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# CRYSTALS BANDS ON THE SURFACE OF FRESHWATER *ULVA* TAXA

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## Abstract

The incrustation process is an important occurrence whose effects were noticeable in the changes in growth of species from genera *Ulva*. It consisted in the precipitation of calcium carbonate on the surface of the cells wall of the freshwater macrogreen alga. The calcium carbonate occurred abundantly and formed characteristic bands on the surface of *Ulva* thalli. Surface incrustation of calcite was clearly rugged. In the first phase of development *Ulva* thalli growth naturally, could reach up to 1 m and was thin and smooth to the touch. It was correlation with small numbers of crystals on the surface. But with time, thalli becomes shorter and rough. The mass of deposit crystals increased with the age of *Ulva* thalli, which may constitute up to half of the dry weight of algae. The great density range of crystals was natural for mature thalli. The main aim of this study was to determine the morphology of the calcium carbonate crystals from the surface of freshwater *Ulva* taxa.

Microscopic observations demonstrated differences in the size and the shape of calcite crystals. For young individuals single or poorly formed nanocrystals were observed. Under favorable conditions nanocrystals grow and change in the microcrystals, which could occur in groups, created polycrystals. Due to the significant differences in the structure, tested crystals were divided into two types. A single or twin-like tetragonal bipyramids were belonged to the first type of crystals. The crystal system was orthorhombic. The second were long, thin needle-like crystals that formed rosettes and the characteristic tetragonal system. Due to possibility of polymorphism of  $\text{CaCO}_3$ , the first type was considered a variety of calcite, while the typical needles as aragonite. In addition, the crystals show a large divergence in size, for example first type could reach average size of  $44,3 \times 9,23 \mu\text{m}$ , where the ratio of length to width was 5:1. The second type of crystals was achieved sizes  $177,0 \times 12,55 \mu\text{m}$  and the ratio was 14:1.

These microscopic studies suggest that calcium carbonate could exists in two polymorphic stage on the surface of the freshwater species of *Ulva*. Calcification in the freshwater macroalga was represented by both intracellular and extracellular processes.

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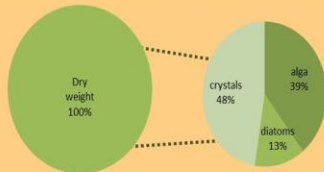
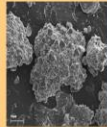
## Incrustation process

PRECIPITATION OF CALCIUM CARBONATE ON THE SURFACE OF THE CELL WALL OF THE FRESHWATER MACROGREEN ALGA

PROCESS CAUSE A CHANGES IN GROWTH OF SPECIES FROM *ULVA* GENERA

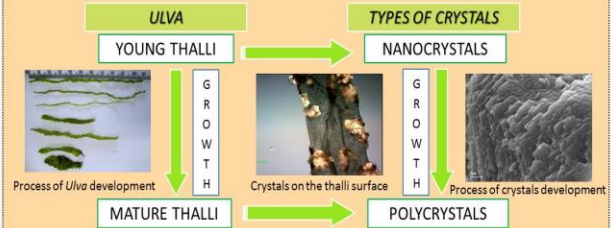
SURFACE INCRUSTATION OF CALCITE WAS CLEARLY RUGGED

CaCO<sub>3</sub> OCCURED ABUNDANTLY AND FORMED CHARACTERISTIC BANDS ON THE SURFACE OF *ULVA* THALLI



Crystals mass on the thalli surface might constitute about **50%** of dry weight

## *Ulva* characteristic



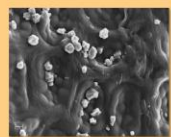
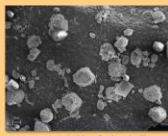
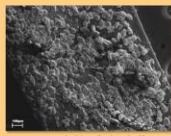
### Basic differences of development phase of *Ulva* thalli

FEATURES	YOUNG THALLI	MATURE THALLI
length	long (> 1m)	shorter
width	thin (1-2 cm)	wider
surface	smooth	rough
the amount of CaCO <sub>3</sub>	<50%	≥50%

The main aim of this study was to determine the morphology of the calcium carbonate crystals from surface of freshwater *Ulva* taxa.

## Morphology of *Ulva* calcification

### SITES OF DEPOSITION

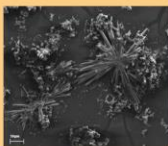
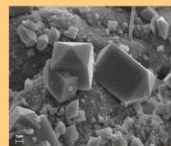


The cell walls of freshwater *Ulva* species is extensive deposits of the calcite crystal isomorph of CaCO<sub>3</sub>.

SEM's image showing the CaCO<sub>3</sub> impregnated cell walls

### POLYMORPHIC STAGE

CALCITE ↔ CaCO<sub>3</sub> ↔ ARAGONITE



SEM view of well developer hexagonal crystals

SEM view of well developer crystals of fine needles

#### Calcite:

- occurred on the outside cells
- extracellular incrustation
- occured commonly
- creating bands

#### Aragonite:

- occurred on the inside cells
- Intracellular incrustation
- occured uncommonly
- forming rays

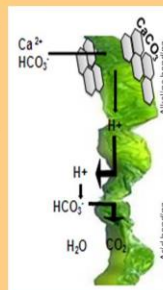
## Calcareous habitat

### MECHANISM

Mechanism of CaCO<sub>3</sub> precipitated on the surface of thalli is based on the pH changed (effects of photosynthesis)

Process CaCO<sub>3</sub> deposits cause a biologically decalcification of water.

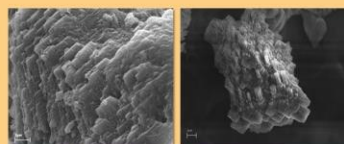
Simplistic model of mechanism of precipitation of calcium carbonate crystals on the surface of freshwater green algae of the genus *Ulva* (changed from Borowitzka M. A. 1987)



### PROCESS OF CRYSTALS FORMATION

#### STEPS OF CRYSTALS FORMATION

crystals nucleation → crystallization



SEM's images of the precipitating of calcium carbonate

NANOCRYSTALS

MICROCRYSTALS

POLYCRYSTALS

CRYSTALS BANDS

With the time crystals types changed

## Results

### COMPARISON OF TWO TYPES OF ISOMORPHIC CaCO<sub>3</sub> OCCURED ON THE SURFACE OF *ULVA* THALLI

features	CALCITE	ARAGONITE
VIEW OF SHAPE		
CRYSTAL SHAPE	hexagonal-rhombohedral	hexagonal prisms
CRYSTAL SYSTEM	orthorhombic	tetragonal
SITES OF DEPOSITION	extracellular	intercellular
LENGTH [µm]	44,3	177,8
WIDTH [µm]	9,23	12,55
RATIO	5:1	14:1

The degree of calcification in the cell walls varies with age of the alga

Aragonite represent a product of intracellular incrustation process

CaCO<sub>3</sub> is a the mineral forms deposited on the surface of *Ulva* thalli

### CONCLUSION

Calcite occurred on the surface of thalli – extracellular deposits

Calcium carbonate occurred as a mixture of two different forms (CALCITE, ARAGONITE)

Calcite created a characteristic bands, while aragonite specific rays