

Annual Cycle of Serum Gonadal Steroids and Serum Lipids in *Capoeta capoeta umbla*, Güldenstaedt, 1772 (Pisces: Cyprinidae)

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Abstract: Seasonal changes in serum concentrations of the testosterone in males, 17 β -estradiol in females and triglyceride and cholesterol in both sexes of *Capoeta capoeta umbla* were determined. Peak concentrations of testosterone (2.828 ± 0.278 ng/mL) and 17 β -estradiol (3.182 ± 0.116 ng/mL) occurred in May. The concentrations of testosterone and 17 β -estradiol were significantly correlated with the gonadosomatic index in both sexes. After the spawning period, steroid hormone levels significantly diminished ($P < 0.05$). The triglyceride concentration was highest in April (607.611 ± 30.146 mg/dL). The serum cholesterol level showed a rising trend until April and reached peak values during this month (393.000 ± 8.991 mg/dL). In the spawning month (May), a significant decrease was observed in triglyceride and cholesterol concentrations ($P < 0.05$). These results suggest that seasonal changes in both serum lipids and steroid hormones were associated with reproductive activity in *C. c. umbla*.

Key Words: *Capoeta capoeta umbla*, reproduction, cholesterol, triglyceride, 17 β -estradiol, testosterone

Capoeta capoeta umbla Güldenstaedt, 1772 (Pisces: Cyprinidae)'nin Serum Gonadal Steroid ve Serum Lipitlerinin Yıllık Değişim Seyri

Özet: *Capoeta capoeta umbla*'nin kan serumunda testosteron (erkeklerde), 17 β -estradiol (dişilerde), kolesterol ve trigliseridin (her iki cinsiyette) konsantrasyonlarındaki mevsimsel değişimleri belirlendi. Testosteron ($2,828 \pm 0,278$ ng/mL) ve 17 β -estradiolun ($3,182 \pm 0,116$ ng/mL) en yüksek konsantrasyonları Mayıs ayında tespit edildi. Her iki cinsiyette de testosteron ve 17 β -estradiolun konsantrasyonlarının gonadosomatik indeks değeriyle korelasyon gösterdiği görüldü. Yumurtlama periyodundan sonra, steroid hormonların seviyeleri önemli derecede azaldı ($P < 0,05$). Trigliserid konsantrasyonu Nisanda en yüksekti ($607,611 \pm 30,146$ mg/dL). Serum kolesterol seviyesi Nisana kadar bir artış trendine girdi ve en yüksek değere bu ayda ulaştı ($393,000 \pm 8,991$ mg/dL). Yumurtlama ayında (Mayıs) kolesterol ve trigliseridin konsantrasyonlarında önemli derecede bir azalma görüldü ($P < 0,05$). Bu sonuçlar *C. c. umbla*'nin her iki cinsiyetinde de serum lipid ve steroid hormonlarının mevsimsel değişiminin üreme faaliyetiyle ilişkili olduğunu göstermiştir.

Anahtar Sözcükler: *Capoeta capoeta umbla*, üreme, kolesterol, trigliserid, 17 β -estradiol, testosteron

Introduction

Gonadal steroid hormones stimulate the development of gonads, and lipids play an essential role in energy requirements during gonadal maturation. Seasonal changes in serum gonadal steroid hormones and serum lipids have been correlated with seasonal gonadal changes in fish (1-3).

The aim of the present study was to determine monthly the sex steroid hormones (17 β -estradiol and testosterone) and lipids (triglyceride and cholesterol) in *C. c. umbla*. A number of investigators have determined the levels of steroid hormones and lipids in the annual fish reproductive cycle. These studies were carried out on *Mugil cephalus* (1), and *Cyprinus carpio* (3,4). There have

been no studies on the steroid hormones and lipid contents in serum over a whole year in both female and male *Capoeta capoeta umbla*.

Materials and methods

A total of 164 *C. c. umbla* (65 female and 99 male, 3-11 years of age, weighing 45.6-853 g) were captured monthly by cast nets of 12-22 mm mesh sizes between December and November (1998-1999) from the Karasu River (40° 45' 33" E, 39° 56' 16" N), one of the most important branches of the Fırat River. Blood samples were collected from the caudal vein of each fish in the research field monthly. Immediately after collection, the blood was centrifuged at 4000 rpm for 15 min and

serum was separated in the laboratory. Serum samples were stored at -20 °C until analysis.

Age, body weight, gonad weight and sex were determined for each fish (5,6). The gonadosomatic index (GSI) is gonad weight expressed as a percentage of body weight (7).

Steroid hormone and lipid levels were determined in the serum of the blood. 17β-estradiol (in females) and testosterone (in males) were determined using an automated system, chemiluminescence (Bayer® ACS:180). Serum cholesterol and triglyceride were determined using an automated system (Hitachi® 717). Analyses were performed three times in each fish monthly and the means were calculated. The correlation coefficient was calculated in order to determine the relationship between changes in the levels of triglyceride, cholesterol and the steroid hormones using "Statistica software".

Results

The gonadosomatic index value for both sexes of *C. c. umbla* peaked in May. The peak values were 7.972 ± 1.269 for males and 8.817 ± 0.816 for females. Prior to the spawning period, the GSIs of both sexes were consistently low. In June, the GSIs of both sexes diminished as spawning was completed (Figure 1).

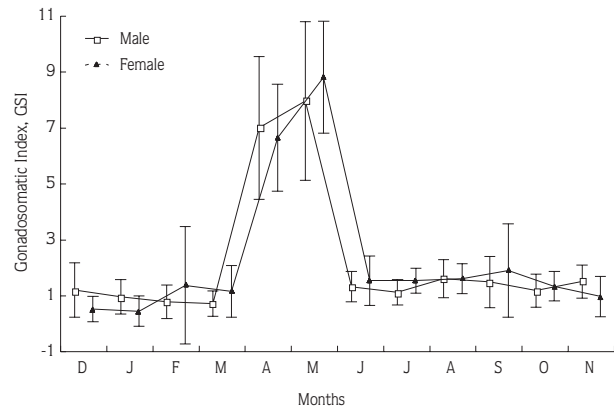


Figure 1. Seasonal variation in the gonadosomatic indexes of *C. c. umbla*. Values are means ± SE.

Throughout the prespawning months, 17β-estradiol and testosterone levels were very low. The steroid hormone levels of both sexes were higher in May (17β-estradiol: 3.182 ± 0.116 ng/mL; testosterone: 2.828 ± 0.278 ng/mL) than in other months (Table 1). After the spawning period, steroid hormone levels significantly diminished ($P < 0.05$). Throughout the prespawning months (December-March) male serum testosterone and female serum 17β-estradiol levels were very low (Figure 2). This seasonal variation in serum gonadal steroids in both sexes is highly correlated ($r = 0.804$, males; $r =$

Table 1. Seasonal changes in the plasma steroids for male and female *C. c. umbla*.

Months	N	Female		Male	
		17β-estradiol (ng/mL) ± SE*	N	Testosterone (ng/mL) ± SE **	N
December	7	0.050 ± 0.007^e	13	0.074 ± 0.006^d	
January	4	0.046 ± 0.003^e	10	0.085 ± 0.006^d	
February	5	0.078 ± 0.008^e	11	0.141 ± 0.014^d	
March	3	0.182 ± 0.042^{de}	5	0.169 ± 0.040^d	
April	11	2.799 ± 0.128^b	7	2.265 ± 0.185^b	
May	6	3.182 ± 0.116^a	5	2.828 ± 0.278^a	
June	2	0.801 ± 0.083^{cf}	3	0.460 ± 0.200^{ce}	
July	4	0.439 ± 0.054^{dg}	4	0.156 ± 0.037^d	
August	4	0.784 ± 0.050^c	10	0.485 ± 0.026^c	
September	6	0.309 ± 0.010^{deg}	9	0.313 ± 0.028^{cd}	
October	8	0.514 ± 0.027^{cfg}	11	0.240 ± 0.022^{de}	
November	5	0.525 ± 0.036^{cfg}	11	0.200 ± 0.023^d	

*.** Mean values with different letters are significantly different at $P < 0.05$.

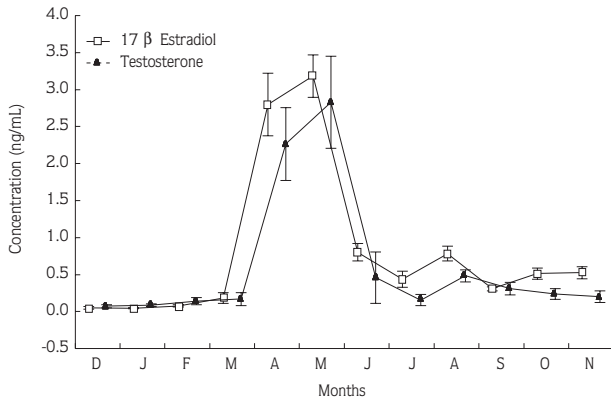


Figure 2. Seasonal variations in serum testosterone (in males) and 17β -estradiol (in females) of *C. c. umbla*. Values are means \pm SE.

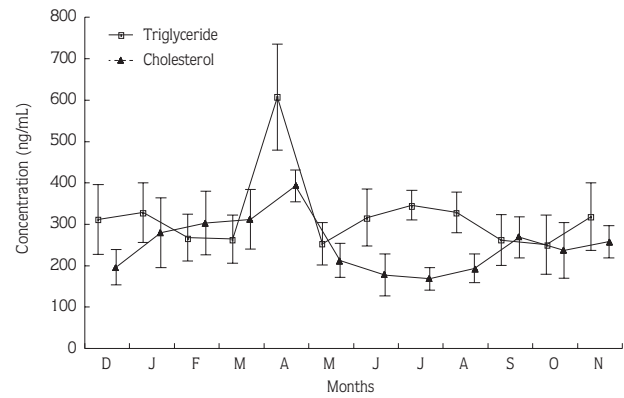


Figure 3. Seasonal variations in serum triglyceride and cholesterol of *C. c. umbla*. Values are means \pm SE.

0.894. females) with the cycle of the gonadosomatic index.

Triglyceride and cholesterol concentrations for both sexes were similar throughout the year (Table 2). The triglyceride concentration was highest in April (607.611 ± 30.146 mg/dL). The serum cholesterol level showed a rising trend until April and reached peak values during this month (393.000 ± 8.991 mg/dL). In the spawning month (May), a significant decrease was observed in triglyceride and cholesterol concentrations ($P < 0.05$). Cholesterol levels diminished until July, while, in contrast, serum triglyceride levels increased (Figure 3).

Discussion

Seasonal variations in gonadal growth, serum steroids, serum triglyceride and serum cholesterol levels from both sexes of *C. c. umbla* suggest that lipid deposition is associated with the reproductive cycle (Figures 1-3). Many researchers have reported that fish deposit the source of foods in their tissue and liver. Then these deposited foods are used in reproduction and other activities (1,5,8,9).

Throughout the prespawning months from December to March, 17β -estradiol and testosterone levels were very low. Our data are consistent with those of other researchers (1,3,4,10). Steroid hormone levels of both

Months	N	Triglyceride (mg/dL) \pm SE*	Cholesterol (mg/dL) \pm SE**
December	20	311.600 ± 18.853^{cde}	196.400 ± 9.589^{gi}
January	14	328.357 ± 19.159^{cd}	279.714 ± 22.463^{bd}
February	16	267.938 ± 14.049^{de}	303.500 ± 19.211^{bc}
March	8	264.375 ± 20.686^{de}	311.875 ± 25.488^b
April	18	607.611 ± 30.146^a	393.000 ± 8.991^a
May	11	253.091 ± 15.299^{eg}	213.000 ± 12.257^{fhg}
June	5	316.200 ± 30.805^{bde}	177.800 ± 22.732^{hi}
July	8	346.375 ± 12.659^{bc}	168.750 ± 9.617^{hi}
August	14	338.929 ± 7.962^{bc}	193.429 ± 9.288^{hgi}
September	15	262.133 ± 15.734^{de}	278.800 ± 10.648^{be}
October	19	250.526 ± 16.399^{ef}	236.895 ± 15.417^{deg}
November	16	318.563 ± 20.424^{cde}	258.063 ± 9.705^{cdef}

Table 2. Seasonal changes in serum triglyceride and cholesterol in *C. c. umbla*.

*-** Mean values with different letters are significantly different at $P < 0.05$.

sexes were highest in May. After the spawning period steroid hormone levels diminished significantly ($P < 0.05$). The rapid increase in serum gonadal steroids in both sexes of *C. c. umbla* is highly correlated with increases in the gonadosomatic index. Seasonal patterns of correlation between serum steroids and gonadal maturation have been reported previously (1,2).

Cholesterol and triglyceride concentrations for both sexes were similar throughout the year. Dindo and MacGregor (1) reported that serum total lipid concentrations in females were often significantly higher than in males but the seasonal fluctuations were similar. In addition, they also reported that cholesterol concentrations for both sexes were similar throughout the year in the striped mullet. The same cholesterol result was reported in *Salvenilus fontinalis* (11).

Associated with an increase in serum triglyceride and cholesterol during April is the period of gonadal enlargement and elevated serum 17β -estradiol and testosterone in *C. c. umbla*. Cholesterol is also the precursor of steroid hormones (12). Triglyceride and cholesterol decreased with the beginning of reproduction activity in May. It is estimated that deposited energy was used for reproduction activity. Low levels of triglyceride and cholesterol at the time of spawning have been confirmed by Dindo and MacGregor (1), Smith (9) and Cerda et al. (10). Serum triglyceride levels increased from May to July. It was postulated that *C. c. umbla* were actively feeding during this period. Similarly, some investigators reported that serum triglyceride levels increase during feeding activity (5,8).

References

1. Dindo, J.J., MacGregor, R.: Annual Cycle of Serum Gonadal Steroids and Serum Lipids in Striped Mullet. *Trans. Am. Fish. Soc.* 1981; 110: 403-409.
2. Matty, A.J.: *Fish Endocrinology*. Timber Press, Portland, Oregon, USA, 1985; p.267.
3. Galas, J., Bieniarz, K.: Seasonal Changes of Sex Steroids in Mature Female and Male Carp (*Cyprinus carpio* L.). *Pol. Arch. Hydrobiol.* 1989; 36 (3): 407-416.
4. Barry, T.P., Santos, A.J.G., Furukawa, K., Aida, K., Hanyu, I., Steroid profiles during spawning in male common carp. *Gen. Comp. Endocrinol.*, 1990; (80): 223-231.
5. Nikolsky, G.V.: *The ecology of fish*. Academic Press Inc., London, 1963; p. 352.
6. Ambrose, J.J.R.: *Age Determination In Fisheries Techniques*. American Fisheries Society, Bethesda, Maryland 1989, p.301-325.
7. Crim, W.L., Glebe, D.B.: *Reproduction in Methods for Fish Biology* (Schreck, C.B. and Moyle, P.B.: Eds.). American Fisheries Society, Bethesda, Maryland, USA, 1990: 529-555.
8. Nikolsky, G.V.: *Fish Population Dynamics*. Oliver & Boyd Ltd, Tweeddale Court, High Street, Edinburgh, 1969; p. 323.
9. Smith, L.S.: *Introduction to Fish Physiology*. T.F.H. Publications, The British Crown Colony of Hong Kong, 1982; p. 352.
10. Cerda, J., Zanuy, S., Carrillo, M., Ramos, J., Serrano, R.: Short and long term dietary effects on female sea bass (*Dicentrarchus labrax*): seasonal change in plasma profiles of lipids and sex steroids in relation to reproduction. *Comp. Biochem. Physiol.* 1995; 111: 83-91.
11. Farrell, A.P., Munt, B.: Cholesterol levels in the blood of Atlantic salmonids. *Comp. Biochem. Physiol.* 1983; 75A (2): 239-242.
12. Stryer, L.: *Biochemistry*. Second edition. W.H. Freeman and Company, San Francisco, USA, 1981; p.949.