First Record of *Oithona davisae* Ferrari and Orsi, 1984 (Copepoda, Cyclopoida) and Seasonal Variations in the Georgian Black Sea Coast

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ABSTRACT

The studies of invasive species of zooplankton in Georgian water areas are few and outdated. The purpose of this study was to find out the new invasive Copepod *Oithona davisae* in the Georgian water areas and its’ distribution patterns. Our study first recorded new invasive Cyclopoid Copepod *O. davisae* in the Georgian Black Sea coast. Samples were taken by 80 um mesh size plankton net via Ilia state university’s ship from pre-selected study areas along the coast in July and September (2015) and in February and April (2016). Copepod samples were preserved immediately in 4% formalin. The outcome of the study showed seasonal variation in *O. davisae* abundance. The high number of Copepod observed in the warm season decreased in the cold season. It is assumed that its distribution is dependent on the seawater temperature. *O. davisae* was successfully established and became a dominant (30%) copepod species in the Georgian water areas.

Key words: Plankton, Copepod, Black Sea, *Oithona davisae*, Georgia.

INTRODUCTION

Oithonids are the small copepods less than 1 mm distributed in the world ocean (Nishida, 1985). They are primary consumers in marine ecosystem and provide food source for the higher trophic level animals. This is the reason behind their vital role in ecosystem (Kovalev et al., 1998; Suthers and Rissik, 2008). *Oithona davisae* is morphologically similar to *O. brevicornis* (Giesbrecht, 1891) and *O. aruensis* (Fruchtl, 1923; Nishida, 1985). The first record of *O. brevicornis* in the Black Sea was in Sevastopol Bay in 2001 (Altukhov and Gubanova, 2006, 2007). This was wrongly described as a result of the similarity to its closely related species *O. davisae*. The specimens were reexamined a few years later and identified as *O. davisae* (Temnykh and Nishida, 2012). The following genetic and morphological studies of this copepod proved that new cyclopoid species found in the Black Sea was not the *O. brevicornis* but *O. davisae*. They were morphologically similar but genetically different species (Altukhov et al., 2014; Shiganova et al., 2015).

Georgian coast is located in the south-eastern part of the Black Sea between the river Fsou and river Sarfi. Total length of the coast is 310 km. About 150 rivers has influence on the geomorphology formation of the Georgian coast (Komakhidze and Mazmanidi, 1998). The studies of Copepod species in Georgian coast area is very few and outdated. According to the study in 1984 to 1996, three species of Oithonids were distributed in the Georgian Black sea coast: *Oithona nana* (Giesbrecht, 1893), *O. similis* (Claus, 1866) and *O. minuta* (Scott, 1894) (Komakhidze and Mazmanidi, 1998). *O. nana* disappeared from the Black Sea since 1990 and its ecological niche was replaced by *O. davisae* (Gubanova et al., 2014). The last research in the Georgian water area was phyto and zooplankton seasonal dynamics in the Georgian Black Sea coast (Gvarishvili et al., 2010). According to this study, copepod species showed seasonal variations but the new copepod *O. davisae* was not identified.

The aim of this study is to find if *O. davisae* new invasive copepod was established in the Georgian water area to promote the species distribution and Cyclopoid Copepod...
species diversity in the Black Sea. Does this new invasive copepod successfully establish in the Georgian Black Sea coast?

MATERIALS AND METHODS

Zooplankton samples were taken in the months of July and September (2015) and February and April (2016) along the Georgian Black Sea coast (Figure 1). Thirteen (13) sampling stations were selected and account of all samples during the study was 42 samples. Copepod samples were collected by horizontal hauls using 80 um student plankton net from the ship of Ilia state university “Saint Ilia”. Ship maximal speed was 9 knots, length (31 m) and width (7 m). All samples were immediately preserved in 4% formalin. The volume of filtered seawater through the net was calculated using the formula:

\[ V = \pi \times R^2 \times L \]

Where \( V \) is volume of water filtered, \( R \) is the nets’ open mouth radius and \( L \) is length of hauls.

Due to sample collection from the ship the length of horizontal hauls was calculated using the formula:

\[ L = V_{sp} \times T \]

Where \( V_{sp} \) is the ship speed in meter per second and \( T \) is towing speed in seconds (Goswami, 2004; Britton and Greeson, 1977).

All equations were modified according to the research. We examined 80 adult specimens of \( O. \) davisae using an OMAX microscope (magnification: 10X to 1000X) for morphological analysis using different identification guides (Al-Yamani et al., 2011; Conway et al., 2003; Shuvalov, 1980). The total length of the specimens was measured using ocular micrometer from the head to the end of the caudal rami. Individuals per cubic meter were counted using the formula:

\[ \frac{(n \times V_s)}{V_m} \]

Where \( n \) is the individuals average amount in 1 ml of the sample, \( V_s \) is the volume of sample bottle while \( V_m \) is the volume of water filtered (Dudiak, 1981).

RESULTS

We found all stage groups of \( O. \) davisae in the Georgian coast. The mean length of males ranged from 0.45 to 0.49 mm while that of the females was from 0.46 to 0.52 mm. The specimens were identified by morphological features according to the study of Temnykh and Nishida (2012).
Figure 2: (a) *Oithona davisae* Male, (b) *O. davisae* Female, (c) Sharply pointed rostrum, (d) P3 swimming leg, (e) The hairs on genital segment is absent.

**Seasonal variations of *Oithona davisae* in the Georgian Black Sea coast in 2015/2016**

(Figure 2). The Cyclopoid Copepod species *O. davisae* showed seasonal variability in the Georgian Black Sea coast. High abundance of *O. davisae* was observed mostly to the North during summer and autumn. Figure 3 shows the number of individuals in 1 m³ seawater during the entire season. The average summer seawater temperature in Georgian coast was 24.4 ± 3.3°C; autumn (24.8 ± 2.4°C); winter (12.7 ± 1.8°C) and in spring (13.7 ± 2.4°C). New invasive copepod *O. davisae* was the dominant species in about 30% of copepod species, but in comparison with
**Penilia avirostris** was found to be the most abundant species in Meso zooplankton community in the whole season during this study (Figure 4).

**DISCUSSION**

During this study we first recorded the *O. davisea* in the Georgian Black Sea coast. It is evident from Figure 2 that the morphological features of *O. davisea* are clear based on identification guides (Conway et al., 2003; Al-Yamani et al., 2011; Temnykh and Nishida, 2012; Shiganova et al., 2015). *O. davisea* replaced the ecological niche of widespread copepod *O. nana* which disappeared from the Black sea during 1990’s (Gubanova et al., 2014). We can find this species in the seawater samples during the whole season in the Georgian Black Sea coast, but the abundance of *O. davisea* changed during the season. High number of *O. davisea* occurred in the warm season. The abundance is higher in warm and wet season than in the cold and wet season. The temperature gradient during the season shows that seawater temperature was high in summer-autumn and decreased rapidly in winter-spring. We assumed that the composition of *O. davisea* in the Georgian water areas depends on water temperature and other water chemical and physical characteristics, but these data are not statistically significant.

The same distribution pattern occurred in Japan where *O. davisea* is native. The high abundance observed in the warm season decreases in the cold season (Uye and Sano, 1995). In the Black Sea in Sevastopol bay the abundance of this cyclopoid copepod is low in spring and increases from summer to autumn as temperature rises (Altukhov et al., 2014). *O. davisea*'s optimal condition is warm seawater not so hot or cold. This is the reason why the high density is usually experienced in warm seasons. From the analysis, we cannot definitely conclude that the temperature is the only parameter dependent on their distribution. Besides we are of the opinion that it is related to the specific habitat due to several rivers inflow in the Georgian Black Sea coast.

The Georgian Black Sea Meso zooplankton community is represented by 6 species. The species are: *Oithona similis*, *O. davisea*, *Acartia clause*, *A. tonsa*, *Calanus euxinus*, *Penilia avirostris* and *Sagitta setosa* (Shvelidze, 2016). The most abundant species during the period was *P. avirosotris* (29%) and *O. davisea* (30%). Both species are considered as mesophile organisms. Mating by parthenogenesis for *P. avirosotris* occurs when the temperature is sufficient and when the temperature becomes insufficient, male specimens of *P. avirosotris* are hatched (Della, 1974).

In conclusion, new invasive copepod *O. davisea* was successfully established in the Georgian water areas as in the other part of the Black Sea region. This species totally replaced the ecological niche of previously distributed cyclopoid copepod species *O. nana*. *O. davisea* occurs with high abundance in warm season and decreased in the cold season. In addition, *O. davisea* is the dominant copepod species by 30% in meso zooplankton community.

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