8(4): 342-345 (2014)

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE

Research Article

TAM MAKALE

Karyotype Properties of Oxynoemacheilus angorae (Steindachner, 1897) (Teleostei, Nemacheilidae) from Anatolia

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Received: 16.07.2014 / Accepted: 02.11.2014 / Published online: 10.11.2014

Abstract: The aim of this study is to reveal karyotype properties of Oxynoemacheilus angorae (Steindachner, 1897). Metaphase chromosomes were obtained from kidney cells. The diploid chromosome number was 2n=50 and karyotype was consisted four pairs of metacentric, 14 pairs of sub-metacentric and seven pairs of subtelo-acrocentric chromosomes. Fundamental arm number (NF) was calculated as 86. Furthermore, constitutive heterochromatin regions were observed on the centromeres of several chromosomes by C-banding. This study will contribute to cytogenetic of Nemacheilidae family.

Keywords: Nemacheilidae; *Oxynoemacheilus angorae*; chromosome; constitutive heterochromatin

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Journal abbreviation: **J FisheriesSciences.com**

Introduction

It was reported that *Oxynoemacheilus* is a species-rich genus (a total of 41 species) of nemacheilid fishes known from Albania east-wards to Central Iran (Freyhof et al., 2011). The systematics of Anatolian nemacheilids is very complex. *O. angorae* that chromosomal proper-ties were investigated in this study has been re-ported as *Nemacheilus angorae* Steindachner, 1897 in Cobitidae family by Geldiay and Balık(1988). Also, it was reported that this species is distributed in the whole of Anatolia except for a small portion of Eastern and South-eastern Anatolia. Kuru (2004) was recorded as *Orthrias angorae angorae* (Steindachner, 1897) in the same family. Otherwise, Fricke et al. (2007) was reported as N. angorae Steindachner, 1897 in Balitoridae family and Freyhof et al. (2011) as *Oxynoemacheilus angorae* (Steindachner, 1897) in Nemacheilidae family.

Numerous cytogenetic studies have been carried out in fish species which maintained by ichthyologists and geneticists. These studies have been contributed fish taxonomy (Rab et al., 2007). Although chromosomal studies have been reported in some species of Nemacheilidae family (Değer, 2011) there is no report about Kızılırmak population of *O. angorae* from Turkey.

The aim of this study is to reveal diploid chromosome number, chromosome morphology and C-banding properties of *O. angorae* from Kizilirmak, Turkey.

Materials and Methods

Seven samples (six female, one male) of *O. angorae* were collected from Kesikköprü, Kırşehir, Turkey (38° 57' N, 34° 11' E). Meta-phase slides were prepared according to Collares-Pereira (1992)'s "Air Drying Technique". Also, Sumner (1972)'s C-banding technique was applied to slides. Preparations were scanned in Leica DM3000 microscope and pho-tographs were taken from good metaphases. Chromosomes were classified according to Levan et al. (1964).

Results and Discussion

As a result of this study diploid chromosome number of *O. angorae* was 2n=50 and karyotype was arranged four pairs of metacentric, 14 pairs of submetacentric and seven pairs of subtelo-acrocentric chromosomes (**Figure 1,2**). NF was found as 86. Constitutive heterochromatin regions were observed on the centromeres of several chromosomes. Furthermore, two heterochromatin blocks were determined at least on two chromosome pairs and large heterochroma-tin bloc was observed at least on two chromosome pairs (**Figure 3**).

It can be said that number of diploid chromosomes are preserved among *Oxynoemacheilus* species that are distributed in Anatolia but their chromosome morphologies vary (**Table 1**). While *O. angorae* has the same number of diploids with *O. argyrogramma*, *O. frenatus* and *Oxynoemacheilus sp.* (Değer, 2011) there are differences between their chromosome morphologies and NF. *O. angorae* is similar to mostly *O. frenatus* in terms of chromosome morphology. On the other hand, while the diploid chromosome numbers of *Turcinoemachei-lus kosswigi* (Değer, 2011; Gaffaroğlu et al., 2012) and *O. angorae* from the same family are similar, their chromosome morphologies are different.

O. angorae has also similar number of chromosomes with some species of *Nemacheilus genus* (Arai, 2011). Also *O. angorae* has similar diploid chromosome number with *Noemacheilus barbatulus* which belongs to same family (Boron, 1995). The metacentric chromo-some numbers of two species are similar. How-ever while the numbers of sub metacentric chromosome pairs are more than *N. barbatulus*, the numbers of subtelo-acrocentric chromosome pairs are less. Accordingly the NF of *O. angorae* is higher.

In *O. angorae* sex chromosomes were not coincided as reported in other *Oxynoemacheilus* species (Değer, 2011).

One of the bandings applied to the fish chromosomes is C-banding. Thanks to this banding, the constitutive heterochromatin regions can be determined in the chromosomes. These regions are mostly found in centromere and telomere of chromosomes. Moreover these regions can be observed through the chromosome arms (Gaffaroğlu and Yüksel, 2009).

In terms of C-bands being located in the centromere of many chromosomes, *O. an-gorae* shows similarity with *O. argy-rogramma*, *O. frenatus* and *Oxynoemacheilus* sp. (Değer, 2011). It was observed that C-bands which were reported in centromere of many chromosomes of *T. kosswigi* (Gaf-faroğlu et al., 2012) were more intensive in *O. angorae. O. angorae* is similar to *N. barbatulus* in terms of C-bands which were reported in centromere of many chromosomes (Boron, 1995). Besides the heterochromatic regions observed as blocks in some chromosomes of N. barbatulus

Figure 1: Giemsa stained metaphase of xynoemacheilusangorae.

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Table 1 Chromosomal studies on some species of Nemacheilidae family from Anatolia.

species	Diploid chromosome number (2n)	Chromosome morphology	NF	References
O. argyrogramma (Tigris River)	50	44m-sm+6a	94	Değer, 2011
O. argyrogramma (Euphrates River)	50	44m-sm+8a	92	Değer, 2011
O. frenatus	50	32m-sm+18a	82	Değer, 2011
Oxynoemacheilus sp.	50	32m-sm+20a	80	Değer, 2011
Orthrias angorae	50	14m+14sm+22a	78	Kaya et al., 2005
T. kosswigi (Tigris River)	50	8m+16sm-st+26a	74	Değer, 2011
T. kosswigi (Euphrates River)	50	8m+14sm-st+28a	72	Gaffaroğlu et al., 2012
O. angorae	50	8m+28sm+14st-a	86	In this study

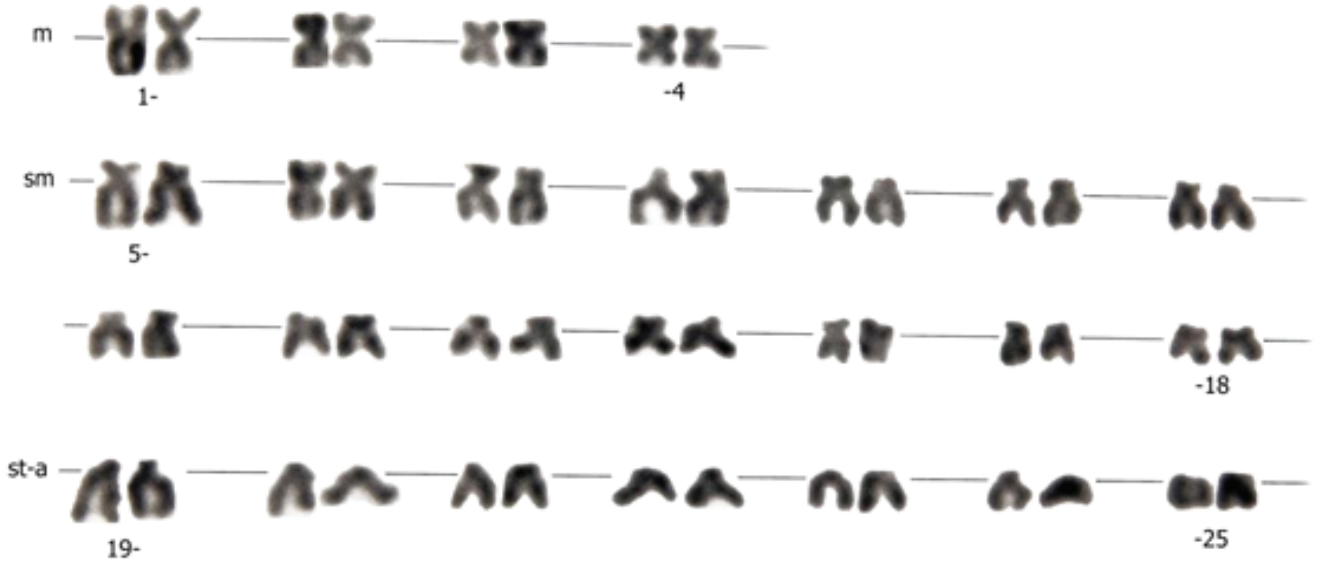

Figure 2: Karyotype of *Oxynoemacheilus angorae.*

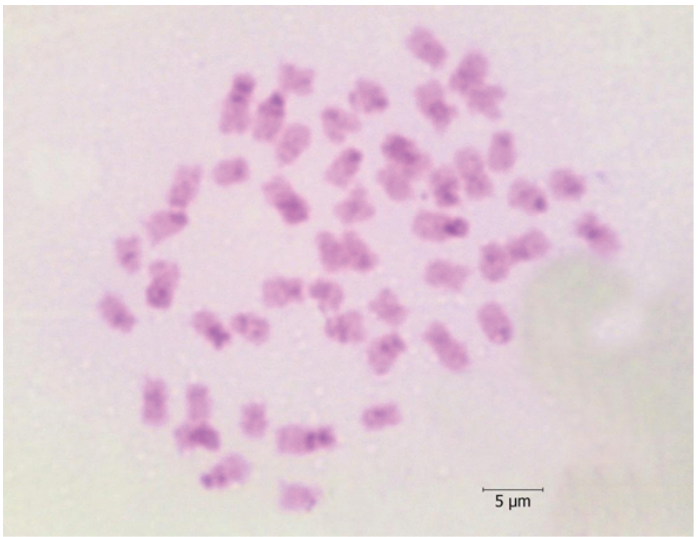

Figure 3: C-banded metaphase of *Oxynoemacheilus angorae.*

(Bo-ron, 1995) and T. kosswigi (Gaffaroğlu et al., 2012) were also observed in this study. The existence of heterochromatin blocks observed in some chromosomes suggested that some intra-chromosomal rearrangements such as pericentric inversion or centric fusion took place (Boron, 1995).

Conclusions

This study is considered to contribute to cytogenetic and cytotaxonomy of Nemacheilidae family.

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