CHAPTER IV

DISCUSSION

Reef Fish Community

Reef fish community of Nai - Wog Bay, Ko Pha - Ngan recorded the total of 76 species. The species richness may be considered relatively high comparing to the other reefs in the Gulf of Thailand, Ko Chang, 18 - 27 species, Ko Mak, 24 - 32 species, Pattaya water, 19 - 29, Sattahip water, 18 - 46 species, Ko Tao, 34 -48 species (CREST, 1989; Satumanatpan and Sudara, 1992). It may be because of the condition of the coral reef in this area are in good condition and the large seagrass area are also found comparing with other reefs in the Gulf of Thailand. Satumanatpan and Sudara (1992) reported that the species richness of fish would be high or increase with increasing of the high percent cover of living coral or the better conditions of coral communities were found. Several workers had examined the relationship between fishes and coral communities and also found the positive correlation (Carpenter et al.,1981; Reese, 1981; Bell and Galzin, 1984; Manthachitra and Sudara, 1991; Satumanatpan and Sudara, 1992).

The adjacent habitat, seagrass bed, may also play the important role to the species richness of reef fish community. Hence, the species richness of reef fishes would be enhanced because of the presence of nearby seagrass bed. Ogden and Zieman (1977), Weinstein and Heck (1979), Zieman (1982) and Robblee and Zieman (1984) found many reef fish species were recruited from the seagrass beds such as the snappers (*Lutjanus*), grunts (*Haemulon*), parrotfishes (*Scarus* and *Sparisoma*), surgoenfishes (*Acanthurus*) and wrasse (*Halichoeres*), etc. Therefore, this is also another factor contributing to the species richness of fishes in the coral reef of Nai - Wog Bay since it was adjacent to the seagrass bed.

The major components of reef fish community of Nai - Wog Bay, composed of : a) the target species which include snappers (Lutjanidae) and groupers (Serranidae) ; b) the indicator species ,namely butterflyfishes (Chaetodontidae), and found to be *Chaetodon octofasciatus* ; and c) the major families which include damselfishes (Pomacentridae) wrasse (Labridae), cardinalfishes (Apogonidae) and parrotfishes (Scaridae). These were similar to the other reefs in the regions , the Philippines (Hilomen and Yap, 1991), Singapore (Lim and Chou, 1991), Malaysia (Mohamed and Badaruddin, 1991) and the west coast oc the Gulf of thailand (Manthachitra and Sudara, 1991).

The variations (spatial and temporal) of coral reef fish communities which include species composition, species richness and abundance, were directly influenced by the environmental factors (biological and physical), i.e., the availability of habitats, foods, larval recruits and survivorship, predation and competition, and the impacts of storm and wave action or the monsoons among the seasons etc. (Sale, 1977; Williams, 1982, 1983; Sale and Douglas, 1984; Robert and Ormond ,1987; Hilomen and Yap, 1991; Miclat, 1991). Sale (1980) pointed out that the storm and wave action would have stronger effect on the shallower parts of reefs while the biotic factors would be the most important effect on the deeper reef. This study could not be carried out in August and October due to the impacts of strong wind and wave actions which caused very poor visibility and the condition not suitable to work but the studies were carried in January and April. After analysis, the variations of fish community among these two sampling periods could be observed. High abundance of reef fishes was found in April and lower in January, while the species richness and species composition were rather consistent. Sale and Douglas (1984) found species richness to be more consistent than fish abundance through heterogenity was significant among reefs and among seasons. Hilomen and Yap (1991) and Miclat (1991)

reported that immediately after typhoons hit the Philippines coral reefs in December, reef fish abundance was drastically decreased but species richness appeared to remain relatively constant. Hilomen and Yap (1991) also found the reef fish abundance will increase in March and June (when the water was clam). Coral communities of Koh Pha - Ngan was of shallow reef, reef fish community would be influenced by the strong wind and wave action in August and October, during the period of southwest monsoon. Therefore, reef fish abundance should be low or decrease during this period and increase in January to April.

Seagrass Fish Community

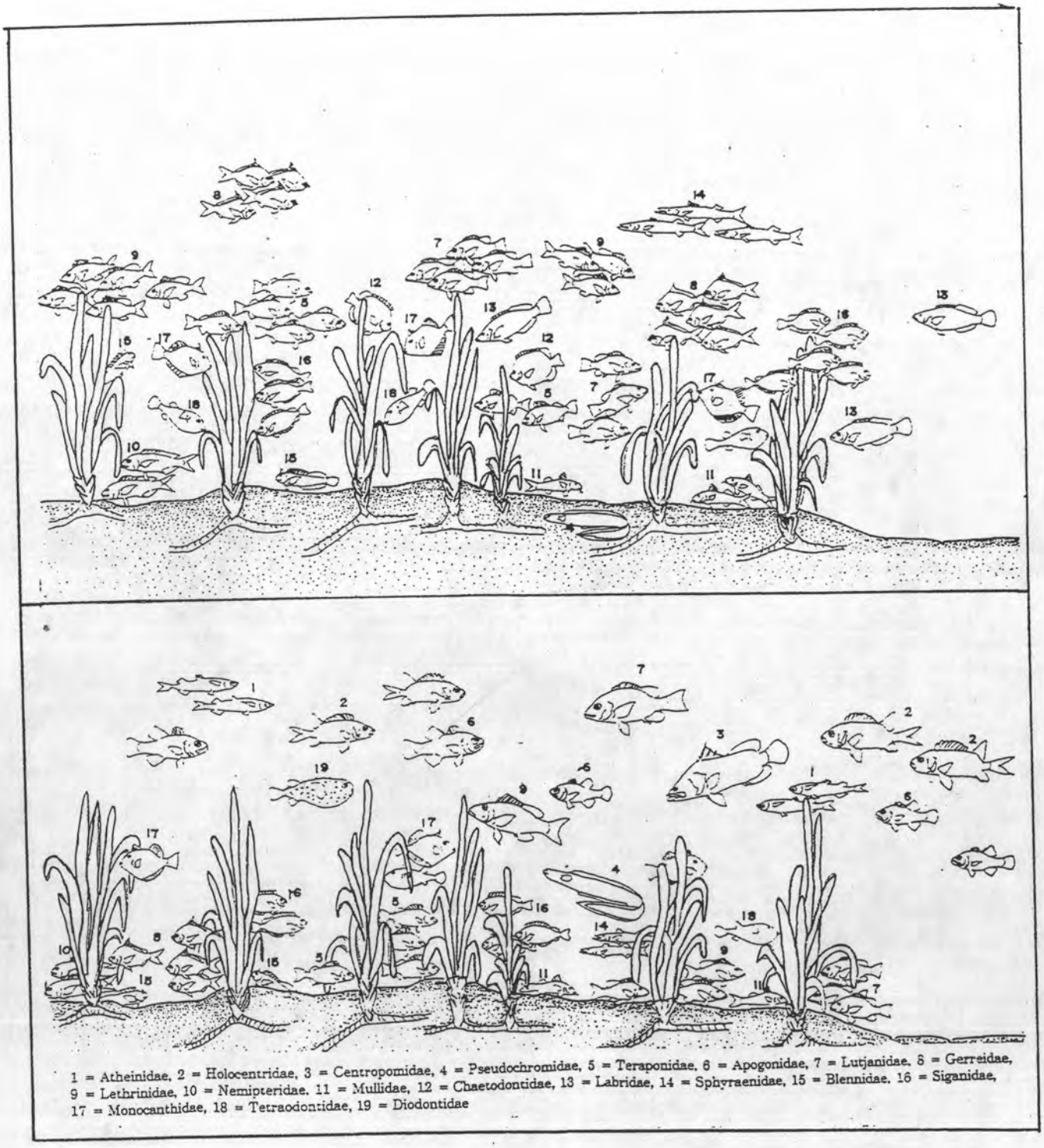
Several scientists reported that the greater number of species and abundance of fish occured in the seagrass beds than bare substrata (Kikuchi, 1966; Orth and Heck, 1980; Zieman, 1982; Bell and Pollard, 1989; Nateekanjanalarp, 1990; Dolar, 1991). Therefore, this study did not attempt to compare of fish communities between seagrass bed and sand substrata but intend to understand the fish community in the seagrass bed.

In general, seagrass fish community of Nai - Wog Bay, Ko Pha - Ngan was dominated by the small size fishes and less commercial value, i.e. *Pelates quadrilineatus* , *Siganus canaliculatus*, bleniids and monocanthids, etc., and the juvenile of fishes from the adjacent habitats, i.e. *Gerres oyena, Lethrinus lentjan., Lutjanus carponotatus* and *L. russelli*, etc.,which were high commercial value. Many families of fish from the adjacent coral reef, such as Holocentridae, Labridae, Chaetodontidae, Siganidae, Apogonidae, snappers Lutjanidae, Diodontidae and Nemipteridae were also found as adult form. These fishes also were commercially important species such as spanishflag snapper *Lutjanus carponotatus*, pink eared emporer *Lethrinus lentjan,* and monocle bream *Scolopsis ciliatus*. The similar results had been reported by Robblee and Zieman (1984), Nateekanjanalarp (1990), Dolar (1991) and Vergara and

Fortes (1991). This is because the seagrass bed plays the important role to fish community. Seagrass beds are as the important habitats and food resources for fishes and they can also serve as nursery and feeding grounds for fishes from the adjacent habitats, coral reefs and mangroves (Kikuchi and Peres, 1977; Kikuchi, 1980; Heck and Orth, 1980; Ogden, 1980; Zieman, 1982; Kenworthy, 1988). Heck and Orth (1980) suggested that the complex structure of seagrass bed provided the living space for fishes for protection from their predators. Seagrass blades may fed directly by herbivores and omnivorous fishes, and the carnivorous fishes fed on the smaller fishes and invertebrates which were rich in the seagrass bed (Kikuchi, 1966; McRoy and Helfferich, 1980; Heck and Weinstein, 1989).

Day and night variations

The abundance of fishes collected during the night time was higher than the day time. The night samples showed an increase in number of individuals in some members of the families Teraponidae, Gerreidae, Lethrinidae, Siganidae and Bleniidae. This evidence was similar to the results of many autors such as Kikuchi (1966), Nateekanjanalarp (1990), Dolar (1991) and Vergara and Fortes (1991). Although the number of species of fish collected between the day and night samples was not significantly difference but the difference in species composition of fish collected between day and night remarkably found (Fig. 21 and 22). The result of fish dissimilarity coefficient indicated that there were two fish assemblages, a night time group and the day time group which the diurnal and nocturnal activities of fish assemblages in the seagrass bed. Bell and Pollard (1989) suggested that abundance of fishes at night than at the day time because some diurnal fish species were non or less active during the night and they would be therefore vulnerable to collected by trawling.



1 = Atheinidae, 2 = Holocentridae, 3 = Centropomidae, 4 = Pseudochromidae, 5 = Teraponidae, 6 = Apogonidae, 7 = Lutjanidae, 8 = Gerreidae, 9 = Lethrinidae, 10 = Nemipteridae, 11 = Mullidae, 12 = Chaetodontidae, 13 = Labridae, 14 = Sphyraenidae, 15 = Blenniidae, 16 = Siganidae, 17 = Monocanthidae, 18 = Tetraodontidae, 19 = Diodontidae

Fig. 21 Vertical distribution of fishes associated with seagrass bed during the day (above) and night (below) at Nai - Wog Bay, Ko Pha - Ngan.

The patterns of diurnal and nocturnal migration of fishes to the seagrass beds from the neighboring habitats, i.e., coral reef and mangrove may attribute to the abundance and species composition of fishes assemblages in the seagrass bed. Weinstein and Heck (1979) found the nocturnal reef fishes migrated from the coral reef to forage over the seagrass bed at night and sheltered in their coral reef by day. Ogden (1980) and Zieman (1982) suggested that large juvenile of fishes would be excluded from the seagrass bed because they were too large to find a shelter within seagrass bed for protection them for the predators during the day and migrated to the adjacent habitats such as coral reef and mangrove surrounding the seagrass bed by day and may move into the seagrass beds at night to feed when predation is less intense. The results of this study revealed that the diurnal reef fishes, found in the seagrass bed during the day were *Siganus virgatus, Halichoeres chloropteres* and *Chelmon rostratus*, etc., and the reef fishes which were collected at night in the seagrass bed were *Sargocentron rubrum, Apogon guamensis* and *Diodon liturosus*, etc.

Seasonal variations

Seasonal variations of seagrass fish community of Koh Pha-Ngan can be observed. Abundance of fishes were high during January and April and decline in August and October. It may be related to the biological factor or structural patterns of seagrass bed, i.e., biomass and surface area, etc., and also physiochemical environmental conditions, i.e., wave, salinity and temperature, etc., and causes of variation in animal communities of seagrass bed which was noted by Kikuchi and Peres (1977) who also suggested that seasonal variation of seagrass community would be influenced to the animal components in the community. Nateekanjanalarp (1990) who studied the seagrass communities of Koh Samui which is located south of Koh Pha - Ngan reported that the seasonal changes in biomass and surface area of Enhalus acoroides at Chaweng Beach found to be higher

during the northeast monsoon (January) and intermonsoon (April) than in southwest monsoon (September). From field observations, seasonal changes of seagrass found to be similar to Nateekanjanalarp (1990). High density and maximum height or lenght of seagrass were also observed during the northeast monsoon (January) and intermonsoon (April) periods.

The predation factor proposed by Heck and Orth (1980) that those plants with more biomass and/ or surface area ought to provide more protection than plants with lower biomass and/or surface area. They also suggested that increasing vegetation biomass and density should be lead to increase in species richness and abundance of juvenile of fishes. Bell and Westoby (1986) pointed out also that the height or lenght (short and long) of seagrass will also influence the complexity of seagrass bed. Sudara and Satumanatpan (1992a) found high abundance of fish within seagrass bed which had high biomass and surface area. The data from this study showed that species richness and abundance of fishes were high in January and April, periods of the northeast monsoon and intermonsoon which was the time for calm water. High biomass which resulted in surface area of the seagrass bed were observed.

The physical environmental condition such as wave, wind, salinity and temperature, might directly influence to the variation of seagrass fish commuity. Weinstein and Heck (1979) found the species and abundance in the expose site decreased were influenced by strong wind and wave actions. Sogard et al. (1989) also suggested that the water circulation would influence and result in seagrass fishes density and migration of fishes to the seagrass beds as nursery ground.

Weinstein and Heck (1979) suggested that the salinity would exert a remarkably influenced on seagrass fish community composition and abundance. Zieman (1982) found members of families Lutjanidae, Haemulidae

(Pomadasyidae) and Scaridae used the seagrass beds as nursery ground when the water conditions was cleared and buffered. He also suggested that clearer water, higher and less variable salinity, juvenile fishes from the adjacent coral reefs would utilize the seagrass beds for nursery grounds. Sogard et al. (1989) stated that the salinity and temperature have as much influence on fish density as structural differences in seagrass canopy, and may result in movement of fishes and directly effect the mortality in laval and juvenile of stenohaline species.

The abundance of fishes collected in this study were high with high salinity (33 ppt.) and calm water during January and April and were lower in August and October with low salinity (28 ppt.) and high strong wind and wave action. The dendrogram of dissimilarity of fishes species composition between the sampling periods showed that fishes inhabited within the seagrass bed in different times. Many juvenile fishes such as *Lethrinus lentjan, Lutjanus carponotatus, L. russelli, Pelates quadrilineatus* and *Gerres oyena*, etc., were found to be highl: abundance and presumeably used the seagrass bed as nursery ground in January and April. Other two sampling periods, August and October and no juvenile of fishes were found. However, many of large size or adult fishes were found during the entire sampling period such as fish from the families Holocentridae, Apogonidae, Labridae, Chaetodontidae, Mullidae and Atherinidae, etc.

Base on the classification of fish assemblages in the seagrass was obtained by Kikuchi (1966). Seagrass fish community of Koh Pha - Ngan can be divided into 3 groups as followed:

1. Residents (Fishes residing in the seagrass bed all year round). The resident fishes were mostly represented by small size and non or less commercially important species. However, they might play an important role in trophic

relationships of the seagrass ecosystem. There are *Pelates quadrilineatus, Gerres oyena, Siganus canaliculatus* and *Petroscirtes lupus*, etc.

2. Seasonal residents (Fishes residing only a season or history stage). The seasonal residents, juvenile to subadult stages utilize the seagrass bed as the nursery ground. The range of body lenght of this group is small as juvenile and as large as adult. Almost all of these fishes are commercially important species as they grow. There are *Lethrinus lentjan, Lutjanus carponotatus, Lutjanus russelli, Siganus virgatus, Sphyraena* sp. and Atherinids, etc.
3. Transients (Fishes that occur in seagrass bed in course of foraging over a variety of habitats). The transient fishes are larger in body size than the other two groups. These fishes migrate to seagrass bed as foraging area from the adjacent coral reef. There are *Apogon guamensis, Sargocentron rubrum, Lethrinus lentjan, Lutjanus carponatatus, L. russelli, Halichoeres chloropterus, Chelmon rostratus, Psammoperca waigensis, Upeneus tragula, Atherinomorus duodecimalis* and *Diodon liturosus*, etc. Some are the ~~commercially important species such as *L. lentjan and L. carponatatus*~~ and *L. russelli*.

Migration of Fishes Between Seagrass Bed and Coral Reef

In the tropical, coral reefs and seagrass bed often adjoin, and prominent interrelationships of fishes from these two habitats occur (Ogden and Zieman, 1977; Weinstein and Heck, 1979; Robblee and Zieman, 1984; Fortes, 1991). At Ko Pha - Ngan and Samui, in the Gulf of Thailand, few seagrass beds and coral reefs adjoined could be found (Sudara and Nateekanjanalarp, 1989; Nateekanjanalarp,1990). Species composition of fish communities in the coral reef and seagrass bed of Pha-Ngan Island

showed that from total of the 76 fish species identified from the coral reef and the 22 fish species identified from the seagrass bed, 13 species were commonly found within both habitats. The similarity in species composition of fish may be reflected the interrelationships of fish communities as fish migrations between these habitats.

By using various mesh-size gillnets was to increase efficiency in catching various size fishes migrating between seagrass bed and coral reef at different time, the variation in abundance of fishes migrated were found between various sampling periods. Their higher abundance of fishes collectd were in January and April and lower in August and October. The physiochemical environmental conditions which had the strong wind and wave action and low salinity during August and October could be the important factors. However, day and night abundance of fishes collected were not consistent.

Distinctive day/night differences in many species of fish collected were also observed which might be resulted from the behavioral migrations of diurnal and nocturnal reef fishes. It was supported by fish similarity index and cluster analysis. These differences had been observed in the tropical seas by several workers (Ogden and Zieman, 1977; Robblee and Zieman, 1984; Wienstien and Heck, 1979).

The day sample included the active diurnal reef fish of the families Labridae, Pomacentridae, Chaetodontidae and Siganidae. They were dominated by *Halichoeres chloropterus* and followed by *Pomacentrus tripunctatus*. The other important species were *Chelmon rostratus*, *Siganus* spp. and *Upeneus tragula*, etc. These fishes were the species commomly found in this area. They might therefore migrate to the seagrass bed for feeding during the day. Ogden (1980) and Zieman (1982) reported that large schools of herbivorous fishes, scarids and acanthurids, migrated

from the coral reef to the adjacent seagrass bed for foraging at day. The small omnivorous and carnivorous reef fishes, i.e. labrids, clinids, pipefishes and filefishes, etc., were also found leaving the reef to feed in the seagrass bed (Heck and Wienstien, 1979; Robblee and Zieman 1984). Feeding habits of fishes collected during the day as observed directly in the field showed the variety of all feeding habits of these fishes which include herbivores, carnivores and omnivores.

The active nocturnal fishes such as the families Holocentridae, Apogonidae, Lutjanidae, Lethrinidae and Atherinidae, etc. were collected at night. These fishes were found occupied the coral reef during the day. The night samples were dominated by *Sargocentron rubrum* (Holocentridae) and followed by *Apogon guamensis* (Apogonidae), *Lutjanus* spp. (Lutjanidae) and *Lethrinus lentjan* (Lethrinidae). The nocturnal reef fishes migrated into the seagrass bed to feed at night and formed the resting school which inhabited in the crevices and caves in their coral reef habitat during the day. Goldman and Talbot (1976) had been noted that the nocturnal reef fishes mostly found were the carnivorous fishes. The nocturnal migration reef fishes to the seagrass bed for feeding of the families Lutjanidae, Holocentridae, Apogonidae, and Haemulidae had been reported by several authors (Golman and Talbot, 1976; Ogden and Zieman, 1977; Weinstein and Heck,1979; Ogden ,1980; Robblee and Zieman, 1984). Ogden and Zieman (1977) also found school of grunts and snappers migrating from a long distance reefs to the seagrass bed and broke up the school to feed individually through the night. At dawn, they would gather and return to the reef on the same pathway.

Fishes migrated between seagrass bed and coral reef showed the patterns in diurnal and nocturnal migrations of fishes during the twilight changover from the day to night and night to day (Table 54). Diurnal reef fishes, *Halichoeres* spp., *Pomacentrus tripunctatus*, *Siganus* spp. and

Chelmon rostratus, etc., would migrate to seagrass bed after the sunrise in the morning and leave the seagrass bed before the sunset in the evening back to the reef. On the other hand, the nocturnal reef fishes, *Apogon guamensis*, *Sargocentron rubrum*, *Letrinus lentjan* and *Lutjanus carponotatus*, etc., would migrate to the seagrass bed after the sunset and leave the seagrass bed before the sunrise back to the reef. These changovers were similarly observed on various tropical reefs (Hobson, 1972, 1984; Goldman and Talbot, 1976; Odgen and Zieman, 1977; Robblee and Zieman, 1984). Goldman and Talbot (1976) also suggested that it was the replacements between the diurnal and nocturnal fishes due to the changeover peroids.

Table 54 Mean percentage of number of fishes entering and leaving the seagrass bed among the various time at Nai - Wog Bay, Ko Pha - Ngan.

Time	Fishes entering the seagrass bed (%)	Fishes leaving the seagrass bed (%)
0600 - 1200	74 %	29 %
1200 - 1800	23 %	77 %
1800 - 2400	70 %	30 %
2400 - 0600	22 %	78 %

Stomach content analysis of fishes migrating between seagrass bed and coral reef confirmed that they migrated to seagrass bed for feeding. More than 90 % of fishes entering the seagrass bed with their stomach empty whereas more than 90 % of fishes leaving the seagrass bed, with stomach contained food. Base on the characteristic of food items found in the stomach content, the feeding habits of fishes could be divided into 3 types, the herbivorous fishes which feed on plant materials, the

carnivorous fishes which feed on smaller invertebrates and fishes and the omnivorous fishes which feed on both plant materials and other animals. These migratory fishes would composed 22 % herbivores, 69 % carnivores and 9 % omnivores, this could be percentage by weight as well as percentage by number of species.

Herbivorous fishes which were found only the day in only this study composed of few species of the family Siganidae which included *Siganus canaliculatus, S. guttatus, S. javus, S. punctatus* and *S. virgatus*. Both algal and seagrass fragments were found in the stomach content. According to the principal food items in the stomach content (frequency of occurrence and weight), *S. canaliculatus* and *S. guttatus* fed mainly on seagrass fragments while *S. javus, S. punctatus* and *S. javus* fed mainly on algal fragments. Siganids had been considered to be the herbivorous fishes (Goldman and Talbot, 1976; Choat, 1991 and Aragones,1987) and also found the siganids fed on algae more than seagrass. Monkolprasit et al. (1987) reported that some invertebrates and small fishes were also contained in the stomach content of some siganids (*S. guttatus* and *S. virgatus*). Dolar and Lepiten (1991) suggested that the siganids may be the omnivorous fishes which mollusc and algae was the main components and seagrass only ranked third. The other herbivorous fishes fed directly on seagrass such as scarids and acanthurids also been reported (Ogden and Zieman, 1977; McRoy and Helfferich, 1980) but these fishes had not been found in the study areas.

The largest group of migrating fishes are found to be the carnivorous fishes. From the index of relative importance of food items, feeding habits of carnivorous fishes could be divided into several groups, the invertebrate feeders, fish feeders and benthic feeders (which included small fishes and invertebrates). Invertebrate feeders were generally the diurnal fishes which included fishes from the familes Labridae,

Chaetodontidae, Gerreidae, Gobiidae, Teraponidae and Nemipteridae. Polychaetes and small crustaceans (amphipods, isopods, mysidaceans and ostracods) were the important prey species of the invertebrate feeders. Two families of Belonidae and Sphyraenidae were the fish feeders or piscivores which feed on smaller fishes such as, clupeids and gerreids, etc. The benthos feeders were both of diurnal and nocturnal fishes which comprising members of the families Serranidae, Apogonidae, Atherinidae, Holocentridae, Lethrinidae, Lutjanidae, Mullidae and Centropomidae, etc. Although, polychaetes and large crustaceans (shrimps and crabs) were the important prey species but the small fishes also usually found also in their stomach content.

Changing in food habits of fishes were observed they were *Apogon guamensis* (Apogonidae), *Sargocentron rubrum* (Holocentridae), *Atherinomorus duodecimalis* (Atherinidae), *Lethrinus lentjan* (Lethrinidae), *Lutjanus carponotatus* (Lutjanidae) and *Upeneus tragula* (Mullidae). Stomachs of these fishes collected in August and October contained the mysidaceans and isopods as the major food items whereas polychaetes, isopods and juvenile and smaller fishes such as blenniids, gobiids, gerreids, and teraponids were the main component of food contained in the stomach of fishes collected in January and April. Changing in feeding habit might be related to the seasonal changes in abundance of prey species. Kikuchi (1966) and Goldman and Talbot (1976) suggested that successive changeover of food habits of fishes based not only on body size and development of digestive system but also on seasonal availability of the prey species.

From the beam trawl samples observed during the sampling period, abundance of mysidacea in southwest monsoon in August and October and abundance of juvenile of fishes in northeast monsoon in January and intermonsoon April were observed. Nateekanjanalarp (1990) also found the crustacea to be abundance in southwest monsoon and decreased in northeast

monsoon to intermonsoon, polychaete was abundance in northeast monsoon and decreased in intermonsoon and juvenile of fishes was abundance in northeast monsoon and intermonsoon.

Few families of the omnivorous fishes which feed on plants and animals found in this study consisted of Hemirhamphidae, Monocanthidae and Pomacentridae. The data on frequency of occurrence and weight of food items showed that these fishes were more of the herbivorous than canivorous. Goldman and Talbot (1976) also suggested that the majority of omnivorous fishes which included some pomacentrids, monocantrids and hemirhamphids, etc., were substantially more carnivorous or vice versa. The stomach content of *Hyporhamphus quoyi* (Hemirhamphidae), contained more seagrass than algae. On the contary, the stomach contents of *Monocanthus chinensis* and *Acreichthyes tomentosus* of the family Monocanthidae and *Pomacentrus tripunctatus* of the family Pomacentridae contained more algae than seagrass. McRoy and Helfferich (1980) reported that the seagrass were found more than algae in the stomachs of *Hemirhamphus brasilensis* (81%) while only 15.4% and less than 4% of seagrass were found in the stomach of monocanthids and pomacentrids.