

## Research Article

# Feeding indices of Isfahan toothcarp (*Aphanius isfahanensis*) in Zayandeh River in Iran (Teleostei: Aphaniidae)

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**Abstract:** The feeding characteristics of *Aphanius isfahanensis* in the Zayandeh River of Isfahan Province were studied by collecting 440 specimens (220 males and 220 females) from July 2016 to May 2017. The specimens were anesthetized in 1% clove oil, fixed in 10% buffered formalin and transferred to the laboratory. The average condition factor for males was 1.7, for female 1.26 and showed significant difference between different months in both sexes ( $P < 0.05$ ). The average length and weight for all specimens were  $38.57 \pm 5.24$  mm and  $1.00 \pm 0.41$  g, respectively. The average length of gut (RLG) for all fish was  $0.54 \pm 0.17$  during the year. The mean RLG in different length classes showed significant differences ( $P < 0.05$ ). The highest Gastrosomatic Index value was in July (0.05) and the lowest in August (0.03) and showed significant differences in different months ( $P < 0.05$ ). A total of 181 empty stomachs were observed amongst the 440 fish and there were significant differences in different months ( $P < 0.05$ ). Therefore, it can be concluded that this is a carnivorous fish (mainly aquatic insect larvae) with a modest feeding throughout the year.

**Keywords:** Relative length of gut, Gastrointestinal vacancy index, Cyprinodontiformes.

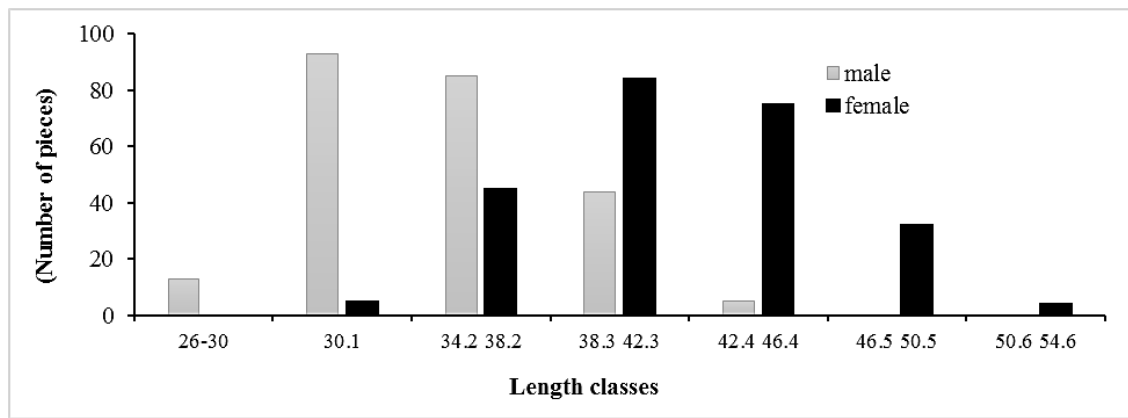
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## Introduction

Examining the feeding ecology of fishes is important for evaluating their ecological role and understanding their position in the food web chains. Food habits and feeding ecology researches are fundamental tools to understand fish roles within their ecosystems since they indicate relationships based on feeding resources and indirectly community energy flux (Hajsiamaea et al. 2003; Pauly et al. 1998). In addition, assessing the diet of fishes is important for aquatic management (Santos et al. 2013). In general, fishes that are economically less valuable are less studied and examining their biological features such as feeding and growth can help to maintain the species stocks. Cyprinodontids are small fishes with dark and light strips and colored spots and moles look beautiful on their bodies. *Aphanius* with 15 species is the only indigenous genus of the Aphaniidae family in Iran (Esmaeili et al. 2018; Teimori et al. 2018).

The extant and extinct species of the toothcarps of the genus *Aphanius* are widely distributed along the Tethys Sea coastlines. The distribution includes coastal areas of the Mediterranean region and the Gir Peninsula of northwestern India to northeastern Somalia, including the Red Sea and the Persian Gulf (Hrbek et al. 2006). *Aphanius isfahanensis* has a significant ecological importance and its systematic, morphology, ecology and biology are summarized (Keivany 2013; Esmaeili & Teimori 2016; Keivany et al. 2016) and due to the increasing pollution and water deficit of the river, its stock has been reduced in recent years.

Although there some studies on other species of *Aphanius*, such as *A. vladkovi* (Coad & Keivany, 2000, 2002; Keivany & Soofiani 2004), *A. farsicus* (Esmaeili & Shiva 2006), *A. sophiae* (Kamal et al. 2009; Alavi-Yeganeh et al. 2011, 2013) and *A. ginaonis* (Golmoradizadeh et al. 2012; Zare et al.



**Fig.1.** Length classes frequency of Isfahan toothcarp in the Zayandehd River (2016-2017).

2015), there is no study regarding feeding indices of *A. isfahanensis*. The karyotype of this species was studied by Esmaeili et al. (2008). Therefore, this study was carried out to provide some information on the feeding characteristics of *A. isfahanensis* in the Zayandeh River.

**Materials and Methods**

Some 440 specimens of *A. isfahanensis* were sampled monthly from July 2016 to May 2017 from the Zayandeh River, using a hand net. Samples were anesthetized in 1% clove oil, fixed in 10% buffered formalin and transferred to the laboratory. After measuring the total length (mm) and standard length with accuracy of 0.01 and body weight with accuracy of 0.01g, the specimens were dissected. Then the gut weight (g) and length (mm) were measured and recorded. Gastrointestinal components were also examined to evaluate the feeding parameters of stomach fullness and contents. The condition factor was calculated from the equation:

$$CF= W/L^3 \times 100$$

Where W= Body weight (g), L= total length (mm) (Biswas 1993). The relative length of gut was obtained from the equation:

$$RLG= Li/L$$

Where Li= length of the gut (mm) and L= total length (mm) (Hyslop 1980). The relative length of the gut is associated with the type of food eaten. If RLG=1 omnivores, RLG<1 carnivores, RLG>1 herbivore. Of course this index is a general one and

should be confirmed by examination of the digestive system contents. Gastrointestinal vacuity index was calculated using the equation:

$$VI= (ES/TS) \times 100$$

Where ES= number of empty stomach and TS= total number of stomachs examined (Biswas 1993).

The index is interpreted as follows:

If 0≤VI<20 Aquatic is rich in food.

If 20<VI≤ 40 Aquatic food is relatively nutritious.

If 40<VI≤ 60 Aquatic medium has a moderate nutritional value.

If 60<VI≤ 80 then the logical conclusion is that aquatic food is relatively low in nutrition.

If 80<VI≤ 100 is a logical consequence of this it is aquatic in terms of low nutrition.

The Gastrosomatic index was calculated using the equation:

$$GI= Wi/W$$

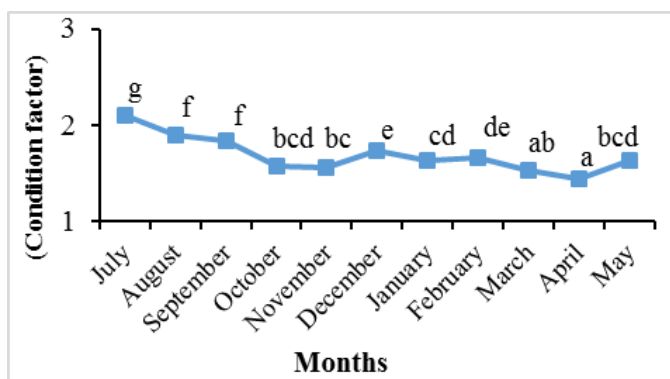
Where Wi= Weight of the Gastrointestine (g) and W= Total body weight (g) (Hyslop 1980). Data were analyzed using SPSS19 statistical software. One-way ANOVA was used to compare the average of variables in different months. When differences were significant at 95% confidence limit, Duncan's test was used to determine the significance amongst different months. Charts were produced in Excel 2013.

**Results**

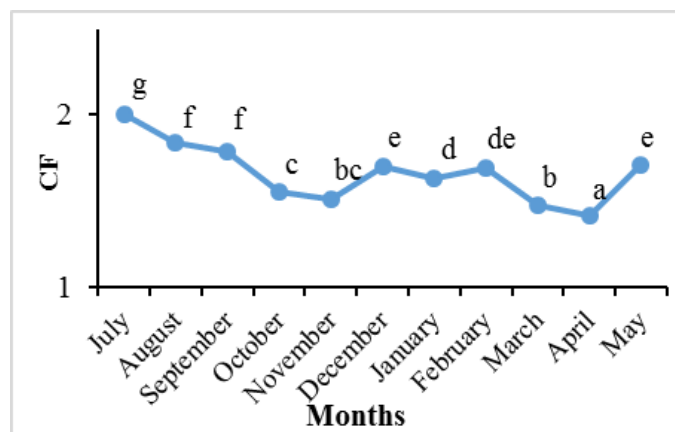
Some 220 female and 220 male specimens were caught. The dominant male and female length class

**Table 1.** Mean total length and weight of 440 specimens (40 each month) of Isfahan toothcarp collected monthly in the Zayandeh River (2016-2017).

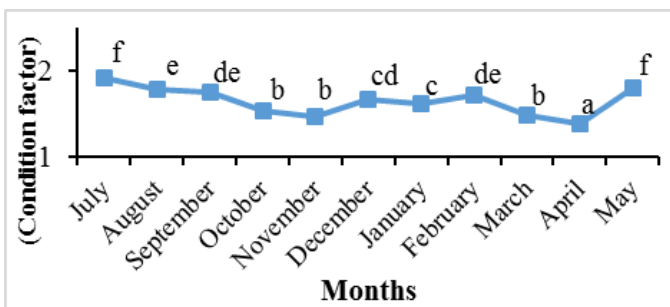
Months	Mean total length ( $\pm$ SD) (cm)	Mean total weight ( $\pm$ SD) (g)
July 2016	5.11 $\pm$ 3.87	0.42 $\pm$ 1.19
August	6.18 $\pm$ 3.57	0.4 $\pm$ 0.89
September	4.42 $\pm$ 3.62	0.3 $\pm$ 0.88
October	5.04 $\pm$ 3.86	0.37 $\pm$ 0.94
November	3.72 $\pm$ 3.64	0.20 $\pm$ 0.74
December	3.54 $\pm$ 4.14	0.32 $\pm$ 1.23
January	5.99 $\pm$ 3.90	0.49 $\pm$ 1.03
February	4.77 $\pm$ 4.10	0.48 $\pm$ 1.22
March	6.62 $\pm$ 3.97	0.5 $\pm$ 1.00
April	4.70 $\pm$ 3.92	0.30 $\pm$ 0.88
May 2017	3.6 $\pm$ 3.86	0.33 $\pm$ 1.02
Total	5.24 $\pm$ 38.57	0.38 $\pm$ 1.00



**Fig.2.** Average condition factor of male Isfahan toothcarp in different months (2016-2017).



**Fig.4.** The average condition factor of both sexes of Isfahan toothcarp in different months (2016-2017).



**Fig.3.** Average condition factor of male Isfahan toothcarp in different months (2016-2017).

and all fishes during different months showed a significant difference ( $P < 0.05$ ) (Figs. 2-4). But there was no significant difference between males and females. The mean of condition factor in males and females was  $1.69 \pm 0.22$  and  $1.64 \pm 0.20$ , respectively. The average RLG was obtained for all specimens as  $0.544 \pm 0.167$  which indicates it as a carnivore fish (feeding on larvae of aquatic insects). Also the comparison of mean of this index in different length classes showed significant differences amongst them ( $P < 0.05$ ). The relative length of gut in the length class 26-30, the smallest class, compared to other length classes, was significantly shorter (Table 2).

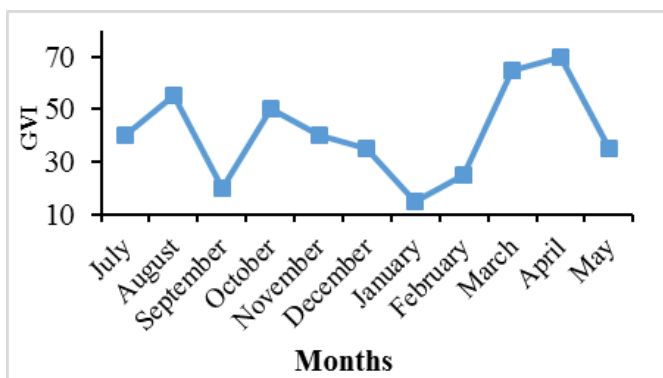
The mean gastrointestinal vacuity index for all specimens was calculated as 41 and showed that the

was the 30.1-34.1mm and 38.3-42.3mm, respectively (Fig. 1). The males total length ranged from 26.81 to 44.89mm ( $35.14 \pm 3.53$ ) and that of females 32.02-53.58mm ( $41.99 \pm 4.36$ ). The range of weight of male and female fish was 0.40-1.56g ( $0.75 \pm 0.24$ ) and 0.48-2.39g ( $1.25 \pm 0.40$ ), respectively (Table 1).

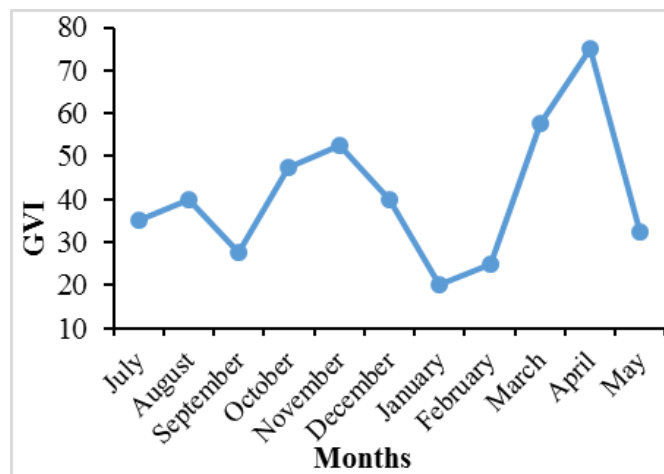
The average condition factor of females and males

**Table 2.** Mean ( $\pm$ SD) relative length of gut of Isfahan toothcarp in different months (2016-2017).

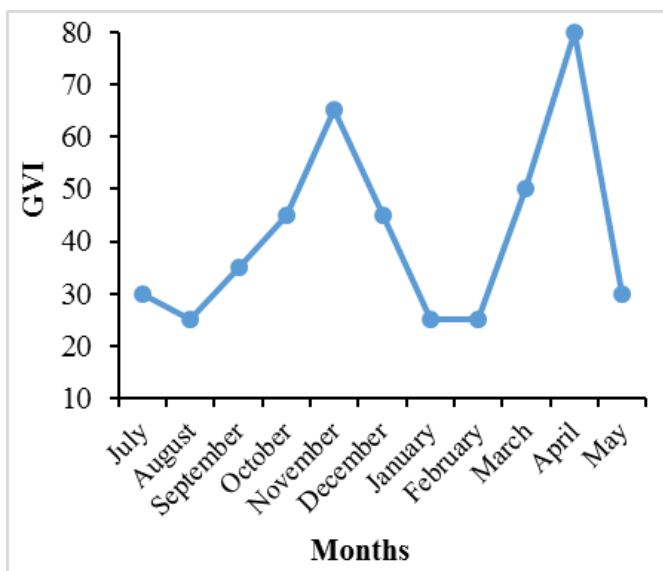
Length class (mm)	Number	Average RLG
26.0-30.0	12	0.134 $\pm$ 0.395 <sup>a</sup>
34.1-30.1	85	0.149 $\pm$ 0.469 <sup>ab</sup>
34.2-38.2	128	0.155 $\pm$ 0.523 <sup>bc</sup>
38.3-42.3	111	0.142 $\pm$ 0.562 <sup>bc</sup>
42.4-46.4	70	0.175 $\pm$ 0.614 <sup>cd</sup>
46.5-50.5	30	0.177 $\pm$ 0.671 <sup>d</sup>
50.6-54.6	4	0.266 $\pm$ 0.643 <sup>d</sup>



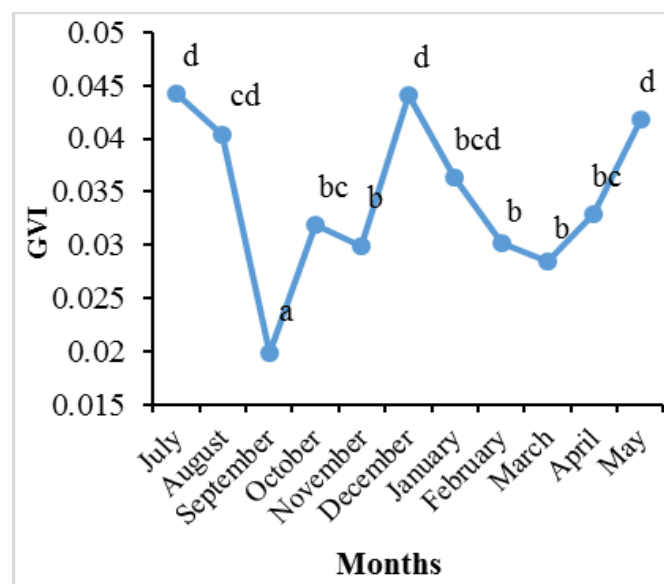
**Fig.5.** Monthly changes in the gastrointestinal vacuity index of males Isfahan toothcarp in different months (2016-2017).



**Fig.7.** Monthly changes in gastrointestinal vacuity index in all fish of Isfahan toothcarp in different months (2016-2017).



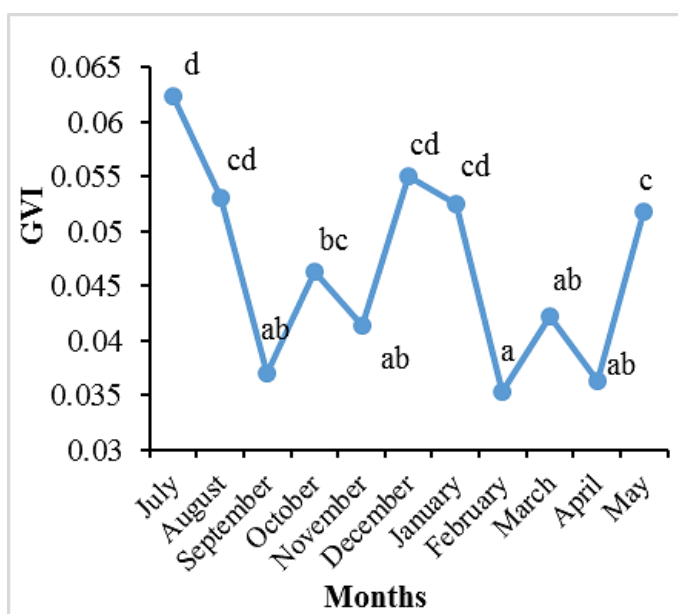
**Fig.6.** Monthly changes in the gastrointestinal vacuity index of female Isfahan toothcarp in different months (2016-2017).



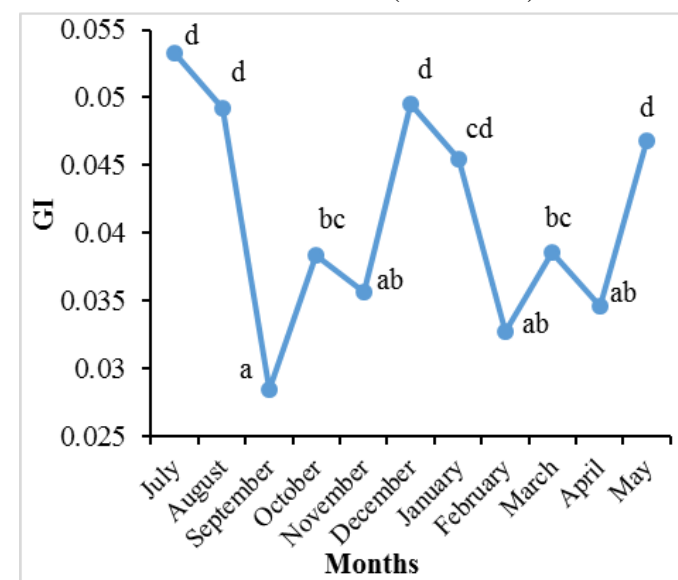
**Fig.8.** Mean of gastroscopic index of Isfahan toothcarp in males in different months (2016-2017).

differences ( $P < 0.05$ ) (Figs. 8-10). The highest value of GI in all fish was recorded in July (0.053) and the lowest in September (0.028).

fish have moderate feeding. This index showed a significant difference in males and females in all months (Figs. 5-7). Comparison of mean values of gastroscopic index (GI) for male and female fish and all fish in different months showed significant



**Fig.9.** Mean gastroscopic index of Isfahan toothcarp in females in different months (2016-2017).



**Fig.10.** Mean gastroscopic index of all fish in Isfahan toothcarp in different months (2016-2017).

**Discussion**

The maximum reported total length for this species is 53mm (Alavi-Yeganeh et al. 2011), but the maximum length we found was 42mm. There is no studies on the biology of this species to compare with, but in studies on other *Aphanius* species, different results were obtained. The length and weight of the female fish were greater than those of males. In general, the differences in length of the

species can be due to differences in time and season of fishing and different geographic areas and biological and or ecological conditions or inter-species and even intra-species differences. The mean of condition factor changes in both males and females showed a significant difference in different months, but there was no significant difference between males and females. The condition factor as an indicator of growth and nutrition intensity is used to compare fitness and fish health (Fagade 1979). Esmaeili & Shiva (2006) found no significant differences between males and female of *A. persicus* (now *A. farsicus*) ( $P>0.05$ ), but found a significant difference among the months in both sexes. The beginning of the spawning period in this fish was coincided with the highest mean condition factor, indicating the effect of gonad weight on the condition factor. Mean changes in the condition factor of Isfahan toothcarp also showed the same trend during the spawning months. The condition factor can be influenced by factors such as stress, season, food availability and water quality.

The mean of vacuity index suggested that Isfahan toothcarp have a moderate feeding. The results show that this species has the highest feeding rate in May-July and August-September. In most cases the contents of the stomach were semi-digested and indistinguishable. The presence of large quantities of semi-digestible material can be due to faster digestion with high metabolic rates (Kalita & Jayabalan 2000). Fish with an empty stomach or low food is common in many species. As expected, there was an opposite relationship between fish VI and GI values. Monthly changes in vacuity index showed that in the summer the average of this index is low and the number of empty stomachs is lower and fish stores its fat reserves, and then there was less feeding until mid-May and February. The fat accumulation around the digestive tract was higher at this time, and in January and February the amount of feeding was high and again low in March and April.

In this study, the mean relative length of gut suggested this species as a carnivore fish and was

confirmed by content of the stomachs (larvae of insects of Chironomidae and Simuliidae, especially in spring and summer). The presence of a food depends on its availability and selectivity, seasonal fluctuations and hydrologic factors (Wootton 1995). The results of the study of gastrosomatic index showed significant differences in different months. The highest average gastrosomatic index was in July-August and December confirmed by a small number of empty stomachs.

In general, *A. isfahanensis* has a moderate carnivorous feeding habit (larvae of aquatic insects), although in the cooler months they continue to feed on algae and plants and nourish throughout the year.

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## مقاله پژوهشی

شاخص‌های تغذیه‌ای کپوردندان ماهی اصفهان (*Aphanius isfahanensis*) در رودخانه  
زاینده‌رود در ایران

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**چکیده:** ویژگی‌های تغذیه‌ای ۴۴۰ قطعه (۲۲۰ نر و ۲۲۰ ماده) کپوردندان ماهی اصفهان (*Aphanius isfahanensis*)، در رودخانه زاینده‌رود، به صورت ماهیانه از خرداد ۱۳۹۵ تا اردیبهشت ۱۳۹۶، مورد بررسی قرار گرفت. نمونه‌ها در محلول گل میخک ۱٪ بی‌هوش، در فرمالین خنثی شده تثبیت و به آزمایشگاه منتقل گردیدند. میانگین ضریب وضعیت نرها ۱/۷ و ماده‌ها ۱/۲۶ بود و تفاوت معنی‌داری بین دو جنس در ماه‌های مختلف نشان داد ( $P < 0.05$ ). میانگین طول و وزن همه نمونه‌ها به ترتیب  $38/57 \pm 5/24$  میلی‌متر و  $1/0 \pm 0/41$  گرم بود. طول نسبی متوسط روده در طول سال در تمام نمونه‌ها  $0/54 \pm 0/17$  بود. طول نسبی متوسط روده در گروه‌های طولی مختلف تفاوت معنی‌داری را نشان داد. بیشینه ضریب معدی در تیرماه (۰/۰۵) و کمینه آن در شهریور (۰/۰۳) بود و در ماه‌های مختلف هم تفاوت معنی‌داری را نشان داد ( $P < 0.05$ ). جمعاً ۱۸۱ معده خالی در بین ۴۴۰ معده مشاهده شد و تفاوت معنی‌داری در ماه‌های مختلف مشاهده شد ( $P < 0.05$ ). بنابراین، می‌توان نتیجه گرفت که این ماهی یک گونه گوشتخوار (عمدتاً لارو حشرات) با تغذیه متوسط در سراسر سال می‌باشد.

**کلمات کلیدی:** طول نسبی روده، ضریب تهی بودن معده، کپوردندان ماهی شکلان.