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BioComp

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LEARNING SCENARIO | ALGAE
MODULE 4 | PREDATORS, PESTS AND PATHOGENS

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Colophon

Authors

This module is part of the Learning Scenario “Algae”. It is developed in the frame of the European project “BioComp”.
Authors are Elke Halm, Hans Blankestijn and Hilda Weges.

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Preface

The Learning scenario "Algae" is part of the Erasmus + project BioComp. In that project, the most relevant competencies for professions in the sector "Algae" are analyzed, described and ranked. Based on these competencies this Learning Scenario has been developed for EQF-level 3-4. The focus is on technical competencies.
See also the BioComp Navigator: http://navigator.biocompetences.eu

Nr	Competences ranked according to the importance	Module
A1	Circular economy - knowing the complete process of algae production.	1
A2	Production and environmental data - Ensure that operations comply with standards for sustainable aquaculture.	3
A3	Maintaining equipment - Measure and control water quality	5
A4	Identify diseases or parasites - Monitor the health, based on feeding and general behaviour. Interpret environmental parameters and analyse mortalities.	4
A5	Breeding, reproduction, structure and cultivating - To know about structure, breeding rearing, and production.	3
A6	Harvest of algae - Ensure that careful, superficial and automated algae harvest.	3
A7	Monitoring and documentation - Compose work-related reports that support effective relationship management and a high standard of documentation	5

These 7 most relevant competencies are covered by 5 modules:

1. Circular economy
2. General aspects of algae
3. Production and harvesting
4. **Predators, Pests and Pathogens**
5. Technical aspects of algae growing

Apart from these 5 text documents, the scenario also has a trailer and a WIKI, with background information. To support the teacher, didactic guidance is available. It can be used for all scenarios and also includes suggestions for learning activities to develop personal and transversal competencies. See for this guidance, also the Navigator.

Content

Module 3 contains the following topics:

1. Introduction
2. Enemies of algae
3. Integrated Pest Management (IPM)
4. Natural protection from microalgae against predators and pathogens
5. Test
6. Quiz
7. Sources

1. Introduction

In nature, it is to eat or to be eaten. Predators are everywhere. Think about insects destroying plants or buffalos grazing grass. At the top of this pyramid, you find animals like lions, jaguars and bears. And of course, we, Homo Sapiens, maybe the biggest predator in the world.

Picture: Some examples of predators

Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA

Algae, as primary producers, are on the bottom of the pyramid. Full of proteins, lipids and carbohydrates, they are popular prey for many organisms. Some of these organisms can become a plague during the industrial growth of microalgae. This module will give some examples of these problems.

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2. Enemies of algae

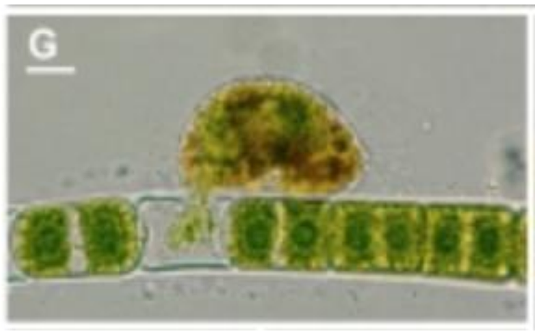
Predators, pathogens and pests of microalgae exist in a big variety. They form a big threat for growers. The main groups which can be found in ponds and other production units are:

Predators

Predators eat algae. There are many groups of predators. Even some predatory algae eat other microalgae. Then they can become a pest.

The main groups are:

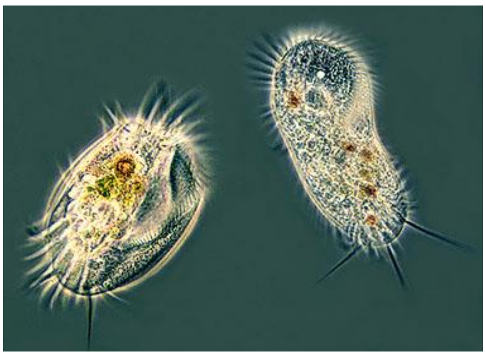
Amoebae



Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA

See also the following videos about Amoebae, eating green algae:
https://www.youtube.com/watch?v=RegP_Lr_i94
https://www.youtube.com/watch?v=UmVmodxYu1c

Ciliates
Typical for this one-cell organism are the cilia. See the picture.



Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA.

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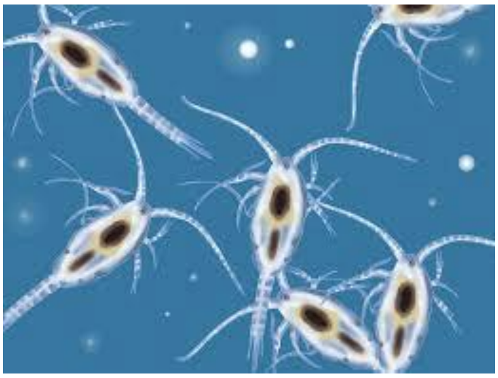
Flagellates

Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA

Crustaceans



Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA.

Rotifers

Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA.

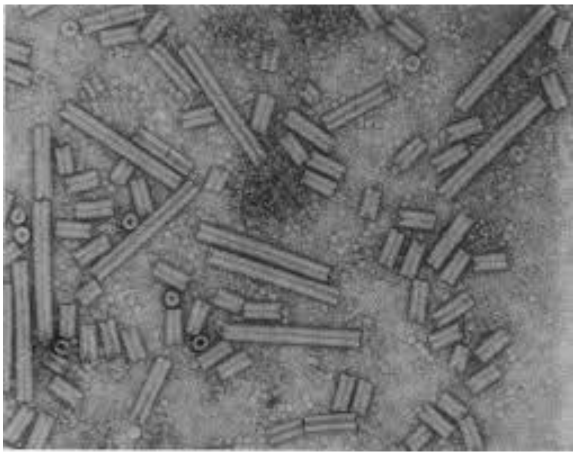
Grazers

This is a snail, just as an example. Think also about fish and tadpoles.

Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA

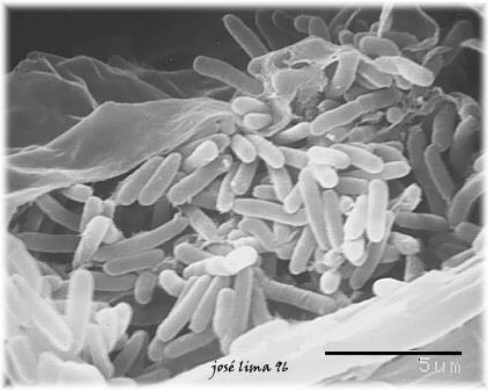
Pathogens

These are viruses.



Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA

These are bacteria.



Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA

Nematoden

Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA

Fungi

Source: Bianca Brahamsha, Scripps Institution of Oceanography, University of California, San Diego, USA.

Pests

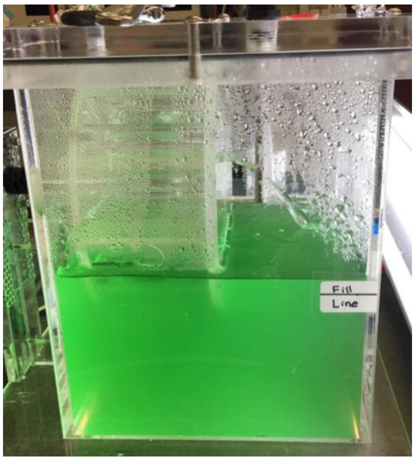
Competition from other Algae and Cyanobacteria

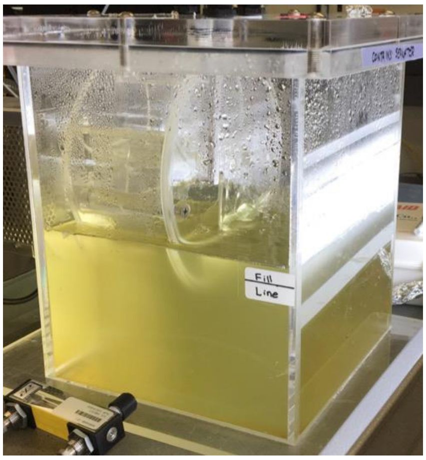
Infected Healthy

Source: Pond photos from Ganuza, et al. (2016) doi: 10.3389/fmicb.2016.00848

Another example of contamination; a disaster in just one day

Day 2 Day 3





Source: Ryan Simkovsky, University of California, San Diego, USA.

3. Integrated Pest Management (IPM)

Increased environmental awareness as well as concerns about safe food, has led to a need for sustainable agricultural production systems. This fits into the principles of circular economy (see module 1)

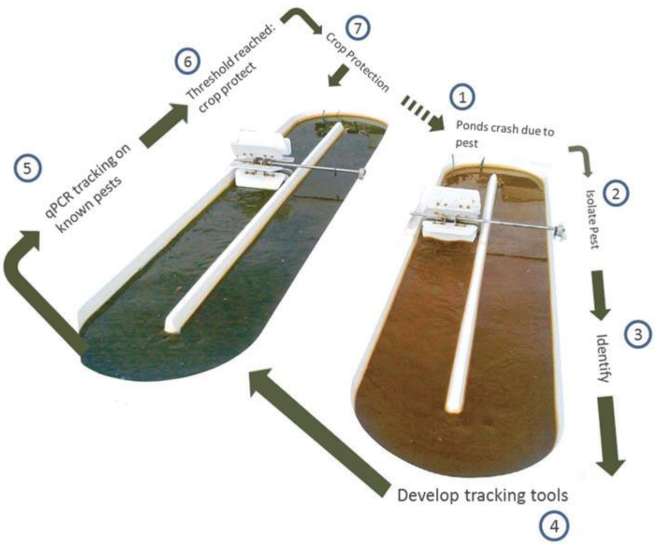
Good agricultural practices and Integrated Pest Management (IPM) have become essential components of sustainable agriculture. The integration of various control measures, with minimal use of pesticides, ensures that pests remain below the economic threshold. The IPM approach limits the negative side effects pesticides can have on the environment as well as on occupational & public health.

While technical solutions towards controlling pests are plentiful in practice, the application of IPM is still a struggle for many farmers, including growers of algae. It starts with the implementation of quality control programs such as Good Agricultural Practices (GAP) and IPM for food safety. Certified producers get access to international markets.

IPM is a multi-stakeholder process. See also the Learning Scenario “Setting up a BBE company, module “Business plan”.

To control the growing process and avoid pests and other threats, growers of algae also use the principles of IPM. This is a continuous cycle of monitoring and identifying pests, triggering preventative or interventive actions in a threshold-dependent manner, and evaluating crop health and control strategies.

Picture: Healthy and ill cultures of algae



Source: McBride, et al. (2014) DOI: 10.1089/ind.2013.0036

Key Components of this system are:

- Knowledge Base
- Detection/Monitoring System, using qPCR techniques (quantitative Polymerase Chain Reaction)
- Control Systems/Interventions

Identification of pests

Identifying the pathogen is not so easy. Next-generation sequencing of DNA, tells us about pond populations & contaminations. However, these can be very diverse. Isolating contaminants and growing up followed by microscopic identification may lead to identification.

Further techniques which can be used:

- Microscopy and Staining
- Molecular Detection
    - Quantitative PCR (qPCR)
    - Hybridization (e.g., Phylochips)
- Spectroscopy
    - Mass Spectroscopy

Intervention and Control Systems

As soon as the indication equipment shows an infection, it is important to have an immediate reaction. In one day, a complete culture of microalgae can be killed.

Depending on the type of infection, one of the following treatments can be chosen (or even a combination)

- Salvage Harvest. This means an early harvest before the infection becomes bigger.
- Chemical Agents can be added. They kill the pest and let the algae live.
    - Abscisic acid (important for growth)
    - Fungicides
    - pH controls
    - Ammonia Exposure
- Physical Methods
    - Sonication (treatment with ultrasonic noise)
    - Filtration
- Biological Methods
    - Breeding or Modification
    - Predators of parasites who kill the main predator or parasite
    - Polycultures

4. Natural protection from microalgae against predators and pathogens

Microalgae have several ways to protect themselves against enemies.

Some evaluated from single cells into colonies. Some got thicker cell walls to resist digestion or special sheaths or toxic proteins on the surface. Others do it with chemicals. They produce toxins that act as repellents. And if you can’t beat them, join them: some algae live together with potential predators.

Industrial growers and scientists have isolated resistant strands during selective breeding. For example Mutations in certain genes of the lipopolysaccharide layer of the cell, envelope makes it resistant to grazing by an amoeba.

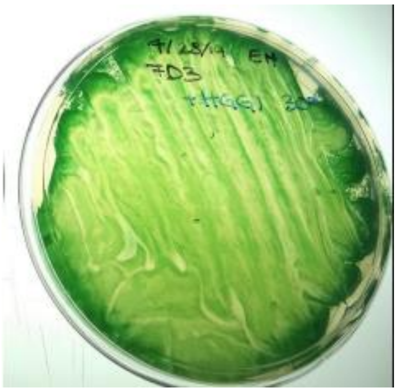
Read more about this in “Algal Predators, Pests and Pathogens II: Detection and Control”, by Ryan Simkovsky (in the wiki)

Example of the advantage of a mutant

Mutations in certain genes of the cell layer of this cyanobacterium make it resistant to grazing by an amoeba. The wild type is infected by an amoeba: the yellow part. The mutant doesn’t show any amoeba activities.

Wild type

Mutant



Source: Ryan Simkovsky, University of California, San Diego, USA

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5. Test

This module contains a test and a quiz. The test has mainly open questions. Answers can be found in the module. Per question, answers are given. The quiz can be answered online, by using the link. The student receives per question an answer good or wrong and has to correct a wrong answer before he can make the next question.

Test

1. Give examples from predators, pathogens and pests in nature.
2. Give three predators from algae
3. Why is avoiding a pest important during the algae growing?
4. Give two methods to analyse a possible pest.
5. Describe the main principles of Integrated Pest Management (IPM).
6. Give three methods to attack a pest in an algae growing process.
7. Give three examples of chemical treatment in IPM and explain how these chemicals to function.
8. How can algae defend themselves against a pest.
9. What is the biggest predator on earth?
10. Give two methods to clean your aquarium from algae.

Answers

1. Predators: cheetah, grasshopper, elephant, etc.
   Pathogens: different viruses and bacteria.
   Pests: exotic plants and animals.
2. Amoebae, flagellates, crustaceans, nematodes, and more.
3. It can destroy the complete algae population in a short time.
4. Microscopy and staining, molecular detection (PCR) and spectroscopy.
5. IPM is a multi-stakeholder process. To control the growing process and to avoid pests and other threats, growers use the principles of IPM: a continuous cycle of monitoring and identifying pests, triggering preventative or interventive actions and evaluating crop health and control strategies.
6. Salvage Harvest, use of chemical agents, physical methods and biological methods.
7. Abscisic acid is important for growth, a fungicide kills predators, pH control optimizes the growth of algae and ammonia exposure kills the pests.
8. Mutants will survive.
9. Humans.
10. Buy a special algae-eating fish or add chemicals or improve the light source above the aquarium.

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6. Quiz

1. True or not true?
    a. Some predatory algae eat other microalgae.
    b. Phytoplankton includes algae
    c. Potassium Hydroxide protects a healthy algae culture.
    d. IPM means International Protein Market.

2. Which combination of quality programs is the right one:
    a. IPM + IMF + CCCP
    b. IPM + GAP + HACCP
    c. IPM + GBP + ACPR

3. A starting algae substrate with a weight of 1 gram, multiplies under ideal circumstances every 6 hours. What is the yield in grams after 3 days?
    a. 9 g
    b. 128 g
    c. 2048 g
    d. 4096 g
    e. 16 kg

4. Mutations in certain genes of the lipopolysaccharide layer of the cell envelope make it resistant to grazing by an amoeba. This is because:
    a. Amoeba don't like the taste of the mutated cell layer.
    b. The cell layer is too strong to be eaten.
    c. Mutated algae become a predator for an amoeba.

   Choose the right answer.

Answers

1. A and B are correct
2. B
3. D
4. B

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7. Sources

Algal Predators, Pests and Pathogens
By Bianca Brahamsha
Scripps Institution of Oceanography
University of California, San Diego

Powerpoint presentation: Algal Predators, Pests and Pathogens II: Detection and Control
By Ryan Simkovsky
University of California, San Diego

https://www.coursera.org/lecture/algae/algal-predators-pest-and-pathogens-ii-detection-and-control-lqPNA

https://www.tau.ac.il/~agolberg/pdf/2018_1.pdf Marin IPM

Carney, L.T., T. Lane. 2014. Parasites in algae mass cultures. Front. Microbiol. https://doi.org/10.3389/fmicb.2014.00278

https://www.wur.nl/en/show/Course-Details-Integrated-Pest-Management-and-Food-Safety.htm

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