The Diversity of Plankton in Sangihe – Sangir Talaud Islands, Sulawesi, Indonesia

Hikmah Thoha and Nurul Fitriya

Plankton and Primary Productivity, Research Center for Oceanography, Indonesian Institute of Sciences,Jl. Pasir Putih No.1, , Ancol Timur, Jakarta 14430, Telp : 62 -21 – 64713850, Fax : 62 -21 – 64711948, E-mail : hikmah_thoha@yahoo.com ; nurulfitriya29@yahoo.com

Abstract

The research of Oceanographical Expedition was conducted on May 2009. Research Vessel of Baruna Jaya VIII was used to accommodate the research team, which is a part of the EWIN (Widya Nusantara Expedition) project with a topic of discovering the ultimate frontier of Indonesia and strengthening our national resilience, such as survival, energy, and natural resources, food, disaster, and health. This paper shows plankton research with environment studies, such as temperature and salinity. Plankton was sampled using Kitahara Net with mesh size of 80 µm for phytoplankton and Norpac Plankton Net with mesh size of 300 µm for zooplankton. The sample was poured into a bottle with formalin of 4% as preservative from 13 stations. The results showed that the phytoplanktons consist of 22 diatom genera and 10 dinoflagellates. The phytoplankton abundance was due the flourishing of *Chaetoceros* sp., *Rhizosolenia* sp., *Nitzschia* sp., and *Thalassiothrix* sp. *Ceratium* sp. and *Protoperidinium* sp., *Pyrocystis* sp., and Cyanobacteria *Trichodesmium* sp. were common among the dinoflagellates. The zooplanktons consist of 30 taxa, the group of which are mostly composed of *Copepoda, Calanoida, Cyclopoida, Oikopleura*, and *Chaetognata*. Environmental studies were also discussed.

Key words: *diversity, phytoplankton, zooplankton, Sangihe – Sangir Talaud Islands*

Introduction

The district of Sangihe is located in Northern Sulawesi Island of Central Indonesia bioregion. The geographical structure formed an archipelago with many islands such as Tahuna, which is the capital city of Sangihe Island Regency. There is a coral reef with a depth of 15 meters, flourishing with the coral reef fish, Anemon, hard-coral and soft-coral, which provides a magnificent view. This location is also perfect for safe night diving. The others island are Mahengetang, Kahakitang, Dagho, Bukide, Nenung, Para, and Kendahe islands and among the district with the longest coastline in the continent. The islands are surrounded by the most amazing features of underwater volcanic ridges between Indonesia and Philippine through the Wallacea line and Coral Triangle, put them into and undoubtedly home for rich marine biodiversity that life coevolutes with types of magical reefs fringing these islands. The beauty and uniqueness that existed in Sangihe, encouraging local government to develop community – based conservation and ecotourism within Sangihe's development strategy (Developing Community Base Ecoturims and Conservation, 2009).

They are like a string of pearls with their white sand beaches and fertile land upon which can be found a vast jungle, nutmeg gardens and coconut trees which decorate the foot of a mighty volcano reaching to the sky. A variety of sea life as well as beautiful wildlife and plant life inhabiting the land create an ornamental picture of nature in harmony which is complemented by the rich culture and friendliness of the local residents. The peaceful and fulfilling island atmosphere will make all visitors fell at home. The unpolluted blue sky and clear crystal waters are incomparable (Pearls of the North, 2009).

The research of Oceanographical Expedition was conducted on May 2009. Research Vessel of Baruna Jaya VIII was used to accommodate the research team, which is a part of the EWIN (Widya Nusantara Expedition) project with a topic discovering the ultimate frontier of Indonesia and strengthening our national resilience, such as survival, energy and natural resources, food, disaster, and health. EWIN Expedition leg-3 activities are marine dynamics such as physical oceanography, chemistry oceanography, microbiology, and plankton. This paper shows plankton research with environment studies, such as temperature and salinity.

Material and Methods

The planktons were carried out on May 2009. Planktons were collected using the Kitahara net for phytoplankton and Norpac net for Zooplankton. The plankton net is equipped with flow – meters at the mouth of the net, to calculate of filtered seawater flowing through the net. The filtered seawater is calculated using the equation : V = r.a.p (where V = volume of filtered seawater, r = rotation of flow-meter, a = area of the mouth of plankton net length of water column for one rotation). The phytoplankton net has mesh size of 80 µm and the zooplankton net has mesh size of 300 µm. The plankton net is deployed horizontally 2 – 5 minute from the sea surface and then hauled up with constant velocity. Plankton samples were removed from the bucket of the net and immediately fixed with 4% neutral formalin. Identification and enumeration of plankton is done under microscope in the laboratory. Plankton counting, sample was enumerated from a fraction (one ml or 1/100 or more of the sample) in term of cells (not in term of chains) for phytoplankton and 2.5 ml for zooplankton. The fraction was poured into a Sedgwick-Rafter counting cell for phytoplankton. Zooplankton counting: Copepods were counted in a fraction (1/4 or 1/2 of the sample) for the big sample. However, in a small sample, the whole animals were examined. The fraction (or the whole sample) was put into a round (wheel) counting chamber and the zooplankton was identified, if possible, up to the genus. In identifying copepods, all animals were generally looked through closely and enumerated. In some cases where the animal was in the larval stage or difficult to recognize, it was identified into the order or the class of the taxon (Wickstead, 1961; Taylor, 1994; Sekiguchi, 2007).

Results and Discussion

The islands under study are Mahengetang, Kahakitang, Dagho, Bukide, Nenung, Para, and Kendahe. These are surrounded by the most amazing features of underwater volcanic ridges between Indonesia and Philippine through the Wallacea line and Coral Triangle, put them into and undoubtedly home for rich marine biodiversity that life coevolutes with types of magical reefs fringing these islands. The plankton samples were collected in depth between 100 and 200 m,13 stations were selected for plankton sampling (Figure 1).

There are 13 sampling sites in Sangihe – Sangir Talaud, North of Sulawesi. In the present observations (May 2009), around 22 genera are recorded which are composed of the population of phytoplankton throughout the stations. The genera of phytoplanktons are mostly composed of diatoms and dinoflagellates. The phytoplanktons consist of 12 diatoms genera and 10 dinoflagellates observed, which predominantly occurred during the survey throughout the stations, i.e. *Chaetoceros* sp., *Nitzschia* sp., *Rhizosolenia* sp. Phytoplankton concentration of this study from horizontal haul samples was 3339 – 31258 cells/m^3. The highest abundance in St 12, 6, 10, 5, 9, 13**,** the lowest abundance is recorded in St 7, 8, 11, 14, 15, 16, and 17 (Figure 2). These values are similar than the Raja Ampat (Thoha, 2009) ; Weda Bay (Thoha, 2009) and Manila Bay (7 x 10^6 cells/m^3) (Bajarias, 1994). Among them, the most common genus of phytoplankton in this study are *Chaetoceros* sp. 14294 cells/m^3 (62,50 %) at St 2; *Nitzschia* sp. 3496 cells/m^3 (73,33 %) at St 7; and *Rhizosolenia* sp. 7104 cells/m^3 (63,93 %) at St 1 of the population throughout the stations.

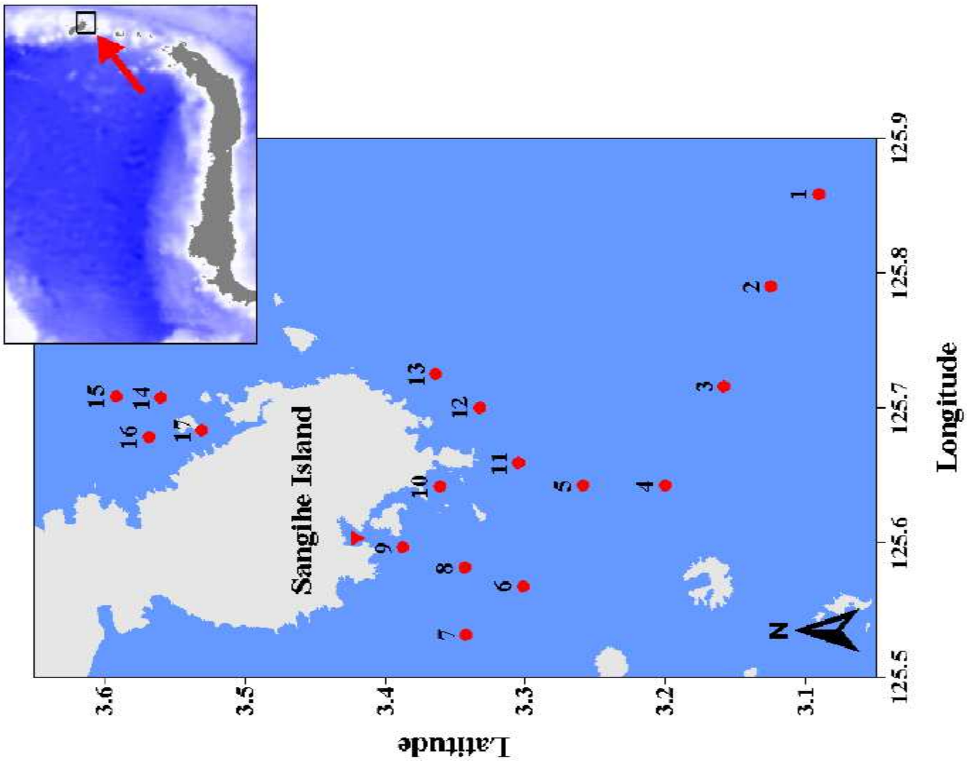


Figure 1. Location of research stations in Sangihe – Sangir Talaud in Northern Sulawesi Island of Central Indonesia Bioregion

In general, as mentioned above, the genus composition on May 2009 were predominated by marine form of diatoms such as *Chaetoceros* sp., *Nitzschia* sp. and *Rhizosolenia* sp. throughout the estuaries studied. These three kinds of diatoms were especially very abundant in all of stations. This indicated that these estuaries were rich in nutrient and were still favourable for the growth of the estuarine net – phytoplanktons. In the 13 sites studied, *Chaetoceros* sp. was commonly found though it not always in tremendous numbers but it could be potentially harmful to aquatic ecosystem. The excessive blooms and died of *Chaetoceros* sp. close to the river mouth of Jakarta Bay and eastern of Sumatera, *Chaetoceros* sp. was generally observed during or after wet season in which monsoon influenced the physico-chemical of the coastal waters and enhanced the nutrients content. Thus the heavy rain can increase the fertility of inshore waters and hence flourishing the phytoplankton community and *Chaetoceros* sp. was usually capable to be the faster growth than other diatoms. The three that were found very common and relatively high percentage (>10%) in some samples were *Chaetoceros* sp, *Nitzschia* sp and *Rhizosolenia* sp. In some past observation of the Indonesian waters such as in Jakarta Bay, Cirebon estuaries, Riau Islands, East Kalimantan Islands, Makassar Strait and Gilimanuk Bay (Thoha, 2007); Raja Ampat island (Thoha, 2009) and in Aceh and West Sumatera (Sidabutar, 2007), where is a countinous enrichment from city and its euthrofication from phospate and nitrate (organic nutrient) in surrounding a coastal areas, also may indicate a recovery to normal conditions of the environment, which in turn provides suffient nutrients for the growth of phytoplankton. This variety occurs in the tropical to temperate areas of all oceans and its very common. there were also very common and mostly in quite prominent concentrations nearly throughout the samples of the estuaries so it can be concluded that the environmental conditions of those estuaries were somehow rich in organic nutrient for the growth of phytoplankton.

The 10 genera of dinoflagelates in some samples were nearly absent or in a low percentage. They are *Amphizolenia* sp., *Ceratium* sp., *Cysts, Dyctiocha* sp., *Noctiluca* sp., *Ornithoceros* sp., *Pyrophacus* sp., *Protoperidinium* sp., *and Pyrocystis* sp. The three genera of *Ceratium* sp., *Protoperidinium* sp. and *Cysts* were more common among the dinoflagellates and very prominent in the innest stations in which having 1.56 – 12.50 cells/m^3 respectively. The highest abundance was in St 9, while the lowest abundance was recorded in St 6. Other genera which were also observed quite common were *Dyctiocha* sp.*, Ornithoceros* sp.*, Pyrophacus* sp. *and Cysts*. There were three genra found in all stations, i.e. *Ceratium* sp.*, Protoperidinium* sp. and *Cysts.* The three genera were potentially to Harmful Algal Bloom or Red Tide. In many cases the bloom of dinoflagellates, certain genus of phytoplankton algal can grow excessively (blooming) that can discolor seawater and known as red tide. The discolored water, however, is not always red depending on the pigment content of the responsible algal species. If the blooming algal produces toxin it can do harm to other organism such as shellfish, crustacean and fish. Certain species of planktonic algae are known as fish killers as their toxin or the anoxic condition they human health if the seafood contaminated with the toxin is eaten by man (Fukuyo, 2005). There are many species that can cause HAB, but the most common are diatoms, dinoflagellates, blue green algae and Cyanobacteria.

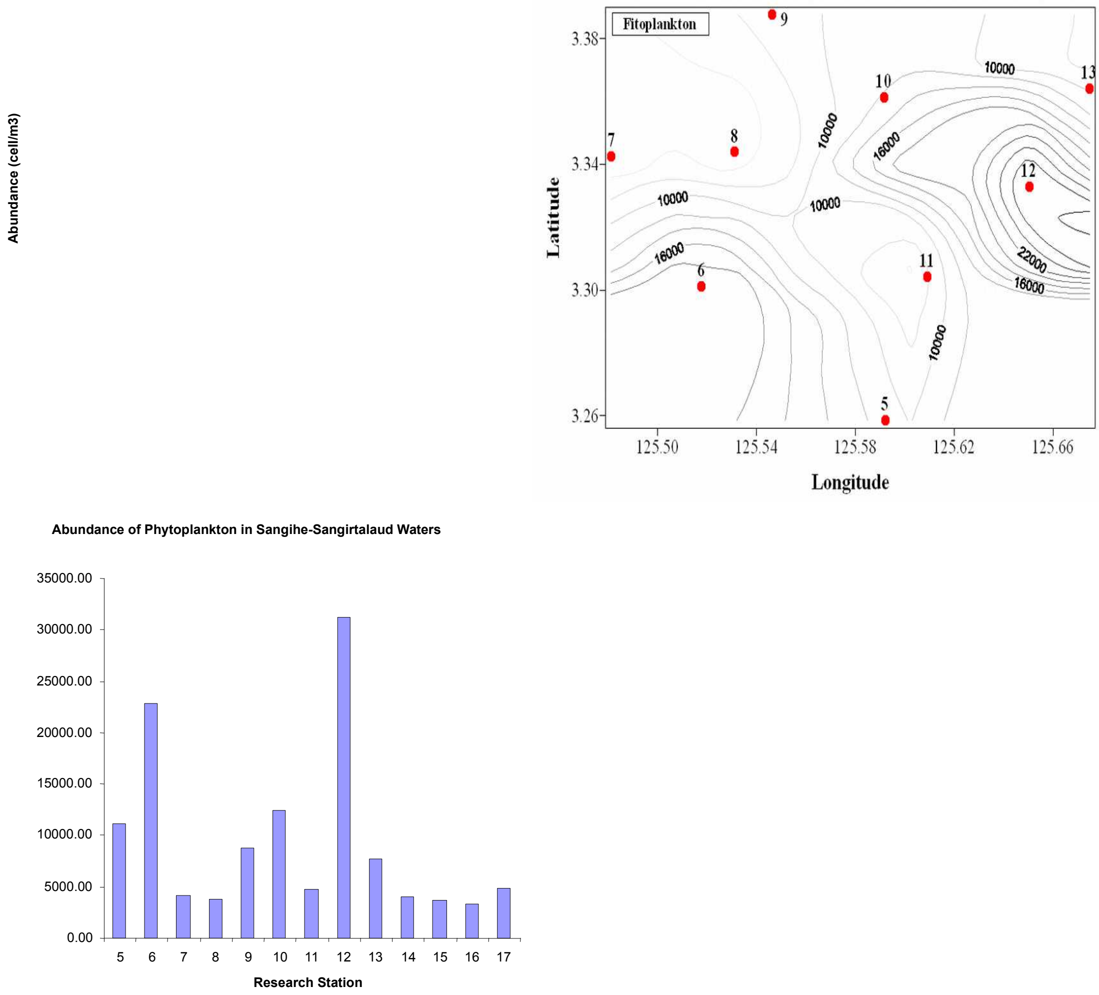


Figure 2. Abundance and distribution of phytoplankton

The results showed that at all stations (St 5 – 17) Cyanobacteria *Trichodesmium* sp. is predominant in abundance with a value of 50 – 95% (Figure 3). *Trichodesmium* sp. concentration of this study obtained from horizontally hauled samples was 4842 – 83043 cells/m^3. The higher abundance was found in St 5, 6, 7, 8, 9, 10, and 11**,** while the lower abundance was recorded in St 11, 13, 14, 15, 16, and 17 (Figure 2). More recently, a sea water discolouration was observed in May 2009 in an area of approximatelly along the east to west of coast of the province of North Sulawesi (Figure2). According to Sutomo and Adnan (2000), *Trichodesmium* sp. bloom occured in Makassar strait in South of Kalimantan with abundance of 218.2 million cells/m^3 or 99.91 % of total phytoplankton. More recently, a sea water discolouration was observed in July 1991 in an area of approximately 7,500 km^2 along the east coast of the province of Lampung in the southern tip of Sumatera. The sea water was reported becoming red, and mass death of pelagic and demersal fish was observed. A dolphin was found dead that time. Examination of phytoplankton samples showed that *Trichodesmium erythraeum* was the predominant species. The red water also affected about 870 hectares shrimp and fish ponds *(tambak)* located along the coast. In 1991 at Jakarta Bay, *Trichodesmium* bloom caused mortality of benthic organisms, presumably due to oxygen depletion because of the decay of the bloom. Considering that red tide cases have been observed in countries around Indonesia, it is reasonable to suggest that the illness and deaths were caused by red tide/toxic algae. However, this cannot be confirmed due to the unpredictable nature of the red tide cases, lack of monitoring program, vastness of Indonesia waters and public ignorance about red tide. Except the Lampung case, the specific causative agents of timing and conditions associated with the red tide are poorly understood in Indonesia (White *et al.*, 1984; Setiapermana, 1992).

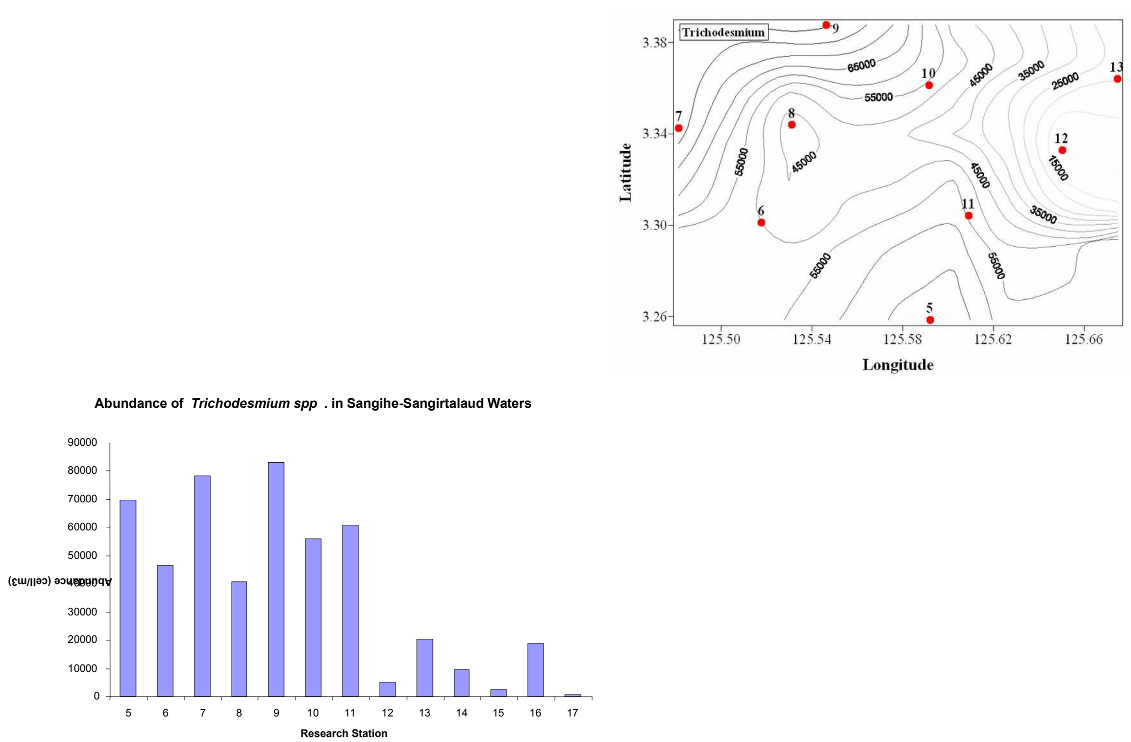
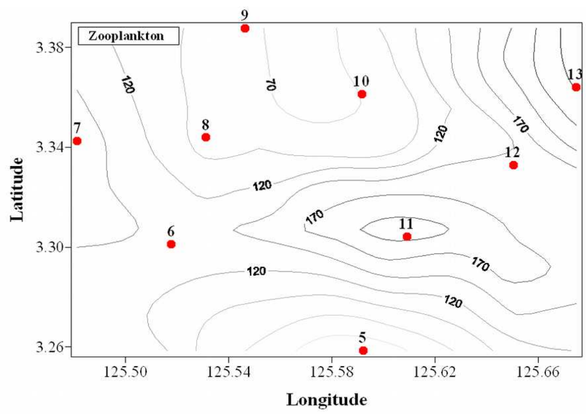


Figure 3. Abundance and dfistribution of Cyanobacteria *Trichodesmium* sp.

The population of zooplankton in Sangihe – Sangir Talaud is composed of 30 groups. The highest number of group is observed in the western coast and the lowest number is recorded in eastern coast. The group of zoooplankton are mostly composed of Copepoda**,** Chaetognata, Polycaheta, Calanoida, Cyclopoida, Harpacticoida, Oikopleura, and Copepoda larvae. Zooplankton concentration of this study from horizontally hauled samples was 8.70 – 261.06 individu/m^3. The higher abundance was found in St 6, 7, 11, 12, 13, 14, 16 and 17**,** while the lower abundance was recorded in St 8, 9, 10 and 15 (Figure 4). These values are similar to those in the Manyalibit, Sorong (Thoha, 2009). Among them, the most common ordo of zooplankton in this study are Calanoida (91.65 individu/m^3 or 64.52%) at St 6; Cyclopoida (65.08/m^3 or 24.93 %) at St 13 ; Harpacticoida (15.41 individu/m^3 or 22.22 %) at St 15 and Oikopleura (6.35 or 4.78 %) of the population throughout the stations (Figure 4). So as the other coastal waters in tropics, the striking feature of samples was the presence of large amount of larval stages zooplankton. The constant number of zooplankton group throughout the survey may indicate that the sea environment is suitable to support the life of zooplankton.

Mulyadi and Rumengan (2007) have listed about 300 species, 55 new records and 11 new species of copepods from whole Indonesian waters. Zooplankton production-related surveys have been conducted during the Baruna Jaya Expedition 1 in 1964. The finding of more abundant zooplankton in Java sea rather than in Indian Ocean were consistent with the results of the other studies afterwards. The similar tendency of temporal zooplankton distribution in the waters around Seribu Islands and that in Jakarta Bay has been found by the Research Center for Oceanography, Jakarta. Zooplankton abundance and biomass data (1970-1985) are available in the online database (global plankton database.htm), including those of Snellius II Expeditions (1984-1985). Conspicuous increase of the plankton knowledge was recorded from this expedition especially on the plankton ecology and biology of the eastern Indonesian waters. Arafura Sea and Banda Sea. Other biological studies are sporadically limited to certain taxa, such as copepods and rotifers. Although Indonesian waters are blessed with mega biodiversity of aquatic organism including plankton, but still less explored. Time series plankton studies are necessary to address for future elaboration of zooplankton and phytoplankton database and for assessment of global warming effects. Some constrains in taxonomy studies due to lacking of taxonomy skills and poor facilities need to be anticipated as well.



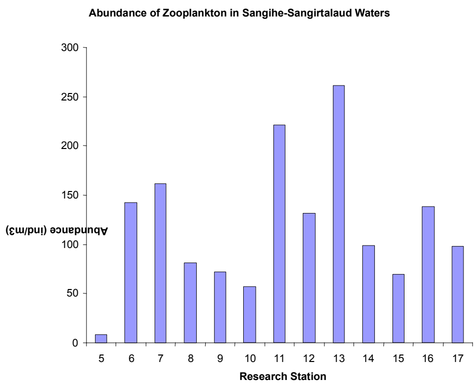


Figure 4. Abundance and distribution of zooplankton

Salinity were analyzed simultaneously with temperature from vertical profiles. Preliminary results showed a sea surface salinity (SSS) minimum of 32.1 psu (along estuaries). The maximum SSS values was 34.7 psu. These values are normal but the salinity is influenced by open sea (Figure 5) (Purwandana, 2009).

Physical Oceanography activities were carried out by researchers and technicians of the Research Center for Oceanography – Indonesian Institute of Sciences (RCO-LIPI). The cruise track started in the Sangihe – Sangir Talaud from estuaries until the open sea of the South Sulawesi. Numbers of oceanographical stations were 13 stations. Preliminary result of the sea surface temperature (SST) shows a minimum value of 25.8°C and a maximum of 29.4°C. These values are normal for coastal water (Figure 5) (Purwandana, 2009).

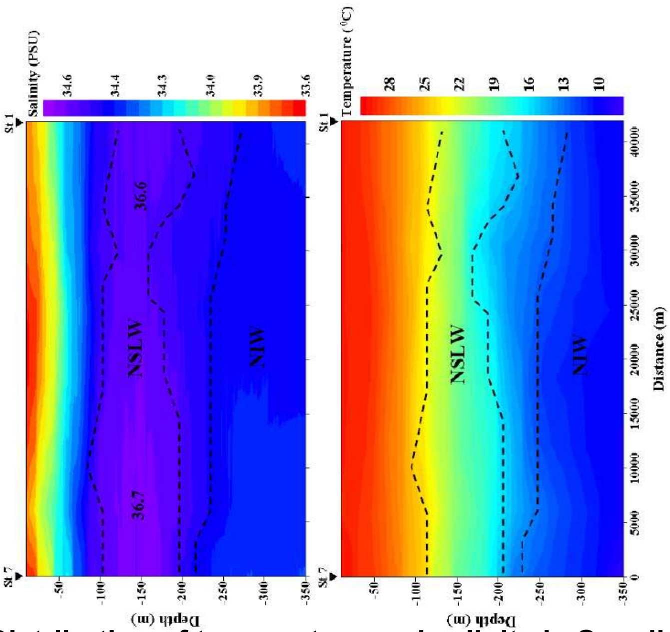


Figure 5 Distribution of temperature and salinity in Sangihe – Sangir Talaud

Conclusion

Based on the results it could be concluded that the phytoplankton abundance was due the flourishing of *Chaetoceros* sp., *Rhizosolenia* sp., *Nitzschia* sp., and *Thalassiothrix* sp. *Ceratium* sp. and *Protoperidinium* sp., *Pyrocystis* sp., and Cyanobacteria *Trichodesmium* sp. were common among the dinoflagellates. Meanwhile, the zooplanktons consist of 30 taxa, the group of which are mostly composed of *Copepoda, Calanoida, Cyclopoida, Oikopleura*, and *Chaetognata*

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