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Feeding ecology of the rabbit fish, *Siganus luridus* inhabiting coral reef and algae habitats in Aqaba Gulf, Egypt

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ABSTRACT

The present study attempted to provide information on the abundance and distribution of dusky spine foot, *Siganus luridus* (Rüppell, 1829), with respect to the food and feeding habits of this species along the Gulf of Aqaba, Red Sea, Egypt. A total of 649 fish specimens were monthly collected from different localities in the Gulf of Aqaba during the period from January to December 2018. After collection, the stomach contents were examined to determine the feeding activity and food items. The abundance and size structure of target species were recorded and estimated using underwater visual census (UVC). Results showed that the fish are moderate actively fed. The annual average of feeding activity constitutes 63.09% of the total stomachs examined. The lowest value of feeding activity was recorded during winter (45.07%), while its highest was during autumn (88.28%). The rabbitfish, *Siganus luridus* is essentially herbivorous consuming a wide range of plant food. Algae (99.73%) were by far the most dominant and preferred food item consumed by the fish, mainly brown algae (87.73%), followed by the turf algae (8.31%) and the red algae (3.69%). Seagrass is sporadically consumed (0.04%) and rubble (0.23%) was found in the stomachs with minor percentages. The highest abundance of *S. luridus* in the algal habitat was recorded during July, August, September, October, and November, while the lowest occurred during December, January and February. On the other hand, the highest abundance of *S. luridus* in coral reef habitats was recorded during spring and summer. In conclusion, the highest abundance of *S. luridus* depends on the algal habitat; in autumn by the end of the spawning season, the highest feeding activity was observed. On the other hand, the highest abundance of fish in the coral reef habitat was recorded during spring and summer in the spawning period of the fish since they use the coral reef as a nursery ground. Besides, opening up the space on the substratum by grazing the algae is necessary to facilitate the colonization of corals.

INTRODUCTION

The Gulf of Aqaba is narrow, with a width that ranges from 14 to 26km, and steep sides descending near its center to almost 2000m. The narrow (6 km) entrance (The Strait of Tiran) of the Gulf has a water depth of about 250 meter. The surface water circulation is generated by a tidal water influx from the northern part of the Red Sea, as well as by the prevailing north-east winds **(Salem, 1999**; **El-Naggar *et al*., 2022)**.

The importance of coral reefs is due to being the second after the rain forests with respect to biodiversity value. The worldwide reefs species are 6 to more than 9 million **(Veron, 2008; Darweesh *et al*., 2021a, b)**. Approximately, 50 genera and 200 species of hard corals and 120 species of soft-corals are recorded in the Red Sea. Coral reefs of the Red Sea support approximately 400 fish species, which exploit them for shelter, food and/or breeding ground **(ERSR, 1998**; **Mohammad, 1999)**.

Large mobile or roving herbivorous fishes are considered a key component in the maintenance of healthy coral dominated reefs. Herbivorous fishes have a critical function on coral reefs, and obviously a need to understand the role and relative importance of individual species on reef processes is recommended. Understanding the role and the relative importance of each species in ecosystem processes not only requires to comprehend the functional impact of each species, but also its distribution among habitats, and hence the area on which species exerts its impact **(Hoey *et al.*, 2013**; **Shaban *et al.*, 2020).**

Four species of the genus *Siganus* exist in the Red Sea (*Siganus rivulatus, Siganus argenteus, Siganus luridus* and *Siganus stellatus*). *S. rivulatus* and *S. luridus* have invaded the Mediterranean Sea through the Suez Canal and remained in the Eastern Mediterranean Sea **(Bariche, 2005**; **Abdelhak, 2021)**. Dusky spinefoot, *Siganus luridus* (Rüppel, 1829) is usually found in the Western Indian Ocean and distributed throughout the Eastern African Coast and around Réunion Island; it is known in the Arabian Gulf and the Red Sea **(Golani *et al*., 2002; Bariche, 2005)**. *Siganus luridus* is a shallow water species which feeds on benthic algae; it may live in solitary though it is more often seen in small groups and spawns in the Red Sea from May to August **(Randall, 1983)**.

For the density and size of fish populations associated with the conservation efforts exerted in the Gulf of Aqaba, the total number was at its lowest and a decrease in fish size was detected. The commercially targeted herbivore species, belongining to families Acanthuridae, Siganidae and Scaridae has witnessed a significantl decrease over time, recording percentages of 22, 17, and 51, respectively **(Mabrouk, 2015)**. The importance of the informative data on food and feeding habits of fish helps understanding their biology. In addition, this helps in detecting the distribution of a fish population, which is highly essential for the successful management of fisheries **(Rao & Durga-Prasad, 2002**; **El-Naggar *et al*., 2019)**.

Due to the growing demand on fish protein and the increasing importance of *Siganus luridus* in Egypt, more researches are required for a better management to preserve good population structure with future sustainability, especially after the decreasing rate of the catch in the last four years **(GAFRD, 2018)**. Few studies are available on the dusky spinefoot, *Siganus luridus* in the Red Sea, with supportive data on identification, common information and distribution **(Randall, 1983; Golani *et al*., 2002** and **Bariche, 2005)**. However, a lack of information was noted on the food and feeding ecology of *S. luridus* in the Gulf of Aqaba, Egypt.

Thus, the present study attempted to provide information on the abundance and distribution of dusky spinefoot, *Siganus luridus* (rüppell, 1829), with respect to its food and feeding habits, in order to develop a strategy to manage and regulate the species' fisheries in the Gulf of Aqaba, Red Sea, Egypt.

MATERIALS AND METHODS

1. Specimens collection

A total of 649 specimens of dusky spinefoot, *Siganus luridus* (Fig. 1) formed the material of the present study. Fish specimens were monthly collected from different localities in the Gulf of Aqaba (Fig. 2) during the period from January to December 2018. Gill net was the main fishing method used to collect the fish specimens. Wherever possible, fish were examined fresh or preserved in 10% formalin solution and transported to the laboratory of Marine Biology, Zoology Department, Faculty of Science, Al-Azhar University, Nasr City, Cairo, Egypt for further examinations. In the laboratory, fish were identified according to the study of **Randall (1983)**; total and standard lengths were measured to the nearest millimeter and recorded. Fish were weighted to the nearest 0.1 gram, and then the following studies were carried out.

Fig. 1. Light photograph of rabbit fish, *Siganus luridus*, collected from Aqaba Gulf, Egypt during 2018

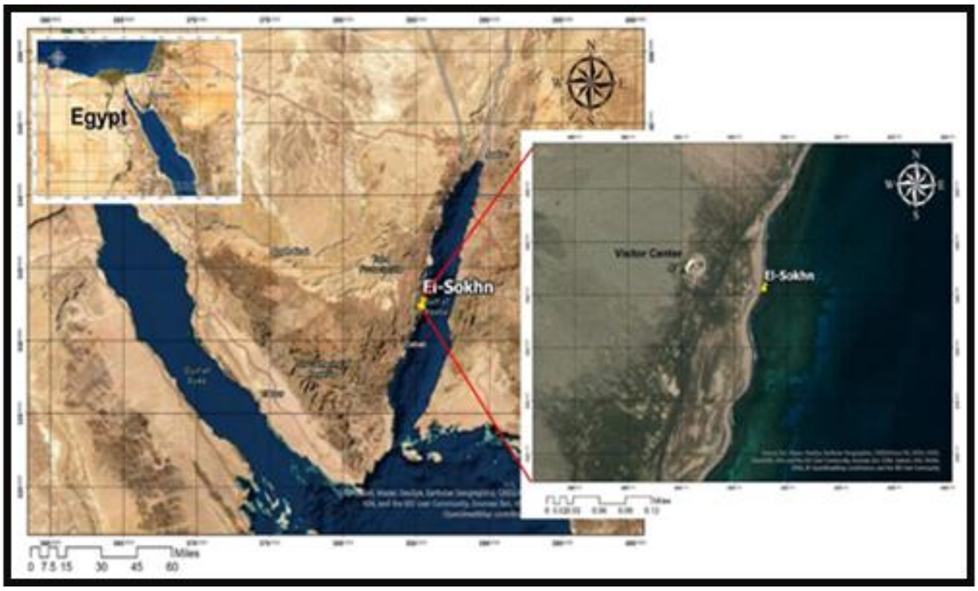

Fig. 2. A map of Aqaba Gulf showing the study area

2. Food and feeding habits

To study food and feeding habits, 649 specimens of dusky spinefoot, *Siganus luridus* (ranging from 12.30 – 28.70 cm in total length) were collected. After collection, the body cavity was opened to allow quick preservation. All the examined specimens were preserved in 10% formalin solution for further examination.

2.1. Feeding activity

To study feeding intensity, all the examined stomachs were assessed. The assessment was based on the visual estimation of the distension of the stomachs and the relative amount of food found within. The examined stomachs were classified into five groups following to the following method of **Geevarghese (1976)**:

1- Heavy: The stomach was gorged with food and the wall was fully distended.

2- Good: The stomach was almost full and the distension of wall was quite evident.

3- Medium: The stomach was nearly half full and the wall was slightly distended.

4- Poor: The stomach contained little food, but the distension of the wall was not evident.

5- Empty: The stomach contained particularly nothing and the wall was evident.

The percentage occurrence of the five categories of the stomachs was calculated. The percentage occurrence of heavy, good and medium stomachs, which was truly reflective of well condition in each season was determined to assess the feeding activity.

2.2. Food composition

To study food items of dusky spinefoot, *Siganus luridus*, the gravimetric method (%) was carried out. After dissection, each stomach was removed, washed with water, and opened while its contents were flushed into a Petri dish and examined under a low power binocular microscope. Food items were taxonomically identified as far as possible up to genera, and the fish consumed a wide range of plant food. Percentage occurrence of each category was estimated and graphically represented for food items.

3. Fish survey (Siganus luridus)

In 2018, monthly surveys were conducted, covering the spawning season for the target species (*Siganus luridus*). Abundance and size structure of target species were recorded and estimated using underwater visual census (UVC) along eight replicates of 50 x 5m wide belt transects per reef zone each month. The size of the target fish was placed in three size categories (recruit = >7.5 cm, juvenile = 7.5 – 15.9 cm, and adult = more than 16 cm of total length). UVC surveys were conducted at the same lunar phases each month; two days before and after new moon and at full moon. Data were collected thrice daily (morning at 9:00, mid-day at 13:00 and evening at 17:00) at each lunar phase. Sampling day was included as a factor to account for between-day variability in community composition.

RESULTS

1. Food and feeding habits

The percentage occurrence of heavy, good and medium stomachs which was truly reflective of well condition in each season was determined to assess the actively fed and the rest poorly fed (Tables 1, 2 & Figs. 3- 5).

1.1. Seasonal variations in the feeding intensity

Table (1) shows that the annual average value of the whole population of rabbit fish, *Siganus luridus*, with empty and poor stomachs constitutes 36.91% of the total fish examined. Such percentage varied considerably with season. The highest value of empty and poor stomachs was recorded during winter (54.93%). It decreases gradually during spring (50.44%), followed by summer (30.61%) and reached the lowest value during autumn (11.72%). The fish are moderately active fed. The annual average value of heavy, good and medium stomachs constitute 63.09% of the total stomachs examined. The lowest value of feeding activity was recorded during winter (45.07%). It increased gradually during spring (49.56%), followed by summer (69.39%) and reached the highest value during autumn (88.28%) (Table 1 & Fig. 3).

Table 1. Seasonl variations in the feeding intensity of rabbit fish, *Siganus luridus* (12.30 – 28.70 cm), collected from Aqaba Gulf, Egypt during 2018

Feeding intensity	Seasons				Annual average
	Winter	Spring	Summer	Autumn	
Empty stomachs	14.83 %	9 %	12.70 %	5.41 %	١٠.48%
Poor stomachs	40.10 %	41.44 %	17.91 %	6.31 %	26.43%
Medium stomachs	31.90 %	27.50 %	41.04 %	43.24 %	35.92%
Good stomachs	11.53 %	16.70 %	19.4 %	34.23 %	20.46%
Heavy stomachs	1.64 %	5.40 %	9 %	10.81 %	6.71%
Actively fed	**45.07%**	**49.56%**	**69.39%**	**88.28%**	**63.09%**
Non actively fed	**54.93%**	**50.44%**	**30.61%**	**11.72%**	**36.91%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**

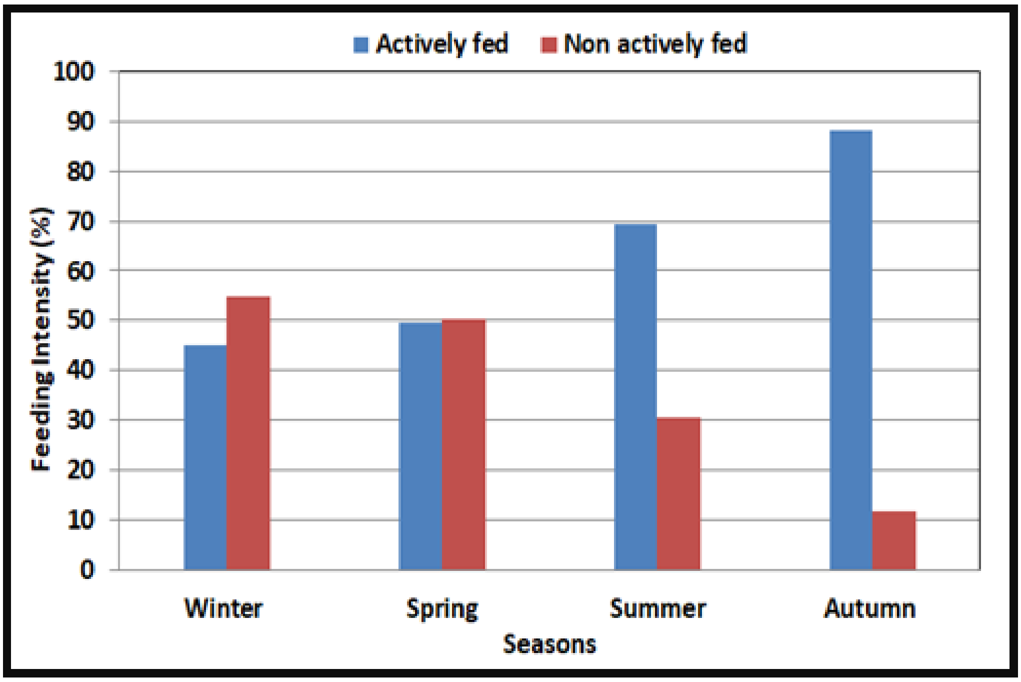

Fig. 3. Seasonl variations in the feeding intensity of rabbit fish, *Siganus luridus* (12.30 – 28.70 cm), collected from Aqaba Gulf, Egypt in 2018

1.2. Seasonal variations in feed items

Results showed that *Siganus luridus* is essentially herbivorous consuming a wide range of plant feed. The major plant food detected in the stomachs of the fish under study was the algae, and the minor item was sea grasses.

In the whole population of the rabbit fish, *S. luridus*, algae (99.73%) were the most dominant and preferred food item. The values of algal food were peaked during all seasons, being 99.95, 99.55%, 99.81 and 99.63 for winter, spring, summer and autumn, respectively. Brown algae (87.73%) were the main algal food consumed. The values of brown algae were peaked during all seasons, recording 84.79%, 89.24%, 89.82% and 87.02% for winter, spring, summer and autumn, respectively. *Sargassum ilicifolium* (31.51%), *Padaina pavonica* (23.77%), *Cystoseira myrica* (20.97%), *Dictyota dichotoma* (7.88%) and *Lobophora variegate* (0.33%) were the main components of brown algae consumed by the fish (Table 2 & Figs. 4, 5).

The highest value of *S. ilicifolium* was recorded during spring (37.21%), and the minimum occurred during autumn (33.78%). The values of *P. pavonica* peaked during winter (34.81%) and summer (29.57%) and declined during spring (17.50%) and autumn (13.20%). The lowest value of *C. myrica* was recorded during winter (15.55%). It increased gradually during spring (17.51%), followed by summer (17.65%) and reached its highest value (33.15%) during autumn. The highest value of *D. dichotoma* was recorded during spring (11.90%), and the lowest (4.52%) occurred during autumn. *L. variegate* was recorded in the stomach in a negligible amount of food during winter (0.62%), spring (0.54%) and autumn (0.15%). It was entirely absent during summer. Un-identified algae (3.27) were sporadically consumed in little amounts, with percentages of 3.53, 4.58, 2.75 and 2.22 for winter, spring, summer and autumn, respectively (Table 2 & Figs. 4, 5).

Turf algae (8.31%) were the second important algal consumed by the studied fish. The maximum value of turf algae (9.64%) was recorded during winter. It decreased gradually during spring (8.35%), followed by summer (7.62%) and reached its minimum value during autumn (7.75%). Red algae (3.69%) were the minor algal food consumed by the fish. The lowest value of red algae (1.96%) was recorded during spring. It increased gradually during summer (2.37%), followed by autumn (4.862%) and reached its highest value during winter (5.52%). *Lorancia obtuse* (3.21%) and *Hypnea esperi* (0.48%) formed the components of red algae. The lowest value of *Lorancia obtuse* (1.51%) was recorded during spring. It increased gradually during summer (2.03%), followed by autumn (4.60%) and reached its highest value during winter (4.73%). *Hypnea esperi* was sporadically eaten by the studied fish in negligable amounts, being 0.79%, 0.45%, 0.34% and 0.26% for winter, spring, summer and autumn, respectively (Table 2 & Figs. 4, 5).

Sea grass (0.04%) was sporadically consumed by the fish in negligible amounts of food, being 0.08% in spring and autumn. It was entirely absent during winter and summer. Rubble (0.23%) was found in the stomach in low percentages, with 0.05%, 0.37%, 0.19% and 0.29% in winter, spring, summer and autumn, respectively (Table 2 & Figs. 4, 5).

Table 2. Gravimetric method (%) of various categories of food items of rabbit fish, *Siganus luridus* (12.30 – 28.70 cm), collected from the Gulf of Aqaba, Egypt during 2018

Food item	**Seasons**				**Annual Average**
	Winter	**Spring**	**Summer**	**Autumn**	
1. Algae	99.95	99.55	99.81	99.63	99.73
1.1. Brown algae	84.79	89.24	89.82	87.02	87.73
Sargassum ilicifolium	20.80	37.21	34.24	33.78	31.51
Padaina pavonica	34.81	17.50	29.57	13.20	23.77
Cystoseira myrica	15.55	17.51	17.65	33.15	20.97
Dictyota dichotoma	9.48	11.90	5.61	4.52	7.88
Lobophora variegata	0.62	0.54	0.00	0.15	0.33
Un-identified algae	3.53	4.58	2.75	2.22	3.27
1.2. Turf algae	9.64	8.35	7.62	7.75	8.31
1.3. Red algae	5.52	1.96	2.37	4.86	3.69
Lorancia obtuse	4.73	1.51	2.03	4.60	3.21
Hypnea esperi	0.79	0.45	0.34	0.26	0.48
2. Sea grass	0.00	0.08	0.00	0.08	0.04
3. Rubble	0.05	0.37	0.19	0.29	0.23
Total	**100**	**100**	**100**	**100**	**100**

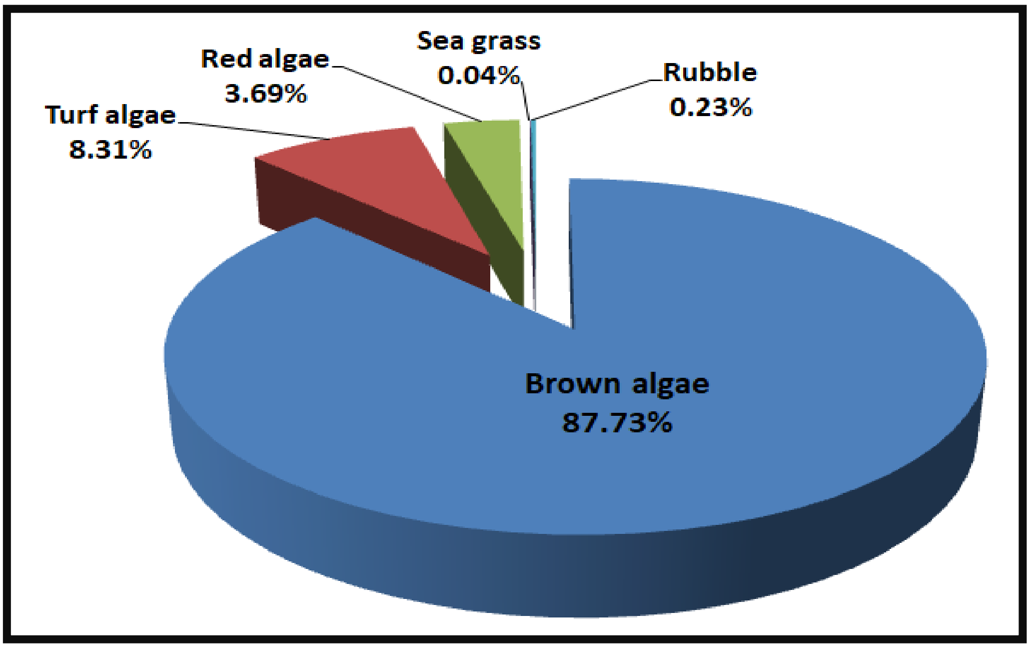

Fig. 4. Gravimetric method (%) of various categories of food items of rabbit fish, *Siganus luridus*, collected from Gulf of Aqaba, Egypt during 2018

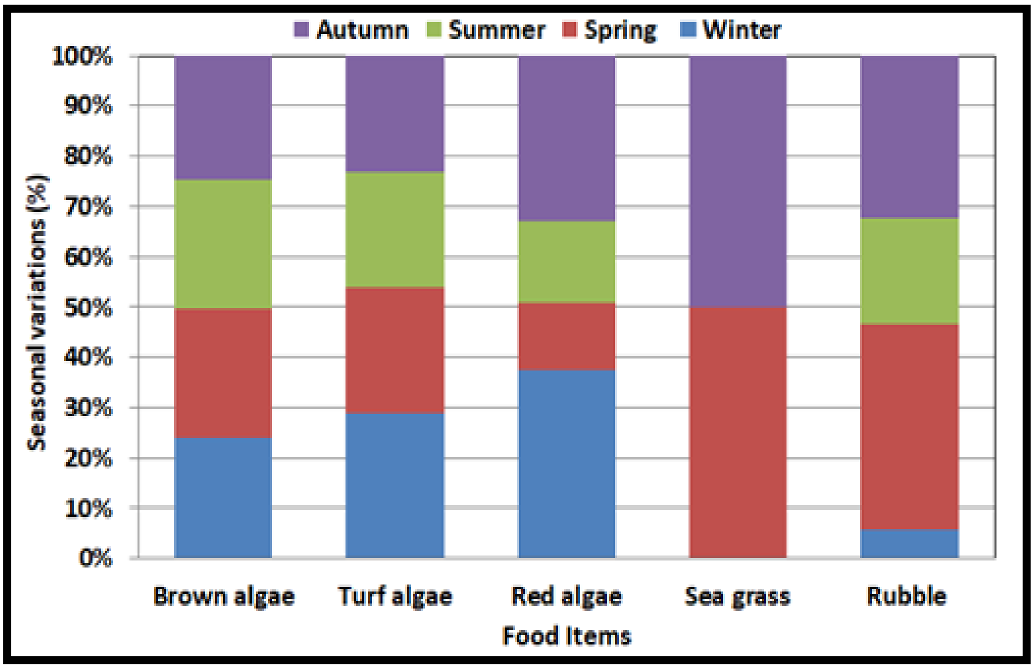

Fig. 5. Seasonal variations (%) of various categories of food items of rabbit fish, *Siganus luridus*, collected from the Gulf of Aqaba, Egypt during 2018

2. Abundance (%) of rabbit fish, *Siganus luridus*

Table (3) showss that the highest abundance of *S. luridus* (ind./250m^2) in reef flat (algal habitat) was recorded during July, August, September, October and November; being 5.61±4.53, 5.38±4.35, 7.33±6.14, 6.72±5.59 and 3.5±2.91 respectively. While the lowest abundance extended from December to June with its value ranged between 1.36±1.14 during December to 2.58±2.17 during February (**Fig. 6**).

On the other hand, the highest abundance of *S. luridus* (ind./250m^2) in reef slope (coral reef habitat) was recorded during February (9.64±6.33), March (12.28±7.3), April (32.93±51.14), May (72.90±97.45), June (27.94±32.87), July (12.31±6.26), August (11.82±10.25) and the lowest abundance occurred in remnant months **(Table, 3** and **Fig. 6**).

Table (3): Monthly variations in the abundance of rabbit fish, *Siganus luridus* (ind./250m^2), counted at El-Sokhn from Gulf of Aqaba, Egypt, during the year, 2018.

Months	Habitats	
	Reef flat	Reef slope
January	1.56±1.33	4.54±2.60
February	2.58±2.17	9.64±6.33
March	2.53±2.19	12.28±7.3
April	1.69±2.2	32.93±51.14
May	2.24±3.13	72.90±97.45
June	2.36±2.4	27.94±32.87
July	5.61±4.53	12.31±6.26
August	5.38±4.35	11.82±10.25
September	7.33±6.14	4.53±1.8
October	6.72±5.59	4.19±1.56
November	3.5±2.91	3.53±1.65
December	1.36±1.14	2.75±1.52

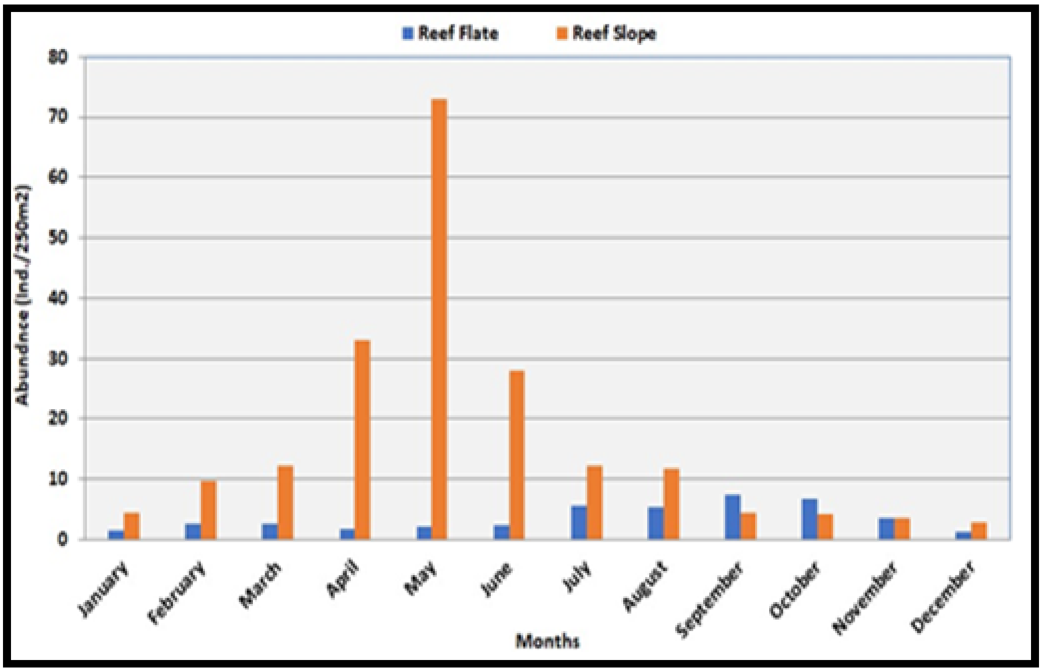

Fig. (6): Monthly variations in the abundance of rabbit fish, *Siganus luridus* (ind./250 m^2), counted at El-Sokhn from Gulf of Aqaba, Egypt, during the year, 2018.

DISCUSSION

The quality and quantity of food are among the most important exogenous factors affect directly on growth and indirectly on maturation and mortality of fish, thus being ultimately related to fitness **(Wootton, 1990).**

Survival growth, migration, reproduction and other biological activities of the fish have depended mainly on the incoming energy, so they were influenced by both the feeding habits of the fish and the ingested food items as well **(Wootton, 1990** and **Shehata, 1994).** In the field of fisheries, dietary habits have been essential for putting future management plans, conservation strategies and predicting population trends for fish species in their habitats (**Abdelhak, 2021).**

In the present study, the feeding intensity of dusky spinefoot, *Siganus luridus* indicated that the fishes changed their feeding activity with the changes of seasons. The lowest value of feeding activity was recorded during winter (45.07%). It increases gradually during spring (49.56%), followed by summer (69.39%) and reached to the highest value occurred during autumn (88.28%). In contrast, **Shakman *et al.* (2009)** showed that *S. luridus* in Libya coast displays more or less the same feeding intensity during all seasons. The differences in feeding intensity between sites may be due to fish needed energy in different habitats or related to the condition of sampling since the fish might be regurgitating or ingesting food by the time it was captured **(Pillay, 1952).**

The lowest rate of feeding activity of *S. luridus* occurred during winter might be due to the effect of turbidity produced by rainfall, low water temperature and limited of food in nature. The fish species appeared to be diurnal feeders. Similar observations were recorded on another species by **Shehata (1994), Shehata & Zaki (1994), Allam (1995), Argyris (2005)** and **Khalaf-Allah (2001& 2013).**

The highest rate of feeding activity of *S. luridus* occurred during autumn might be due to the fish needed more energy after the finish of spawning season (spring – summer) or as a reflex of recovery strategy from energy consumed in gonad maturation. In addition to **(Dart, 1972)** concluded that the herbivore fish opening up of space on the substratum by grazing of the algae is necessary to facilitate colonization by corals.

The diversity in feeding habits in fish is the result of evolution leading to structural adaptations for getting food from the equally great diversity of situations that have evolved in the environment **(Bone & Moore, 2008)**. In the present study, eye size in *S. luridus* is large, blunt and elongated snouts, the mouth is terminal in position and jaws are not protrusible adapted for grazing the algae from the hard bottom. **Hixon (2001)** noticed that well-developed eyes are found in most fish that are diurnal feeders.

In the present study, analysis of the stomach contents of *S. luridus* revealed that the fish is mainly herbivorous; brown algae, turf algae, red algae and seagrass were the main food items consumed by this fish. Similar findings were detected in the Red Sea where their original habitat **(Lundberg & Lipkin, 1979** and **Lundberg, 1981),** in the eastern Mediterranean **(Dowidar *et al.*, 1992; Lundberg & Golani, 1993 & 1995** and **Hamza *et al.*,**

2000), in the western Mediterranean **(Shakman, 2008)** as well as comparative studies have also been conducted between their diet in the native populations in the Red Sea and the populations in the Mediterranean **(Lundberg & Golani 1995; Bariche, 2006** and **Shakman *et al.*, 2009).**

In the present study, brown algae (87.73%) were the main algal food consumed by *S. luridus*. The values of brown algae were peaked during all seasons, being 84.79%, 89.24%, 89.82% and 87.02% for winter, spring, summer and autumn respectively. This means that brown algae were the prefeared food item consumed by *S. luridus*. Similar observations were detected by **Shakman (2008)** and **Shakman *et al.* (2009).** They mentioned that *S. luridus* a stronger affinity for brown algae. Therefore, since red and brown algae have been shown to have considerably different carbohydrate compositions **(Stiger-Pouvreau *et al*., 2016).**

In the present study, *Sargassum ilicifolium* (31.51%), *Padaina pavonica* (23.77%), *Cystoseira myrica* (20.97%), *Dictyota dichotoma* (7.88%) and *Lobophora variegate* (0.33%) were the main component of brown algae consumed by the fish. These results were matching with availability of brown algae in nature. **Ateweberhan (2004)** mentioned that the typical large canopy species in reef lagoons are the fleshy brown algal genera *Sargassum* and *Turbinaria* (Fucales). Other browns that are common and sometimes dominant are the foliose genera *Dictyota* and *Padina* (Dictyotales).

In the present study, *S. luridus* eat whatever is available during the unfavourable season, such as *Sargassum* and *Padina.* It is common in nature that animals feed on species when abundant and ignore them when scarce; a behaviour termed “switching” **(Shakman, 2008).**

In the present study, Seagrass is sporadically consumed (0.04%) and eaten by the fish in negligible amount of food, being 0.08% in spring and autumn. It was entirely absent during winter and summer. In contrast, **Shakman (2008)** showed that the food of *S. luridus* in Libya coast contain seagrass as a part of the diet in all seasons. The differences in quantity of seagrass in the component of food in different habitat may be due to the availability of algae (essential food) in nature. Although the traces of sediments which recorded in the diet of *S. luridus* where it as substrate for algae, but no item of food.

Stomach contents reflect the relative density of food items in different seasons and the ability of the fish to make use of the available food according to their need. Similar observations were observed on another species by many authors **(De Bruin *et al*., 1995; Abdel-Hakim *et al*., 1997; Khalaf-Allah, 2001; Argyris, 2005 and Oliveira *et al.*, 2007).**

The importance of the knowledge of food and feeding habits, of fish in understanding their biology have been well established. This helps in finding the distribution of a fish population, which is highly essential for successful management of fisheries **(Rao & Durga-Prasad, 2002** and **El-Naggar *et al*., 2019).** The distribution patterns of species and subspecies of organisms have been determined by three kinds of factors: historical episodes, dispersal abilities and niche requirements **(Woodland, 1999** and **Mona *et al*., 2019).**

In the present study, the highest abundance of *S. luridus* in algal habitat was recorded during July, August, September, October and November, while the lowest abundance occurred during December, January and February. It was concluded that the highest abundance of fish depends on algal habitat with finish of spawning season which synochronization with highest feeding activity. **Shakman (2008)** concluded that *S. luridus* at Libyan coast was found in one specific vegetation habitat (rocks with algae) by percent of 87.74%. On the other hand, the highest abundance of *S. luridus* in coral reef habitat was recorded during spring and summer. It may be due to spawning period of the fish, because this fish uses the coral reef as nursery ground.

In the present study was greatest in areas of moderate macroalgae density. The reasons for declines in rabbitfish abundance in denser macroalgae beds are unclear, but may be related to higherpredation risk associated with these areas. High complexity areas provide ample refugia but may also serve to effectively conceal predators. Indeed, some studies have reported positive relationships between macroalgal density and the abundance of predominantly ambush predators **(Wilson *et al*. 2014)**, which are more effective in densely vegetated habitats than transient predators reliant on visual acuity **(Horinouchi *et al*. 2009)**.

CONCLUSION

The highest abundance of *S. luridus* depends on algal habitat in autumn with finish of spawning season which synchronization with highest feeding activity. On the other hand, the highest abundance of the fish in coral reef habitat was recorded during spring and summer synchronization with spawning period of the fish, because this fish uses the coral reef as nursery ground. Besides opening up of space on the substratum by grazing of the algae is necessary to facilitate colonization by corals. Although denser and longer macroalgae habitats likely provide greater shelter and food resources, the abundance of newly settled sigmoids in this study was greater in areas of medium density of macroalgae. The reasons for the decrease in the abundance of rabbit fish in macroalgae beds are unclear, but may be related to the higher predation risk associated with the study area. Highly complex areas provide ample sanctuaries but may also effectively conceal predators in dense vegetation habitats from transient predators dependent on visual acuity. Therefore, further study is needed to fill some empirical gaps in our understanding of rabbitfish ecology.

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