Chapter 4

Discussions

4.1 Quality control of data

4.1.1 Estimation of Chlorophyll-a from fluorescence data

Phytoplankton data in this study was available only surface layer, while subsurface chlorophyll maximum is a common phenomenon in the tropical area (Anderson ,1969 cited in Laevastu et al.,1996). Therefore, fluorescence data that available at every meter was used to estimate chlorophyll-a in this study. The result could give an over view of vertical distribution of phytoplankton in the study area.

Although, the manufacturer reported that fluorometer output (fluorescence) is a linear response to chlorophyll-a but the r-square of linear correlations of them in this study were low (Fig. 3.1 and 3.2). The reason could came from some source of error such as: The uncertainty of the result of attempting to sample thin layer of concentrated chlorophyll (often only 1-3 m thick) with a standard CTD and bottle rosette system. Because the rosettes were themselves 1 m long and situated at about 1 m above the fluorometer, it can be difficult to associate reliable fluorometer voltages with these localized and patchy chlorophyll layers (Sharples et al., 2001). The error could be came from the inappropriate sensitivity gain of fluorescence. The Sea Tech fluorometer using in this study was set from factory at medium sensitivity (3X) which particularly suitable for data with a range between 0 to 10 mg/m^3. The range of the September 1995 data set was 0.008 -0.230 mg/m^3, which should select high sensitivity gain (10X) (Sea Tech inc., 1987). This medium sensitivity gain was more suitable for the April-May 1996, which have a range of chlorophyll-a from 0.614 to 9.193 mg/m^3 than the September 1995 data set.

4.1.2 Preformed nitrate and AOU

Preformed nitrate and AOU were used as parameters to identified water masses by OMP analysis method. The calculation of Preformed nitrate and AOU were explained at equation 2.1 and 2.3 respectively.

Although, high fluorescence (high abundance of phytoplankton) was observed at bottom layer of some station (Fig. 4.1) but the calculated preformed nitrate in the area was minus value. It would be explained by of the low concentration of dissolved oxygen (high AOU) in that area, which indicated that total respiration in the area, exceeded the photosynthesis.

Most of minus preformed nitrate situation occur below the pycnocline layer, this would support that the pycnocline was a barrier between different water mass.

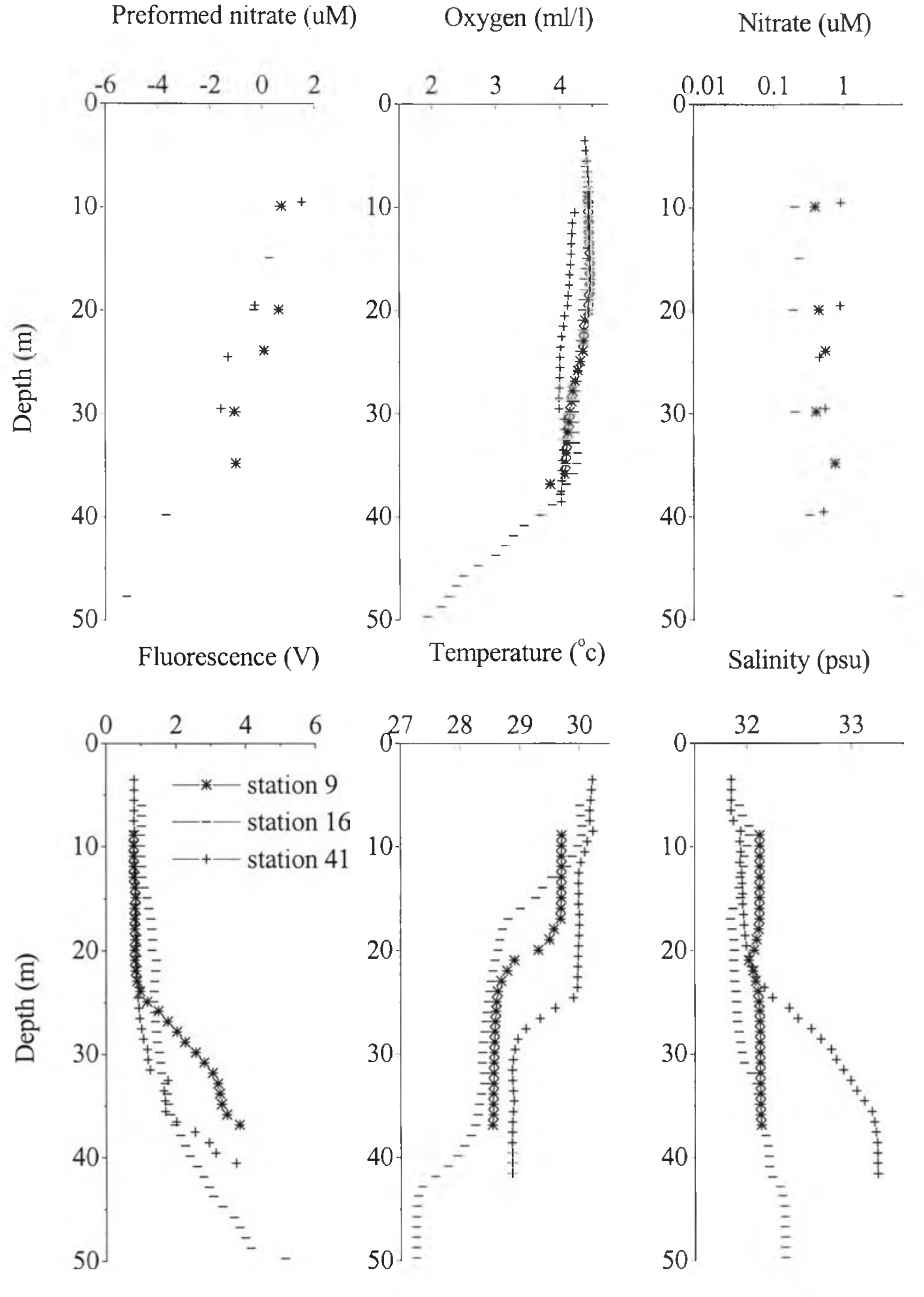

Figure 4.1 Profiles of preformed nitrate (μM), dissolved oxygen (ml/l), nitrate (μM), fluorescence(V), temperature (°C) and salinity (psu) of station no.9, 16 and 41 in April-May 1996

4.1.3 Oceanographic data

All oceanographic data were controlled their quality by the excessive gradients check procedure of the National Oceanographic Data Center (NODC). Result from excessive gradient check showed that the gradient limitation from NODC might not applicable for data of this area, which is a semi-enclose area in the tropical zone. In some station that presented thermocline and halocline, gradients were higher than the limitation of NODC. If follow the NODC procedure, those data should be removed. But when consider in detail of those data such as data from the station 65-68 of September 1995 (Fig.42), the trend of data showed that large gradients were not from any error but from the characteristic of data in this area. So, those data still were used in this study.

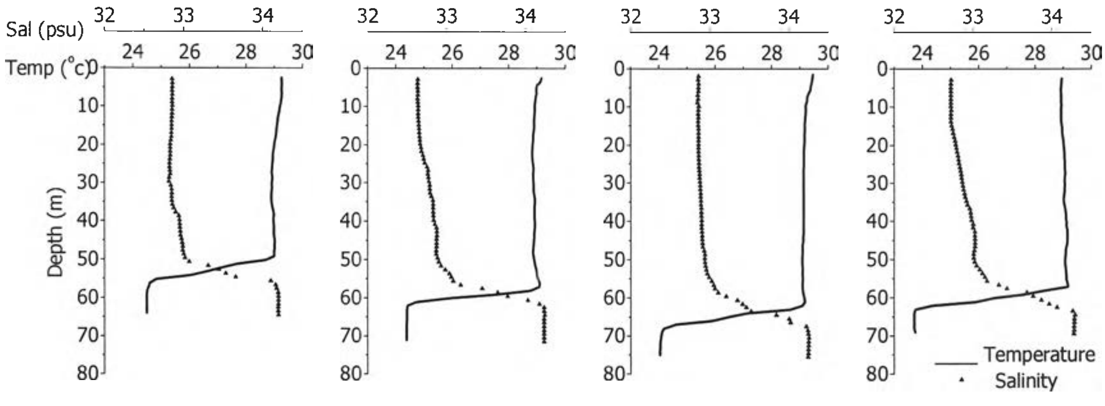

Figure 4.2 Vertical profiles of temperature (°C) and salinity (psu) of station no. 65 to 68

4.2 Characteristic and distribution of water mass

Characteristic of water mass in surface layer of all season in the Gulf of Thailand and the South China Sea had been studied by Siripong (1984) The study used data from Japan and USA. National Oceanographic Data Center from 1907-1973. All existing data were average for 1-degree grid. Gulf of Thailand and East Coast of Peninsular Malaysia were identified to be one water mass for all season with large temperature and salinity interval.

The used of CTD for Southeast Asian Fisheries Development Center data was allowed to get 1 meter depth interval of temperature and salinity. These data should give more information and allow studying characteristic and distribution of water of the whole water column.

Characteristics of water masses and their distribution suggest that there were five water masses in the study area. Summary of water mass identified by three methods was shown in table 4.1.

1. Characteristic of water mass 1 in TS diagram matched with characteristic of surface mass 1 in TS-time diagram and GOT water mass in OMP analysis (29.5-30.5 °C, 31.5-32.25 psu). But it was different from characteristic of all water mass in the adjacent area (Rojana-anawat et al., 2000 and 2001). This water mass would originate in the study area so call Gulf of Thailand water mass (GOT water mass).

2. Characteristic of mass 2 in TS diagram (29.5-30.5°c, 32.5-33.5 psu) cannot match with any water mass and water type in TS-time diagram and OMP-analysis. Their characteristic overlaid with characteristic of water mass near Mekong river (Rojana-anawat et al., 2001). This water mass would be an inflow of Mekong water to the study area so call Mekong water mass.

3. Characteristic of Mass 3 in TS-diagram matched with surface mass 2 in TS-time diagram and SCS water mass in OMP analysis (27-30 °C, 33.5-34 psu). The characteristic could be overlaid with the characteristic of the surface of the South China Sea water mass (surface water to 50 meter depth) from the study of Rojana-anawat (2000 and 2001). It showed the intrusion of water mass from surface layer of the South China Sea to the study area (Surface South China Sea water mass, SSCS).

4. Characteristic of Mass 4 in TS-diagram (25-30 °C, 32.5-34 psu) matched with characteristic of surface mass 3 in TS-time diagram and S-PM upper water type in OMP analysis. Their characteristics were between characteristic of the GOT and SSCS water masses. It should be a mixture of GOT water mass and SSCS water mass.

5. Characteristic of Mass 5 in TS-diagram matched with S-PM lower water type in OMP analysis (23.5-26°C, >34 psu). Their characteristic could be overlaid with the subsurface of the South China Sea water mass (SuSCS water mass) in the study of Rojana-anawat et al. (2000 and 2001). The intrusion of SuSCS water mass came to the study area at 50 to 150 meter depths.

Table 4.1 Summary of water mass identified by three method

Water mass	Name in TS-diagram	Name in TS-time diagram	Name in OMP-analysis
GOT	mass 1	surface mass 1	GOT
Mekong	mass 2	-	-
SSCS	mass 3	surface mass 2	SCS
Mixing of GOT and SSCS	mass 4	surface mass 3	S-PM upper
SuSCS	mass 5	-	S-PM lower

Seasonal variation of water mass distribution

Seasonal variation of horizontal distribution of water mass in this area is mainly influence by monsoon wind, water density different and tidal current. (Lowwittayakorn, 1998 , Snidvongs 1998 and Yanagi et al., 2000).

During September 1995 which is the Southwest monsoon season, there was a strong inflow of surface layer of SCS water mass to the Gulf of Thailand at the west coast, then strong wind induce mixing with the local water mass (GOT water mass). This explanation was encouraged by the study of Yanagi et al. (2000) that the stratification is weak in this season. The whole area excepted the bottom water of East Coast of Peninsular Malaysia was occupied by mixture of GOT water mass and SSCS water mass (Fig. 3.6 a and b). The bottom water of East Coast of Peninsular Malaysia (50-80 m) was occupied by SuSCS water mass. The observation implied that there was the intrusion of SuSCS water mass from the South China Sea by the influence of wind and density different.

In April-May 1996 which is a transition period between Northeast to Southwest Monsoon season, stratification occurred the whole area that depth grater than 30 meter due to large sea surface heating and weak sea surface wind. The development of stratification separated high temperature and low salinity GOT water mass at upper layer from the others at lower layer (Fig. 3.6 c and d).

It was observed in this study that SSCS water flowed into the Gulf of Thailand at bottom layer and both surface and bottom layer at the mouth of the Gulf of Thailand while GOT water flowed out the Gulf of Thailand at upper layer (Fig.3.6 c and d). The SSCS water mass at bottom water in the Gulf of Thailand should flow from the South China Sea through the channel connecting the deepest part of the Gulf of Thailand and the South China Sea. Yanagi et al., 2000 suggested that it was due to the density different between the head of the Gulf of Thailand and tip of Peninsular Malaysia which about 2.0 sigma-t at 20 m below the water surface in this season. The intrusion was limited their horizontal distribution only at the deep area of the Gulf of Thailand (> 80 meter).

Mekong water mass was found only surface layer of station at the mouth of the Gulf of Thailand and east coast of Peninsular Malaysia (Fig. 3.6 c). This water mass came from a coastal jet flowing southwestward along the southeast coast of Vietnam by the influence of Northeast Monsoon wind as indicated by Shaw and Chao (1994). The coastal jet water is from mixing between South China Sea water mass and run off of Mekong River. Although, there was no coastal jet during the survey period because of the weak NE monsoon wind but Mekong water mass still remained in the area.

Mixing of GOT and SSCS water mass was found in two area. The first area was the bottom layer of the central of the study area between the area of the GOT water mass and the intrusion of SSCS water mass. This water mass should be originated from the turbulent mixing which most pronounced along isopycnal surface (Open University, 1989). Fig. 3.6 d and Fig.4.3 showed that GOT and SSCS water masses occupied on the isopycnal surface of the first area. The second area was both surface and bottom water of the southern part of the study area. Mixing of GOT and SSCS water mass in this area should be the remained water mass from the Northeast Monsoon season that stratification was destroyed due to sea surface cooling and strong northeast monsoon wind (Yanagi et al., 2000).

The study of water masses would give the exchanging rate between water mass in the Gulf of Thailand and outside. Unfortunately, survey area was not cover all the Gulf of Thailand, the calculation of exchanging rate is not possible. However, the exchanging rate had been studied by Stansfield and Garrett, (1997) with an annual volume exchange of 10,800 km^3 and flushing time of about 1 year.

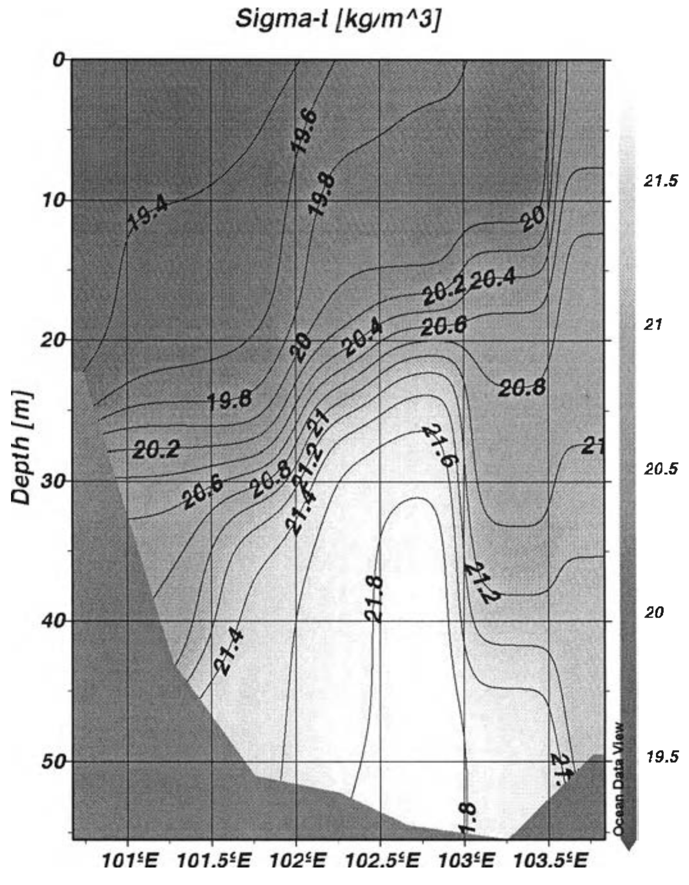

Figure 4.3 Vertical distribution of sigma-t along latitude 7°20'N (from station 40 to 46) in April - May 1996

4.3 Ecological implication

Zooplankton

The presents of SSCS water mass either surface or bottom water or both layer (water mass group B, D and F) in TS-diagram coincided with the area of zooplankton cluster A, which was high abundance ratio of chaetognatha and low total abundance of zooplankton (Fig. 3.17 and 3.18). This suggest the possibility to use SSCS water mass as the indicator of low total abundance of zooplankton with high proportion of chaetognatha area. Jiwaluk (2001) also reported that high abundance ratio of chaetognatha in the area of open sea water mass in Vietnamese water which its characteristic is the same as SSCS water mass (Rojana-anawat et al, 2001).

Phytoplankton data

Relationship between water masses and phytoplankton were found at the boundary between the Gulf of Thailand and South China Sea in April - May 1996. All stations of this area were SSCS water mass (Fig. 3.6) and were grouped as cluster C by the abundance and the dominance and associate species of phytoplankton (Fig. 3.18). These showed relationship between surface layer of SSCS water mass and the high abundance ratio of blue green algae, which was a dominated characteristic of phytoplankton cluster C.

The high abundance ratio of blue green algae in the SSCS water mass could not observed in West Coast of the Philippines (Rojana-anawat et al., 2000) and Vietnamese water (Rojana-anawat, 2001). The abundance of Diatom was the highest rations in both areas (Boonyapiwat, 2000 and 2001). This suggested that the relationship between blue green algae and SSCS was local or short period phenomena. The use of type of water mass as an indicator of phytoplankton abundance is not possible.

The relationship between type of water masses and phytoplankton data are not clear. One question is " Does kind of dominance and associate species of phytoplankton and their percentage appropriate for cluster analysis? " The use of species and abundance should improve the result.

Chlorophyll-a data and relative abundance of pelagic fish

Results from the relationship between water masses and chlorophyll-a and relative abundance of pelagic fish suggested that there was the possibility to indicate the abundance of phytoplankton and pelagic fish by the water type.

Although the relationship between chlorophyll-a and relative abundance of pelagic fish form the model and the existing data was low but it could be improved by the good preparing for the data collecting for this specific propose. The low relationship would be come from the suspicion about the chlorophyll-a data as discuss in 4.1.1 and pelagic fish data. The relative abundance of pelagic fish in this study was from the calculation of the volume back scattering strength (SV) and the target strength (TS) of *Sadinella gibbosa.* While the observation area was defined as the rich bio-diversity area, the use of single species is still in doubt for their appropriation.