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Research Article

**INTRODUCTORY STUDIES ON THE MORPHOLOGY OF THE  
GENUS *CLADOPHORA* FROM THE GULF OF GDAŃSK**

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**Abstract**

*Cladophora* is one of the most abundant genera of benthic green algae in the Gulf of Gdańsk, where seven species have been noted: *Cl. aegagrophila* (L.) Rabenhorst; *Cl. albida* (Hudson) Kützinger; *Cl. fracta* (Müller ex Vahl) Kützinger; *Cl. glomerata* (L.) Kützinger; *Cl. rupestris* (L.) Kützinger; *Cl. sericea* (Hudson) Kützinger; *Cl. vagabunda* (L.) van Hoek. The taxonomical descriptions by different authors are lacking in continuity. Therefore, the morphological features which would enable comparisons were studied. Two keys were prepared based on the results of the study; the first employs macroscopic characteristics, while the second is based on microscopic features. In the macroscopic key the shape of the thallus and the stage of attachment to the substratum were used. The shape of ordinary cells, their width, and the thickness of cell walls, followed by the shape of apical cells and the type of cell division (apically or intercellularly) were the basis for microscopic analyses.

## INTRODUCTION

Species of *Cladophora* occur all over the world in the littoral zones of both freshwater and marine environments. They are often permanently attached to some type of substratum, especially when they grow in moving waters such as rivers and the littoral zones of lakes and seas. In quiet waters, however, they can occur in unattached, free-floating mats (Fritsch 1965). The majority of these species occur in the seas. Of the thirty-eight species noted in Europe, twenty-seven inhabit the seas, while eleven occur in freshwater environments (Starmach 1972). The following citation from Prescott (1951) is still very much relevant today:

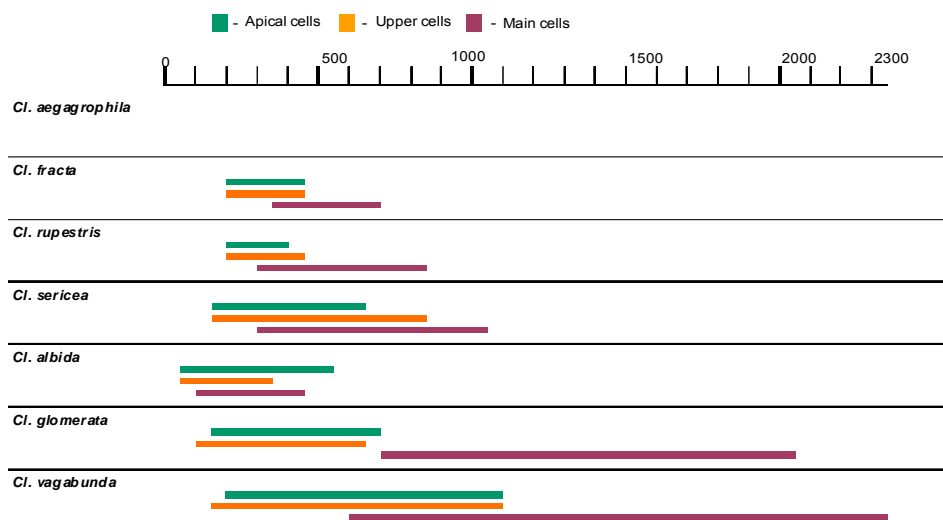
*“There is a great deal of variation within a species with respect to cell shape and manner of branching, apparently related to environmental conditions. The interpretations of these variations by taxonomists, and the limitations which have been set up to define species in the genus are conflicting. A great deal of confusion has arisen in the literature because these variables and intergrading forms have been separately described. An examination of supposedly authentically named herbarium material is of little help to the student, because the specimens frequently are not in agreement with the original descriptions. There is a great need, therefore, for a monographic review of the genus and clarification of the synonymy which exists among the names attached to herbarium specimens and in the literature.”*

Knowledge pertaining to the genus *Cladophora* in the Gulf of Gdansk is also insufficient. Herbarium material for the description made by Lakowitz (1907, 1929) is no longer available. At the same time, no comparative material for contemporary data is available either. Based on the available literature, Pliński (1988) reported that seven species of *Cladophora* inhabit the Gulf of Gdańsk. These data were the first step in cataloguing the descriptions of the *Cladophora* species from the Gulf of Gdańsk. The aim of the current paper is to conduct comparative morphological studies of the *Cladophora* species occurring in the Gulf of Gdańsk.

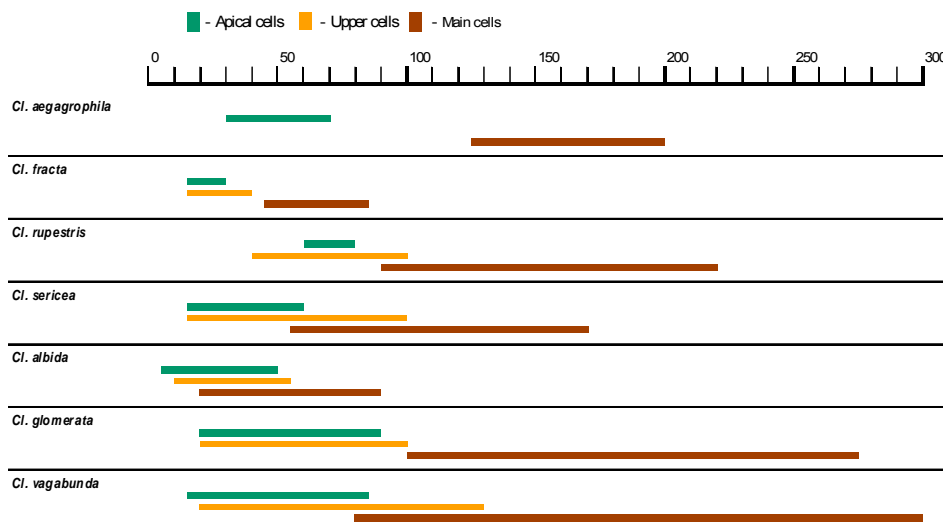
## MATERIAL AND METHODS

The material was collected during the summer (usually in June and August) from 1999 to 2004 from the shore at maximum depths of 0.5 m along the coast of the Gulf of Gdańsk. Thalli were collected from piles and stones, sampled directly in the water, and from beaches where they had washed ashore. The material collected was placed in 0.5 l plastic bottles and immediately preserved in a 4% formalin solution. Morphological and taxonomical analyses were

conducted in the laboratory using a binocular light microscope. The widths and lengths of thalli and cells were measured, and photographic documentation was made.



**Fig. 1.** Cell length range in individual species from three thallus segments (apical, upper, main) based on diagnostic descriptions (Pliński 1988).

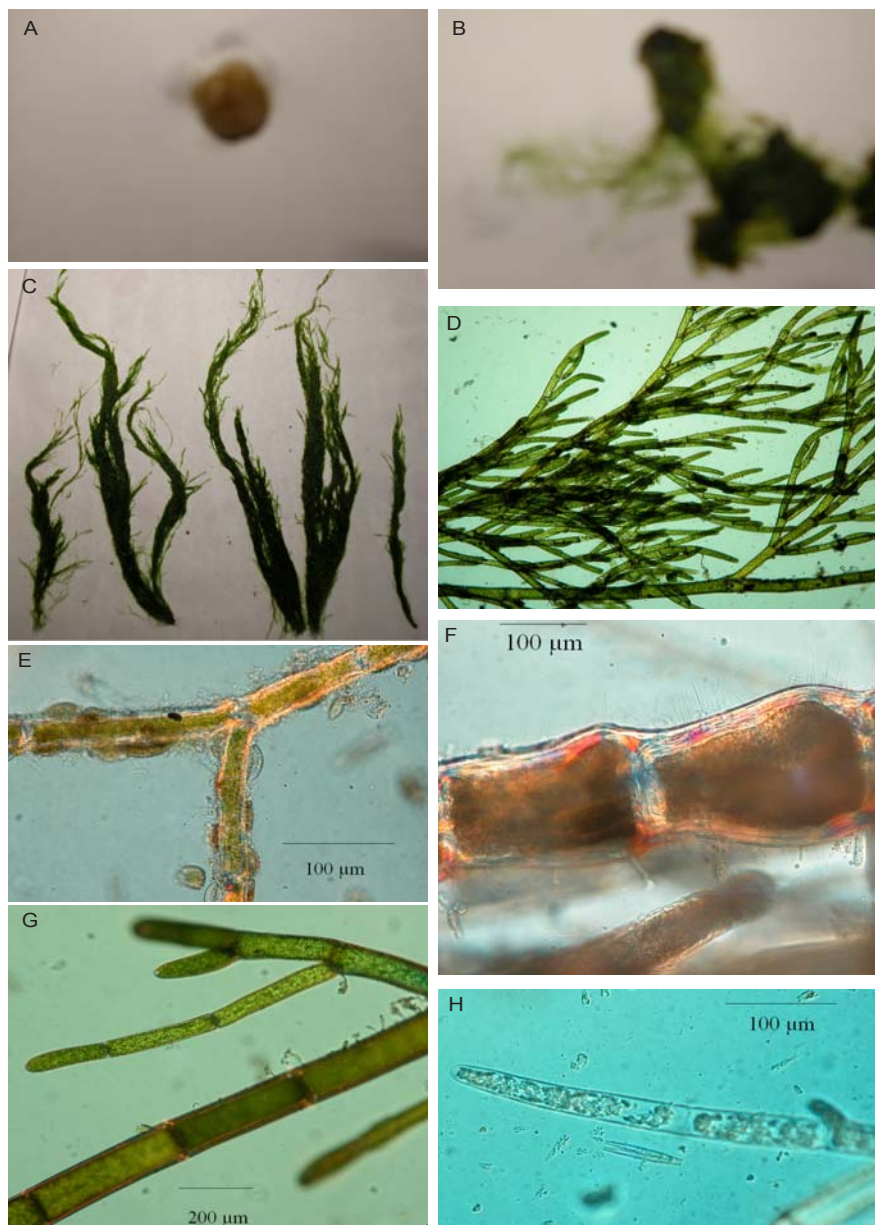


**Fig. 2.** Cell width range of individual species from three thallus segments (apical, upper, main) based on diagnostic descriptions (Pliński 1988).

## RESULTS AND DISCUSSION

The following species were noted in the collected material: *Cl. aegagrophila* (L.) Rabenhorst; *Cl. albida* (Hudson) Kützing; *Cl. fracta* (Müller ex Vahl) Kützing; *Cl. glomerata* (L.) Kützing; *Cl. rupestris* (L.) Kützing; *Cl. sericea* (Hudson) Kützing; *Cl. vagabunda* (L.) van Hoek. One of the significant taxonomic characters is cell size. This is the basis of all species descriptions, and thallus measurements are usually presented in three aspects – the main thallus axis, the upper portion of the thallus, and the apical cell. The length of the apical cells and those from the upper portion of the thallus did not differ significantly (Fig. 1). However, the cells of the main stem could be divided into two groups: the first had long cells, and *Cl. glomerata* and *Cl. vagabunda* were included in it. There is a lack of data in the literature regarding cell length in *Cl. aegagrophila*. Based on the current studies, this species should also be assigned to this group. The second group includes the remaining species in which the lengths of cells in the thallus are not significantly different. As regards cell width, differentiation among the species was more defined (Fig. 2). This also refers fundamentally to the cells of the main stem. The group with wide cells included *Cl. aegagrophila*, *Cl. rupestris*, *Cl. glomerata*, and *Cl. vagabunda*. Narrow cell widths were characteristic of *Cl. fracta* and *Cl. albida*, while medium widths were characteristic of *Cl. sericea*.

Many other morphological characters are used a variety of identification keys (Dillard 1989, Hoek 1963, Prescott 1951, Söderström 1963, Starmach 1972). The overall appearance (shape) of the plant presents as round-compact (Fig. 3A)), wadded-spongy (Fig. 3B), and bushy with clingy (Fig. 3C) or outstretched branches (Fig. 3D). The cell shapes include cylindrical (Fig. 3E) or club-shaped (Fig. 3F). The end of the apical cells are cylindrical with blunt (Fig. 3G) or sharp ends, like thorns (Fig. 3H). The precise morphological analyses of the taxonomic characters of the collected material on both macro- and microscopic scales, based upon which species of the genus *Cladophora* were identified, allowed formulating two systems. One permits determining species based on macroscopic characters (Key I), while the second is based microscopic characters (Key II). The application of just one of these system is insufficient. The proposed approach appears in many cases to be very useful, especially in work with green algae, in which the thallus characters are already very different.



**Fig. 3.** **A** – Round-compact thallus in *Cl. aegagrophila*; **B** – Wadded-spongy thallus in *Cl. albida*; **C** – Bushy thallus with clingy branches in *Cl. rupestris*; **D** – Outstretched branches in *Cl. glometara*; **E** – Cylindrical cells in *Cl. fracta*; **F** – Club-shaped cells in *Cl. aegagrophila*; **G** – Apical cylindrical cells with blunt ends in *Cl. rupestris*; **H** – Apical cylindrical cells with sharp ends, like thorns in *Cl. sericea*.

**Two different keys for the identification of *Cladophora* species occurring in the Gulf of Gdańsk:**

**Key I.** Identification key based mainly on macroscopic characters

1. Thalli compact, forming woolly balls.....*Cl. aegagrophila*
- 1a. Thalli shaped differently.....2
2. Thalli free floating.....3
- 2a. Thalli settled, attached to the substrate.....4
3. Thalli woolly.....*Cl. vagabunda*
- 3a. Thalli loose.....*Cl. fracta*
4. Thalli clustered.....*Cl. rupestris*
- 4a. Thalli turf-like.....5
5. Thalli tufted.....*Cl. albida*
- 5a. Thalli in rows.....6
6. Cells thin walled; intercalary growth.....*Cl. sericea*
- 6a. Cells thick walled; apical growth.....*Cl. glomerata*

**Key II.** Identification key based mainly on microscopic characters

1. Cells club-shaped cells.....*Cl. aegagrophila*
- 1a. Cells rectangular.....2
2. Cells thin walled.....3
- 2a. Cells thick walled.....5
3. Mean cell width in the upper branches of thalli under 25  $\mu\text{m}$ ....*Cl. fracta*
- 3a. Mean cell width in the upper branches of thalli above 25  $\mu\text{m}$ .....4
4. Cells apical pointed.....*Cl. sericea*
- 4a. Cells apical cylindrical or rounded.....*Cl. albida*
5. Intercalary growth.....*Cl. rupestris*
- 5a. Apical growth.....6
6. Thallus turf-like.....*Cl. glomerata*
- 6a. Thallus woolly.....*Cl. vagabunda*

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