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Aspects of Growth, Reproduction, and Feeding Habit of Three Pomacentrid Fish From Gulf of Aqaba, Jordan

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Abstract

Some aspects of growth, reproduction, and feeding habit were investigated in three species of Pomacentridae, *Dascyllus timaculatus, Chromis pelloura* and *Teixeirichthys jordani* from the Gulf of Aqaba. A total of 647 fish were collected during March 99 until April 2000. Growth was determined by analyzing the Length-weight relationship (LWr) and Fulton-type condition factor (K). The gonadosomatic index (GSI) was measured to examine the gonadal maturation and spawning season. The frequency of occurrence method was used to describe the different food items in fish gut. The dietary significance of food items to fish was determined using the index of relative importance (RI). For LWr, results suggested an allometric growth, and the correlation between total length and weight was high in the three fish except *T. jordani*. However, the regression value (b) was less than 3 in males and females of all fish indicating negative allometric growth except in females of *D. trimaculatus* that exhibited positive allometric growth (b>3). The condition factor was relatively high in both sexes of all fishes. The spawning months differed according to species. In *D. trimaculatus* and *T. jordani,* spawning extends mainly from late summer to early winter while it extends to three months only for C. *pelloura* during the spring. Feed variability might be related to the composition of available food items in fish habitat. RI results showed that crustacean were the major dietary component in the three fish. However, noticeable difference was observed in composition, consumption, and occurrence of food during the reproductive season for each of the three fishes.

الملخص

تمت دراسة بعض الظواهر الحياتية الأساسية مثل النمو والتكاثر وكذلك نوعية وكمية الغذاء لثلاثة انواع من اسماك عائلة ال (Pomacentridae) آكلة الهوائم من خليج العقبة وذلك خلال دورة سنوية واحدة (1999 ولغاية 2000). اجريت الدراسة على 647 عينة سمكية جمعت بشكل شهري شملت الانواع الثلاثة (*Dascyllus timaculatus, Chromis pelloura* and *Teixeirichthys jordani*) حيث أخذت قياسات مثل الطول الكلي والمعياري والوزن لكل سمكة على حدة. تم عزل و قياس أوزان الأعضاء التناسلية وكذلك المعد من مجموع العينات السمكية الكلي. من خلال تحليل العلاقة بين الوزن والطول (LWr) وكذلك قياس معامل الحالة (k) تمت دراسة النمو في الانواع الثلاثة. استخدم معامل الخصوبة لدراسة موسم التبييض والتكاثر، كما استخدمت طريقة التواجد المتكرر لعناصر الغذاء في معدات الأسماك وذلك لوصف عناصر الغذاء المختلفة، وان اهميتها لكل نوع من هذه الاسماك قد تم تقديرها عن طريق حساب معامل الأهمية النسبية لهذه العناصر.

Keywords: Pomacentridae, growth, reproduction, feeding habit, Gulf of Aqaba,

1. Introduction

The Pomacentrids, commonly known as Damselfishes, occur in shallow coral reefs and few species penetrate to a depth of 80 m or more (Khalaf and Disi, 1997). Fishes are diurnal; and tend to cluster around coral head for shelter during night. Many species of this family are plankton feeders, others are omnivores that feed on benthic invertebrates and algae. Pomacentridae is an important plankton feeding fish family in the Red Sea (Khalaf and Disi, 1997). Plankton feeder fish are the most abundant feeding guild on coral reefs, as well as in the sea grass dominating habitats (Khalaf and Kochzius, 2002a). *Labridae* and *pomacentridae* dominated the Jordanian ichthyofauna in terms of species richness (Khalaf and Kochzius, 2002b).

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Along with the forty-five species of the family recorded from the Red Sea, about 29 species were reported from the Gulf of Aqaba (Khalaf and Disi, 1997).

Among the few studies, centering on reproduction of Pomacentridae, is that of Macdonald (1981). He examined seasonal patterns of spawning, food acquisition, and fat storage in two Hawaiian damselfishes; and proposed that both use fat reserves built up during the period of peak food availability to support later spawning. Breeding season of the planktivory *Chromis notatus* were reported to extend from May to August, and the maturity length is found for both males and females about 60 mm (Go and Jean, 1983a). However, the reproduction of some damselfish species is uniformly high throughout most of the year, but ceases in winter due to fish nesting activities (Stanton, 1985). Thresher (1985) examined the spawning and larval recruitment of eight damselfishes from the Caribbean and Pacific coasts of Panama; and found that the average seasonal pattern of spawning and settlement did not match in any of the eight species. Pomacentrids are very divers in their feeding habits, most are either aggregating planktivores such as the *Chromis* and *Dascyllus* or omnivores like the *Pomacentrus* (Sale, 1990). Richard (1981) reported that the Blacksmith (*Chromis punctipinnis*) regularly forages on zooplankton during the day and shelters in rocky reefs at night. In the analysis of stomach contents of *Chromis notatus,* it was found that the fish feed primarily on zooplankton mainly copepods which constitute more than 99 % of the total prey number (Go and Jean, 1983b). Planktivory fishes are very diverse in coral reef ecosystems, and the Red Sea as well. However, little is known on some ecological aspects of these fish in the Gulf of Aqaba, the north eastern extension of the Red Sea . In view of the importance, diversity, and the high abundance of plankton feeding fish in coral reef ecosystem of Gulf of Aqaba, a series of ecological and biological studies were conducted on six different fish species. Fishes selected in the present study (*D. trimaculatus*, *C. pelloura* and *T. jordani*) are representatives of the pomacenridae in Jordanian waters of Gulf of Aqaba. Some aspects of growth, reproduction, and feeding habit were investigated in the three fishes over 13 months period.

2. Materials and Methods

Fish samples were collected at depths between 5-20 m mainly from coral reef habitat and the adjacent sea grass beds at the North Beach of Gulf of Aqaba (Fig. 1). Fish were collected monthly (March 1999 to March 2000), using gill net with different mesh size. The number of collected *D. trimaculatus* is 139, *C. pelloura is* 250, and *T. jordani is* 278.

Fish specimens were measured for total length (TL), standard length (SL), and body weight (Fig. 2). Growth was determined by analyzing LWr and K. The LWr was obtained by using the equation Wt = Log a + b Log L., where, Wt = total fish wet weight in g, L = total length in cm, *a* and *b* are constants (Nielson and Johnson, 1983). K was calculated according to the formula, $K = (Wt / SL^3)$ 100. Where, Wt = total fish weight in g and SL= standard length in cm (Nielson and Johnson, 1983). Reproduction cycle was estimated by using the gonadosomatic index

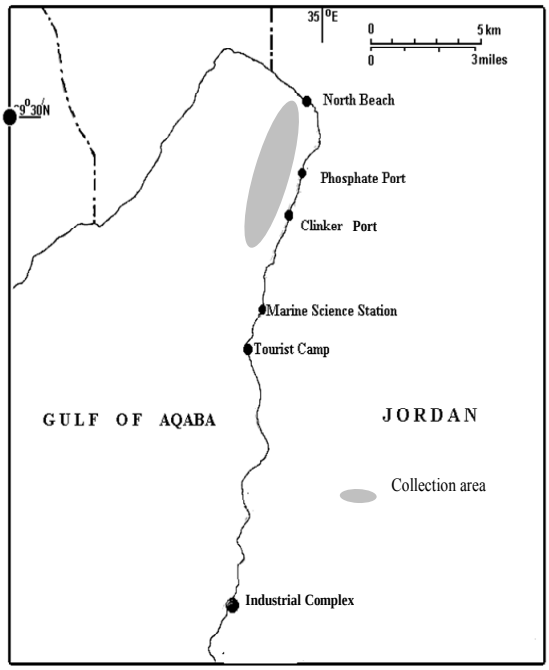

Figure 1. The locations on Gulf of Aqaba where most of fishes were collected

(GSI) following the formula *GSI = (W / Wt) 100* (Gailliet *et al.,* 1986). Where, W; gonad weight in g and Wt; total fish weight in g. Food content analysis was performed, and food items were categorized into major taxonomic groups and the relative importance index (RI) was obtained (Newell, 1993; Smith, 1996). Food content analysis (Hyslop, 1980) was used to describe the importance of the different food items in fish gut. Main items were determined by computing RI following the formula *RI = (AI / ∑ AI) 100.* Where, AI = % frequency of occurrence + % total # + % total weight (George and Hadley, 1979).

3. Results

3.1. LWr and K

LWr results of *D. trimaculatus, C. pelloura,* and *T. jordani* are summarized in Fig. 3. The correlation coefficient (r^2) in *D. trimaculatus* was the highest among other species ($r^2 = 0.91$, n = 127). K in *D. trimaculatus, C. pelloura,* and *T. jordani*, are shown in Fig. 4. *D. trimaculatus* showed the highest K (0.8-.82) as compared to other two examined fish. Both sexes of *D. trimaculatus* showed maximum K values during early summer with a minimum value during October. *C. pelloura* revealed high K values for both sexes in March with obvious decrease observed in August. Both sexes in *T. jordani* exhibited approximately equal K values with a range of (0.36-0.38) with clear decrease of K occurred in August.

3.2. GSI

Seasonality of gonad development was observed for the three fish (Fig. 5). The GSI of *D. trimacultus* showed that fish females spawn during August through January while males become sexually active during October through February. The GSI of *C. pelloura* suggests spawning activity during January through March. Results of GSI in

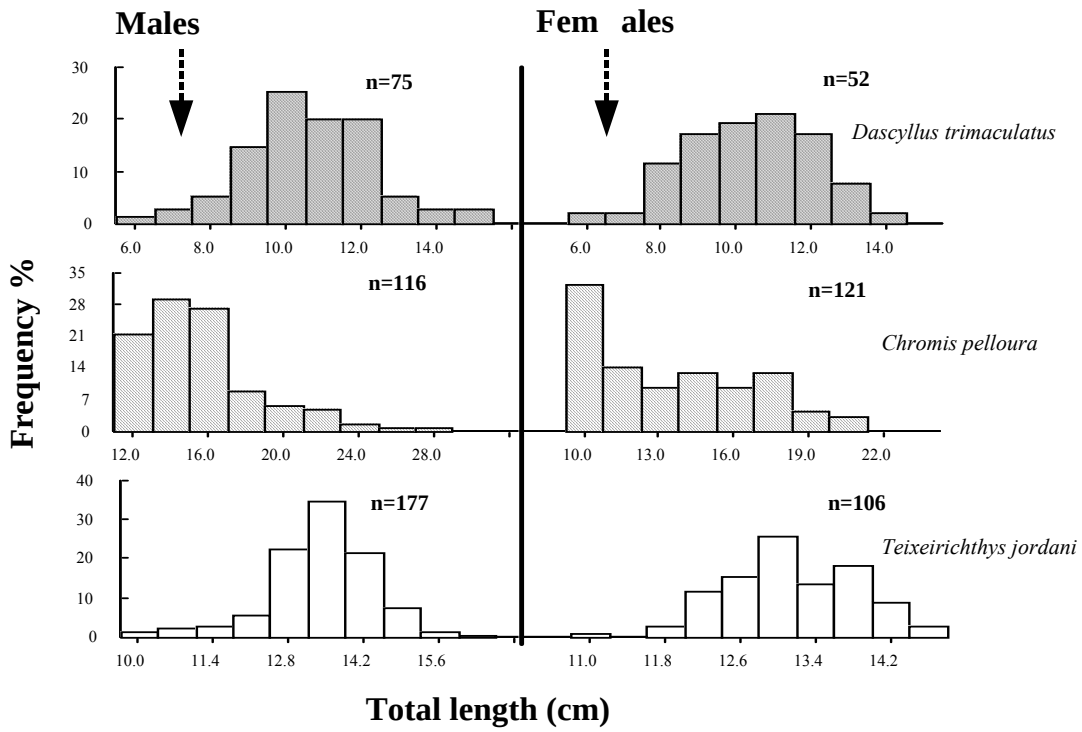

Figure 2. Length-frequency histograms of both sexes for the three fish.

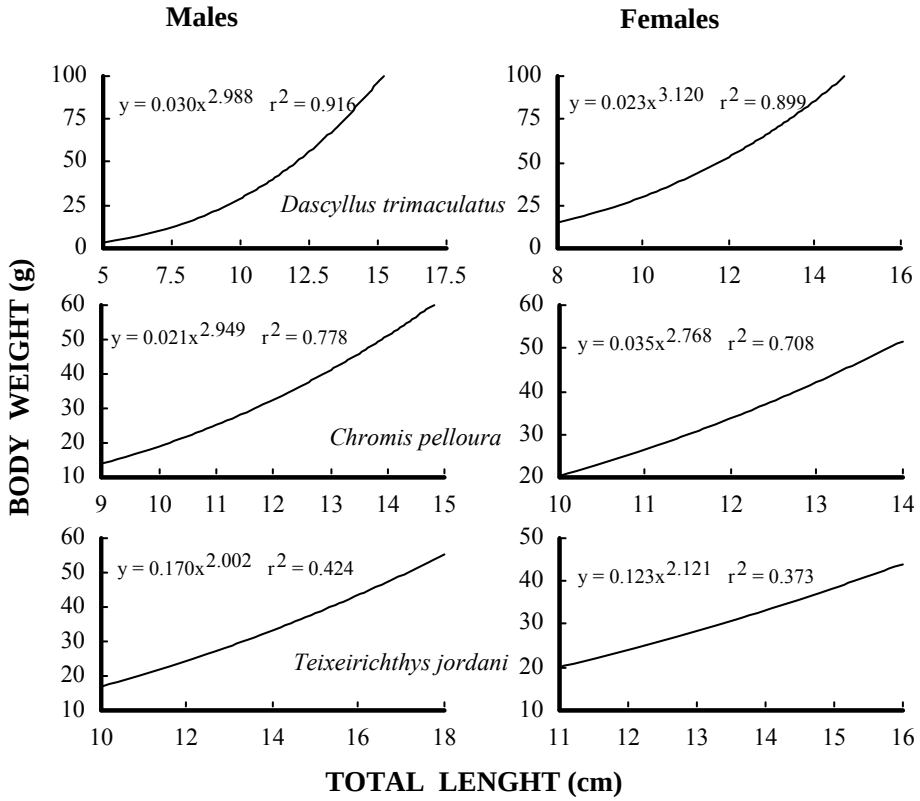

Figure 3. Length-weight relationship of both sexes for the three fish.

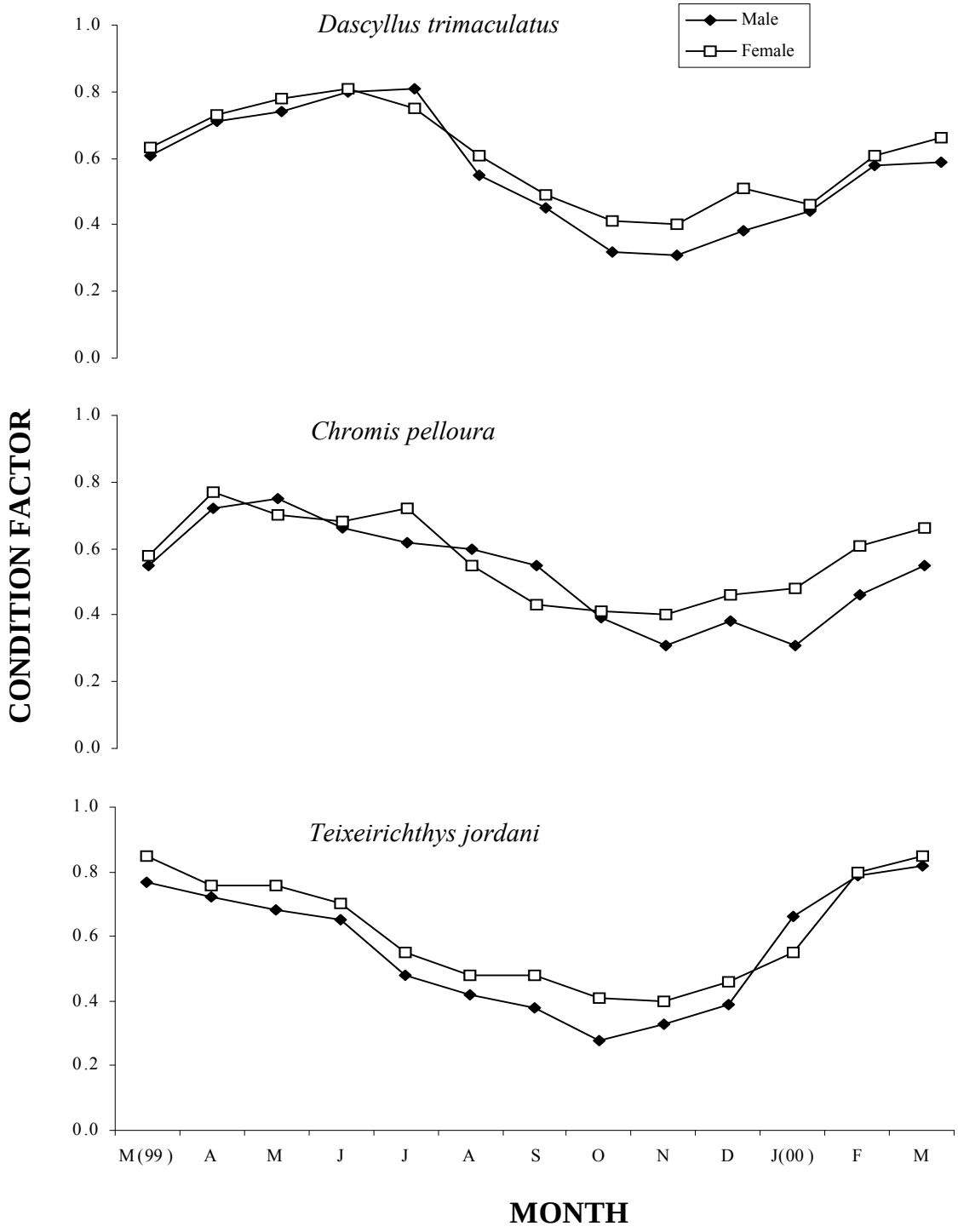

Figure 4. Monthly changes in the condition factor (mean ± SE) of both sexes for the three fish.

T. jordani showed that spawning extend from August until December.

3.3. Food Composition and Consumption

Results on gut content analysis are shown in Table 1. RI values showed that crustaceans generally represented the main food item in the three species. The second important food item for D. *trimaculatus* was polychaets. Based on the frequency of occurrence, crustaceans represented the major food item in guts of the three fish. In *D. trimaculatus,* it accounted for 65.6%, *C. pelloura* 64.9% and *T. jordani* 38.3% of all food items.

Seasonal variation in food composition was expressed based on percentage occurrence of the various identifiable food items in guts of *D. trimaculatus, C. pelloura* and *T. jordani* (Table 2). Crustaceans, Molluscs and polychaets were present in the guts of *D. trimaculatus* throughout the year. Crustaceans exhibited highest percentage during March through June. Molluscs were the highest among

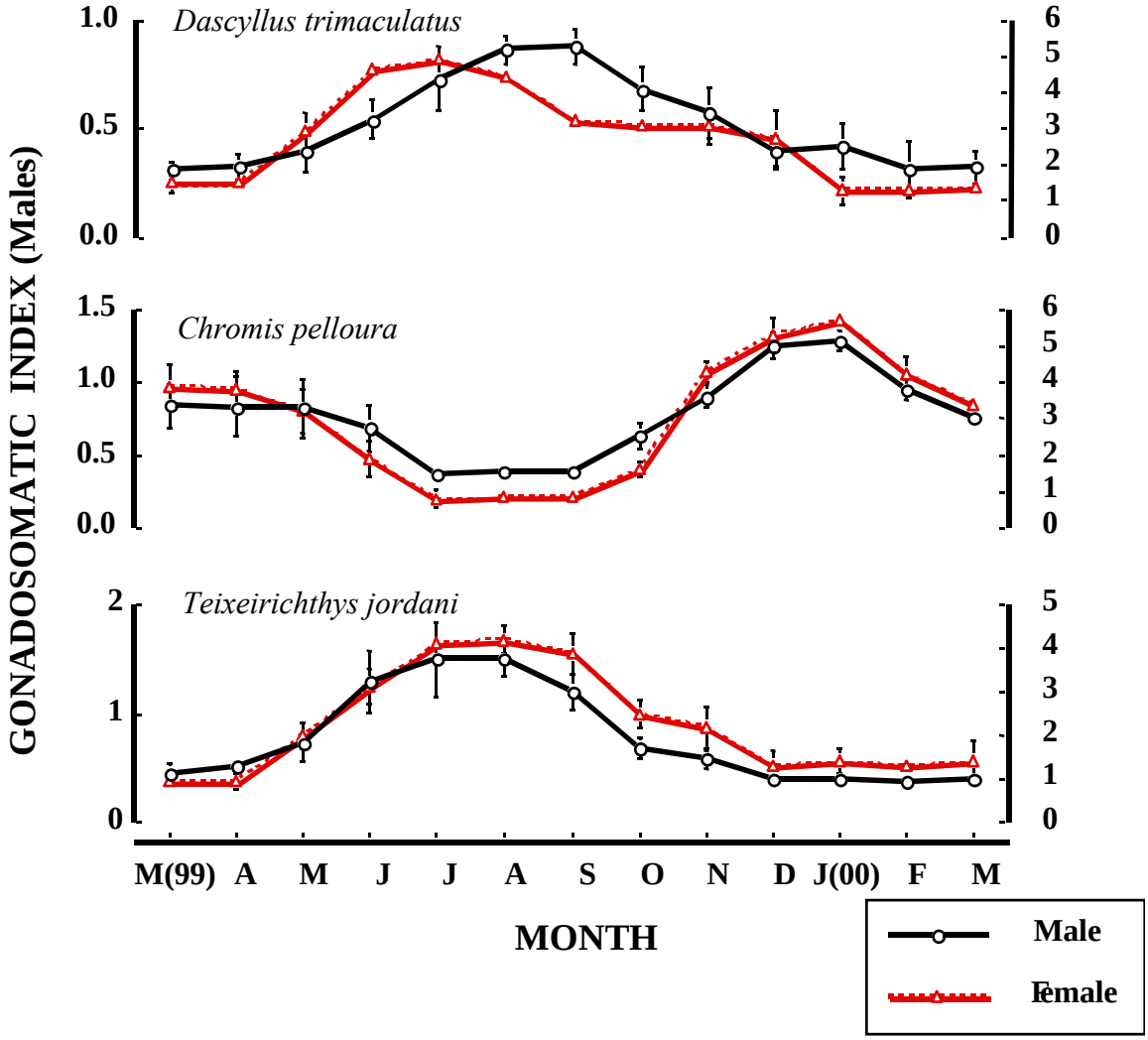

Figure 5. Monthly changes in the gonadosomatic index of both sexes for the three fish.

Table 1. Food composition expressed by frequency of occurrence and the index of relative importance (RI).

Dascyllus trimaculatus

Food items	Frequency		RI
	F	%	
Crustacea	59	65.6	50.6
Molluscs	13	14.4	5.8
Polychaeta	8	8.9	3.0
Small fish	7	7.8	10.1
Eggs	52	57.8	30.5
No. fish examined = 129		No. fish feeding = 90 (69.8%)	

Chromis pelloura

Food items	**Frequency**		RI
	F	**%**	
Crustaceans	24	64.9	49.7
Molluscs	2	5.4	2.5
Small fish	3	8.1	6.8
Eggs	17	45.9	41.0
No. fish examined = 242		No. fish feeding = 137 (56.6%)	

Teixeirichthys jordani

Food items	Frequency		RI
	F	%	
Crustacea	23	38.3	35.0
Molluscs	2	3.3	4.1
Small fish	1	1.6	1.1
Eggs	19	31.7	59.8
No. fish examined = 284		No. fish feeding = 166 (58.4%)	

F = frequency of occurrence;

RI = 100(AI/∑AI). AI = % frequency + % total number + % total weight.

Table 2. Monthly changes in percentage occurrence of various identifiable food items in the stomach of the three fish.

	Crustacea (%)			Polychaeta (%)	Molluscs (%)			Small Fish (%)			Eggs (%)		
Month	Cp	D t	T j	D t	Cp	D t	T j	Cp	D t	T j	Cp	D t	T j
Mar (1999)	100	100	100	14.3			5.5		57	33		100	
Apr	100	25	100		100	25						75	
May	100	33										33	
Jun	33	71		14.3		43						71	
Jul	86	50	30	50.0	14	50	20			50	43	50	43
Aug	33	40	50	20.0		20						33	
Sep		78	67	11.1		17			11			72	
Oct		75							13			100	
Nov	100	20	100	20.0							100	40	100
Dec	100	91				27		100			100	55	100
Jan (2000)		90	72					67			33	30	33
Feb	60	33	100								100	33	100
Mar	83	100	31	33.3			6.3				67	40	67

other food items of the three fish all year round except in winter. Seasonal variation in food composition and consumption (g food/ g fish) of *D. trimaculatus, C. pelloura* and *T. jordani* are shown in Table 3 and Fig. 6, respectively. Food consumption of *D. trimaculatus* was highest in March while that of *C. pelloura*, it peaked in January. The maximum food consumption for *T. jordani* was observed in August.

4. Discussion

4.1. LWr

An allometric exponential form LWr was observed for the three fish, and that the equation of LWr applies well to *D. trimaculatus, C. pelloura* and *T. jordani*. In *D. trimaculatus,* female however, b value was slightly above 3 suggesting a positive allometric growth (the fish become more rotund as length increases). The isometric growth (b= 3) exists when fish shapes do not change as fish grow (Neilson and Johnson, 1980). Our results indicated that the increase in fish weight is accompanied by an increase in total length and body depth. Results showed also that the three fish are laterally compressed which could be an adaptation to its habitat since these fish live in the vicinity of coral reef. Coral substrata, depth, and location were found among the different factors that affect the growth of a pomacentrid fish*, Dascyllus aruanus,* and *Pomacentrus amboinensis* (Sale, 1990). Growth varies among the different habitats in *Acanthochromis sp.* (Thresher, 1985).

The K values in the three fish changed with sex and season. The increment during periods of low K values for all fish could be related to the seasonal change in seawater temperature, hence attributed to the corresponding variations in food availability. However, K values varied within relatively narrow limits. This might explain appropriate environmental conditions for the three fish in Gulf of Aqaba.

Food consumption increased after the completion of spawning, and that the fish must feed more in order to compensate the energy drawn upon during the period of fasting. The attainment of sexual maturity appears to have an influence on LWr (at sexual maturity the rate of fish growth slows down). Spawning activity may also slow down growth, since many species do not feed properly during nest building and guarding of eggs (Goulet, 1997).

Table 3 Food item % composition (total monthly food g/total weight in g) in stomachs of the three fish

Food Item	Crustacea (%)			Polychaeta(%)	Molluscs (%)			Small Fish (%)			Eggs (%)		
Month/Fish	**Cp**	**D t**	**T j**	**D t**	**Cp**	**D t**	**T j**	**Cp**	**D t**	**T j**	**Cp**	**D t**	**T j**
Mar (1999)	100	48.6	45.3	3.6			3.3		54.5	49.1		1.2	5.2
Apr	59.9	96.7	19.4		67.7	2.2							6.3
May	98.2	92.3										7.2	
Jun	1.2	21.4		6.5		18.3						8.2	
Jul	74.1	7.8	5.9	14.3	0.8	72.3	27.2			31.1	19.6	3.4	23.8
Aug	0.4	0.8		1.2		1.8						6.5	28.8
Sep		12.6	24.3	11.4		13.1			26.2			10.8	65.5
Oct		13.2							58.2			4.1	
Nov	89.9	6.5	16.2	1.4							2.7	1.1	
Dec	48.6	30.3		8.8				54.4			3.2	0.6	
Jan (2000)	22.1	7.8	8.2					53.1			1.4		
Feb	5.1		9.3							62.2	2.9		5.4
Mar	50.1	98.2	1.1				2.7				6.7	0.9	1.8

Cp: C. pelloura, Dt: D. trimaculatus, Tj: T. jordani

4.2. Reproduction

The overall changes in mean GSI for males and females of the three fish were almost similar, but with higher GSI values for females. *D. trimaculatus* females attained sexual maturity earlier (July) than males (September) which could be as a result of prolonged and complicated courtship of males. Sexual maturation and spawning activity of *T. jordani* and *D. trimaculatus* occurred during summer, while that of *C. pelloura* in winter. It was observed that the three fish enter a resting period during which growth as well as food consumption increased until period of next reproductive season. Diversion from somatic growth to the growth of gonads was indicated by the decrease in K during spawning season (females might be busy in nesting activities) with low food consumption during this period. The duration of spawning could be considered as an adaptation to minimize competition for food and space among larvae. The onset of *D. trimaculatus* and *T. jordani* spawning occurred during warm season whereas that of *C. pelloura* occurred during considerably cold season. The initiation of the reproductive season for the damselfish *Amblyglyphidodon leucogaster* was regulated by seawater temperature in Gulf of Aqaba (Goulet, 1997). Similar findings were observed in three Hawaiian damselfishes (MacDonald, 1981, Stanton, 1985). The environmental conditions associated with the seasonal changes, particularly in temperature and light intensity, are both important factors in the regulation and timing of spawning among fish (Abu-Hakima, 1987, Wahbeh, 1992).

4.3. Food and Feeding Habits

Certain limitations must be kept in mind when discussing data on feeding habit. The use of gillnets may stress fish severely since fish are hold for long hours, during which much of the diet can be digested. As a result, food items identification becomes more difficult, and sometimes the loss of valuable dietary information may occur. The composition of food in *D. trimaculatus* showed that the fish feeds mainly on crustaceans, Molluscs, and polychaets. The occurrence of these items in their guts throughout the year suggests food availability in fish habitat (Sarker *et al.,* 1980). Coral reefs are major source of feeding and refuge for fishes (Fishelson, 1977), and that the existence of certain food item in fish guts probably depends on its availability in the natural habitat (Gordon, 1977). Highest zooplankton abundance was recorded in Spring with a peak in June in Gulf of Aqaba (Al-Najjar, 2000). The occurrence of chaetognaths, being a major component of Red Sea zooplankton in addition to polychaets in the gut of *D. trimaculatus,* suggests that this fish is a generalist predator. Fishes can capture and feed on such benthic forms probably, during their breeding migration from the bottom (Gordon, 1977). The low variety of food items in food of three fish could be related to the fact that these fishes are also consuming benthic invertebrate and algae besides being plankton-feeders (Khalaf and Disi, 1997).

Considering the seasonal changes, data showed that when the occurrence of one food item is scarce, the presence of other item is abundant. Food consumption might be affected by seawater temperature and/or spawning activity. The mean annual range of sea temperature in Aqaba is 20 °C in February and 27 °C in August (Badran, 2001). Consequently, low phytoplankton primary productivity occurs during summer while high productivity occurred during winter in the Gulf of Aqaba, (Badran and Foster, 1998). Maximum food consumption of *D. trimaculatus* during winter with a minimum in summer can be related to change in water temperature. Major consumption of *C. pelloura*, was in January and minor in August, and this is probably related to the spawning activity, which exists during the same period. Consumption of *T. jordani* could be connected to the spawning activity during fall. Such an alteration in food and feeding habits of all investigated fish may be

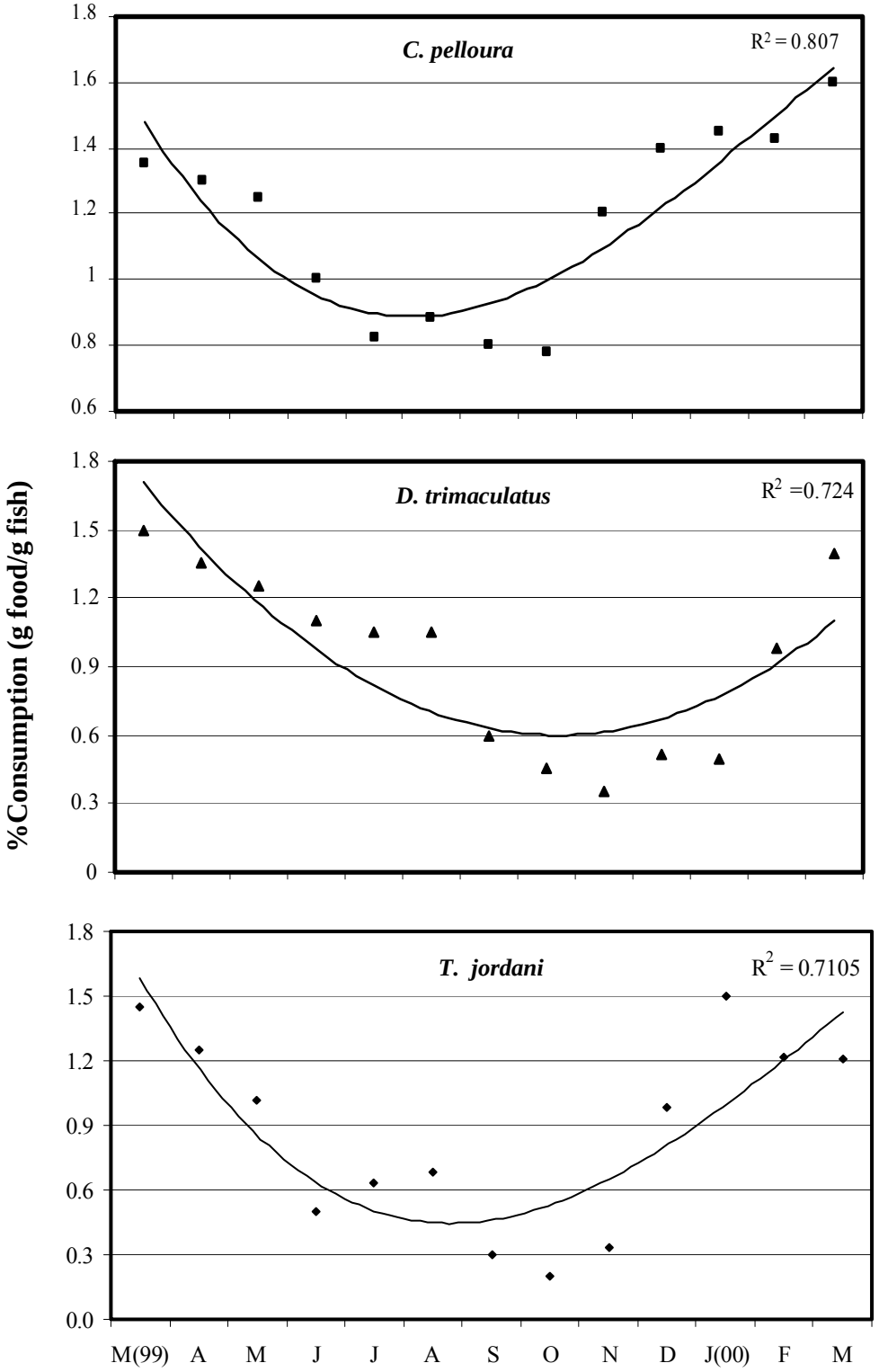

Figure 6. Monthly change in food consumption % (gut content Wt g/fish Wt g*100) of the three fish

considered advantageous in reducing intra specific competition.

Reference

Abu-Hakima, R. 1987. Aspects of the reproductive biology of the grouper, *Epinephelus tauvina* (Forsskal) in Kuwaiti waters. J. Fish. Biol., 30:213-222

Al-Najjar,T. 2000. The seasonal dynamics and grazing control of phyto and meso zooplankton in the northern Gulf of Aqaba. PhD thesis, Bremen University, 122pp

Badran MI. 2001. Dissolved Oxygen, Chlorophyll a and Nutrients: Seasonal Cycles in Waters of the Gulf of Aquaba, Red Sea. Aquat Ecosyst Health Manage. 4:139-150

Badran MI and Foster P. 1998 Environmental quality of the Jordanian coastal waters of the Gulf of Aqaba, Red Sea. Aquat Ecosyst Health Manage 1:75-89

Gailliet, GM, MS. Love and Ebling, AW. 1986. Fishes, A field and laboratory manual on their structure, identification and natural history. Wadsworth publishing Co., Belmot. 194 pp.

Fishelson L. 1977. Sociobilogy of feeding behavior of coral fish along the coral reef of Gulf of Eilat (Gulf of Aqaba), Red Sea. Isr. J. Zool., 26:114-134

George, EL and Hadley, WF. 1979. Food and habitat partitioning between rock bass *Ambloplites rupestris* and small mouth bass *Micropterus dolomieui* round of the year. Tran. Am. Fish. Soc., 108:253-261.

Go, YB and Jean, DS. 1983a. Fisheries biology for fishing improvement and optimum catch of a damselfish, *Chromis nutatus* (Pisces, Pomacentridae) in Seogwipo, Jeju Island. 1. Life cycle and spawning. Bull. Resour. Res. Inst. Jeju-Natl., Univ., 7:207-221

Go, YB and Jean, DS. 1983b. Community structure, social organization and ecological requirement of coral reef fish, *Chromis nutatus* (Pisces, Pomacentridae). Food and feeding habits. Bull. Resour. Res. Inst. Jeju-Natl., Univ., 7:1-14

Gordon, JDM. 1977. The fish populations in inshore waters of the west coast of Scotland, the food and feeding of the whiting (*Merlanguis merlangus I.*). J. Fish Biol., 11:513-529

Goulet D. 1997. Reproductive behavior and spawning success of female *Amblyglyphidodon leucogaster* (Pisces: Pomacentridae) from the Red Sea. Envir. Biol. of Fishes, 50(1) 49-60

Hyslop EJ. 1980. Stomach contents analysis, a review of methods and their application. J. Fish Biol. 17, 411-429

Khalaf, MA and Disi, AM. 1997. Fishes of the Gulf of Aqaba. Marine Science Station-Aqaba, 252 pp

Khalaf, MA and Kochzius, M. 2002a. Community structure and biogeography of shore fishes in the Gulf of Aqaba, Red Sea. Helgol. Mar. Res., 55:252-284

Khalaf, MA and Kochzius, M. 2002b. Changes in trophic community structure of shore fishes at an industrial site in thje Gulf of Aqaba, Red Sea. Mar. Ecol. Prog. Ser., 239:287-299

MacDonald CD. 1981. Reproductive strategies and social organization in damselfishes. PhD thesis, University of Hawaii, 226pp

Newell GE. 1993. Marine plankton practical guide. Hutchinson of London, 859 pp

Nielson LA and Johnson DL. 1983. Fisheries techniques. American Fisheries Society, Bethesda, Md, 468 pp

Richard N, Miller, Alan C and Geesey G. 1981. The Fish Connection: A Trophic Link between Planktonic and Rocky Reef Communities? Science, 214: 204-205

Sale. PF. 1990. The ecology of fishes on coral reef. Oceanog. Mar. biol., 18: 367-421

Sarker AL Al-Daham, NK. and Bhatti, MN. 1980. Food habits of the mudskipper, *Pseudapocryptes dentatus* (Val.). J. Fish Biol., 17:635-639

Smith DL. 1996. A guide to marine coastal plankton and marine invertebrates. 250 pp

Stanton FG. 1985. Temporal patterns of spawning in the demersal brooding blackspot Sergeant *Abudefduf sordidus* from Kaneohoe Bay Hawaii). Proc. 5th. Intl. Coral reef Congr., Tahiti, 5:361-366.

Thresher RE. 1985. Habitat effects on reproductive success in the coral reef fish, *Acanthochronic polyacanthus* (Pomacentridae). Ecology 64: 1184-1199.

Wahbeh MI. 1992. Aspects of the reproduction biology and growth of two species of goatfish (Mullidae) from Aqaba, Red Sea. Senkenbergiana merit., 22(3/6):255-253