CHAPTER 4

DISCUSSION

Plant community structure

Seaqrass Distribution

At Yai Point, 3 species of seagrasses, *Halodule uninervis* (wide-leaved form), *Halophila ovalis* and *H. ovata* were found together at the depth of 5-7 meters, on fine to medium sand substrate.

Halodule uninervis (both wide and narrow forms), *Halophila ovalis* and *H. ovata* also found at Chon Khram Point with the most abundant of *H. uninervis* (wide-leaved form). They grow on medium to coarse sand substrate, at 2.5-3.2 meters depth.

The Halophilid ; *Halophila ovalis* , *H decipiens* and *H. ovata* were found at Hin Com Point, growing on medium sand at 4.2-4.5 meters depth. The study of seagrass community at this site could done only in summer due to the disappearance of seagrasses during rainy and winter season which might be due to the high turbidity in the water column overlying the seagrass bed. Soil erosion was the major cause of heavy siltation in that area resulting from the constructions nearby on shore. These small seeagrasses cannot tolerate this high turbidity condition.

Enhalus acoroides was found at Chaweng Beach on coarse substrates ranging from medium to coarse sand and also with coral rubbles. The water depth was only 0.5-1.0 meters.

Environmental factors usually contributing to the differences in seagrass distribution were substrates, depth and turbidity. The latter factor is usually related to depth. This can be explained by the seagrass morphology itself. The small plant, *Halophila spp.* having the small and delicate structure, can survive on soft substrates. These substrates are not too strong or compact for the delicate rhizomes. According to den Hartog (1977), *Halophila ovata* grew on the liquid on littoral mud, H. decipiens grew on the soft mud. *H. ovalis*, the largest species of this genus, grew on various substrates ranging from soft mud to coarse coral rubble. He also reported that this species is the most eurythermic of the seagrasses, occuring abundantly in tropical and warm temperate waters. However, it is often being the first pioneer species to settle on newly available substrata. It is unable to stabilize them, as the plants are small and their growth is not dense enough to accomplish a permanent stabilization of the bottom. Its root easily them from fragments and it can tolerate being covered by sand and mud. It has repeatedly been found completely covered by sediments but still in good conditions same as *H. ovata.*

The moderate size of *Halodule uninervis* (wide-leaved form) grew on sandy substrates from fine to coarse sand in the exposed sublittoral reef. Menez et al. (1983) reported that this species distributed widely on sandy substrates in sheltered or exposed areas from shallow intertidal to the upper subtidal zone. In the Philippines, occasional patches of *H. uninervis* can be found mixed with *Thalassia hermprichiii, Halophila ovalis, Syringodium isoetifolium,* *Enhalus acoroides* and *Cymodocea serrulata* and *Halodule uninervis* at Koh Samui were found mixed with *Halophila ovalis* and *H. ovata.*

Both forms of *Halodule uninervis*, wide-leaved and narrow-leaved form, occurred together at Chon Khram Point. The narrow-leaved form was found only in a small number in summer. This narrow-leaved from along the east coast of the Gulf of Thailand, grew on exposed sandy intertidal beaches. The wide-leaved form was usually found in the deeper area in the sublittoral zone (personal observation). This pattern corresponded with those reported by Johnstone(1978a,b), Brouns and Heijs (1985) and Fortes (1986).

Various forms in *Halodule uninervis* were found to be the adaptation to salinity changes (den Hartog, 1970). Fortes (1986) concluded that the three forms of *H. uninervis* are : (1) small plants with narrow-leaved 0.5-1.0 mm. wide, occupying the uppermost, often times exposed shore portions, (2) bigger plants with long or short stems, the leaves 2.5-4.7 mm. wide, occupying similar but slightly deeper, protected habitats, and (3) intermediate sized plants, linking by gradual transitions in leaf length and diameter. Johnstone (1978a), on the other hand, reported that *H. uninervis* (narrow-leaved form) occured in the littoral zone often thrived well above the upper limit of other searasses. This is due to its tolerance to desiccation and freshwater at low tide.

This species is pioneer species usually gregarious and dominant in all places which are less suitable for other seagrasses. It grew well where the vegetation has been destroyed by digging or storms. *Halodule uninervis* is usually the first species to establish due to its rapid and dense growth. It soon colonizes the open spots and re-stabilizes the bottom. Beside the role of stabilizer, *H. uninervis* is also of importance as a sediment accumulator. Moreover, *H. uninervis* is able to grow vertically by the elongation of erect shoots and the development of new branches and roots from lateral buds of these erect shoots. In this way it can keep peace with the sedimentation process (den Hartog, 1970).

Monospecific bed of *Enhalus acoroides* was found only at Chaweng Beach, growing on medium sand, coarse sand, and coral rubble in sheltered reef. This species often occurred on various substrates ranging from sandy mud, coarse coral sand to muddy substrate in shelter areas of the intertidal and upper subtidal zones (Menez et al., 1983). This plant's thick and strong rhizome at least 1 cm. thick, help to support the seagrass on various substrate (Lanyon,1986). This species was found in coarse coral sand, growing together with *Thalassia hemprichii* at Wog Tom Bay, Ko Pha-Ngan (personal observation). In the Philippines, the plant occurred in pure stands next to a mangrove where silt was thick and water was merkey, or in occasional patch in coarse coral sand growing together with *Thalassia hemprichii*, or mixed with *Halodule uninervis, Cymodocea serrulata, Syringodium isoctifolium* and *Halophila ovalis* (Menez et al., 1983).

In relations to the depth of water, it can be concluded that the seagrasses in the study area could be categorized into 3 groups: *Halophila spp.* growing at the depth of 4-7 meters, *Halodule uninervis* at the depth of 2.5-7 meters and *Enhalus acoroides* at the depth of 0.5-1 meters. It had been pointed out by den Hartog (1977) that the depth at which seagrasses grew was directly related to turbidity in the water column which corresponded to Buesa (1975) and Zieman and Wetzel (1980). This was also evidenced from the distribution of *Halophila spp.* at Yai Point and Hin Com Point. At Yai Point, the water was clear with the light intensity of 1802 lux. Thus seagrasses occurred at the depth of 5-7 meters. At Hin Com Point, the water is more turbid, *Halophila spp.* occured at lesser depth of 4.2-4.5 meters where the light intensity of 170.5 lux.

Competition might also play an important role in determining the searass distribution as viewed by den Hartog (1970). He pointed out *Enhalus* was specialized, large, stenobiont forms with a good capacity to compete (den Hartog, 1977). The magnozosterids and syringodiids are medium sized forms with a high tolerance to environmental variatons. They are able to inhibit a wider range of habitats. However, they are inferior to the Enhalid in term of competition. The Halophillids and Parvozosterids are usually small, eurybiontic forms, with low competition capacity; they occur in all kinds of habitats unsuitable to the other seagrasses.

Halophila decipiens was found only in small clusters comparing to the dominant *H. ovalis* at Hin Com Point. This was probably *H. decipiens* was not a good competitor. H. ovalis being a good competitor fovored the organic enrichment in the area, thrived and dominated the area.

In general, two zonations in the seagrass beds at Koh Samui existed :(1) *Halodule-Halophila* zone, (2) *Enhalus* zone.

Seagrass biomass

Seagrass is one of the major primary producers in coastal waters. Apart from being primary producers, seagrasses also contributed to the grazing food chains. Thus the seagrass production or biomass is important. The seagrass biomass estimated from this study was in the range of 0.004-1111.53 g.dry wt./m^2. Different species of seagrasses contributed to the biomass differently. Seasonal variations also occured in the seagrass biomass. The highest biomass values for Chon Khram Point and Chaweng Beach were in the rainy and winter seasons respectively. At Yai Point where the studies were during the summer and winter seasons only, the highest biomass also recorded to be in winter.

Flowering and fruiting seasons might contributed to these higher biomass values. This was evidenced in the *Enhalus acoroides* bed at Chaweng Beach. Some flowering specimens of E. acoroides were recorded in the summer time at Chaweng Beach. Thus the study on seagrass phenology such as flowering and fruiting season is therefore necessary. It was observed that the flowering season of *E.acoroides* at Koh Samui coincided with those at Koh Pha-Ngan. Menez et al. (1983) reported the fruiting of E. acoroides were found in May-October in Central Visayas and during April staminate flowers were collected from southern Luzon in the Philippines. According to den Hartog (1970), this plant probably beared flowers and fruits all year round. From Khung Krabane Bay, on the east coast of the Gulf of Thailand, *E. acoroides* also beared flowers all year found (personal observation).

Halophila spp. showed the average ratio of shoot:root and rhizome in the range of 1:0.44 to 1: 0.58. The same ratios for *Halodule uninervis* ranked from 1:1.07 to 1:1.61 and 1:2.45 for *Enhalus acoroides.* In small species such as *Halophila ovalis, H. ovata* and *H. decipiens*, the majority of biomass lies in the above ground (shoot) portion. The large species *H. uninervis* has more biomass in the root and rhizome system than shoot. *Enhalus acoroides*, the largest species, has the majority of the biomass in root and rhizome system in the sediment. This species has the most developed root and rhizome system as compared to the other seagrasses. Further studies are needed in order to be able to correlate the ratio of leaf:root and rhizome to the substrate types as those reported by Zieman and Wetzel(1980) and Zieman(1982).

The relationships between percent coverage and biomass were shown in some species such as *Halodule uninervis* and *Enhalus acoroides* in certain seasons. This might due to the age of stages of seagrass and the flowering and fruiting seasons. In the two areas with the same degree of percent coverage, the biomass could be lower in one area than the other due to the abundance of young plants. On the other hand, flowers and fruits in seagrass would be added to the original biomass giving the high biomass values.

Animal Community Structure

Zooplankton

Zooplankton compositions in the seagrass beds at Koh Samui can be categorized in according to their abundance in various sites. The calanoid copepod was the dominant group at Yai Point. Copepod, Mysidacea and zoea of brachyura were abundant at Chorn Khram Point. Ostracod, mysidacea, tanaidacea and zoea of brachyura were the dominant groups at Chaweng Beach. Kikuchi (1966) studied the food items in the stomach of some fishes in the eelgrass beds and found that copepod, ostracod and mysis played an important role as the important food for fishes. In 1980, Simenstad et al., (cited by Phillips, 1984) found that the density of epibenthic harpacticoid copepod, a favorite food of juvenile chum salmon in the Pacific northwest, was four time as high in a thick stand of eelgrass than nearby habitat without eelgrass. This lead to dense school of juvenile chum salmon feeding upon and among the eelgrass beds.

Tanaidacea is one of the links in the marine food chains. Depending on species size and mode of living, the tanaidaceas were parts of the diets of polychaetes, amphipods, decapods, and fishes (Sieg, 1988). Tanaidacea was incredibly abundant only in the *Enhalus acoroides* bed at Chaweng Beach.

The another distinct group in the zooplankton was zoea of brachyura (*Portunus spp.*) which found numerously in the summer. This might coincided to the spawning season of these portunid crabs which Tantigul (1983) reported that Koh Samui was the spawning area of portunid crabs. The spawning season was from March to June with the maximum peak in December. Portunid crabs were abundant at Chaweng Beach associated with *E. acoroides*. These crabs favored the coarse sand substratum. At Chon Khram Point, found less abundant than other area due to the fine or muddy sand substrates. Large specimens of portunid crabs were also observed in the *E. acoroides*.

Benthic fauna

The most dominant groups of benthic faunas in the seagrass community were amphipods, polychaetes and mollusks. In the mixed seagrass bed of *Halodule uninervis, Halophila ovalis* and *H. ovata* at Yai Point, the dominant groups were corophiid amphipods, nereid and eunicid polychaetes, and pelecypods (Mytilidae) respectively. Whereas at Chon Khram Point dominated by *H. uninervis*, neried polychaetes, corophiid amphipods, three families of pelecypods (Mytilidae, Lucinidae and Veneridae), and 2 families of gastropods (Cerithiidae and Triphoridae) were found. For the mixed *Halophila* bed at Hin Com Point, two distinct group were found, the corophiid amphipod and the cerithiid gastropod. The benthic fauna were more diverse in the *Enhalus acoroides* bed at Chaweng Beach. Tanaidacean, amphithoid amphipod, nereid, syllid and capitellid polychaetes, gastropods from 2 families of Cerithiidae and Pyreneidae and turbellarian worms were recorded.

Species diversity in the benthic community showed relationships to seagrass biomass. At Yai Point and Chon Khram Point, the high diversity occurred in the same season when the seagrass biomass reached maximum. On the other hand, the benthic faunas were more diverse at the time of low biomass in winter at Chaweng Beach.

In small seagrass species such as *Halodule uninervis, Halophila ovalis* and *H. ovata*, small organisms like amphipods, polychaetes and molluscs dominated the communities. Several attached forms were found on the seageass blades. Porifera, sea anemone, turbellaria and bryozoa attached to the surface blades of *Enhalus acoroides* and *Halodule uninervis*. Differences in host plant species and growth forms in seagrasses might be the explanation to the different associative faunas found. The leaf shapes ranged from the narrowed leaves of *Halodule* and the oblong-elliptic or finely branched, shallow rhizomes of *Halophila* to the coarse, very robust and deep penetrating rhizomes of *Enahlus* (den Hartog, 1970; Kikuchi and Peres, 1977; Orth, Heck and Montfrans, 1984). The leaf standing crop or shoot density was also another factors to considered. These characteristics in turn, may alter competitive or predator-prey relationship interactions depending on the shape of leaves or density of shoots (Orth et al., 1984).

Enhalus acoroides bed had the highest diversity of associated benthic fauna followed by the *Halodule uninervis* bed, mixed species of *H. uninervis, Halophila ovata* and *H ovalis* bed, and the mixed *H. ovata, H. ovalis* and *H. decipiens* bed, respectively. Nateekanjanalarp, Sudara and Satumanatpan (1990) also reported the highest diversity of animals found in *Enhalus acoroides* bed at Koh Pha-Ngan as compared to the other types of seagrasses. Heck and Wetstone (1977) considered that animal diverversity associated with seagrass increased with the increasing plant biomass. While this may be generally true, other factors also play a significant role in determining the abundance of particular species associated with seagrass habitats. Heck and Orth (1980a) suggested that plants with more foliose leaves reflecting, greater surface area per unit weight, should provide more protection than plants with simple leaves with lower surface area per unit weight. Stoner (1980b) reported that for equal number of shoot, turtle grass (*Thalassia testudinum*) has a greater biomass but smaller surface area than Cuban shoal grass (*Halodule wrightii*). He further found that three amphipod species were more abundant on the seagrass with the higher biomass.

Nekton

Nekton in the seagrass bed was more diversed than the sand flat at Chaweng Beach. Similar results also reported by Kikuchi (1966), Zieman (1982) and Dolar (1989). Seagrasses play the role as the shelter and food sources for fishes and shrimps. Seagrass beds also produce a living space for protection the fishes and shrimps from their predators (Heck and Orth, 1980b). Seagrass blades may be fed directly by the herbivorous fishes such as *Siganus spp.* or fed by the omnivorous fishes such as gobiids, blennies and file fishes (Kikuchi, 1966; Thayer et al., 1984). The carnivorous fishes, lutjanid and pomadasid fishes also fed on the invertebrates or the small fishes that lived on the seagrass beds (Heck and Orth, 1980a). As for shrimps, some species may fed on the seagrass leaves and others on small invertebrates and detritus (Kikuchi, 1966).

Most of the shrimps, crabs and fishes collected from the seagrass beds at Koh Samui were juveniles. These results coincided to Dolar (1989) and Sudara et al. (1989a). As of the potential nursery role of seagrass beds; food availability to juveniles may be unlimited and as they forage within the canopy they are protected from a larger predatory carnivores or piscivores (Kenworthy et al., 1988). The seagrass blades also protect the animals from sunlight and desiccation during low tide especially at day time.

The night trawled samples, revealed more diversed of shrimps and crabs as compared to day samples. This was also evidenced by the works of Kikuchi, (1966), Bauer (1985) and Dolar (1989). Kikuchi (1966) and Bauer (1985) related this species richness in night samples to the nekton nocturnal migration and activity. Caridean shrimps were the most dominant group in nekton found at Koh Samui. Bauer (1985) and Dolar (1989) also reported that the caridean shrimps were the major component in their decapod catches. Kikuchi (1966) reported that some species of caridean shrimps were the permanent residents spending their whole life within the seagrass beds such as *Alpheus brevicristatus* and *Palaemon ortmanni*. The penaeid shrimps were the seasonal residents which used seagrass beds as a nursery gruond. For this aspect, the shrimps associated within the seagrass beds at Koh Samui were similar to those reported by Kikuchi (1966). The role of seagrass beds as nursery was quite evidenced by the rich juveniles of penaeid shrimps and portunid crabs collected at the *Enhalus acoroides* bed at Chaweng Beach.

Seasonal variations in fishes were recorded during the summer. Juveniles of *Siganus spp.* were most abundant at Chon Khram Point and Chaweng Beach. Siganid fishes were absent at Yai Point. The most dominant fish during the winter was *Favonigobius sp.* at Chon Khram

Point, while at Chaweng Beach in the same season, *Gerres sp.* was the most dominant fishes. Kikuchi (1966) reported the the juveniles of *Gerres macrostoma* used the seagrass beds as a nursery ground and as a foraging area when they became adults. Satumanatpan (1990) reported that juvaniles *Signus sp.* were found all year round at Khung Krabane Bay, Chanthaburi Province. They used the seagrass beds as nursery ground. Juvenile and adult of gobiid fishes were also throughout the year. It was concluded that the gerried, and siganid fishes were seasonal residents that use the seagrass beds as nursery ground and the gobiid fishes were permanent residents.

The decapods (shrimps and crabs) and fishes in the seagrass beds at Koh Samui can be divided into two groups based on Kikuchi (1966).

1. Permanent resident, (found both seasons), such as caridean shrimps and fishes *Fanovigobius sp.*, *Pelates quadrilineatus* and *Acreichthys hajam.* These fishes are rather small and of no economical value. However they might play an important role as food fishes to other economically important fishes.

2. Seasonal residents, (found only one season), such as *Psammoperca waigiensis*, *Siganus spp.*, *Epinephelus tauvina* and *Gerres sp.* The economically important fishes in this gruop may be used the seagrass beds as nursery ground.

The species richness of decapod and fishes were highest at Chon Khram Point followed by Chaweng Beach and Yai Point. However the highest abundance of decapods and fished were recorded at Chaweng Beach followed by Chon Khram Point and Yai Point. These might be related to forms and zonation within seagrass beds (Kikuchi and Peres, 1977). The mixed species of seagrass beds from (*Halodule uninervis* and *Halophila spp.*). as found at Chon Khram Point and Yai Point. These were small and short plants. The *Enhalus acoroides* bed was high and large plant, was found at Chaweng Beach. The seagrass bed was very dense at Chon Khram Point reflecting high density of decapods and fishes as compared to those found at Yai Point. The nekton was richest in term of species and abundance in the *Enhalus acoroides* bed at Chaweng Beach. Nelson (1979) and Heck and Orth (1980b) suggested that the high density of seagrasses would provide more living space of foraging predators (Nelson, 1979; Kenworthy, et al., 1988), the height and density of shoot and large plant surface area will interfere the movement of the larger predators (Kenworthy et al., 1988). According to the habitat complexity's theory (Heck and Orth, 1980b), the complexity of habitat would increase with increasing vegetation density thereby leading to the increase in species among the invertebrates and juvenile of fishes. Dominant associated faunas within different seagrass beds at Koh Samui were summarized in Figure 23.

The ecological roles of seagrasses can be summarized as follow:

1. Seagrass production contributing to the productivity of coastal waters

2. Habitat and shelter for numerous associated faunas. Seagrass beds (specialized with the mixed species of *Halodule uninervis* with *Halophila ovata* and *H. ovalis* at Chon Khram Point and pure stand of *Enhalus acoroides* bed at Chaweng Beach) served as a nursery ground

for the portunid crabs, the siganid fishes and shrimp juveniles such as *Penaeus sp.*.

3. Food sources. Although direct grazing on seagrasses has been considered relatively unimportant, the detritivores have emerged as the major benefit of energy fixed by seagrasses. Green turtles, sirenians and several fishes are the major seagrass macroherbivores, feed on seagrasses. The gastropod, Cerithiidae, Triphoridae and Pyreneidae feed with the epiphytes on the seagrass blades. Amphipod, mysis and tanaidacea are detritus feeder.

4. Protection from predator. Because the plant-canopy and root-rhizome effects these provide more living space for the animals.

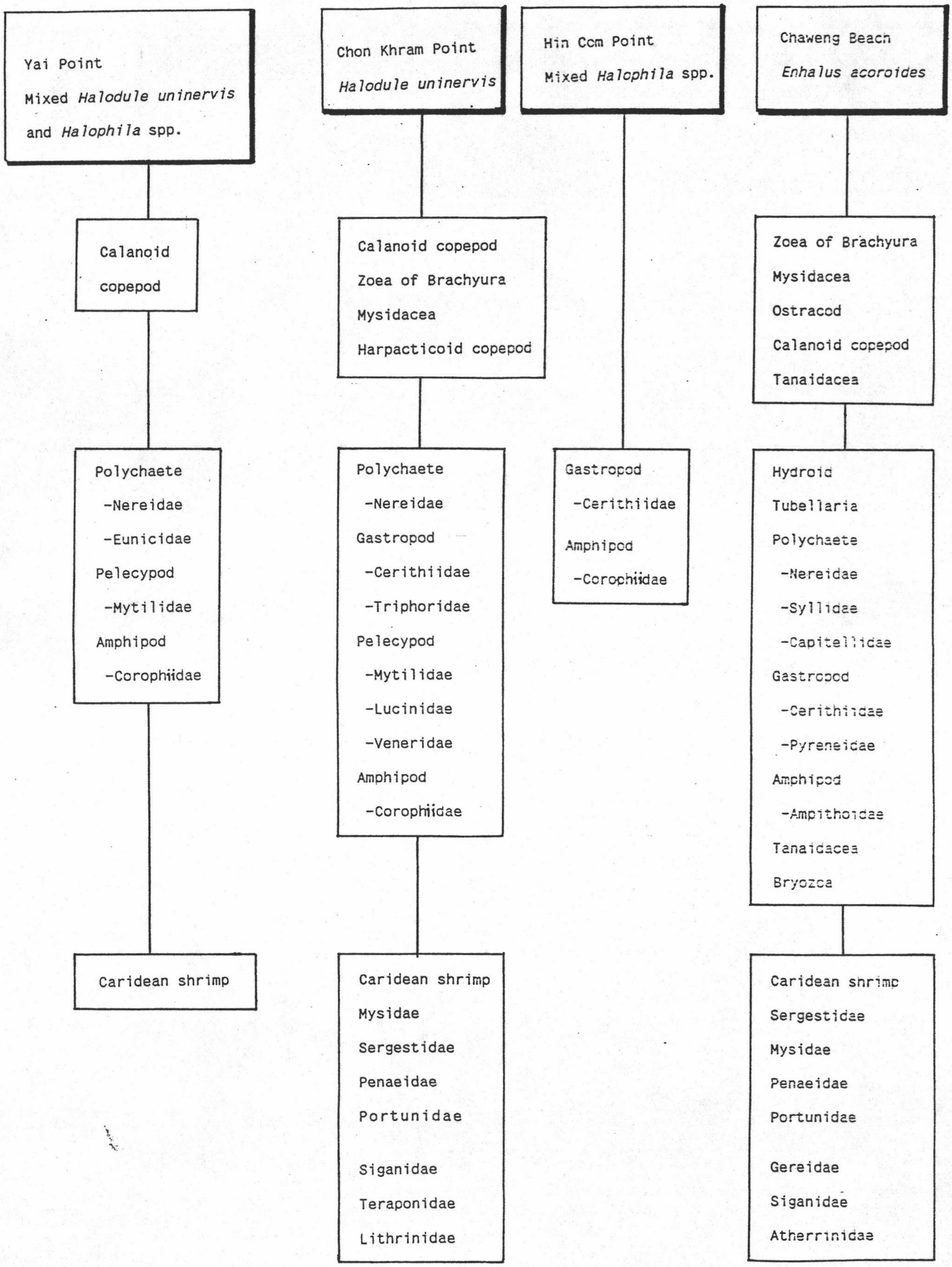

Figure 23 Digram of dominant associated faunas within different types of seagrass beds at Koh Samui