

## Research Article

# Age and growth of *Alburnoides cf. tabarestanensis* (Teleostei: Cyprinidae) in the Zav Stream, Southeastern Caspian Sea basin

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**Abstract:** This study was carried out from February to June 2016 in Zav Stream (Northern Iran). A total of 195 specimens including 87 females and 107 males of *Alburnoides tabarestanensis* were collected from this stream. Even though the sex ratio was obtained 1:1.22 in favor of males, however, there were no significant differences in sex ratio from 1:1 statistically. Means of the length and weight ( $\pm$ SD) were determined as  $6.38\pm 1.28$ cm and  $4.26\text{--}2.71$ g for males,  $6.2\pm 1.84$ cm and  $4.64\pm 4.48$ g for females. The maximum age was observed as 5<sup>+</sup> in both sexes. Length-weight relationship (LWR) was estimated as  $W=0.0151TL^{2.9784}$  for males,  $W=0.0119TL^{3.1214}$  for females and  $W=0.013TL^{3.067}$  for combined sexes, indicating that growth model is negative allometric for males and positive allometric for females and total population. The highest and lowest values of condition factor were observed in May and February. The VBGF was and  $L_t=12.90(1 - e^{-0.23(t+0.664)})$  and  $L_t=13.97(1 - e^{-0.23(t+0.156)})$  for males and females respectively. Information provided here could be used in the conversation and management of this cyprinid fish species.

**Keywords:** Spirilin, Growth pattern, Length-weight relationship, Condition factor.

**Citation:** Ghojoghi, A.; Patimar, R.; Hojat Jafaryan, H. & Golzarianpour, K. 2017. Age and growth of *Alburnoides cf. tabarestanensis* (Teleostei: Cyprinidae) in the Zav Stream, Southeastern Caspian Sea basin. Iranian Journal of Ichthyology 4(4): 331-339.

## Introduction

Knowledge on basic parameters are prerequisite in biological investigations (Pauly 1993). The exactly prediction of these parameters is essential to analysis population characteristics at a particular time (LeCren 1951; Ricker 1975). In general, analysis of the fish parameters is carried out by mathematical relations. The biometric relationship is used to transform data collected in the field into appropriate indices (Garsia et al. 1989; Pauly 1993; Haimovici & Velasco 2000). The age determination and growth in fishes are the basis for fisheries managements, hence lack of this kind of information may lead to high uncertainty in management actions (Ricker 1979)

Fish species of the family Cyprinidae are the

most diverse freshwater fishes of Iran with 119 reported species including 12 species of *Alburnoides* (Esmaeili et al. 2017). Members of the genus *Alburnoides* Jeitteles, 1861 are generally known as Spirilin (Lelek 1987; Bogutskaya & Coad 2009). The *Alburnoides* populations are widely distributed in Europe and in North and West Asia such as the Turkey and Iran (Lelek 1987; Bogutskaya 1997). They are widely distributed along the southern Caspian Sea basin from the Aras-Kura to the Atrak rivers (Esmaeili et al. 2014, 2017).

Until recently, *A. bipunctatus* (Bloch, 1782) was the name applied to most populations of riffle minnows across Europe and the Middle East from France north of the Alps eastwards to the Black,

**Table 1.** Descriptive statistics of length and weight of *Alburnoides tabarestanensis* from the Zav Stream.

	Number	Min-max TL	Min-max W	Mean±sd TL	Mean±sd W
Male	107	4-10.5	0.874-19.034	6.38±1.28	4.26±2.71
Female	88	2.8-11.1	0.288-23.34	6.2±1.84	4.64±4.48
Population	195	2.8-11.1	0.288-23.34	6.3±1.56	4.43±3.61

Caspian and Aral Seas basins (see Coad & Bogutskaya 2009). However, it seems that *Alburnoides* populations from the almost eastern parts of the Southern Caspian Sea basin (except Atrak River) belong to *A. tabarestanensis* (see Mousavi-Sabet et al. 2015; Esmaeili et al. 2017). Few papers have been published about growth of *Alburnoides* species in the Southern Caspian Sea species. Tabatabaei et al. (2014) reported some information on age and growth of *A. eichwaldii*. Esmailpour poode et al. (2012) reported a positive allometric growth for this species in the Tajan, Babolroad and Aras Rivers. Patimar et al. (2010) studied life history characteristics of the Spiralin populations in the qanat Uzineh, and found a unique characteristic of the species in this unique environment. Additionally, Georgiev (2003), Treer et al. (2006) and Seifali et al. (2012) provided important information on the growth and reproduction of Spiralin in different localities.

Despite of its wide distribution in the upstreams of the Southeastern Caspian Sea, there is a lack of comprehensive information on growth parameters of the species. Therefore, in this study we aimed to investigate basic age and growth parameters of a *Alburnoides* population inhabiting the Zav Stream (Gorgan River tributary, Caspian Sea basin), Northern Iran.

### Materials and Methods

A total of 195 specimens of *A. tabarestanensis* were collected by electrofishing and small beach-seine (5mm mesh size) from the Zav stream during 5 months from February to June 2016. The Zav stream is one of Gorgan River branches which is located in the Golestan Province, southern Caspian Sea

(37°30'57.5"N, 55°44' 04.4"E.).

The collected specimens were fixed in 10% formaldehyde solution and transformed to the laboratory. The total length was measured to the nearest 1mm for all fishes sampled. Total weight was recorded with an electronic analytical balance to the nearest 0.001g. Ages were determined using operculum under a binocular microscope.

The relation between TL and W was estimated using equation of  $W=aTL^b$  (Wotton 1990). The instantaneous growth rate ( $G$ ) was determining by:  $G = (\ln w_{t+1} - \ln w_t) / \Delta T$  (Pauli 1984). For determination of growth model we used von Bertalanffy equation which it expressed by:  $L_t = L_{\infty} (1 - e^{-k(t - t_0)})$  (Bagnal and Tesch 1978). Fulton factor determined using  $C_f = 100 \times (W/L^3)$ , where  $W$  is weight (gr) and  $L$  is total length (cm) (Biswas 1993). All analysis done for sexes separately using SPSS and Excel software packages.

### Results

Specimens ranged from 2.8 to 11.1cm in total length and 0.288 to 23.34g in weight, in which females were 2.8 to 11.1cm in length and 0.288 to 23.34g in weight, while males were 4 to 10.5cm in length and 0.874 to 19.034g in weight. Sex ratio was 1:1.22 and the  $\chi^2$  analysis showed significant differences from excepted 1:1 ( $\chi^2=1.851$ ,  $P<0.05$ ), indicating unequal sex ratio between males and females (Table 1).

Age estimation showed the maximum age of 5<sup>+</sup> for males and females. 2<sup>+</sup> age was the most frequent age group in the both males and females (Table 2). The highest growth rate ( $G$ ) observed 0.97 between age groups 3<sup>+</sup> and 4<sup>+</sup> in females and 4.29 between age groups 4<sup>+</sup> and 5<sup>+</sup> in males. The lowest values of  $G$

**Table 2.** Average total length (cm) and weight (g)-at-age of *Alburnoides tabarestanensis* in Zav stream.

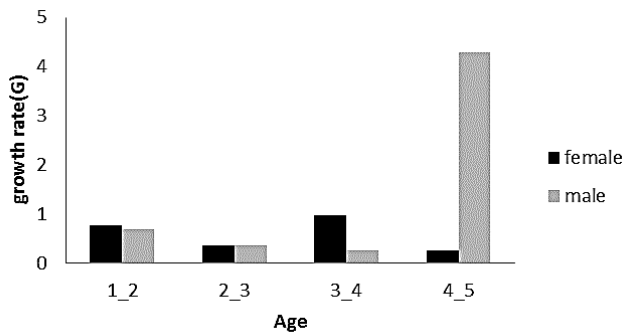
	Male		female	
	TL±SD	W±SD	TL±SD	W±SD
1 <sup>+</sup>	4.15±0.12	1.009±0.13	3.57±0.36	0.626±0.17
2 <sup>+</sup>	5.89±0.58	3.014±0.81	5.91±0.65	3.279±0.94
3 <sup>+</sup>	7.47±0.32	6.19±1.18	7.75±0.54	7.29±1.30
4 <sup>+</sup>	8.55±0.42	8.35±1.43	9.12±0.7	12.61±2.27
5 <sup>+</sup>	9.43±1.05	12.90±5.72	10.23±0.25	16.3±2.52

**Table 3.** LWR parameters of *Alburnoides tabarestanensis* from the Zav Stream.

	N	t <sub>Pauly</sub>	a	b	r <sup>2</sup>
Male	107	-0.594	0.0151	2.9784	0.97
Female	88	3.295	0.0119	3.1214	0.98
Male and Femal	195	2.858	0.013	3.067	0.98

**Table 4.** Values of some parameters of Von Bertalanffy in *Alburnoides tabarestanensis* the in Zav Stream.

	K	L <sub>∞</sub>	t <sub>0</sub>
Male	0.23	12.90	-0.664
Female	0.23	13.97	-0.156

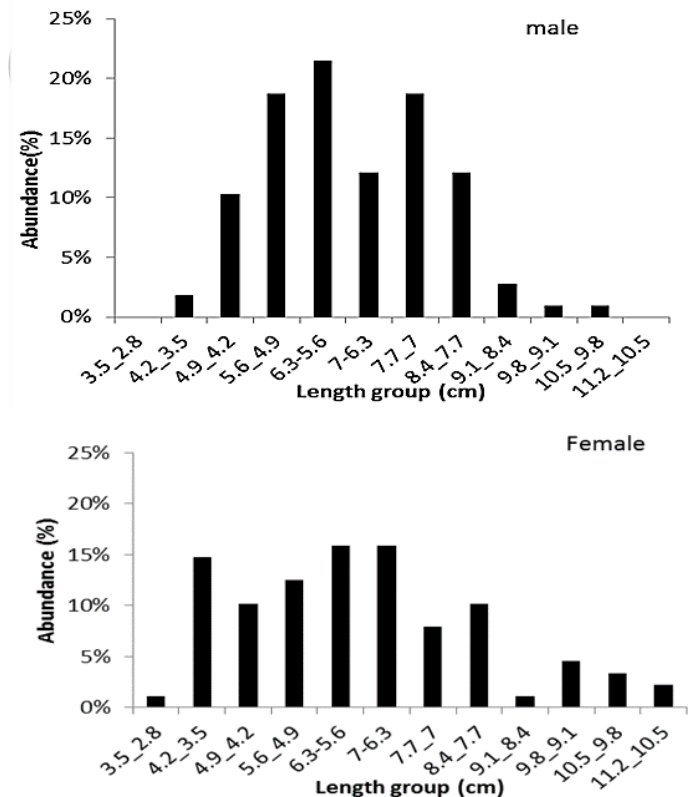


**Fig.1.** Frequency of growth rate (G) at-age in *Alburnoides tabarestanensis* from the Zav Stream.

recorded for females and males between ages 4<sup>+</sup>-5<sup>+</sup> and 3<sup>+</sup>-4<sup>+</sup>, respectively (Figs. 1, 2).

Length-weight relationships (LWRs) were obtained for 3 groups: LWRs were  $W=0.0151TL^{2.9784}$  for males,  $W=0.0119TL^{3.1214}$  for females and  $W=0.013TL^{3.067}$  for combined sexes ( $t_{males}$ : 0.594,  $t_{females}$ : 3.295,  $t_{population}$ : 2.858) (Table 3).

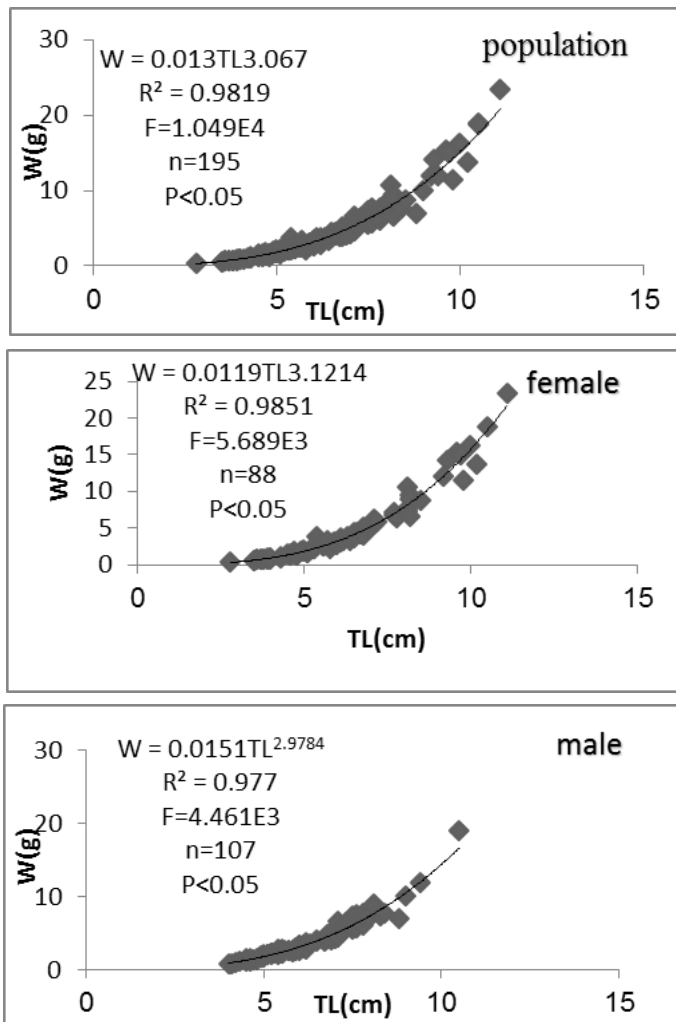
The *b* values of LWR were estimated to be 3.039 to 3.204 for females, 2.890 to 3.067 for males and 3.008 to 3.126 for the combined population. The von Bertalanffy growth function showed that females grow faster than males. VBGF was found to be  $L_t = 12.90(1 - e^{-0.23(t+0.664)})$  for males, and  $L_t = 13.97(1 -$



**Fig.2.** Total length (cm) abundance of male and female specimens of *Alburnoides tabarestanensis* in the Zav Stream, northern Iran.

$e^{-0.23(t+0.156)}$  for females (Table 4).

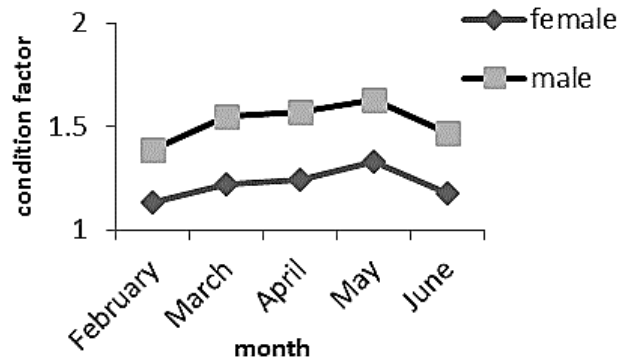
The dominant length class was 5.6-6.3cm for



**Fig.3.** Relative length-weight relationships for combined sexes (population), male and female specimens of *Alburnoides tabarestanensis* in the Zav Stream.

male, 5.6-6.3cm and 6.3-7cm for females. The lowest length abundant was observed in 2.8-3.5cm and 10.5-11.2cm for males and 2.8-3.5 and 8.4-9.1cm for females. Consequently, the maximum length was observed in female individuals (Fig. 3).

Mean condition factor for females and males was 1.21 and 1.51, respectively. The highest value of CF was  $1.11 \pm 0.32$  for males and  $1.62 \pm 0.15$  for females in May while the lowest value for female and male were obtained in February ( $cf_{\text{female}}: 1.12 \pm 0.06$ ,  $cf_{\text{male}}: 1.38 \pm 0.05$ ) (Fig. 4). CF variation among age groups showed that females have lower values than that of males (Table 5). 3<sup>+</sup> age groups of males and 4<sup>+</sup> age group of females had the highest cf.



**Fig.4.** Mean condition factor (CF) in males and females of *Alburnoides tabarestanensis* in the Zav Stream.

### Discussion

Despite the wide spread abundance and high diversity of spirilins in Iran, little is known about their biology and life history. The previous studies on age and growth Spirilin are scarce (Ahmadi et al. 2011; Patimar et al. 2012; Abbasi et al. 2013; Monajjemi et al. 2014) and this is the first documented attempt to study age and growth of *A. tabarestanensis* in the Zav Stream.

In this study maximum total length and weight (11.1cm and 23.34g) was obtained less than length of 13 and 13.8cm, weight of 25.26 and 28g reported by Sari et al. (2012) and Raikova-Petrova et al. (2011), respectively. Differences in size in different population could be results of different patterns or ecological condition that has significant effect on growth. Table 6 shows different length and weight of this species in different localities.

The Sex ratio of *A. tabarestanensis* was 1:1.22 in favor of males. According to Patimar et al. (2012) male:female ratio was 1:1.16, while Tabatabaei et al. (2014) reported a balanced sex ratio for *A. eichwaldii* in the Aras River. Nikolsky (1980) have been reported that sex ratio is different from species to species. Furthermore, the ratio of male to female may be affected by habitat, season, sampling mistakes, sex or mortality (Fernandez & Rossomanno 1997).

In this study the relation between TL and TW were found to be positive allometric growth model

**Table 5.** Average condition factor at-age of *Alburnoides tabarestanensis* in the Zav Stream.

	1 <sup>+</sup>	2 <sup>+</sup>	3 <sup>+</sup>	4 <sup>+</sup>	5 <sup>+</sup>
Male	1.44±0.06	1.5±0.07	1.58±0.16	1.4±0.28	1.53±0.18
Female	1.14±0.05	1.19±0.12	1.14±0.1	1.27±0.19	1.14±0.14

**Table 6.** Maximum and minimum length and weight of *Alburnoides* in different regions.

Location	sex	n	Max TL	Max W	References
Iskar River	Both	–	11.4	31	Raikova-Petrova et al. (2006)
Talar river	Both	809	96.14 (mm)	9.27	Ahmadi et al. (2011)
Iskar River	Both	69	13.8	28	Raikova-Petrova et al. (2011)
Qanat Uzineh	Male	129	11	14.68	Patimar et al. (2012)
Qanat Uzineh	female	111	11.1	15.95	Patimar et al. (2012)
Basin Aras River	Both	162	11.14	15.5	Cicek et al. (2016)
Zav stream, northern Iran	male	107	10.5	19.034	Present study
Zav stream, northern Iran	female	88	11.1	23.034	Present study

for the combined males and females, and negative allometric for males. Patimar et al. (2010) reported positive allometric for both sexes, females and males in the Qanat of Uzineh. Seifali et al. (2012) showed a positive allometric growth for the species in Kesselian Stream (Caspian Sea basin). The growth model of *Alburnoides* population (now *A. tabarestanensis*) was positive allometric in the Tajan River (Tabatabaei et al. 2014) while Torcu-Koç et al. (2000), Erguden & Goksu (2009), Abbasi et al. (2013) and Monajjemi et al. (2014) reported a negative growth pattern for some *Alburnoides* species.

The functional regression  $b$  value is directly related to the weight affected by ecological factors such as temperature, food supply, spawning conditions and habitat characteristics within a year (Ismen 2005). In this study  $b$ -value of females as a coefficient of allometry was larger than 3, and of males smaller than 3. Comparison of provided data on LWR with the reported  $b$ -value shows that the species has great variation in growth pattern. The variation may be the effect of habitat characteristics and population traits as well.

The maximum age observed for the studied population was greater than those reported by Patimar et al. (2012) and Treer et al. (2006).

Tabatabaei et al. (2014) reported a maximum age of 5<sup>+</sup>. Abdoli & Naderi (2009) and Raikova-Petrova (2011) found a maximum age of 6<sup>+</sup> years for Spirlin.

Condition factors are used for comparing the condition, fatness, or well-being of fish (LeCren 1951; Bagenal & Tesch 1978). It is also supplied information on the variation of fish physiological status factor that can be used to determine the feeding activity of a species. Fulton's condition factor of *A. tabarestanensis* were obtained. The highest observed value of CF was in May that is in agreement with the results reported by Patimar & Dowlati (2007). Azizi et al. (2015) studied some biological traits of the species at the up and down stream of Shahid Rajaii dam Lake of the Tajan River (*A. eichwaldii*), and found a condition factor of larger than 2 for this species. It is obvious that  $CF$  is different for different populations of a species and depends on several ecological factors of the habitat.

The comparison of growth parameters obtained for this species with those of other studies showed that the  $L_{\infty}$  and  $K$  are not similar. Table 4 shows the variation of  $L_{\infty}$  values among population of the different spirlin species ranging from 9.96cm of the population inhabiting Zarin-Gol Stream (Iran) to 16.36cm for population from Aras River tributary (Turkey). The  $K$  parameter of VBGR varies from a

**Table 7.** Estimates of von Bertalanffy length-at-age growth parameters for populations of Spiralin in the distribution area (Iran and European regions).

Location	sex	$L_{\infty}$ (mm)	K (year <sup>-1</sup> )	$t_0$ (year)	Reference
Zarin-Gol River, northern Iran	male	99.64 (mm)	0.51	-0.715	Patimar & Dowlati (2007)
Zarin-Gol River, northern Iran	female	107.23	0.55	-0.548	Patimar & Dowlati (2007)
Qanat of Uzineh, northern Iran	male	140.7	0.27	-0.92	Patimar et al. (2012)
Qanat of Uzineh, northern Iran	female	153.7	0.23	-1.08	Patimar et al. (2012)
Shirud River	unsex	12/08	0/55	-0/65	Monajjemi et al. (2014)
Tajan	unsex	123.01 (mm)	0.29	-1	Tabatabaei et al. (2014)
Aras River Basin in Turkey (River)	unsex	12.91	0.548	-1.41	Cicek et al. (2016)
Aras River Basin in Turkey (Lake)	unsex	16.36	0.237	-2.89	Cicek et al. (2016)
Zav stream, northern Iran	male	12.90	0.23	-0.664	Present study
Zav stream, northern Iran	female	13.97	0.23	-0.156	Present study

small value of 0.23 for the studied population (present study) to 0.56 for the population from Aras River basin (Turkey) (Table 7). Considering  $L_{\infty}$  and  $K$  parameters, our results are very close to finding of Cicek et al. (2016) and Tabatabaei et al. (2014).

### Acknowledgments

This study was founded by Gonbad Kavous University. We thank the editor and two anonymous reviewers for their useful comments on an earlier version of the manuscript, and Arsalan Bahalkeh (from Gonbad Kavous University) who helped with the experimental fishing and sampling sessions.

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## مقاله پژوهشی

# بررسی سن و رشد ماهی خیاطه طبرستانی *Alburnoides cf. tabarestanensis* (ماهیان استخوانی عالی: کپورماهیان) در رودخانه زاو - حوضه جنوب شرق دریای خزر

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**چکیده:** این مطالعه از ماه بهمن تا خرداد ۱۳۹۵ در رودخانه زاو (شمال ایران) انجام گرفت. تعداد ۱۹۵ عدد ماهی خیاطه (*A. tabarestanensis*) شامل ۸۷ عدد ماده و ۱۰۷ عدد ماهی نر از این منطقه جمع آوری گردید. اگر چه نسبت جنسی ۱/۲۲:۱ با غالبیت نرها همراه بود، اما از نظر آماری هیچ اختلاف معنی‌داری همراه نبود. میانگین طولی و وزنی نرها به ترتیب  $6/38 \pm 1/28$  سانتی‌متر و  $2/71 - 4/26$  گرم و میانگین طولی و وزنی جنس ماده  $6/2 \pm 1/84$  سانتی‌متر و  $4/64 \pm 4/48$  گرم بود. در هر دو جنس نر و ماده حداکثر سن قابل مشاهده شده  $5^+$  ساله بود. رابطه طول-وزن برای جنس نر  $W=0.0151TL^{2.9784}$ ، برای جنس ماده  $W=0.0119TL^{3.1214}$  و برای جمعیت  $W=0.013TL^{3.067}$  بدست آمد که بیانگر رشد آلومتریک منفی برای نرها و رشد آلومتریک مثبت برای ماده‌ها و کل جمعیت است. بیشترین و کمترین مقدار فاکتور وضعیت در ماه اردیبهشت و بهمن مشاهده گردید. معادله رشد وان‌برتالانفی به ترتیب  $L_t=12.90(1 - e^{-0.23(t+0.664)})$  برای جنس ماده و  $L_t=13.97(1 - e^{-0.23(t+0.156)})$  برای جنس نر بود. اطلاعات بدست آمده از این تحقیق می‌تواند در حفاظت و مدیریت این گونه استفاده شود.

**کلمات کلیدی:** ماهی خیاطه، الگوی رشد، طول-وزن، فاکتور وضعیت، رودخانه زاو