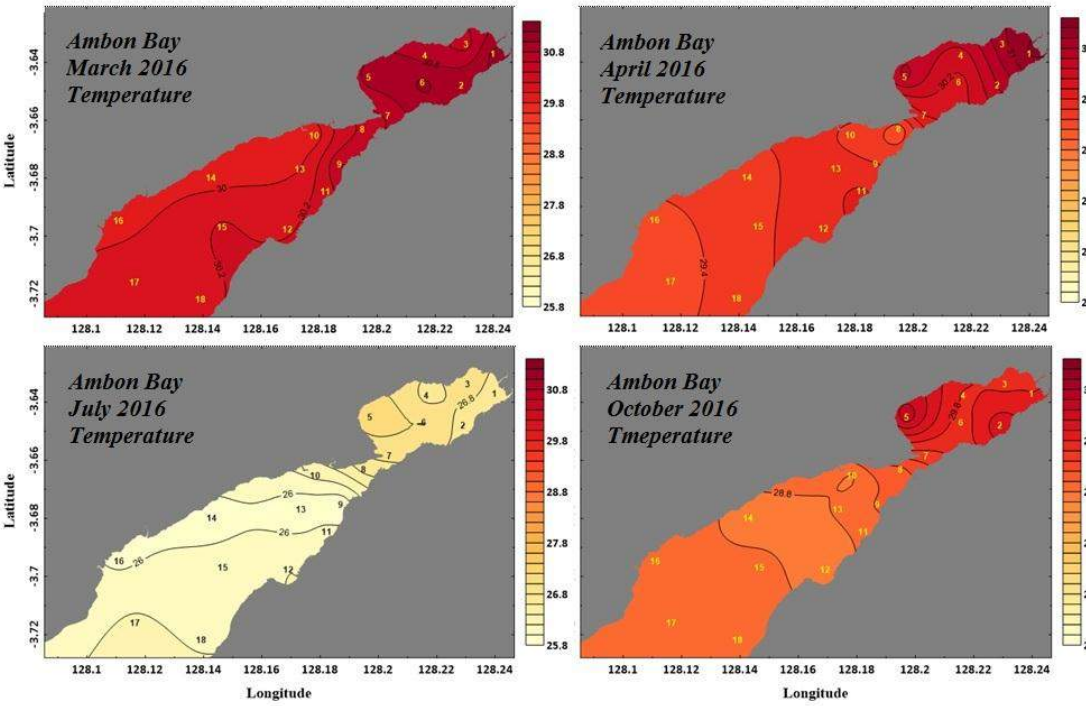


Figure 2. Sea Surface Temperature distribution in Ambon Bay, Maluku

The temperature distribution that seasonal dependent was not only observed in the surface but also into 10m depths which clearly shown in Figure 3. The distribution of temperature in Outer Ambon Bay (OAB) was lower and homogeny than Inner Ambon Bay (IAB). Differences in oceanographic characteristic between OAB and IAB were expected due to difference in bathymetry where IAB had a lower depth (±45m) compared with OAB (> 600m in the most outer station). The presence of narrow sill which separate OAB and IAB was also guessed as the cause of unique oceanographic characteristic in Ambon Bay.

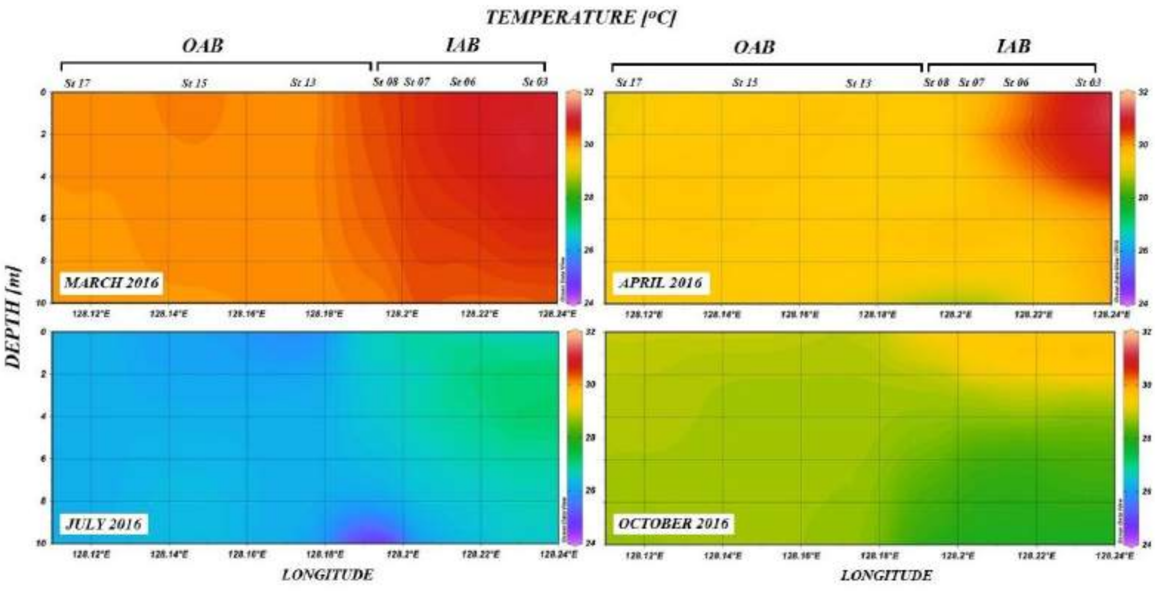


Figure 3. Vertical distribution of temperature in Ambon bay (station 3, 6, 7, 8, 13, 15, 17).

The measurement of sea surface salinity (SSS) in Ambon Bay shown that the distribution of salinity in IAB was lower and varied than OAB which expected due to mixing with fresh water from river along the coast of IAB (Figure 4). Anomaly in the SSS pattern was occurred in southeast monsoon (July) where salinity in OAB tends to be lower and varied than IAB. It is because there was a heavy raining in OAB during the measurement of oceanographic parameter. This anomaly was observed into 10m depth in station 13 where the station location was near the estuary (Figure 5).

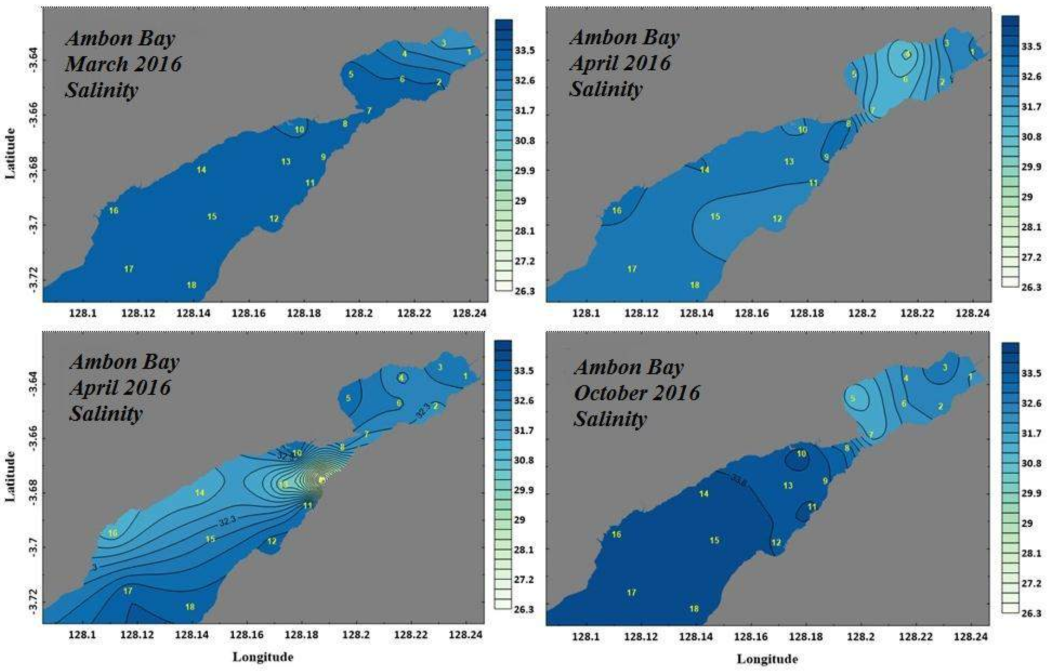


Figure 4. Sea Surface Salinity in Ambon Bay, Maluku

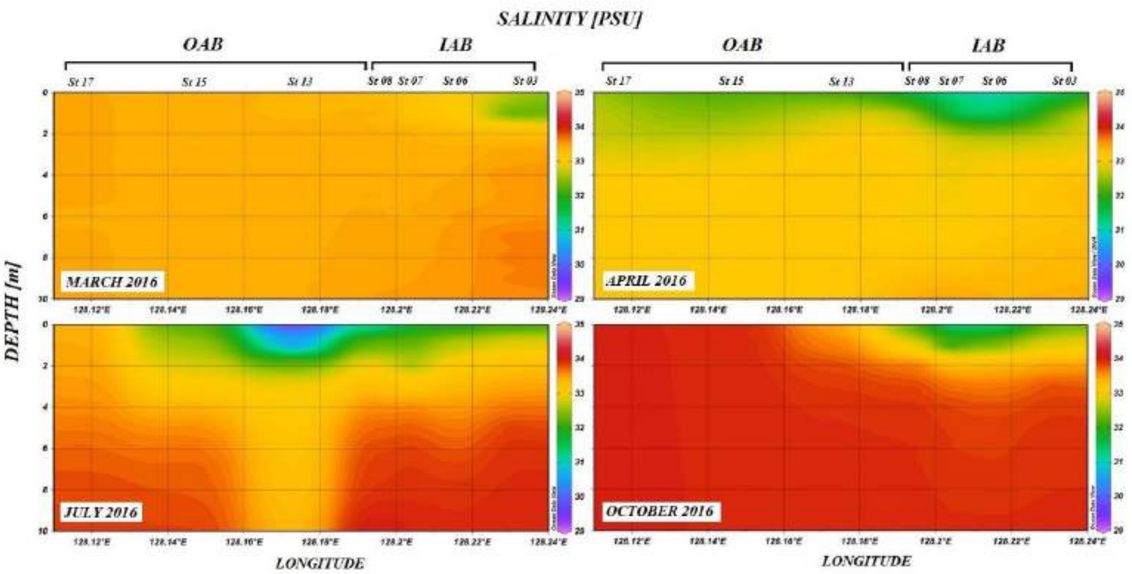


Figure 5. Vertical distribution of salinity in Ambon bay (station 3, 6, 7, 8, 13, 15, 17).

As well as the vertical temperature data, the distribution of salinity in this area was changed following the season (Figure 5). In northeast monsoon and transition II, the salinity value was higher than northwest monsoon and transition I. The high value of salinity in southeast monsoon and transition II was predicted due to upwelling phenomena in Banda Sea where water mass with low temperature and high salinity from the deep was pumping up into the shallow depth and then entering Ambon Bay [9,24].

3.2. Zooplankton abundance

The seasonal pattern total abundance of zooplankton was fluctuated between 403-42097 ind/m^3. Detail of dynamics zooplankton abundance during observation was shown in Figure 6.

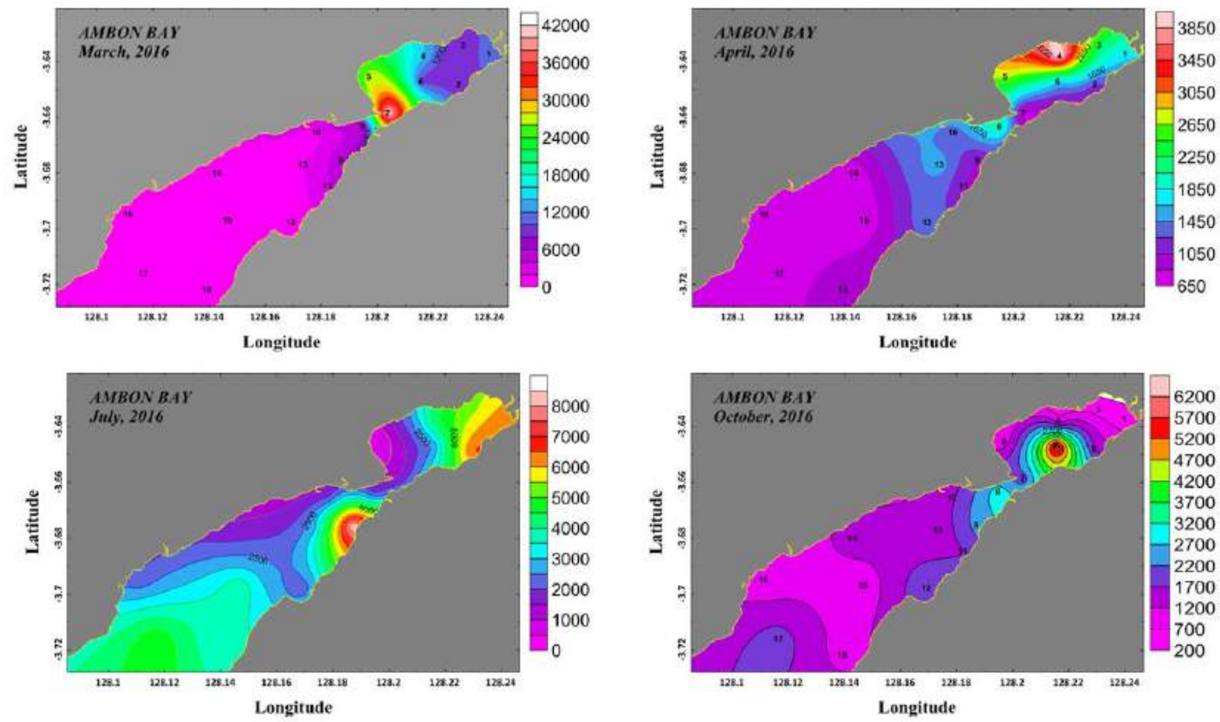


Figure 6. Total abundance of zooplankton in Ambon Bay, 2016.

The total abundance of zooplankton was higher in IOB and lower in OAB during March, April and October. In other side, the value of total abundance of zooplankton was changes on July. In this period, the amount of total abundance of zooplankton was more abundant in OAB and less in IOB due to oceanographic factors. It was suggested that hydrological conditions e.g. temperature, salinity, and primary production play an important role for zooplankton [5, 25]. The primary productivity in IAB was higher than in OAB because of the nutrient input from the land gave more impact in IAB than in OAB during northwest monsoon, transitional I and II while upwelling from Banda Sea influenced the primary productivity more in OAB than that in IAB during Southeast Monsoon [10].

The average abundance of zooplankton was rise and fall periodically over the periods (figure 7). During northwest monsoon, the value of mean abundance of zooplankton was the highest compared with other season. Started from above 7000 ind/m^3 in the beginning, the mean abundance was decrease nearly fivefold on July. The amount of average abundance of zooplankton slightly increased during northwest monsoon and decreased in the end of period.

The highest abundance of Annelida larvae in IAB was observed during northwest monsoon comprising 7818-42097 ind/m^3 (72-91%) of total zooplankton, while 576-6039 ind/m^3 (2-73%) in OAB (except in station 14 and 16 was absent) in figure 7. The second predominant group were identified e.g. *Acrocalanus*, *Eucalanus*, *Oithona*, *Corycaeus*, *Evadne*, *Lucifer*, *Sagitta*, *Larvacea*, echinoderm larvae and Siphonophora. The highly abundance of Annelida larvae expected due to spawning season of sexually mature Annelida. [16] It was reported that mass swarming, prior to spawning of Annelida worms (Nereididdae) at Ambon Island was occurred on March. Further, [26] explained that meroplankton was abundant in neritic environments and formed by eggs or larval stages of marine organisms which presence in the pelagic zone was only temporary.

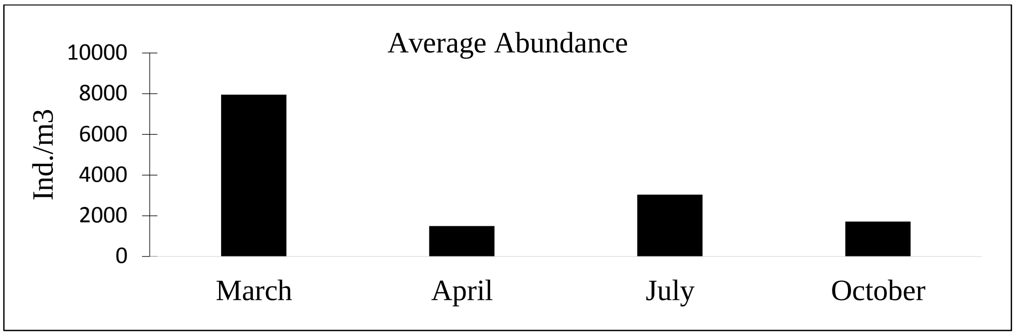
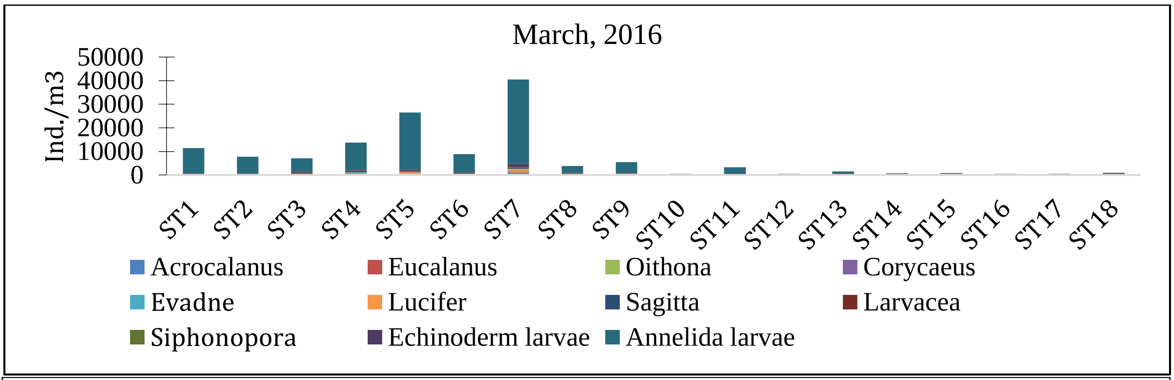


Figure 7. The average abundance of zooplankton in Ambon Bay (ind/m^3), 2016.

The changes of seasonal abundance of zooplankton were occurred during southeast monsoon (figure 8). The eggs and juvenile copepod was peak in OAB (except in station 12 and 16) following by Penaidae larvae and *Acrocalanus* during this season. In contrast, zooplankton group from planktonic shrimp *Lucifer* was remarkably high in IAB comprising 14-36% of total zooplankton. In this period, the level of chlorophyll-a and primary productivity in Ambon Bay was higher than other seasons due to upwelling process in Banda Sea and the water mass was entering to Ambon Bay [10, 9, 24]. Zooplankton would response the higher concentration of primary productivity to its growth and reproduction. Vargas *et al* (2010) explained that when the environment conditions were suitable for Copepod, they would grow fast which indicated by the high value of egg production rates [5, 27].



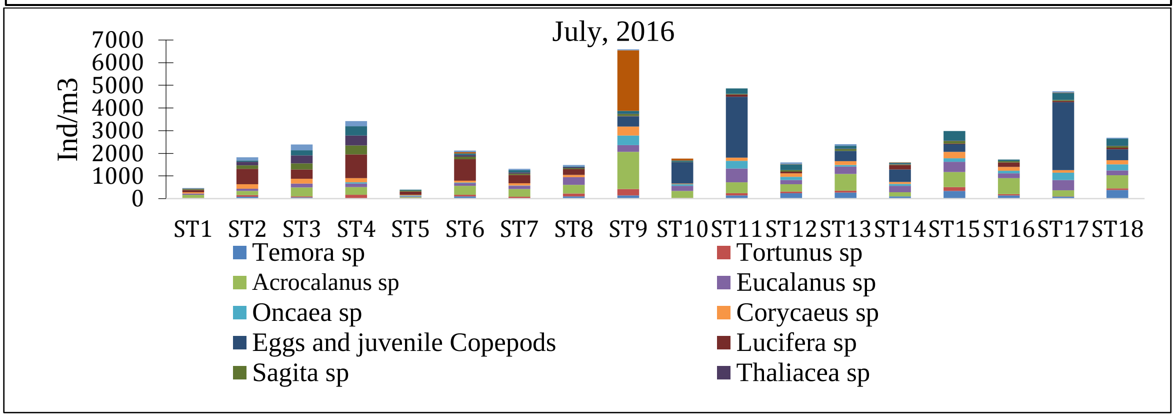


Figure 8. Zooplankton predominant during northwest monsoon and southeast monsoon in Ambon Bay, 2016

4. Conclusion

The abundance of zooplankton in Ambon Bay was dynamics following the season. The highest average abundance of zooplankton occurred in March (Southwest monsoon) where the temperature was higher than other season. The lowest average abundance occurred in April (transition) where the salinity was lower than other season. In Southwest monsoon, spawning of Annelida and Echinoderm larvae were the most indicated larvae. Meanwhile, in Southeast monsoon we indicated that the Copepod eggs and larvae as the most abundance in the waters.

Acknowledgement

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