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PROOF RESEARCH PAPER

Karyotypes of *Capoeta antalyensis* (Battalgil, 1944) and *Capoeta baliki* Turan, Kottelat, Ekmekçi & İmamoğlu, 2006 (Actinopterygii, Cyprinidae)

Muradiye Karasu Ayata[1], Sevgi Ünal[2,*], Muhammet Gaffaroğlu[1]

[1] Department of Biology, Faculty of Science and Arts, Ahi Evran University, Kırşehir, Türkiye.
[2] Department of Biology, Faculty of Science, Gazi University, Ankara, Türkiye.

* Corresponding Author: Tel.: +90.312 2021511;
E-mail: sevgiunal@ymail.com

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Abstract

Chromosome numbers and morphologies of *Capoeta antalyensis* (Battalgil, 1944) originating from Boğa Creek and *Capoeta baliki* Turan, Kottelat, Ekmekçi & İmamoğlu, 2006 originating from Kızılırmak River were investigated. Four females and two males specimens of *C. antalyensis* and three females and five males specimens of *C. baliki* were analyzed. Metaphase chromosomes were obtained from kidney cells. The diploid chromosome number of *C. antalyensis* was found 2n=150, of which 42 pairs were meta-submetacentric chromosome and 33 pairs were subtelo-acrocentric chromosome, and fundamental arm number (NF) was found 234. The diploid chromosome number of *C. baliki* was 2n=150, consisting of 44 meta-submetacentric chromosome pairs and 31 subtelo-acrocentric chromosome pairs, and the number of arms was 238. Neither species showed any sex chromosome differentiation.

Keywords: Capoeta antalyensis, Capoeta baliki, karyotype, Anatolia.

Introductıon

It is known that 19 species of the genus *Capoeta* Cuiver-Valenciennes 1842, belonging to Cyprinidae family live in the inland waters of Turkey. *Capoeta antalyensis* is an endemic species that prevails in the rivers in the vicinity of Antalya Province. *C. baliki*, previously was named as *Capoeta tinca*, is another endemic species that pervades in Sakarya and Kızılırmak Rivers (Geldiay and Balık, 2007; Kuru *et al*., 2014).

Polyploidy as one of the most striking aspects of fish genetics can also be analyzed with chromosome counts (Thorgaard and Disney, 1990). In a study about the karyology of five *Barbus* species in South Africa, Oellerman and Skelton (1990) found that chromosome counts ranged between 2n=148 and 2n=150 with a majority of the species in the Cyprinidae family having 2n=50 chromosomes, and argued that the latter species were of hexaploid origin. Rab and Collares-Pereira (1995), on the other hand, stated that *Barbus* species were cyprinids of tetraploid origin and were characterized by 2n=100 diploid count. According to these authors, polyploidy in cyprinid fish is an extremely complicated event resulting from various origins and the chromosome number in polyploid species increases in integral multiples of the most common chromosome value (2n=50). It was noted that *Barbus bynni* (Syn: *Barbus bynni occidentalis*) and *B. wurtzi* had a chromosome number of 2n=148 and *B. petitjeani* had a chromosome number of 2n=150 and that all three species were hexaploid (Guegan *et al*., 1995).

Chromosome number and morphology can vary intra and interspecifically. Analysis of this variation within and among species is currently a popular approach which is widely used by fish systematists. While intraspecific variations can be used for analysis of population structure and dynamics, interspecific variations are useful sources to apply for analyzing an array of evolutionary and genetic hypotheses. For this purposes the research of fish chromosomes has become an important area (Thorgaard and Disney, 1990). Although many cytogenetic studies have been carried out on Anatolian fishes (Gaffaroğlu *et al*., 2006; Gaffaroglu *et al*., 2012) no cytogenetic study about *C. antalyensis* and *C. baliki* has been found. The present study is the first to examine the karyotype characteristics of *C. antalyensis* and *C. baliki*.

Materials And Methods

Specimens of *C. antalyensis* (four females and two males) originating from Boga Creek, Antalya,

Türkiye (36°51′N, 30°37′E) and *C. baliki* (three females and five males) originating from Kızılırmak River, Kırşehir, Türkiye (38°57′N, 34°12′E) were analyzed (Figure 1). They were transported alive to the laboratory and kept in well-aerated aquaria until analysis. Mitotic chromosome slides were prepared according to Collares-Pereira (1992) from kidney cells. The specimens were injected intraperitoneally with 0.1% colchicine solution and head kidneys of specimens were removed and placed in KCl solution. The cell suspension was centrifuged and supernatant was discarded. The cell suspensions were dropped onto cleaned slides. The slides were stained with 10% Giemsa. At least 10 metaphases were counted per specimen. Chromosomes were classified using the nomenclatures proposed by Levan *et al.* (1964). Meta-submetacentric (M-SM) chromosomes were taken as biarmed while subtelo-acrocentric (ST-A) chromosomes were taken as uniarmed. Classification of chromosomes was made according to ratio of long and short arm. Metacentric (M) means a chromosomes with equal-sized arms, Submetacentric (SM) means a chromosomes with the ratio of long arm more than the ratio of short arm. ST-A means a chromosomes with the short arm at the end of centromere and/or centromere is non-terminal (uniarmed). The preparations were observed and photographed digitally at a Leica DMLB 3000 research microscope.

Results

Diploid chromosome numbers of *C. antalyensis* and *C. baliki* were determined to be 2n=150. Chromosome morphology of *C. antalyensis* consisted of 42 pairs of M-SM and 33 pairs of subtelo-acrocentric ST-A chromosomes with NF 234 (Figure 2) and *C. baliki* had 44 pairs of M-SM and 31 pairs of ST-A chromosomes with NF 238 (Figure 3). There was no sex chromosome differentiation in these two species.

Discussion

A review of literature has shown that there is no previous cytogenetic study about *C. antalyensis* and *C. baliki*. The present study is the first to determine the chromosome number and morphology of *C. antalyensis* and *C. baliki* and to characterize their karyotype.

Diploid chromosome numbers of *C. antalyensis* and *C. baliki* have been found identical. However, there are differences in their chromosome morphologies. Two pairs of chromosomes identified as ST-A in *C. antalyensis* were determined to be M-SM in *C. baliki*. Due to the differences in their chromosome morphologies, NF of *C. antalyensis* and *C. baliki* were also found different.

Results obtained from *C. antalyensis* and *C. baliki* are similar to those found in other Anatolian *Capoeta* species (Table 1). *Capoeta trutta* and *Capoeta umbla* (Syn: *Capoeta capoeta umbla*) originating from Tigris River system (Kılıç-Demirok and Ünlü, 2001), *Capoeta capoeta gracilis* originating from Sefidroud and Shahroud Rivers (Pourali *et al*. 2006), *Capoeta damascina* originating from Ceyhan and Seyhan River system (Ünal, 2015) carry the same number of chromosomes with *C. antalyensis* and *C. baliki*. Besides, *C. umbla* bears significant similarities to *C. antalyensis* and *C. baliki* in terms of chromosome morphology. The only difference between them is that a chromosome pair identified as ST-A in *C. antalyensis* is M-SM in *C. umbla* and a chromosome pair identified as M-SM in *C. baliki* is ST-A in *C. umbla*. Also *C. damascina* is similar to *C. baliki* in terms of the number of M-SM and ST-A chromosome pairs whereas is different from *C. antalyensis* in terms of the number of chromosome

Figure 1. Map shows the sampling sites.

pairs classification as M-SM and/or ST-A. However, there are occasional differences between the chromosome morphologies of *C. trutta* on one hand and *C. antalyensis* and *C. baliki* on the other. *C. antalyensis* and *C. baliki* have a higher number of M-SM chromosome pairs and a lower number of ST-A chromosome pairs than *C. trutta*. Furthermore, number of arms of *C. antalyensis* and *C. baliki* is higher than *C. trutta* and *C. umbla*. Moreover *C. baliki* has the same number of arms with *C. damascina* but number of arms of *C. antalyensis* is lower than *C. damascina*.

On the other hand, diploid chromosome number of *C. antalyensis* and *C. baliki* is the same with *Capoeta capoeta* (Safar *et al*., 2000) and *Capoeta sevangi* (Syn: *Varicorhinus capoeta*) (Krysanov, 1999) but it is different from *C. damascina* (Gorshkova *et al*., 2002). In terms of chromosome morphology *C. antalyensis* and *C. baliki* are very different from *C. sevangi* but they are very similar with the others. Moreover, number of arms of *C. antalyensis* is the same with *C. capoeta*. Otherwise

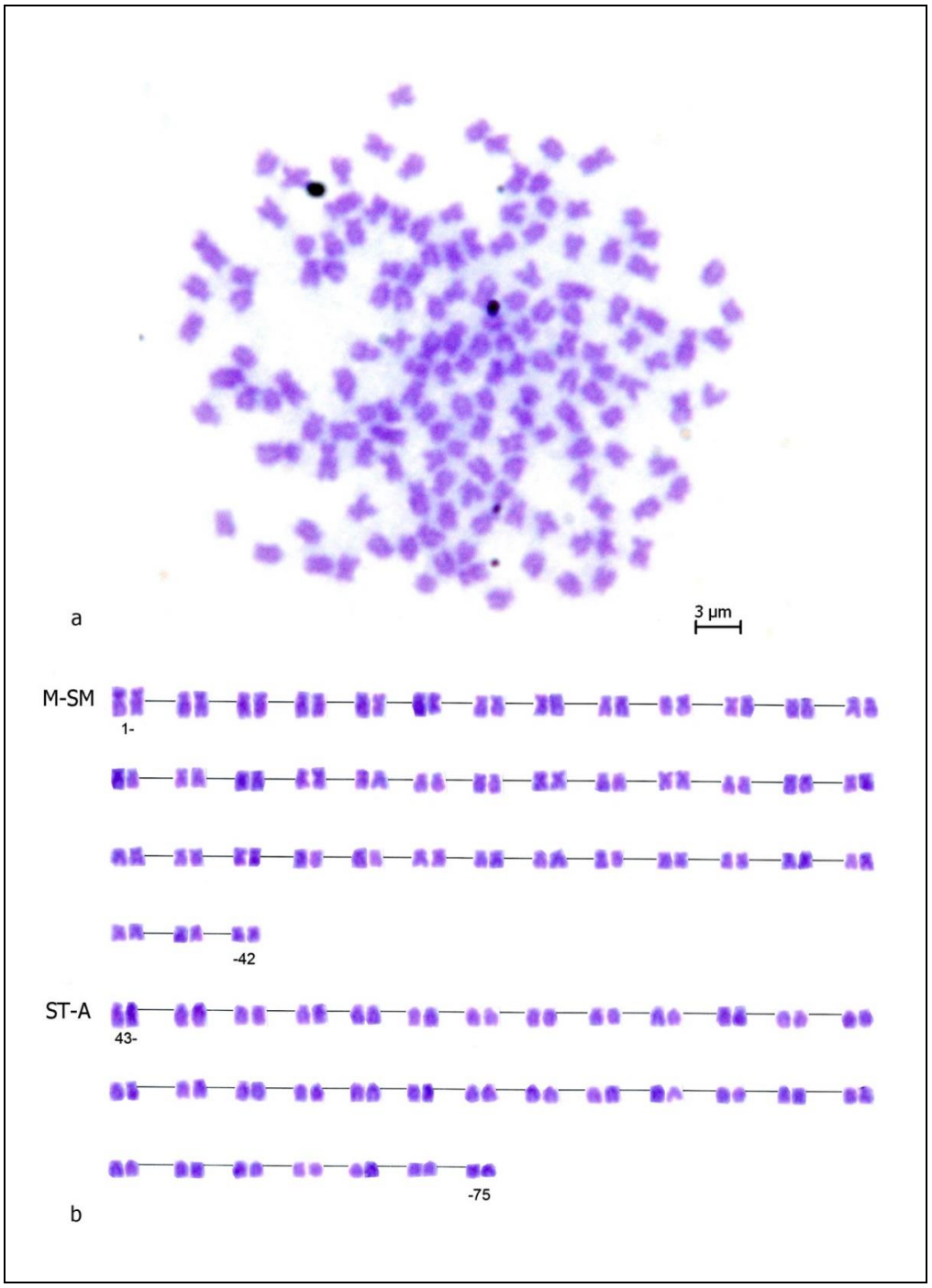

Figure 2. (a) Metaphase and (b) karyotype of *Capoeta antalyensis*. Bar represents 3 µm.

number of arms of *C. antalyensis* and *C. baliki* is higher than *C. sevangi* but it is lower than *C. damascina*.

Kılıç-Demirok and Ünlü (2001) reported that *C. trutta* and *C. umbla* could also be hexaploid species. Apart from cyprinids, *Misgurnus angillicaudatus* of the Cobitidae family was noted to be a hexaploid species having 6n=150 chromosomes (Abbas *et al*., 2009). Chromosome number of the hexaploid *Carassius gibelio* (Syn: *Carassius auratus gibelio*) was found 2n=160 (Mayr *et al*., 1986). These studies suggest that *C. antalyensis* and *C. baliki* may also be hexaploid species.

Just like *C. sevangi* (Krysanov, 1999), *C. trutta*, *C. umbla* (Kılıç-Demirok and Ünlü, 2001) and *C. damascina* (Ünal, 2015) and as well as many other species in the same family (Rab and Collares-Pereira, 1995), *C. antalyensis* and *C. baliki* were also found to lack sex chromosome differentiation.

Fishes show more extensive chromosomal diversity. Determination of numerical and structural chromosome differences are essential for genetic data

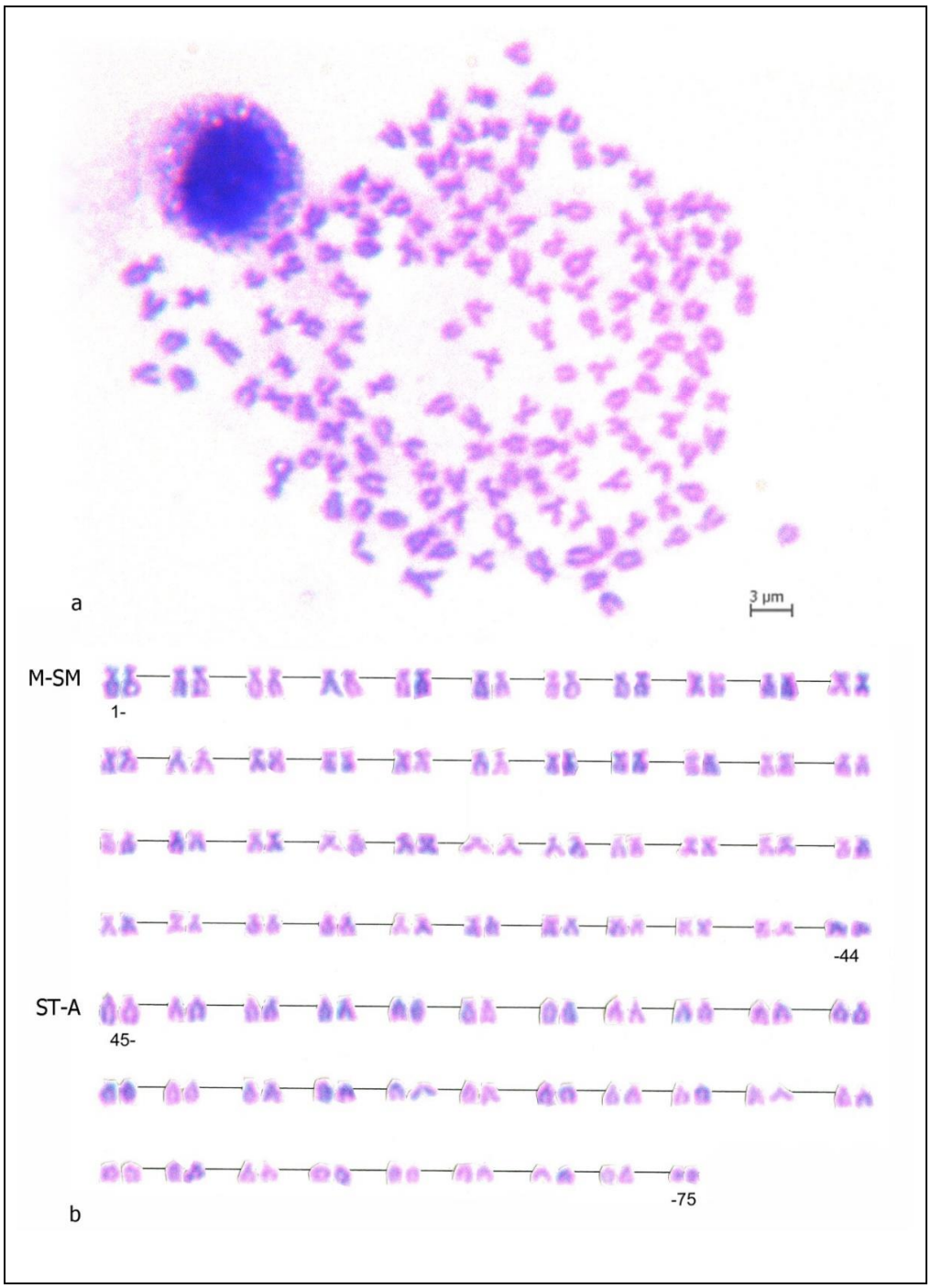

Figure 3. (a) Metaphase and (b) karyotype of *Capoeta baliki.* Bar represents 3 µm.

Table 1. Karyotype characteristics of *Capoeta* species that prevail in the inland waters of Turkey

Species	2n	Chromosome morphology	NF	References
C. trutta	150	70M-SM+80ST-A	220	Kılıç-Demirok and Ünlü, 2001
C. umbla	150	86M-SM+64ST-A	236	Kılıç-Demirok and Ünlü, 2001
C. damascina	150	46M+42SM+62ST-A	238	Ünal, 2015
C. antalyensis	150	84M-SM+66ST-A	234	In this study
C. baliki	150	88M-SM+62ST-A	238	In this study

of species. It is believed that the results we have obtained will contribute to the cytogenetics of *C. antalyensis* and *C. baliki*.

References

Abbas, K., Li, M. Y., Wang, W. M. and Zhou, X. Y. 2009. First record of the natural occurrence of hexaploid loach *Misgurnus anguillicaudatus* in Hubei Province, China. Journal of Fish Biology, 75: 435-441. doi:10.1111/j.1095-8649.2009.02320.x

Collares-Pereira, M. J. 1992. In vivo direct chromosome preparation (protocol for air drying technique). *First International Workshop on Fish Cytogenetic Techniques*, France, 15-20.

Gaffaroğlu, M., Karasu, M. and Unal, S. 2012. Karyotype of river loach *Turcinoemacheilus kosswigi* Bănărescu and Nalbant, 1964 (Cypriniformes, Balitoridae) from the Euphrates River, Turkey. Journal of Agricultural Science and Technology, 14: 821-826.

Gaffaroğlu, M, Yüksel, E. and Rab, P. 2006. Note on the karyotype and NOR phenotype of leuciscine fish *Acanthobrama marmid* (Osteichthyes, Cyprinidae). Biologia Bratislava, 61(2): 207-209. doi:10.2478/s11756-006-0031-y

Geldiay, R. and Balık, S. 2007. Freshwater fish of Turkey. Ege University Press, İzmir.

Gorshkova, G., Gorshkov, S. and Golani, D. 2002. Karyotypes of *Barbus canis* and *Capoeta damascina* (Pisces, Cyprinidae) from the Middle East. Italian Journal of Zoology, 69: 191-194. doi:10.1080/11250000209356459

Guegan, J. F., Rab, P., Machordomo, A. and Doadrios, I. 1995. New evidence of hexaploidy in 'large' African *Barbus* with some considerations on the origin of hexaploidy. Journal of Fish Biology, 47: 192-198. doi:10.1111/j.1095-8649.1995.tb01888.x

Kılıç-Demirok, N. and Ünlü, E. 2001. Karyotypes of cyprinid fish *Capoeta trutta* and *Capoeta capoeta umbla* (Cyprinidae) from the Tigris River. Turkish Journal of Zoology, 25: 389-393.

Krysanov, E. Yu. 1999. Karyotypes of *Varicorhinus capoeta* and *Barbus goktschaicus* (Cypriniformes) from lake Sevan, Armenia. Journal of Ichthyology, 39: 187-189. ISSN 0032-9452

Kuru, M., Yerli, S. V., Mangıt, F., Ünlü, E. and Alp, P. 2014. Fish biodiversity in inland waters of Turkey. Journal of Academic Documents for Fisheries and Aquaculture, 3: 93-120.

Levan, A., Fredga, K. and Sandberg, A. A. 1964. Nomenclature for centromeric position on chromosomes. Hereditas, 52: 201-220. doi: 10.1111/j.1601-5223.1964.tb01953.x

Mayr, B., Rab, P. and Kalat, M. 1986. NORs and counterstain-enhanced flourescence studies in Cyprinidae of different ploidy level. Genetica, 69: 111-118.

Oellerman, L. K. and Skelton, P. H. 1990. Hexaploidy in yellowfish species (*Barbus*, Pisces; Cyprinidae) from Southern Africa. Journal of Fish Biology, 37: 105-115. doi: 10.1111/j.1095-8649.1990.tb05932.x

Pourali, D. S., Bazyar, L. A. and Hasanzadeh, K. B. 2006. A karyological study of *Barbus capito*, *Barbus mursa* and two populations of *Capoeta capoeta* from Northern Iran. Iranian Journal of Natural Resources, 58(4): 831-842.

Rab, P. and Collares-Pereira, M. J. 1995. Chromosomes of European Cyprinid fishes (Cyprinidae, Cypriniformes): A review. Folia Zoologica, 44(3): 193-214.

Safar, P., Mahmood, K., Bahram, K. and Masoud, S. 2000. Karyological study of two populations of *Capoeta capoeta* from North Iran. Cytologia, 65: 231-234. http://doi.org/10.1508/cytologia.65.231

Thorgaard, G. H. and Disney, J. E. (1990). Chromosome preparation and analysis. In: Schreck, C. B, Moyle, P. B. ed. Methods for fish biology, American Fisheries Society, Maryland, USA, 29pp.

Ünal, S. 2015. Seyhan ve Ceyhan nehir sisitemlerinde yaşayan bazı cyprinid türlerinde karyolojik araştırmalar. PhD thesis, Ahi Evran University, Kırşehir.