Qatar Univ. Sci. J. (1997), 17(2): 377-385

FISH DIVERSITY IN CORRELATION WITH SOME ENVIRONMENTAL FACTORS IN THE MANGAL OF TWO PROTECTORATE AREAS, RAS MUHAMMED AND NABQ ON THE RED SEA IN EGYPT.

By

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بعض الدراسات البيئية والتنوع السمكي في مناطق أشجار الشورا في محميتي رأس محمد ونبق على البحر الأحمر في مصر

السيد فكري علي الضوي

يتناول هذا البحث ـ للمرة الأولى ـ دراسة التنوع السمكي في خمس قطاعات من غابات الشورا في اشهر محميتين طبيعيتين هما رأس محمد ونبق على البحر الأحمر بجنوب سيناء في مصر.

وقد أوضحت الدراسة وجود ٢٢ نوعاً من الأسماك تصنف الى ١٥ عائلة، ١٢ تحت رتبة، ٩ رتب، طائفتين. وقد امكن التعرف على ٧ أنواع من بينها ـ تنتمي الى ٥ عائلات ـ لم يتم تسجيلها من قبل في هذه المناطق وهذه الأنواع هي : اثيرينومورس لاكيونوزس، إستبلينيس اندامانينسيس، سالاريا فاسكياتس، جناسوليبيس انجيرينسيس، إستيجوبيس اورناتس، سيدريا بكتا و أروثرون ديادياماتس.

كما اوضحت الدراسة أن مناطق غابات الشورا في جنوب سيناء تحتوي على أنواع قليلة من الأسماك بالمقارنة بتلك الموجودة في البيئات البحرية الاخرى. وقد وجد أن بعض من هذه الأسماك ينتمي الى ٦ عائلات ذات قيمة اقتصادية عالية، وعلاوة على ذلك فإن هذه المناطق تمثل بيئة ملائمة لنمو صغار العديد من الأسماك المختلفة، خاصة الاقتصادية منها، كتلك التي تنتمي إلى العائلة البورية وعائلة الدنيس.

ومن ناحية أخرى فقد تم تسجيل بعض القياسات البيئية كالملوحة ـ الحرارة، ونسبة الاكسوجين المذاب في الماء وايضاً الأس الهيدروجيني ـ وذلك لمعرفة مدى تأثيرها على هذا النظام البيئي الفريد.

وقد استنتج من هذا البحث أن انخفاض التنوع السمكي في هذه المناطق يعود الى ارتفاع نسبة الملوحة والحرارة مع انخفاض نسبة الأوكسوجين المذاب في الماء بجانب طبيعة القاع في هذه المناطق.

Key Words: Ecology, Fish Diversity, Mangal, Red Sea, Egypt.

ABSTRACT

The present investigation is an attempt to study the fish diversity at five sites of the mangrove forests (Mangal) in two famous protectorate areas : Ras Muhammed and Nabq on the Red Sea in Egypt. The present investigation revealed that the high salinity and temperature as well as the decrease in dissolved oxygen in Ras Muhammed and Nabq has a profound effect on the low density and diversity of species inhabiting these areas. This study revealed that 22 fish species belonging to 15 families, 12 suborders, 9 orders and 2 classes are represented in the studied areas. Among these collected fish species, 7 species belonging to 5 families, have not been recorded in the studied areas, These fish species are : *Atherinomorus lacunossus, Istiblennius andamannensis, Salaria fasciatus, Gnatholepis anjerensis, Istigobius ornatus, Siderea picta,* and *Arothron diadematus.* Also, the study has revealed that the mangal in South Sinai contains few fish species compared to any other marine habitats. Some of these fishes are economically important . Moreover, the mangal is considered as a nursery ground for many fish species, especially those which are economically important such as, *Mugil cephalus* and *Crenimugil crenilabis* (F. Mugilidae) and *Acanthopagrus bifasciatus, Diplodus noct, Rhapdosargus haffara* (F. Sparidae).

INTRODUCTION

Mangrove forests or (mangal) called El-Shura as used by Bedouins is a general term used to describe a variety of tropical inshore communities dominated by several species of trees or shrubs that have the ability to grow in salt water. Mangrove forests have played an important role in the economics of people for thousands of years and till now constitute a reservoir and refuge for many unusual plants and animals. They support commercial and recreational fisheries and provide many other direct and indirect services. It is thought that the mangrove environment also provides living space for diverse biota of more than 1000 species of epiphytic plants, invertebrates and fish. Such diverse and expansive communities are found in only few areas and are not represented in all mangals of the Red Sea (1.2).

Ascherson (3) was the first to describe the Sinai mangrove, whereas the mangroves of the Egyptian African coast were recorded by (4). However, the mangrove (mangal) of the Red Sea have generally received less attention. The most extensive survey of marine habitats of the Red Sea is that of (5) who characterized communities, including the mangal in the Gulf of Aqaba and (6) who gave a detailed descriptive account on the zonation, algae and animals of the mangal of Sinai and provided a list of animal species, comprising 114 species; of which 19 fish species are recorded.

Most studies that have been conducted principally on mangal of Sinai (7,8,9,10) have considered several aspects of mangal ecology and productivity. Concerning the vegetation, mangal surveys have been undertaken in other parts of the Red Sea coasts (4,11,12,13). Price *et al.* (13) pointed out that the mangal of the Red Sea represent a composite habit containing both hard and soft substrates, and is inhabited by fauna typical of each.

In respect to the faunal composition of the mangal of South Sinai, few studies were carried out. El-Serehy *et al.* (14 a & B) gave an excellent account on the ecology, occurrence and seasonal distribution of the brachyuran crabs in a variety of habitats around shores of South Sinai, including Naama Bay, Sharm El-Maya Bay and the mangrove sites of Nabq and Ras Muhammed Protectorates. With regard to the mangrove fishes, (15) studies the parasitic helminthes relationship of sixteen fish species belonging to six orders collected from both El-Ruwaysia and El-Monqata, Gulf of Aqaba, South of Sinai.

It is thus clear that no detailed studies had been so far made on the fish fauna of the mangal of Southern Sinai. Accordingly, the present investigation represents the first recent attempt to survey and identify in detail most of the fish species which inhabit the five sites of such important community (the mangrove forests or mangal) of South Sinai of Egypt. Moreover, some ecological parameters were determined during two seasons to study their effect on the fish diversity. Intensive collection from other parts of the coast of the Red sea seems a necessity to enrich our knowledge of the fish fauna and hence provide a better understanding of the biodiversity of the mangrove in general. It is anticipated that such a survey could provide a baseline for a proper management and conservation of marine resources in Southern Sinai which is threatened by the increasingly touristic activities particularly in Sharm El-Sheikh and its surroundings.

MATERIALS AND METHODS

Two protected areas at Southern Sinai : Ras Muhammed and Nabq were visited from September 1994 to July 1995, during summer and winter. Five Sites of collection were selected, one at Ras Muhammed (mangrove channel) and four at Nabq (El-Monqata, El-Ruwaysia, Marsa Abou Zabad and El-Gharqana (Fig. 1).

Fish were collected by using a trammel and tow nets as well as from the commercial catch. Underwater observations on the fishes and the habitat description were recorded using snorkelling and underwater photographs by 35 mm underwater camera. Some of the collected fish samples were freshly photographed and immediately preserved in 10% formalin-sea water. Others were kept in an ice tank and taken to the Egyptian Environment Affairs Agency the (EEAA) research laboratory at Sharm El-Sheikh where the coloured fishes were photographed and preserved either in 70% alcohol or/ and Bouin's fixative (1 : 1) and then transported to the laboratory of Zoology Department, Faculty of Science, Ain Shams University for identification.

At the laboratory, fish specimens were identified and measured according to the morphometric characters and meristic counts of each species using standard texts (16, 17, 18, 19). A complete list of the recorded fish species were made. The preserved samples of fish species were labeled and prepared as museum samples in Zoology Department, Faculty of Science, Ain Shams University.

Different environmental parameters (temperature , dissolved oxygen, pH and salinity) were measured, at irregular intervals, during summer and winter by using a Water Quality Checker HB 27 HB, England.

RESULTS

The basic characteristic and habitat of the mangal sites

The Sinai mangal is a type of mangal which grows on hard bottom without being connected with a riverine estuary. It is a monospecific *Avicennia marina* forest (El-Shura), which lies under extreme conditions of salinity and temperature. The temperatures, dissolved oxygen, pH and salinity in the water of the mangal showed remarkable fluctuations (Table 1). In summer , high temperatures (30.4°C and 33.6°C) are associated with increased salinity of 46.5‰ and 48.4‰ in Ras Muhammed and Nabq, respectively. On the other hand, decrease in temperature is usually associated with decrease in salinity during winter (Table 1). It is observed that strong stormy wind in winter leads to a decrease of temperature 14.6°C.

The lowest value of salinity (42.5‰) was recorded at the periphery of the mangrove areas opposite to the open sea whereas, the highest value (52.9‰) was recorded in isolated puddles among the mangrove trees. It is also noted that the temperature and salinity in Ras Muhammed mangals are usually lower than those of Nabq, especially against the open sea.

There are five sites of mangrove forests in southern Sinai along the coast of the Gulf of Aqaba, one at Ras Muhammed Protected area (mangrove channel) and four at Nabq Protected Area, from North to South (El-Monqata, El-Ruwaysia, Marsa Abou Zabad and El-Gharqana (Fig. 1). The latter four sites are found along a stretch which corresponds to the alluvial fan of Wadi Kid (between 28° 07 N - 28° 18 N) to the north of the small Oasis of Nabq (6,20) (Fig. 1).

The four Mangal areas at Nabq include:

I - El-Monqata, the lagoon is open and is encircled by small groups of *Avicennia marina*, isolated small trees being found on a seaward reef. The inshore lagoon is surrounded by a thicker mangrove and a narrow canal leads into the *Avicennia* thicket.

II - El- Ruwaysia and Marsa Abou Zabad are the best developed and the biggest of the mangrove forests, where the main lagoon is encircled by the offshore mangrove.

III - El-Gharqana, consists of a thin offshore mangrove surrounding the mangrove lagoon and sparse inshore. Isolated *Avicennia* shrubs are found on a fossil reef flat, as well as towards the shore.

El-Ruwaysia is the largest of the mangrove forests, followed by those at Marsa Abou Zabad. The forests at El-Monqata are moderate, while those at both El-Gharqana and Ras Muhammed mangrove channel are small and found in patches of aggregated trees.

There are many different biotopes in Sinai mangroves; such as the mangrove lagoon, the aerial roots and the seaward fossil reef flat.

I - Mangrove lagoon: The lagoons are permanently water filled, even at low tides; they are completely separated from the sea. The bottom is covered by a thin layer of mud, followed by a deeper level of coarse sand intermixed with mud. The sediment is poorly oxidized.

II - Aerial roots: The aerial roots of the mangrove forests are inhabited by many species of algae which give a suitable habitat to many animals either invertebrates or vertebrates.

III - Seaward fossil reef flat: This biotope is found in El-Ruwaysia and El-Monqata mangals. The reef flat is covered by crusts of the green algae. On the flat, there are many residual pools with some coral growths. In these residual pools, there are several algal species and sea grasses.

Fish diversity:

Fish collections from the 5 sites of the mangrove forests in

both Ras Muhammed and Nabq areas revealed the presence of 22 species belonging to 15 families, 12 suborders, 9 order and 2 classes (Table 2). Among these species *Atherinomorus lacunosus* (Bloch and Schneider, 1801) and *Monodactylus argenteus* (Linnaeus, 1758) are economically important. Another 7 species, *Crenimugil crenilabis* (Forsskal, 1775), *Mugil cephalus* (Linnaeus, 1758), *Parupeneus macronema* (Lacepede, 1801), *Siganus rivulatus* (Forsskal, 1775), *Acanthopagrus bifasciatus* (Forsskal, 1755), *Diplodus noct* (C. and Val., 1830), *Rhapdosargus haffara* (Forsskal, 1775) have a highly economic importance (Table 2).

Order Perciforms is represented in the mangal by 2 suborders, 6 families and 10 species. Order Mugiliforms is represented by 2 suborders, 2 families and 3 species, whereas, the remaining 7 orders, each includes one suborder and one family. All these families include the remaining 9 species (Table 2).

It is found that, the lagoons are dominated by *Aphanius dispar* (Ruppell, 1828) and *Gnatholepis anjerensis* (Bleeker, 1850). Furtheremore, the lagoons are the nursery grounds for many other fish species such as, *Acanthopagrus bifaciatus, Diplodus noct, Rhabdosargus haffara* and *Bothus pantherinus* (Ruppell, 1828).

The ground of the aerial roots of the mangrove forests are inhabited by some fish species, such as : *Trachyrhamphus bicoarctatus* (Bleeker, 1857) and *Mugil cephalus* (Linnaeus 1958). Moreover, these aerial roots give a suitable shelter to *Crenimugil crenilabis* which is the dominant species in such biotope.

On the other hand, the fish diversity of the seaward fossil reef flat, in El-Ruwaysia and El-Monqata sites is more marked. It is inhabited by *Mugil cephalus; Siderea picta* (Ahl, 1789) ; *Pterois volitans* (linnaeus, 1758) and *Arothron hispidus* (Linnaeus, 1758).

DISCUSSION

The term "mangrove" refers to the individual plants, whereas the forest, mangrove swamp, tidal forest and mangal refer to the whole community or association dominated by these plants (21,22). Furthermore, the mangrove ecosystems are thought to contain about 60 species of trees and shrubs and more than 20 additional species frequently associated with the mangrove flora, but not necessary restricted to it (2).

On the Egyptian coasts of the Red Sea, where rivers and estuaries are absent, mangrove forest tend to be found in sheltered water associated with enclosed soft-bottom habitats or in shallow bays protected by a fringing reef. The mangrove forests have developed in extreme environmental conditions where the high temperature together with high salinity and low exygen levels combine to limit the faunal diversity. Nevertheless, the mangal is one of the highly productive environments of the marine shore (6). The latter authors believe that the mangal as an ecosystem is based on accumulation of nutrients produced by the mangrove trees upon which lives a high biomass of a relatively low diversity algae and animals which resist the extreme environmental conditions. Odum and Heald (23) pointed out that the mangal system is based on recycling of the mangrove tree products only.

From the aforementioned discussion, and the present study, it can be concluded that the mangal productivity is based, not only the recycling of the mangrove tree products as previously mentioned (6,23), but also on the products of the micro and macrofauna including fishes, as they are dependent on each other. Otherwise, what is the role of the huge number of species of (more than 1000) of fish, invertebrates and epiphytic plants (1.2) ?

In the present study, it is found that both temperature and salinity in the mangrove areas are directly correlated with each other, as the increase of temperature in summer is associated with an increase in salinity and *vice versa* (Table 1). The average increase in both parameters is relatively higher than in the other adjacent areas lacking mangroves (24). Por *et al.* (6) showed that the increase of temperatures and salinity is much influenced by evaporation and dry winds; such increase is highly attributed to the high evaporation. The localized areas of the mangrove forests, shallow bays as well as dry wind represent the main accessory factors for evaporation and consequently the increase in temperature and salinity. Moreover, the

precipitation of the faeces of the members of fauna (either micro or macrofauna) is supposed to cause an elevation or disbalance of the salinity as well as the pH values.

In the present investigation, the lowest value of salinity recorded was 44.7‰ ± 1.9 whereas the highest value was 48.4‰ ± 4.5. In both cases, the values are higher than those of open seas (>40.2‰). An observation which confirms the previous finding (25) in Gulf of Aqaba. In Sinai mangals, highest value of salinity (52.9‰) was recorded during summer in the tidal channels as that of El-Ruwaysia whereas the lowest value of salinity (42.8‰) was recorded during winter. In the Gulf of Aqaba (6) observed an increase and decrease of salinity values (47.00‰ and 40.9‰) in August and September, respectively. They attributed such decrease in salinity to the stormy wind and water flushing by the freshwater of the rain. According to (6) the limit attained in Wadi Kid is not determined by increased salinity but by the decrease in temperature (few days below 10 °C). The latter authors showed that the temperature ranges from 9.1 °C in March to 36°C in July, and salinity from 41 to 47‰. Furthermore, they suggested that the fresh groundwater flow through the sediment preventing the mangrove to become hypersaline.
On the other hand, the dissolved oxygen in the mangrove areas in Sinai shows high fluctuations from time to time especially during the day and night and from one area to another (24). It is found that a decrease in dissolved oxygen is recorded during the low tide and an increase with the incoming tide. Such a finding confirms that of (6) who stated that high tide brings oxygenated water which in turn is rapidly depleted till in the low tide.

It can be concluded that such variation in the climatic and chemical factors have a profound effect on the biodiversity of different species inhabiting such areas.

In the present investigation, it was found that the diversity of the mangrove fishes is relatively low with 22 species belonging to 15 families, 12 suborders, 9 orders and 2 classes being recorded from the 5 sites of the mangrove forests of Southern Sinai (Ras Muhammed and Nabq). Por *et al.* (6) showed that the high salinity is the main factor that limit the mangrove species and also some algal and animal species associated with the mangal in Southern Sinai. Moreover, (14b) pointed out that the difference in the density of the different species of crabs in the three mangrove sites (El-Gharqana, El-Ruwaysia and El-Monqata) might be explained by the difference in sediment characteristics of each site. This factor is apparently the main one influencing the distribution and abundance of species in the mangroves. The seasons of the year were shown to have no obvious effect on the density of the different brachyuran species, although there is a slight change in winter due to the low activity but such a change is not considered significant.

It is suggested that the decrease of the biodiversity of different faunal elements in the mangrove areas is not only affected by one or two factors, but rather with a combination of different factors (salinity, temperature, oxygen deficiency and nature of the bottom). Apparently, high salinity, as well as oxygen deficiency are probably the main factors restricting the number of mangrove fish species.

Among the collected fish species, seven species have been reported for the first time in the studied mangrove areas. These species include: *Atherinomorus lacunosus, Istiblennius andamannensis, Salaria fasciatus, Gnatholepis anjerensis, Istigobius ornatus, Siderea picta, Arothron diadematus.*
El-Etreby (15) recorded, 16 fish species. Whereas, (6) listed 19 species in the mangrove areas of the South Sinai. these species are: *Arothron hispidus, Crenimugil crenilabis, Mugil cephalus, Diplodus noct, Rhabdosargus haffara, Monodactylus argenteus, Aphanius dispar, Mugil subviridis, Valimugil sebeli, Liza carinata, Tylosurus crocodilus, Elops saurus, Dasyatis uarnak, Crenidens crenidens, Mulloidichthys samoensis, Lutijanus fulviflama, Holocentrus sp., Lithrinus nebulosus and Ronciscus stridens.* The last nine of the collected fishes by (6) are only just visitors for moments, and highly adapted away from such areas and are usually found in the adjacent areas near the open sea, especially in Ras Muhammed, whereas, *Mugil subviridis, Valimugil sebeli and Liza carinata* can not be observed in such areas. The importance of the mangrove forests is not only attributed to their fish fauna especially

those of economic importance, but due to its lagoons that are considered as nursery grounds for many fish species such as sparids, cyprinodonts and bothiids. Moreover, the aerial roots give a suitable shelter to another fish species such as *Crenimugil crenilabis* and *Mugil cephalus* (6).

ACKNOWLEDGEMENTS

I am greatly indebted to Prof Dr Helmy M. Bishai, Professor of Fish Biology and Aquatic Science, Department of Zoology, Faculty of Science, Cairo University, for guidance, encouragement and advice. Thanks to Dr Ahmed M Azab, Marine Biology Section, Department of Zoology, Faculty of Science, Al Azhar University, for useful informations and collection of some specimens.

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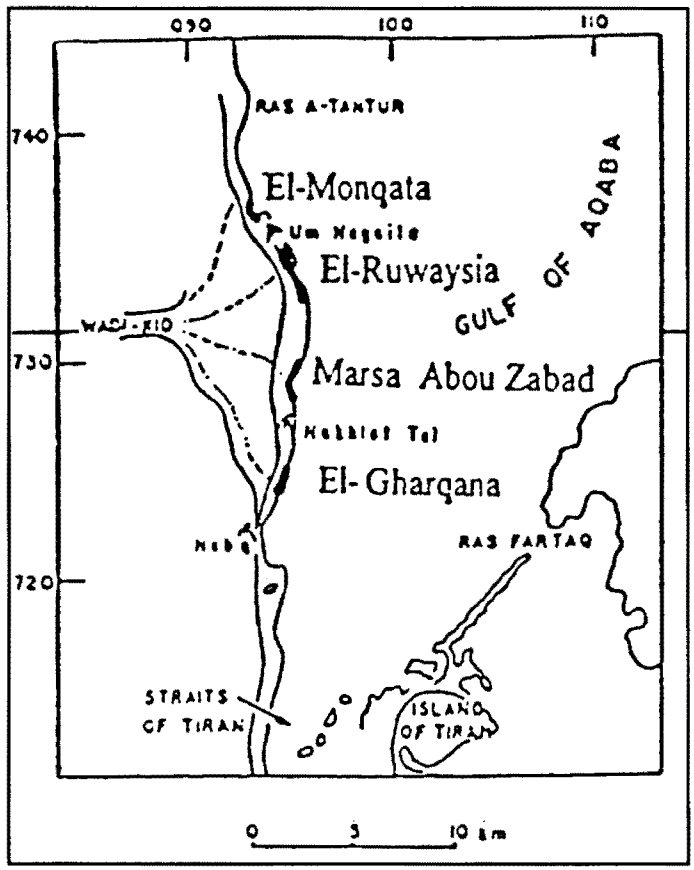

Fig. 1 : A map showing survey sites of mangrove forests (shaded areas) of Wadi Kid (Nabq) After Por *et al.* [6] and Ulken [20]

Table 1 : The mean measurements of different parameters in the mangrove sites of Ras Muhammed and Nabq Protectorate Areas.
(S.D) : Standard deviation.

Seasons / Parameters		Summer		Winter	
		Mean	S.D	Mean	S.D
Ras Muhammed	Temperature (°C)	30.4	± 1.2	18	± 3.4
	Dissolved O_2 (mg/l)	4.2	± 0.2	4.1	± 0.5
	% saturation	60		43	
	pH	9.3	± 0.3	9.1	± 0.5
	Salinity (‰)	46.5	± 3.1	44.7	± 1.9
Nabq	Temperature (°C)	33.6	± 0.9	20	± 2.3
	Dissolved O_2 (mg/l)	4.8	± 0.4	4.3	± 0.7
	% saturation	66		48	
	pH	9.5	± 0.2	8.9	± 0.4
	Salinity (‰)	48.4	± 4.5	45.9	± 1.1

Table 2 :

List of classes, orders, suborders, families, species habitats and status (St) of fishes represented in the mangals of Southern Sinai Protectorate Areas in Egypt. (*): Families with species of an economic importance. (**): Families with species of a highly ecomomic importance. (+): Rare (++): Frequent (+++): Common (R.M): Ras Muhammed (N): Nabq.

Class / Order / Suborder / Family	Species	Locality	Habitat	Average length	Status
Cl : Chondrichthyes					
O : Torpediniformes F : Torpedinida	*Torpedo marmorata* (Smith, 1949).	R.M	sluggish sp. buried in sand and mud	50 cm	++
Cl : Osteichthyes					
O : Arguilliformes SO : Arguilloidei F : Muraenidae	*Echidna nebulosa* (Ahl, 1789) *Siderea picta*	R.M	shallow water under rock & sea grass	29 cm 32 cm	+ ++
O : Gasterosteiformes SO : Syngnathoidei F : Syngnathidae	*Trachyrhamphus bicoarctatus*	N	algal or sea grass bottoms	18 cm	++
O : Cyprinodontiformes SO : Cyprinodontoidci F : Cyprinodontidae	*Aphanius dispar*	R.M & N	saline pools and sandy shores	6 cm	+++
O : Mugiliformes SO : Mugiloidei **F : Mugilidae	*Crenimugil crenilabis* *Mugil cephalus*	N	inshore and between aerial roots	30 cm 40 cm	+++ +++
SO : Atherinoidei * F : Atherinidae	*Atherinomorus lacunosus*	R.M	schooling, near the surface in sandy area	12 cm	+
O : Perciformes SO : Percoidei **F : Sparidae	*Acanthopagrus bifasciatus* *Diplodus noct* *Rhapdosargus haffara*	R.M & N R.M & N R.M	sandy bottom around coral reefs exposed rocky shore sandy and muddy area near coral reef	25 cm 18 cm 22 cm	+++ +++ ++
F : Mullidae	*Parupeneus macronema*	R.M	muddy-sand bottom	23 cm	+
* F : Monodactylidae	*Monodactylus argenteus*	R.M	silty reef	13-20 cm	++
SO : Blennioidei F : Blenniidae	*Istiblennius andamannensis* *Salaria fasciatus*	N	reef flat heavy algal cover	9.5 cm 6 cm	+++ +++
SO : Gobioidei F : Gobiidae	*Gnatholepis anjerensis* *Istigobius ornatus*	R.M & N	estuarine environment and sandy bottom	7 cm 8 cm	+++ ++
SO : Acanthuroidei ** F : Siganidae	*Siganus rivulatus*	R.M & N	about reefs & weedy bays	22 cm	+++
O : Tetraodontiformes SO : Tetraodontoidei F : Tetraodontidae	*Arothron hispidus* *Arothron diadematus*	R.M	around reef flat rocky and coral reef	15 cm 11 cm	+++ +
O : Pleuronectiformes SO : Pleuronectoidei F : Bothidae	*Bothus pantherinus*	N	shallow water buried in sady patches	6-10 cm	++
O : Scorpaeniformes SO : Scorpaenoidei F : Scorpaenidae	*Pterois volitan*	R.M	reef-dwelling on coral reef of reef flat	25 cm	++