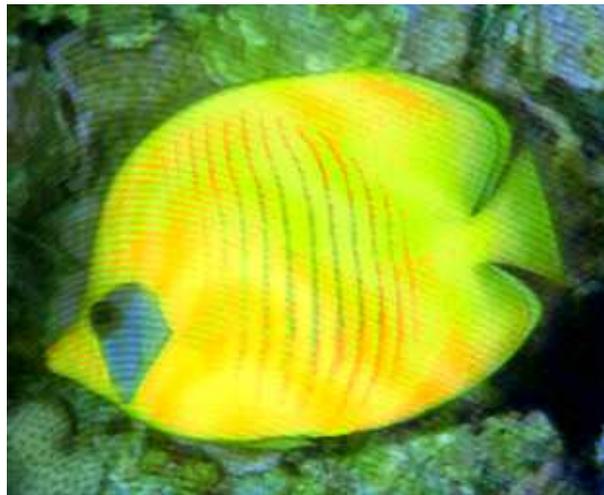


Ecological and Biological Studies on Some Coral Reef Fishes in South Sinai (Red Sea – Gulf of Aqaba)



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1997

Abstract of Master Thesis

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In the present study, 11 different sites were investigated along the coast of the Gulf of Aqaba. Shore profile and overview of each site was initially surveyed. This eleven sites are divided into two groups; firstly, seven sites (1-7) were visited to collect data (2 weeks for each site). Secondly, four sites (8-11) were studied for 14 months period. Site 9 was visited more repeatedly to study feeding habits of different species.

The elements of the substrates in the study area (sites 1-7) were analysed. The main components of substrate were estimated as a percentage cover. These components were classified to hard corals, soft corals, plants, associated fauna and dead components.

Studied Species:

Sixteen species belonged to two families (Butterfly and Angel fishes) were recognized along the coast of the Gulf of Aqaba. Butterflyfishes (Chaetodontidae) were represented by 9 species inhabited fringing reef, beside two new recorded species. Angelfishes (Pomacanthidae) were represented by 5 species on fringing reefs.

Distribution of fishes along the Gulf of Aqaba

During the field work some of the ecological parameters had been recorded, such as temperature, rugosity and visibility.

A- Distribution According to Sites (Horizontal Distribution):

Regardless to depths, the number of individuals and species varied between different sites. In general, the northern sites (1 and 2) had the lowest number of individuals and species comparing with southern sites.

Butterflyfishes: At site 1, 5 species of butterflyfishes in total were found at different depths (*Chaetodon auriga*, *C. fasciatus*, *C. austriacus*, *C. paucifasciatus* and *Megaprotodon trifascialis*). While, a total of 6 species were recorded at site 2. In this site, *Heniochus intermedius* was seen beside the 5 species of site 1. In the three sites 3, 5 and 6, eight species have been recorded. A total 7 species (*C. auriga*, *C. fasciatus*, *C. austriacus*, *C. paucifasciatus*, *M. trifascialis*, *C. lineolatus* and *H. intermedius*) were recorded at sites 3, 5 and 6. *Chaetodon melannotus* was recorded at site 3 in addition to the above seven species, while at site 5 and 6, *Chaetodon semilarvatus* was seen beside the other seven species. At site 4; seven species in total were recorded, while at site 7, all butterflyfish species (9 species) were recorded. The *C. paucifasciatus* was the most abundant butterflyfish on the reef at four sites (1, 2, 4 and 6). In contrast, the *C. austriacus* was the most abundant species at other three sites (3, 5 and 7).

Angelfishes: four species of angelfishes were found at site 1 (*Pomacanthus imperator*, *Centropyge multispinis*, *Pygoplites diacanthus* and *Genicanthus caudovittatus*). Only the three of the previous species were recorded at site 2. In the three sites (3, 5 and 7); four species in total of the angelfishes were recorded. At the two sites (4 and 6), all species of the angelfishes were recorded (*Pomacanthus imperator*, *P. maculosus*, *Centropyge multispinis*, *Pygoplites diacanthus* and *Genicanthus caudovittatus*). In the northern part of the Gulf of Aqaba at site 1 and 2,

the angelfish *C. multispinis* was the dominant; while *G. caudovittatus* was the most abundant species at all other sites (3, 4, 5, 6 and 7).

Diversity and Similarity Between Sites: The highest richness of butterflyfishes was recorded at site 7 (1.67), while the lowest richness was found at site 1 (0.91). In case of the angelfishes, site 1 had the highest richness (1.25), while the lowest record was at site 5 (0.57). The evenness of butterflyfishes shows that site 1 was low (0.59), while site 5 was the highest one (0.8). For the angelfishes, site 1 recorded the highest evenness (0.96), while site 2 recorded the lowest value of evenness (0.56).

The results of a Bray-Curtis similarity index cluster analysis, which classifies the sites according to abundance of butterflyfishes shows three clusters. The first included sites 1 and 2; while the second included sites 4 and 6; the third included 3, 5 and 7. The abundance of angelfishes was given three clusters. The first included sites 3 and 5; while the second included 4 and 6, while the third included 1 and 7.

B- Distribution According to Depths (Vertical Distribution):

In general, there are two obvious patterns of distribution of all fishes with depth along the Gulf of Aqaba. The first, the total number of individual of all fishes increases with depth. The second, the total number of species of all fish species showed an increase until reached a highest value under 15 m depth.

Butterflyfishes: The average abundance of *C. auriga* shows high abundance at the shallow depths rather than at the deeper ones. The average abundance of *C. fasciatus* along the Gulf of Aqaba shows the preference of this species to shallow water habitat (Reef Flat (RF), Reef Edge (RE), 5m, and 10m depth) rather than deep waters (more than 20m). *C. lineolatus* was a very rare species of butterflyfishes along the Gulf of Aqaba. The *C. austriacus* was the most abundant butterflyfish species along the Gulf. *C. paucifasciatus* was the second most abundant butterflyfish species. Along the Gulf of Aqaba, the *C. semilarvatus* was preferred the RE. The *M. trifascialis* preferred the shallow water at the most sites. *H. intermedius* found at all depths from the RE to 25m depth at the most sites.

Angelfishes: The average abundance of the angelfish *P. imperator* was approximately constant along the Gulf. *P. maculosus* was the most rare species among angelfishes in the Gulf of Aqaba. It was not represented completely on the reefs at four sites. *C. multispinis* was the most abundant angelfish species recorded at the study sites. The depth clearly affects the distribution of this species. The *P. diacanthus* was recorded at most depths. Finally, *G. caudovittatus* was restricted to deeper waters (more than 15m) at all sites.

Diversity and Similarity Between Depths: The highest richness of butterflyfishes was recorded at 25m (1.31), while the lowest richness were recorded at the RE (1.13). The richness of angelfishes shows the reverse trend of the butterflyfishes. The evenness of butterflyfishes shows that the 5m depth has the highest evenness (1.31), while the 25m depth has the lowest one (1.13). In case of the angelfishes, the highest value of the evenness was recorded at 10m (0.68), while the lowest was recorded at the RF (0.57).

The results of a Bray-Curtis similarity index cluster classify the depths according to abundance of butterflyfishes into three clusters. The first included RF

only, the second include RE, 5m and 10m; and the third included 15, 20 and 25m depth. Also, the abundance of angelfishes included three clusters. The first included RF only, the second included 10, 15 and 20m; and the third included the RE, 5 and 25m depth.

C- Relationship Between Substrate and Fishes:

The linear regression equations were calculated to investigate the relationships between fish community and benthic composition of substrate. The total number of fishes has strong relationship with living components of substrate ($r = 0.65$), while with dead component, the relationship was relatively weak ($r = 0.47$). the abundance of the hard corallivorus (*C. austriacus* and *M. trifascialis*) did not correlated significantly with the percentage of hard coral ($r = 0.15$). while, the soft corallivorus (*C. lineolatus* and *C. melannotus*) shows close relationships with soft corals, where the correlation coefficient was high ($r = 0.62$). finally, the omnivorus correlated significantly with percentage of different groups of animals ($r = 0.72$).

Seasonal Variations

Maximum air temperature usually occurs in July-August and the minimum in January-February. In general, the water visibility of the Gulf of Aqaba is high. The average value of visibility was 13.08 m at Shark Bay site, while it was 10.89 m at the Tower site. The average of visibility at Um El-Seid site was 12.96 m, while at Marine Station site was 12.41 m.

A- Seasonal Variations in Fish Abundance:

In general, the distribution of all fishes belonging to the two families and even on the species level was varied according to sites, zones, months and the time of measurements. On the RF, there was no obvious pattern in monthly abundance of all fishes at 8:00 AM and 12:00 PM. In contrast on the RE, there is a clear pattern of distribution for all fishes. It is noticeable that the abundance of all fishes belonging to the two families was higher at 8:00 AM rather than at 12:00 PM allover the year. There is a clear trend of increasing abundance of all fishes at 8:00 AM during autumn to reach a maximum value in winter.

In general, the total abundance of butterflyfishes was higher on the RE rather than on the RF at both time of measurements. On the RE the distribution pattern of butterflyfishes was varied according to the time of measurements. The monthly abundance of angelfishes on RF did no show any trend at the two different time of measurements. On the RE, the abundance of angelfishes was increased in autumn to reach its highest abundance in November then decreased after that in spring.

B- Dominance of Fish Species:

The dominance of 12 species of butterfly and angel fishes estimated as percentage of occurrence of the total count of each families. On the RF of all sites, 5 species (*Chaetodon auriga*, *C. fasciatus*, *C. melannotus*, *C. austriacus* and *C. paucifasciatus*) were represented by more than 90 %. In addition only 3 species of butterflyfishes (*C. austriacus*, *C. paucifasciatus* and *H. intermedius*) were represented by more than 70 % on the RE of all sites. A certain degree of specialization in

zonation could be observed in the distribution of butterfly and angel fishes on RF and RE. Therefore, it can be divided the nine species of butterflyfishes into three groups. The first group as restricted strongly or reasonably to the RF, including 3 species (*C. auriga*, *C. fasciatus* and *C. melannotus*). The second group was dominated on the RE (*C. austriacus*, *C. semilarvatus* and *H. intermedius*). The third group had no trend of distribution either on the RF or on RE (*C. paucifasciatus* and *C. lineolatus*). Concerning the angelfishes, only 3 species of the Pomacanthidae were recorded over all the investigated sites. *P. imperator* was a very rare species of Pomacanthidae. The other two species of the angelfishes showed different patterns of zonation. It is noticeable that *C. multispinis* is mainly restricted to the RE. In contrast, *P. diacanthus* was mainly dominated on the RF of most sites.

C- Distribution of Species:

The data of monthly abundance for each species of butterfly and angel fishes were averaged to calculate the seasonal average abundance of each species.

*** Butterflyfish Species.**

Chaetodon auriga: this species abundant at Shark Bay rather than other sites. There was no clear seasonal pattern of *C. auriga* distribution at different sites, except Shark Bay site. ***Chaetodon fasciatus***: the highest abundance was at two sites (Tower and Shark Bay), comparing with the other sites. However, there was no defined pattern of distribution on the RF or RE at different sites according to season. ***Chaetodon lineolatus***: in general, there was no clear trend of abundance where this this species was very rare allover the different sites. ***Chaetodon melannotus***: the seasonal abundance of this species illustrated the preference to inhabit the the RF rather than RE. *C. melannotus* was more abundant on the RF and RE of two sites only. ***Chaetodon austriacus***: it was extremely abundant on the RE rather than on the RF. The seasonal pattern reflect the highest abundance which are mostly in autumn and/or winter, while the lowest abundance was in spring. ***Chaetodon paucifasciatus***: in general, the abundance of this species was higher at 8:00 AM rather than at 12:00 PM. This trend is more clear on the RE comparing with the RF. ***Chaetodon semilarvatus***: the zonation trend of this species was very clear. This species was restricted to the RE of all sites at all seasons. It is clear that *C. semilarvatus* has no obvious seasonal pattern. ***Megaprotodon trifasciatus***: there was no clear pattern of seasonal variations in the abundance among all sites. The abundance were extremely higher on the RE rather than on the RF of all sites. ***Heniochus intermedius***: according to the seasonal abundance of this species, the higher abundance was found on the Shark Bay; while the lowest was recorded on the RE of Um El-Seid site.

*** Angelfish Species.**

Pomacanthus imperator: it was the most rare species among angelfishes. It was not represented completely in the community of angelfishes at Shark Bay and Marine Station sites. ***Centropyge multispinis***: the zonation of this species was clear, where it was mainly restricted to the RE of all sites. There was a reasonable trends in the seasonal distribution of this species. ***Pygoplites diacanthus***: this was the most abundant angelfishes species recorded in the study area.

The diversity index was calculated for all sites of two families together due to a few numbers of angelfishes. The richness, Shannon-Wiener and evenness were

estimated for the four sites and two zones (RF and RE). The results of a Bray-Curtis similarity cluster analysis of RF and RE of the four sites depending on the overall abundance of butterfly and angel fishes shows that, seven clusters were identified.

Food and Feeding

A- Biting Rates:

The biting rate as an index for feeding activity was determined for 5 species; 4 species of Chaetodontidae (*Chaetodon auriga*, *C. austriacus*, *C. paucifasciatus* and *Megaprotodon trifascialis*) and one species of Pomacanthidae (*Pygoplites diacanthus*). In comparison, highest biting rates (feeding activity) were recorded for *C. austriacus* and *M. trifascialis* with an overall means of about 378 bites / 30 minutes at afternoon. In contrast, the lowest biting rate was recorded for the angelfish *P. diacanthus*, it is being 119.2 and 98.6 bites / 30 minutes at noon and afternoon respectively.

Seasonal Variation in Feeding Rate of *C. fasciatus*:

In general, highest feeding activity of *C. fasciatus* was recorded in summer at noon where the biting rate was 166.6 bites / 30 minutes. At the same time of the day, the lowest biting rate was recorded in spring (70.9 bites / 30 minutes). In addition, the biting rates at noon in autumn and winter were 104.2 and 119.5 bites / 30 minutes, respectively.

B- Feeding Intensity and Diet Composition:

In total 113 specimens belonging to 8 species of butterflyfishes (*Chaetodon auriga*, *C. lineolatus*, *C. melannotus*, *C. austriacus*, *C. semilarvatus*, *M. trifascialis*, *C. paucifasciatus* and *H. intermedius*), and one species of angelfishes (*P. imperator*) were examined to study the diet composition of the previous species. Out of the nine species, 2 species (*C. lineolatus* and *C. melannotus*) were found to feed totally on the soft corals, where 100 % of stomach content was composed of soft coral polyps. Also, 2 species (*C. austriacus* and *M. trifascialis*) were totally hard coral feeders. Macroalgae were found to be the main food item for three species (*C. semilarvatus*, *C. paucifasciatus* and *P. imperator*). Polychaetes were the more important food items in the stomachs of *C. auriga* and *H. intermedius*. Planktonic food were represented reasonably in the stomach of *C. paucifasciatus*. It is also noticeable that the detritus or dead materials were represented as one of the important food item in the stomach of *H. intermedius*.

Feeding Intensity of *C. fasciatus*:

A total of 44 stomachs of *C. fasciatus* were examined to study the seasonal feeding intensity and the seasonal variations in diet composition of this species. The highest feeding intensity was recorded in summer and autumn with an overall means of stomach contents weights of 1.46 and 1.67 gm, respectively. In addition, the lowest feeding intensity was found in spring with an overall mean of stomach content weight of 1.37 gm.

Composition of the Diet in *C. fasciatus*:

The food items recorded in the stomach of *C. fasciatus* were algae, polychaetes, jelly-fishes, soft corals, zooplankton, hard corals, ascidians and eggs. The occurrence of each food item in the stomach of *C. fasciatus* was varied according to season. Algae and polychaetes were composed the most food items.