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AGE, GROWTH AND REPRODUCTION OF THE CHINESE MINNOW, *PHOXINUS OXYCEPHALUS* IN THE JIULONGFENG NATURE RESERVE OF THE HUANGSHAN MOUNTAIN

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Abstract: The age, growth and reproduction of Chinese minnow *Phoxinus oxycephalus* in the Jiulongfeng Nature Reserve of the Huangshan Mountain were examined. A total of 437 specimens were collected monthly from May 2011 to April 2012. The sex ratio was 0.77 : 1, significantly differing from the excepted 1 : 1 ratio. The population of *P. oxycephalus* was composed of three age groups for female and two age groups for male, and age 1 and age 2 were the dominant age groups in both sexes. Length growth was fastest in the first year while slowing in the second and third years. Fifty percent of individuals reached sexual maturity at age 1. Results from the monthly changes in gonadosomatic index (*GSI*) and the oocyte development process showed that the fish spawned from April through July. Absolute fecundity was relatively low, and increased with body size and varied between age classes, whereas no significant difference was observed in relative fecundity in relation to age class. Besides restricted distribution and small population, the relatively low fecundity of *P. oxycephalus* may suggest that this species is vulnerable to anthropogenic disturbance and environmental changes.

Key words: Age; Growth; Reproduction; *Phoxinus oxycephalus*; Jiulongfeng Nature Reserve
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Phoxinus (Leuciscinae, Cyprinidae, Cypriniformes) is a genus of small freshwater fish (approximately 100 mm of the maximum standard length) which widely distributes in Europe, North American, and the northern areas of Asia[1]. *Phoxinus* fish often inhabit small streams that are typically characterized by high elevation and low temperature. Mature fish are omnivorous, feeding on woody detritus, aquatic invertebrate and periphyton. There is no obvious diet shift occurs across their different life-history stages[2]. Most *Phoxinus* fish show the same life-history traits, including short life-span (the longest longevity not more than 3 years), low fecundity (absolute fecundity less than 3000 eggs), early maturity (maturing at the 2nd year after birth) and nest associate spawner (mature fish not nesting themselves but spawning eggs into the nests of other species)[2—6]. During spawning seasons, males are often more flowery than females, suggesting the sexual color dimorphism of *Phoxinus* fish[2, 4].

In total, ten species and subspecies of *Phoxinus* have been recorded in China, among which *Phoxinus oxycephalus* distribute most widely from the Liao River (north) to the Min River (south)[7]. This species often inhabit cold, running or still, yet well oxygenated waters, especially preferring stream headwaters with high elevation[8, 9]. The distribution of *P. oxycephalus* in many temperate and subtropical areas of South China is believed to be a result of distribution shift during the last glaciation period, which may explain why this species is only limited to stream headwaters in these areas[9]. Associated with their restricted geographic distributions, small population sizes, and low reproductive investments, *P. oxycephalus* may be very vulnerable to anthropogenic disturbance and environmental change as well as other *Phoxinus* fish, such as *P. tennesseensis*[6] and *P. cumberlandsis*[2]. According to Yu, *et al.*[9], when facing global climate change, the potential distribution of *P. oxycephalus* will sharply shrink over time and become much more restricted in their current situations especially in South-

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eastern China, of where this species will possibly extinct in 2080s.

However, the information on the biological and ecological traits of *P. oxycephalus*, which are essential for their conservation programs and management actions, is rare up to now. Based on 437 specimens collected monthly from May 2011 to April 2012 in the Jiulongfeng Natural Reserve of the Huangshan Mountain, the age, growth and reproduction of *P. oxycephalus* was examined in this study. Our aims were (1) to determine the life-history characteristics of this species, including age structure, growth, sexual maturity, timing of spawning and reproductive investment, and (2) to assess the potential associations between life history and their surrounding environment conditions, including limited resources, unstable habitat and local hydrological rhythms.

1 Material and method

1.1 Study area

The Jiulongfeng Nature Reserve (E 117°58′–118°04′; N 30°04′–30°08′) locates at the eastern part of the Huangshan Mountain, China. The area of this reserve is 27.2 km^2, of which 95.8% is covered by forests. The highest peak is 1281 m of elevation, and most piedmonts are composed by phyllite, granite and slate. The soil compositions show substantial changes along elevation-gradient, including mountain-yellow-brown (above 1000 m elevation), mountain-yellow (800–1000 m) and red-yellow soils (600–800 m). Due to the local subtropical monsoon climate, this area is characterized by asymmetries in seasonal temperature and precipitation. Air temperature ranges from –13.5℃ to 36.0℃ with a mean of 15.5℃. Annual rainfall is abundant, at approximately 1759 mm/yr, but approximately 79% of it occurs during spring and summer, while $< 5\%$ occurs during the cold and dry winter. A headwater stream, the Yinxi Stream, is originated in this nature reserve and flows northeast toward to the Chencun Reservoir, which is located at the middle segment of the Qingyi River, a tributary of the lower reach of the Yangtze River, China.

1.2 Sample collection

Fish were collected using backpack electro-fishing gear (CWB-2000 P, China; 12 V import and 250 V export) by wading at the upper segment of the Yinxi Stream. Sampling site encompassed diverse habitat-patches, including riffles, pools and backwaters. This procedure was conducted monthly during the 3nd week of each month from May 2011 through April 2012. The sampling efforts (e.g., duration and distance) may vary among months, being determined by the number of *P. oxycephalus* collected. *P. oxycephalus* was sorted out, and the standard length (*SL*, 0.1 mm) and total weight (*TW*, to the nearest 0.1 g) were individually measured. Individuals were dissected to determine the sex, and then gonads were removed and weighed (*GW*, 0.01 g). Gonad maturity stages (I–VI) were scored following Yin[10]. Somatic weight (*SW*, 0.1 g) was reweighed after removing the inner organs. All specimens and mature ovaries at stage IV, at which point ovaries were characterized by well-deposited vitellogenic granules, were preserved in 8% neutral formaldehyde solution.

1.3 Age estimation

Due to the difficulty in age-determination from some bone tissues (e.g., scale and otolith), the age classes of *P. oxycephalus* were estimated from histograms based on standard length measured, which have been widely used for determining the age of many *Phoxinus* fish[3, 6]. The specimens collected in this study were less than 45 during each month, which resulted in the scattering of individuals (especially for old fish) within monthly length-frequency histogram. According to the periodicity in local climate conditions and the potential life-history events of fish, the 12 sampling months were divided into four somatic-growth seasons to overcome this shortage, including the breeding (May–July), post-breeding (August–October), over-wintering (November–January) and pre-breeding (February–April) seasons. After drawing the length-frequency histograms, in terms of the number of their length-frequency peaks, the size classes and their size ranges were estimated independently for each season. For an example of the over-wintering fish, they were comprised of four size classes (Fig. 1), and the *SL*s were (48.7 ± 3.5) mm (Mean ± SD), (68.6 ± 8.9) mm, (108.1 ± 6.8) mm and (128.5 ± 8.1) mm for the 1st–4th size classes, respectively. The mean *SL*s increased 19.9 mm from the 1st to the 2nd size-class, 39.5 mm from the 2nd to the 3rd size-class and 20.4 mm from the 3rd to the 4th size-class, respectively, which suggested that *P. oxycephalus* grew relatively slower in early life-stage than in mid-late stages if the four size classes represented four age groups. However, according to Yin[10], many fish (especially the small and short-longevity fish) often grow fast in their early life-stages. From this perspective, the 1st and the 2nd size classes should be regarded as the two colonies of the same age group, of which they were SC1a (1st size-class fish hatched during autumn) and SC1s (1st size-class during summer). Then, the 3rd and the 4th size-classes were regarded as SC2 and SC3, respectively (Fig. 1). In this study, due to that fish of SC0 (newly born fish) began to be collected during May, both fish of SC0 during May–December and those of SC1 during January–April next year were regarded as age 1 fish. Accordingly, the age 2 and 3 fish were defined using the similar method.

1.4 Reproduction

Maturity was defined as the length or age at which 50% individuals of each sex were matured. $L_{50\%}$ and $T_{50\%}$ were estimated by fitting the binomial maturity data to the logistic function: $P = 1/[1 + e^{-(a + bx)}]$, where P is the proportion of mature fish in each 5 mm size or each 1-year age interval; x is the standard length or age, and a and b are both constants. Length and age at maturity were expressed as –a/b. Spawning timing was determined following the monthly changes of the gonado-somatic index (*GSI*), an index descrybing the relative size of gonads and further indicating the gonad development process by its sequential variation month by month[10], calculated from *GSI* = 100 (*GW*/*SW*)%. Following Oliva-Paterna and Torralva[11] and Yan, *et al.*[12], egg development was determined from 36 females (three fish per month) with similar standard length (ca. 90 mm) to show a representative sequence of developmental events. Oocytes were divided into three categories based on their sizes and colors: transparent (< 300 μm in diameter), semitransparent (300–1000 μm) and vitelline oocyte (> 1000 μm). Absolute fecundity (*AF*) was estimated in terms of the number of the whole oocytes, including immature and vitelline oocytes. Relative fecundity *(RF)* was calculated as *RF* = *AF*/*SW*, where *AF* is the absolute fecundity and *SW* is the somatic weight.

1.5 Data analysis

Analysis of covariance (ANCOVA) was used to compare *SL*–*TW* relationships between both sexes with *SL* as covariate. The difference between the observed sex ratio and expected 1∶1 was tested by one-sample chi-square test. One-way ANOVA was carried out to test the variations in standard length for each age group and *GSI* for both sexes, respectively. Independent *t*-test was used to compare the standard length between two sexes for each month and age and to test the variations in *AF* and *RF* between age II and III groups, respectively. Statistical significance was accepted at $P<0.05$.

2 Result

2.1 Habitat conditions

The sampling segment in the Yinxi Stream was approximately 500 m of elevation. Water temperature ranged from 1.3 (December) to 22.6℃ (July) with a mean of 16.3℃. Mean dissolved oxygen was 8.50 mg/L. The streambed was mainly composed of bedrocks, boulders and large cobbles. However, most *P. oxycephalus* were collected in small pools with relatively fine substrates (e.g., silt and fine gravel) and relatively low velocity. In addition, the microhabitats preferred by *P. oxycephalus* were often shaded by woody vegetation and characterized by woody debris and other materials serving as cover.

2.2 Sex ratio

Of the 437 specimens of *P. oxycephalus* collected, 175 were females (37.5–134.2 mm *SL*, 0.9–27.3 g *TW*), 226 were males (37.3–106.5 mm *SL*, 0.6–20.6 g *TW*), and the sex of the remaining 36 fish was undetermined. The sex ratio estimated from all sex-identified fish was 0.77∶1, which significantly differed from the expected 1∶1 ratio ($\chi^2 = 6.49$, $df = 1$, $P<0.05$). However, most monthly sex ratio did not significantly differ from 1∶1 ($P > 0.05$) with the exception of those in January and November ($P<0.05$) (Tab. 1).

Tab. 1 Sex ratio of *P. oxycephalus* in the Jiulongfeng Nature Reserve

	Number of individuals		Sex ratio (F:M)	χ^2	*P*
	Female	Male			
Jan.	10	28	0.36	8.53	< 0.01
Feb.	15	20	0.75	0.71	0.40
Mar.	5	13	0.38	3.56	0.06
Apr.	15	15	1.00	0	1.00
May	27	22	1.23	0.51	0.48
Jun.	14	16	0.86	0.13	0.72
Jul.	10	12	0.83	0.18	0.67
Aug.	13	9	1.44	0.73	0.40
Sep.	14	20	0.70	1.06	0.30
Oct.	26	18	1.44	1.45	0.23
Nov.	11	28	0.39	7.41	<0.01
Dec.	15	25	0.60	2.5	0.11
Total	**175**	**226**	**0.77**	**6.49**	**0.01**

2.3 Size class and age composition

Fish of breeding season (May–July) were comprised of four size classes, representing SC0s, SC1a, SC1s and SC2, respectively. *SL*s were 35.0–50.0 mm (43.3 ± 4.0 mm; Mean ± S.D.), 52.5–75.0 mm (64.5 ± 7.0 mm), 77.5–112.5 mm (89.6 ± 9.6 mm) and > 115.0 mm (117.0 ± 1.4 mm) for 1st–4th classes, respectively. During post-breeding season (August–October), fish were consisted of five size classes, of which *SL*s were 35.0–42.5 mm (SC0a), 42.6–65.0 mm (SC0s), 65.1–92.5 mm (SC1a), 95.0–112.5 mm (SC1s) and > 120.0 mm (SC2). For over-wintering fish (November–January), their *SL*s were 40.0–50.0 mm (SC1a), 55.1–92.5 mm (SC1s), 95.0–115.0 mm (SC2) and > 120.0 mm (SC3). *SL*s of pre-breeding fish (February–April) were 50.0–75.0 mm (SC1a), 80.0–107.5 mm (SC1s), 110.0–120.0 mm (SC2) and > 125.0 mm (SC3) (Fig. 1).

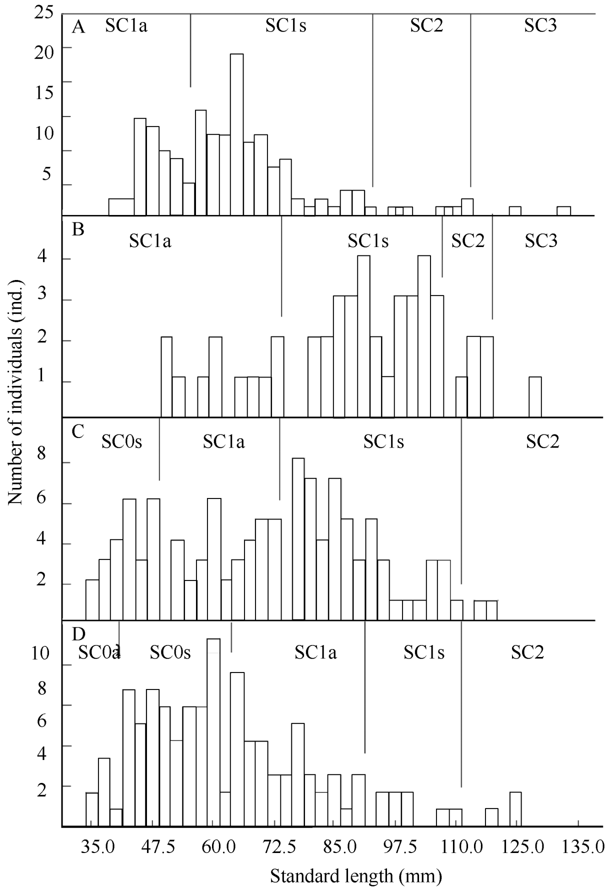

Fig. 1 Histograms in standard length frequency for *P. oxycephalus* during four seasons

A, B, C and D show the over-wintering, pre-breeding, breeding and post-breeding seasons. SCx represents the x-th size class, and SCxa and SCxs indicate the two colonies born during autumn and summer within the same year, respectively

Based on the results in size classes from the above seasonal histograms, the size classes and their distribution ranges were estimated for fish collected in each month. When combining females and males together, the length-frequency distributions of fish in each month did not exceed three peaks. Individuals at SC0 commenced to appear during May, and gradually increased in abundance from June through October. Old fish at SC2 were collected in most months with the exception of December and January, and those at SC3 were only collected during January and April (Fig. 2). When independently regarding females and males, the size classes for females included SC0–SC3 and all males were only comprised of SC0 and SC1 (Fig. 2).

Consequently, the whole fish were comprised of four size classes, i.e., SC0, SC1, SC2 and SC3. The relative abundance of fish at each size class was 36.6% (SC0), 60.0% (SC1), 3.4% (SC2) and less than 1.0% (SC3). When regarding the fish of SCx during May–December and those of SC(x+1) during January–April as the same age group, the oldest fish was age III for females and age II for males. The relative abundance at each age was 35.4% (age I), 58.3% (age II) and 6.3% (age III) for females and 49.1% (age I) and 50.9% (age II) for males, respectively. The preponderant age groups were ages I and II for both sexes, of which their relative abundances were more than 90.0%.

2.4 Growth

The *TW*–*TL* equation was $TW = 4 \times 10^{-5}SL^{2.76}$ ($R^2 = 0.88$, $N = 175$) for females and $TW = 6\times 10^{-5}SL^{2.62}$ ($R^2 = 0.75$, $N = 226$) for males, respectively. They were not combined because the difference between the two equations for both sexes was significant (ANCOVA, $F = 23.37$, $P<0.01$). During April, fish were (83.4 ± 20.0) mm *SL* and (5.4 ± 3.6) g *TW* for age I group, (114.7 ± 1.8) mm and (14.7 ± 1.8) g for age II group, and 125.7 mm and 19.7 g for age III group. These results indicated that *SL* growth was fastest in the first year while slowing in the second and third years; however, *TW* growth was fastest in the second year of life.

The age I groups showed significantly variation in *SL* from May to April next year (One-way ANOVA, $F = 30.26$, $P<0.01$). Results of post-hoc comparisons indicated that significant month-sequential increase in *SL* occurred from July to August, from October to November and from February to March ($P<0.05$). Also, *SL*s of the age II groups differed significantly from May through November (One-way ANOVA, $F = 29.46$, $P<0.01$); however, no significant variation in *SL* was observed between two sequential months ($P>0.05$). Both sexes showed similar *SL* growths because *SL*s did not significantly differ between sexes in each month for each age group (independent *t*-test, $P>0.05$) (Fig. 3).

2.5 Reproduction

Fifty percent of individuals reached sexual maturity at age II. $SL_{50\%}$ was 93.0 mm for females and 76.9 mm for males, respectively (Fig. 4). The minimum standard lengths at sexual maturity were 49.8 mm (female) and 51.2 mm (male), both at age II.

*GSI*s showed significantly monthly variations for females and males (One-way ANOVA, females: $F = 22.93$, $P<0.01$; males: $F = 10.73$, $P<0.01$). In females, the *GSI* markedly increased and got the maximum mean value in April (approximately 8.8%), remained relatively high during May and June, and then declined sharply in July. The *GSI*s in males showed similar monthly changes with females (Fig. 5). These results indicated the breeding season of *P. oxycephalus* lasted from April to July.

Semi-transparent oocytes began to form in January, increased in number and size through February and March, and developed into vitelline oocytes in

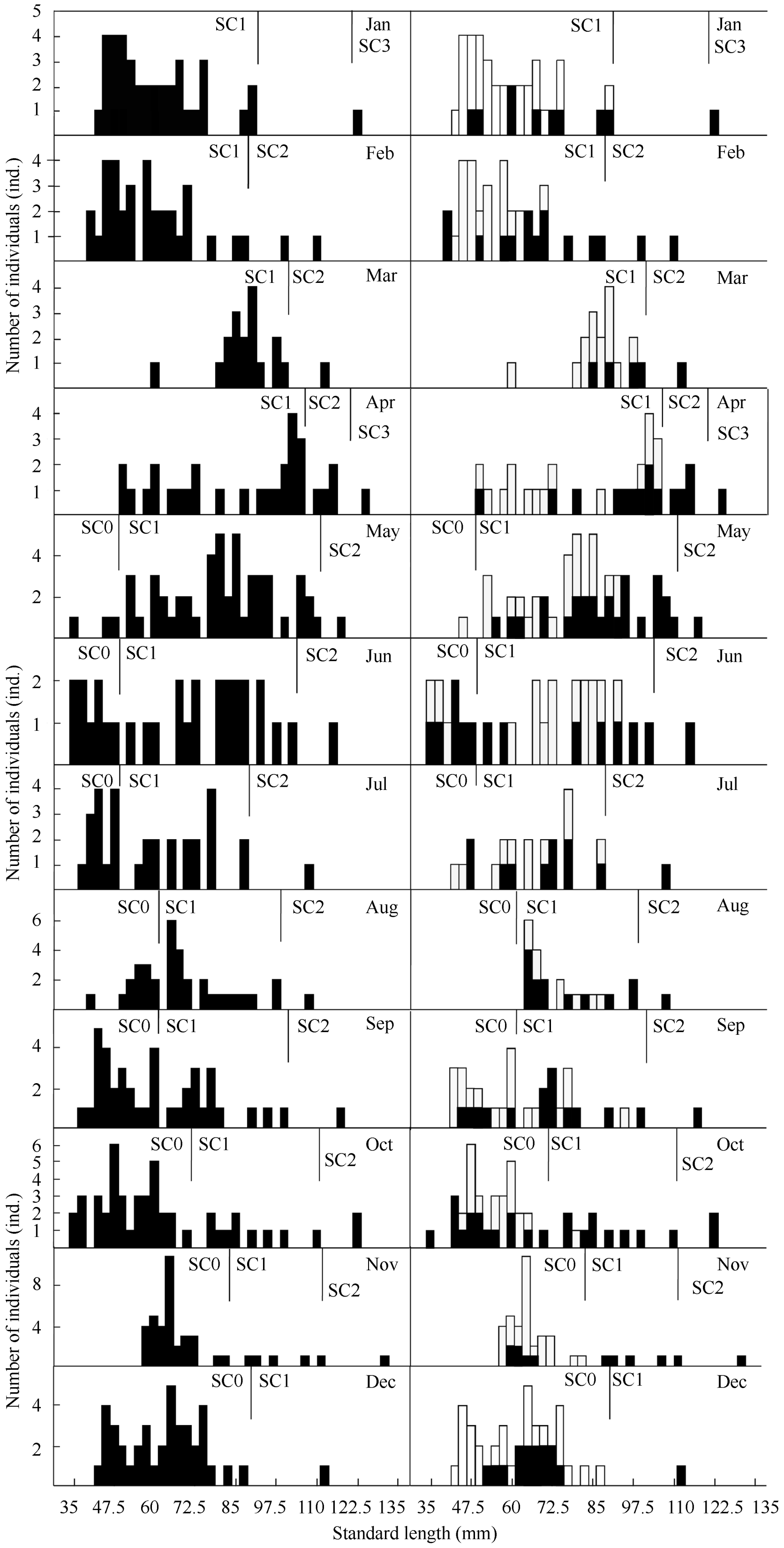

Fig. 2　Histograms in standard length frequency for *P. oxycephalus* collected in each month

The left row show fish combined of females and males. The right row show fish independently for females and females, and the black and white columns represent the females and males, respectively. SCx indicate the fish of x-th size class

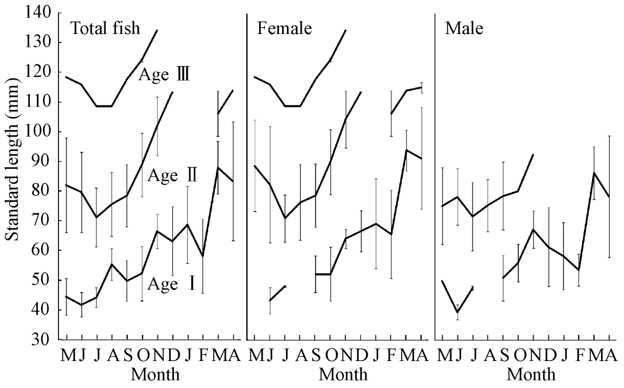

Fig. 3 Monthly variations in standard length for each age group of *P. oxycephalus* in the Jiulongfeng Nature Reserve

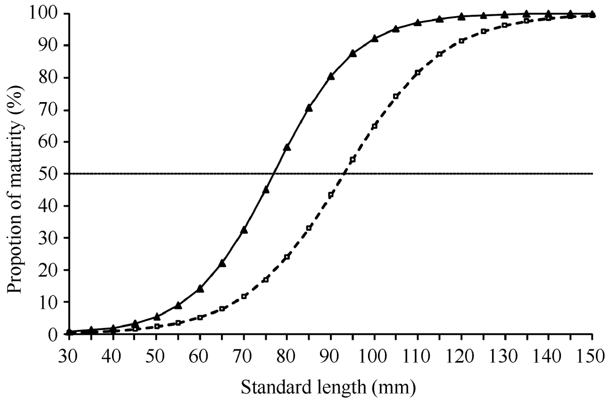

Fig. 4 Percentage contributions of mature female and male *P. oxycephalus* in sequential 5-mm standard length intervals
Dashed and solid lines indicate female and males, respectively. Horizontal dashed line shows 50% maturity

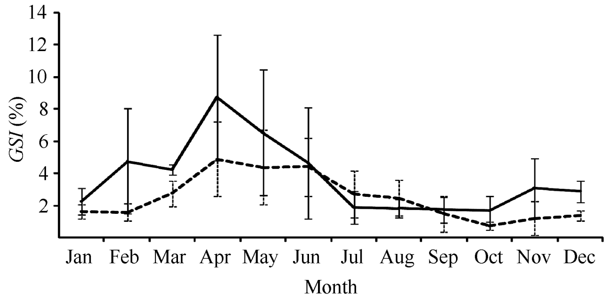

Fig. 5 Monthly changes in the gonado-somatic index (*GSI*) of *P. oxycephalus* in the Jiulongfeng Nature Reserve
Dashed and solid lines indicate females and males, respectively

April. Meanwhile, transparent oocytes decreased in number from January through March, but rebounded in April. Semi-transparent oocytes decreased sharply in June and remained relatively small number from July and October. Vitelline oocytes kept numerous from April through July, decreased sharply in August, and disappeared in November (Fig. 6). Based on the egg development process during one year, the breeding activities of female *P. oxycephalus* were carried out from April through July, which was similar to the result indicated from the monthly changes in *GSI*.

In total, 67 mature females were used for fecundity estimation during the breeding season. Absolute fecundity ranged from 174 (of the individual of 49.00 mm *SL*) to 2151 ova (121.4 mm), with a mean of 867 ova per fish. Absolute fecundity significantly varied between ages II (710 ± 331 ova) and III (1462 ± 269 ova) (independent t-test, F = 14.83, t = –5.99, df = 65, P<0.01) and increased with standard length and total weight, as specified by the equations as $AF = 0.001SL^{2.87}$ ($R^2 = 0.93$, N = 67) and $AF = 62.69TW + 9.41$ ($R^2 = 0.69$, N = 67), respectively. Relative fecundity ranged from 25.2 to 282.9 egg/g with a mean of 84.6 egg/g and did not significantly differ between ages II (79.1±43.5 egg/g) and III (105.3 ± 35.4 egg/g) (t-test, F = 0.30, t = –2.64, df = 65, P>0.05).

3 Discussion

Frost[13] used the scales on the caudal peduncle to determine the age of *P. phoxinus* and Starnes and Starnes[2] aged *P. cumberlandensis* by the scales removed from just above the lateral line beneath the dorsal fin origin. However, Mills[3] stated that scales were not suitable for aging *P. phoxinus* from the Frome River because no obvious annulus sign can be observed on their scales, which is possibly due to that the scale development of this species only commences at 17–20 mm length and is completed at 28–30 mm length[14]. Hamed, *et al.* [6] also found that the rings on scales of *P. tenresseensis* were equally spaced and presented no annulus sign. In addition, Myllylä, *et al.* [15] and Mills and Eloranta [16] used otoliths to age *P. phoxinus*. However, Frost[13] and Mills[3] revealed that, compared with the ages determined from length-frequency distributions, those estimated from alternating opaque and hyaline bands on otolith may over-age *P. phoxinus* by one or two years. This over-aging perhaps suggests that otoliths are not available in the age determination of this species, because these fish were generally not more than three years of their life spans[13]. According to Mills[3], for the overwintering individuals of *P. phoxinus* in the Frome River, the fish in the second length-frequency peak contained one, two or three principal hyaline bands rather than one band that would have been expected if the dark hyaline bands were laid down annually. In this study, we have once attempted to estimate the ages of *P. oxycephalus* by scales and otoliths. But we could not find any annulus sign on the scales because the rings were equally spaced and showed no sign of slower growth during winter and other seasons, which was similar with the results revealed for *P. phoxinus* and *P. tenresseensis*[3, 6]. Also, comparing with the ages based on length frequency distribution, those estimated from otoliths of *P. oxycephalus* generally over-aged 1 or 2

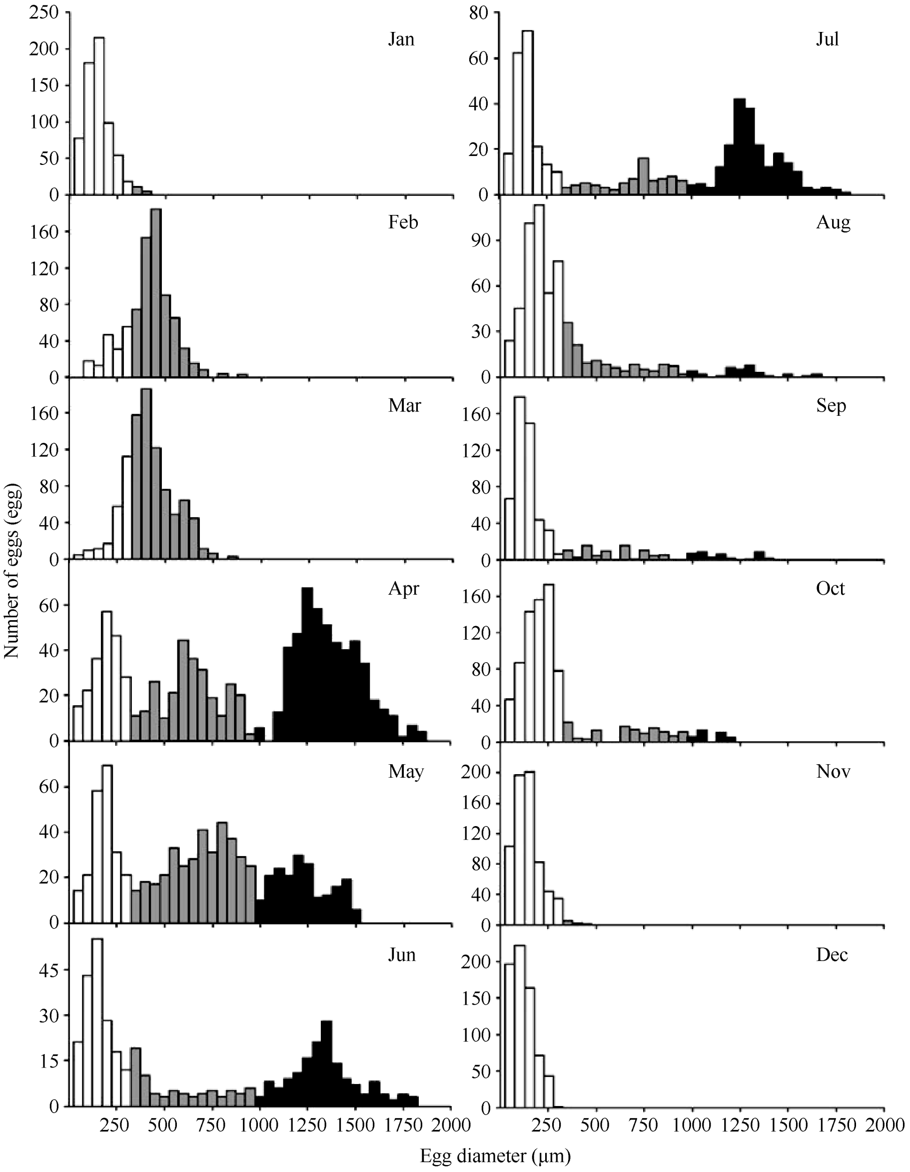

Fig. 6 Monthly changes in size-frequency distribution of oocytes for female *P. oxycephalus* in the Jiulongfeng Nature Reserve

White, gray and black bars indicate the transparent, semi-transparent and vitelline oocytes, respectively

years, just as the results observed by Mills[3]. Therefore, scales and otoliths are possibly not suitable for determining the ages of *P. oxycephalus* (our unpublished data), which is the reason why we used the method of length frequency distribution to estimate the age classes in this study. In fact, this method has been successfully performed to determine the ages of *P. tenresseensis* and to verify the ages estimated from scales of *P. cumberlandensis* and from otoliths of *P. phoxinus*[2, 6, 16].

Our results of standard length distributions revealed that the population of *P. oxycephalus* is composed of three age groups for female and two age groups for male, and age 1 and age 2 were the dominant age groups in both sexes, representing over 90% in the relative abundance. Most *Phoxinus* fish have only three age classes and females often comprise more age 3 individuals than males. For examples, *P. phoxinus* in the Frome River have a life span of 3 years, and the relative abundances for each age class were 66.6% (1 yr), 32.3% (2 yr) and 1.2% (3 yr)[3]. Also, both *P. cumberlandensis* and *P. erythrogaster* are structured by 3 age classes, and females may survive longer than males[2, 4]. Starnes and Starnes[2] found that males showed higher mortality than females after their first maturity for *P. cumberlandensis*. These authors deemed that males were more vulnerable to their predators (e.g., largemouth bass, creek chub and green sunfish) due to their more contrasting colors. In this study, goby *Ctenogobius* sp. was the only sympatric fish distributed in our sampling segment. This species in the headwater streams of this study are omnivorous, mainly feeding on organic detritus and aquatic invertebrates[17]. Therefore, the predation pressure on *P. oxycephalus* in this study area may not derive from predating fish.

The spawning season of *P. oxycephalus* lasted from April to July in the Jiulongfeng Reserve, which was similar with most others *Phoxinus* fish, such as *P. phoxinus*[3], *P. tenresseensis*[6], *P. cumberlandensis*[2] and *P. erythrogaster*[4]. Water temperature was considered as one of the most important factors influencing the spawning timing of *P. cumberlandensis* and *P. tenresseensis*[2, 6]. In addition, the spawning season generally related to annual flood for many riverine fish[18], because floods can extend the spawning habitat, increase food availability and decrease predation fish[19]. In this study area, rainfall mainly concentrated during April to September[20, 21], which is synchronous with their spawning time.

Most *Phoxinus* fish have relatively low absolute fecundity, such as *P. cumberlandensis* (724–2872 ova with a mean of 1540 ova)[2], *P. tennessensis* (398–721 ova and mean 556 ova)[6] and *P. erythrogaster* (140–681 ova)[4]. Because Settles and Hoyt[4] and Hamed, *et al.*[6] only counted the mature ova, not including immature ova, it precludes us to compare the reproductive investment among these *Phoxinus* fish. However, the result of Starnes and Starnes[2] is based on the number of both mature and immature ova of mature females, just as those used in this study, suggesting the comparability in fecundity between *P. oxycephalus* and *P. cumberlandensis*. The fecundity of *P. oxycephalus*, ranging from 174 to 2151 ova with a mean of 867 ova, is relatively lower than *P. cumberlandensis*.

Sexual maturity, an important life-history event of fish, is combinedly affected by both genetic and environmental factors[22]. The size and age of maturity may be the trade-offs among different life-history variables. For example, early maturity will result in shorter life span and slower somatic growth[23]. Generally, early maturity is one of the tactics for fish inhabiting unstable environment to adapt their surrounding conditions[24]. In our study, both female and male *P. oxycephalus* got 50% maturity at age 2 and with standard length of 93.0 and 76.9 mm, respectively. The timing of maturity for *P. oxycephalus* was similar with other *Phoxinus* fish, such as *P. phoxinus*[3], *P. cumberlandensis*[2] and *P. erythrogaster*[4].

In conclusion, *P. oxycephalus* in the headwater streams of the Huangshan Mountai, China, show some similar life-history traits with most others *Phoxinus* fish, such as short life-span, early maturity and low fecundity. These life-history characteristics may be a combined result of genetic and environmental factors. Within the headwater streams, the local habitat conditions (e.g., limited resource and dynamic environment) may take an important role in determining the life history of this species. *P. oxycephalus* may be vulnerable to anthropologic disturbance and environmental changes due to their restricted distribution, small population and low reproductive-investment.

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黄山九龙峰保护区尖头鱥的年龄、生长和繁殖

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摘要: 于 2011 年 5 月至 2012 年 4 月逐月采集标本, 对黄山九龙峰保护区尖头鱥(*Phoxinus oxycephalus*)的年龄、生长和繁殖等生活史特征进行了研究。尖头鱥雌、雄鱼性比为 0.77∶1, 与 1∶1 差异显著。根据体长频率分布来确定年龄组成,结果显示雌鱼和雄鱼的最大寿命分别为 3 龄和 2 龄, 均以 1 龄和 2 龄为优势年龄组。1 龄时的体长生长速度最大, 至 2 龄或 3 龄逐渐变缓。雌、雄鱼的初次性成熟年龄均为 2 龄, 对应体长分别为 93.0 mm 和 76.9 mm。尖头鱥繁殖时间为 4—7 月; 绝对繁殖力较低(174—2151 卵粒), 且在 2、3 年龄组间显著差异, 但相对繁殖力无显著的年龄组间差异。尖头鱥的上述生活史特征, 可能体现了对局域环境条件(如营养贫乏、环境动荡及水文周期等)的生态适应性。尖头鱥在我国东南部的高海拔地区呈零星分布, 种群数量小, 加之繁殖投入低下, 因此该物种在面临人类干扰和环境变化时极易濒危和灭绝。

关键词: 年龄; 生长; 繁殖; 尖头鱥; 九龙峰保护区