First record of the dinoflagellate *Tripos rotundatus* (Jørgensen) Gómez in the Adriatic Sea

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First record of the dinoflagellate *Tripos rotundatus* (Jørgensen) Gómez in the Adriatic Sea

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Running title: *TRIPOS ROTUNDATUS* IN THE ADRIATIC SEA

**Abstract** – This report presents the first record of *Tripos rotundatus* (Jørgensen) Gómez in the Adriatic Sea. The species was found in the net sample in the layer of 50 – 100 m depth, on July 2021 at the coastal southern Adriatic Sea. The species *T. rotundatus* was probably previously mistaken as morphologically similar species *T. digitatus* (Schütt) Gómez.

**Keywords**: biodiversity, NE Mediterranean, phytoplankton, southern Adriatic, taxonomy

**Introduction**

Dinoflagellates are an important group of protists with a remarkable diversity of life forms (i.e. free-living, parasites, and mutualistic symbionts), habitats (plankton and benthos), and nutrition modes (heterotrophic, chloroplast-containing) (Gómez 2012).

In the Mediterranean Sea, 673 taxa have been identified, while 322 taxa have been reported for the Adriatic (Gómez 2003). In general, dinoflagellates are organisms dominated in oligotrophic waters (Gómez 2003).

Among dinoflagellates, the genus *Tripos* Bory includes the greatest number of taxa (~800) (Gómez 2021) and is globally widespread in marine waters. Previously, species of the genus *Tripos* were known as the marine section of the genus *Ceratium* Schrank, until morphological and molecular data supported the separation of marine and freshwater species of *Ceratium* at the genus level and restricted *Ceratium* to freshwater species (Gómez et al. 2010). Marine species are consistently large and robust, often with horns (Gómez 2021).

The aim of this study was to report the first record of *Tripos rotundatus* (Jørgensen) Gómez for the Adriatic Sea.

**Materials and methods**

Sampling was conducted on July 17, 2021 at the Lokrum coastal station, near Dubrovnik (southern Adriatic Sea, 42°37'21" N, 18°06'05"E) (Fig. 1). Vertical profiles of temperature and salinity were measured from the surface to the bottom (90 m depth) at each meter using a multiparametric conductivity-temperature-depth (CTD) probe, and density (*sigma-t*) was calculated from these data. Water samples were collected using 5-L Niskin bottles for dissolved oxygen, nutrients, chlorophyll *a* (*Chl-a*), and phytoplankton at the surface and at 5, 10, 20, 50, 75, and 100 m depth. Net samples were collected using a Nansen net with 53 μm mesh and 200 μm mesh in two layers: 50 – 0 m and 100 – 50 m. Dissolved oxygen was determined by Winkler titration, and oxygen saturation (*O₂/O₂'*') was calculated from the solubility of oxygen in seawater as a function of corresponding temperature and salinity (Weiss 1970, UNESCO 1987). Nutrient samples were analysed in the laboratory using a spectrophotometer according to Strickland and Parsons (1972). To estimate *Chl-a*, 1 L subsamples were filtered through Whatman GF/F glass microfiber filters and were analysed fluorimetrically (Holm-Hansen et al. 1965). The trophic index (TRIX) was calculated to classify the trophic status of coastal marine
area (Vollenweider et al. 1998). Phytoplankton samples were preserved in neutralized formaldehyde (2.5% final concentration) and observed with an Olympus IX-71 inverted microscope according to the Utermöhl method (Utermöhl 1958). For a detailed description of the method used to analyse nutrients, Chl-α, and phytoplankton (for details see Jasprica et al. 2022). The nomenclature of taxa follows Guiry and Guiry (2023).

Results

Vertical thermal stratification of the water column was found during sampling date. The water column in the upper layer (50 – 0 m) was stratified, with a temperature range (15.93 – 26.25 °C), salinity (36.56 – 38.93) and density (24.36 – 28.78) (Tab. 1). O₂/O₂' ranged from 0.83 to 1.06 and was lower (0.83 - 0.86) in the bottom layer.

TIN was calculated as the sum of nitrate (NO₃), nitrite (NO₂), and ammonium (NH₄). NH₄ accounted for the highest proportion of TIN in the entire water column, 59.5%, and NO₃ for the lowest, 16.3%. PO₄ ranged from 0.01 to 0.066 µM, with the highest value measured at 10 m depth. SiO₄ ranged from 1.23 to 4.84 µM, with higher values in the upper 50 m.

The highest Chl-α concentration (0.32 mg m⁻³) and phytoplankton abundance (2.1 × 10⁵ cells L⁻¹) were found at 75 m depth. TRIX ranged from 1.1 to 2.8 classifying the station as oligotrophic.

Altogether, 48 phytoplankton taxa were identified in seven samples. Thirty-five, 35 taxa were dinoflagellates, 10 diatoms and three coccolithophorids. Among larger phytoplankton cells (> 20 µm cell long) Thalassionema nitzschioides (Grunow) Mereschkowsky, Oxytoxum sphaeroideum Stein, Oxytoxum variabile J. Schiller, Oxytoxum caudatum Schiller were the most abundant (> 945 cell L⁻¹). Nanophytoflagellates (2-20 µm cell long) dominated (96.3%) in total phytoplankton abundance.

Tripos rotundatus was found in the net sample in the layer 100 - 50 m depth (Fig. 2).

Discussion

Water column stratification is a common occurrence during the summer season, as is the occurrence of a thermocline and water column stability (Ninčević Gladan et al. 2015). The low nutrient and Chl-α concentrations, and in general low trophic status, indicated a common summer situation in the oligotrophic coastal area. Moreover, the oligotrophy of the Lokrum station is confirmed by the abundance of phytoplankton dominated by nanophytoplankton, typical of the spring and summer period in the coastal southern Adriatic Sea (Caroppo et al. 1999), and by the highest abundance of dinoflagellates, typical organisms of oligotrophic waters (Gómez 2003).

As T. rotundatus was pooled as T. digitatus (Schütt) Gómez, and most of the records are not illustrated, we have little information on the distribution of the species. Tripos rotundatus was previously reported as T. tasmaniae (E.J.F.Wood) F.Gómez in Pacific Australian waters (Wood 1963).

Tripos rotundatus also had a different taxonomic status in the literature (Guiry and Guiry 2023). Originally, T. rotundatus has been named as Ceratium digitatum Schütt var. rotundatum Jørgensen 1920. The species was found west of the island of Rhodes in the Aegean Sea in August 1910. Our data coincided with Jørgensen’s findings, regarding the season of sampling (in summer) and position of the station (coastal).

Tripos digitatus, a morphologically similar species, was found in the Mediterranean Sea (Gómez 2003) and in the northern Adriatic Sea (Revelante 1985). The morphological characteristic between these two taxa has been recently highlighted (Gómez 2021). There are differences in the epithea and hypotheca. The epithea of T. digitatus is strongly reflected towards the dorsal side, the left antapical horn is anteriorly directed and the apex has a short
projection. In *T. rotundatus*, the epitheca is less bent towards the dorsal side, the short projection on the apex is missing, and the left antapical horn is directed laterally (Gómez 2021). The morphological description of the species *T. rotundatus* follows the morphology of the taxa recorded at the Lokrum station. In our case, the cell of *T. rotundatus* was 110 μm long and 30 μm wide.

This finding contributes to a better understanding of the diversity of dinoflagellates in the Adriatic Sea. However, further continuous studies of phytoplankton diversity in the coastal regions of all parts of the Adriatic Sea are required.

**Acknowledgments**

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**References**


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Tab. 1. Physico-chemical parameters, chlorophyll $a$ and total phytoplankton abundance in two layers (0-50, 50-100 m) of the water column on the Lokrum station in the southern Adriatic Sea, 17th July 2021 (n = 7).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Layer (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 – 50</td>
</tr>
<tr>
<td>Temperature ($^\circ$C)</td>
<td>15.93 – 26.25</td>
</tr>
<tr>
<td>Salinity</td>
<td>36.56 – 38.93</td>
</tr>
<tr>
<td>Density (kg m$^{-3}$)</td>
<td>24.36 – 28.78</td>
</tr>
<tr>
<td>Oxygen saturation (O$_2$/O$_2^*$)</td>
<td>0.95 – 1.06</td>
</tr>
<tr>
<td>Phosphate ($\mu$M)</td>
<td>0.01 – 0.06</td>
</tr>
<tr>
<td>Total inorganic nitrogen ($\mu$M)</td>
<td>0.23 – 0.33</td>
</tr>
<tr>
<td>Nitrate ($\mu$M)</td>
<td>0.01 – 0.08</td>
</tr>
<tr>
<td>Nitrite ($\mu$M)</td>
<td>0.008 – 0.03</td>
</tr>
<tr>
<td>Ammonium ($\mu$M)</td>
<td>0.21 – 0.23</td>
</tr>
<tr>
<td>Silicate ($\mu$M)</td>
<td>1.49 – 4.84</td>
</tr>
<tr>
<td>Chlorophyll $a$ (mg m$^{-3}$)</td>
<td>0.06 – 0.16</td>
</tr>
<tr>
<td>Total phytoplankton abundance (cells L$^{-1}$)</td>
<td>9.1×10$^4$ – 1.4×10$^5$</td>
</tr>
</tbody>
</table>

Fig. 1. Position of the coastal Lokrum station in the southern Adriatic Sea, where dinoflagellate species *Triptos rotundatus* (Jørgensen) Gómez was found, 17th July 2021 (derived and adapted from Google earth).
Fig. 2. Dinoflagellate species *Tripos digitatus* (Schütt) Gómez (A, B) (Gómez et al. 2021, with permission), *Tripos rotundatus* (Jørgensen) Gómez (C, D) found for the first time in the Adriatic Sea at the Lokrum station on 17th July 2021. Black arrows indicate on morphological differences between species *T. rotundatus* and *T. digitatus*. Scale bars = 50µm.