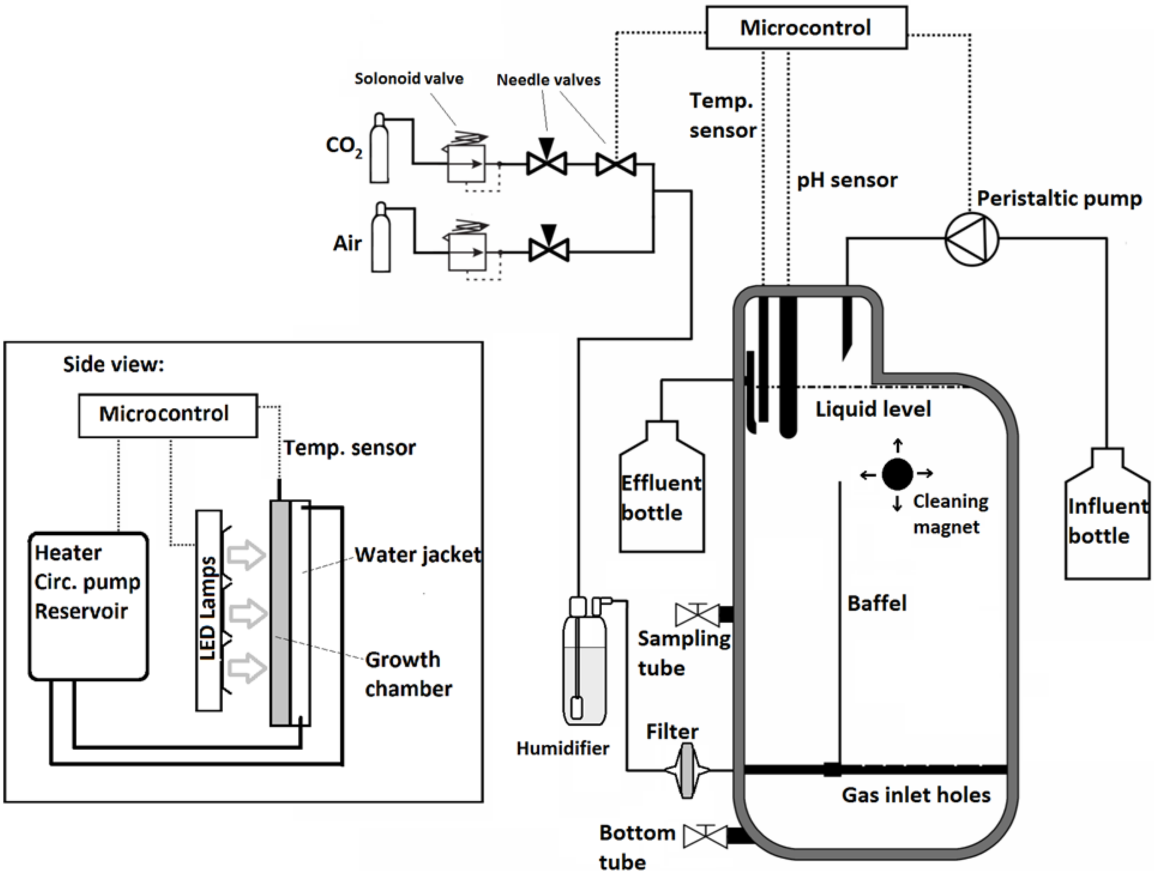
OCEAN Appendix A1



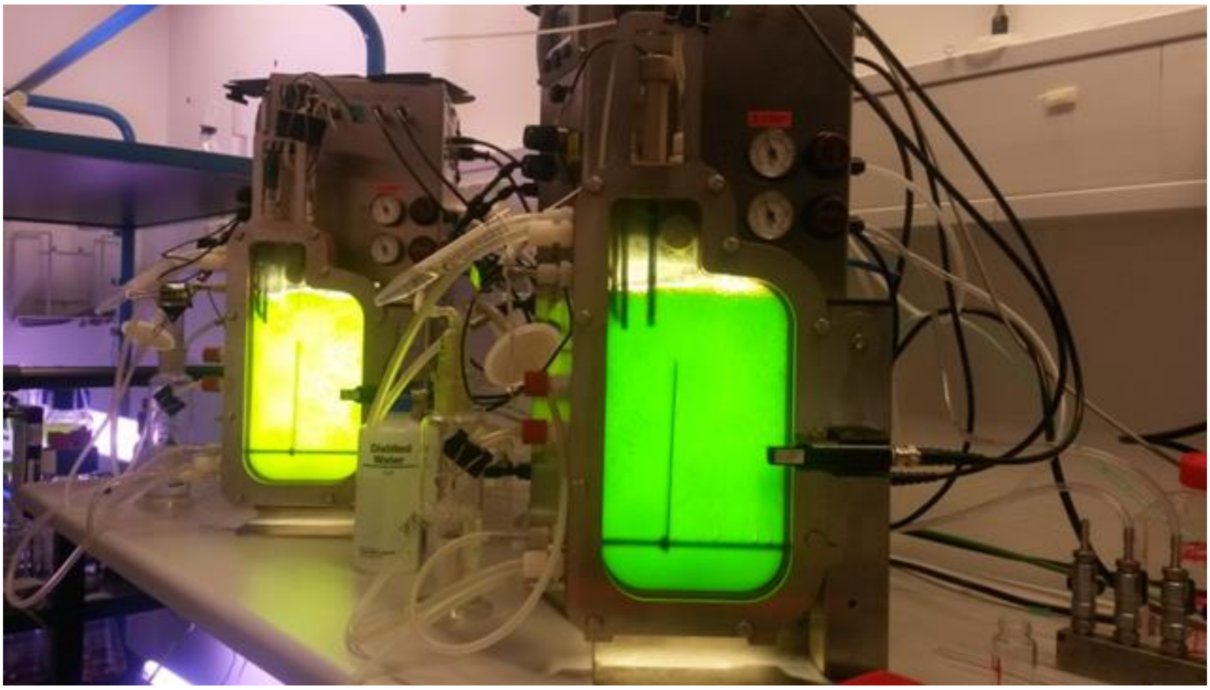


Figure S1. Schematic drawing and a photograph of photobioreactors.

OCEAN Appendix A2

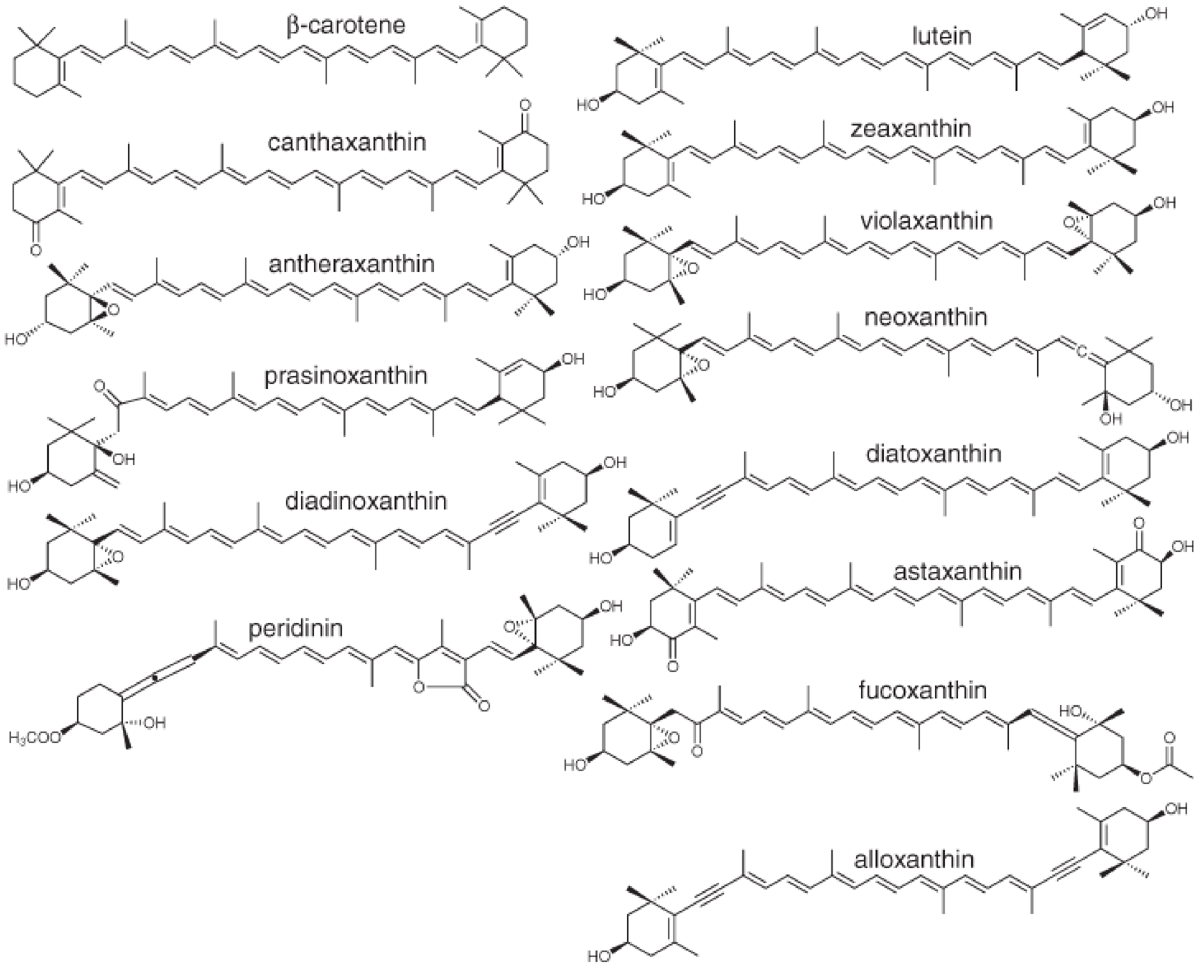
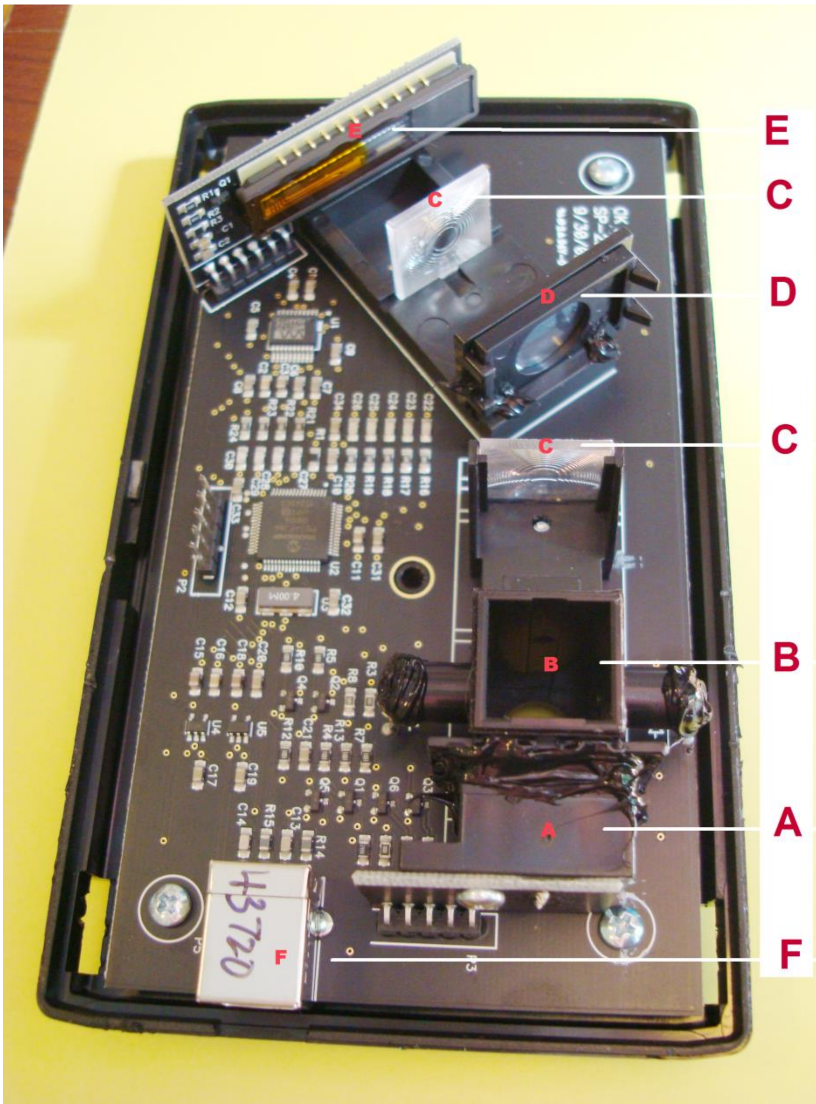


Figure S2. Chemical structure of some carotenoids.

OCEAN Appendix B



Spectrophotometer inside.
A: Lamp housing. B: Cuvette holder. C: Lenses. D: Diffraction grating. E: Sensor array. F: USB connector.

OCEAN Appendix C1

Videos are placed on the desktop on the PC.

Introduction to Copepods.

Copepods (see figure C1) are small, free swimming creatures and are the most abundant animals in the world's oceans. They are considered as important 'grazers' of phytoplankton and serve as an important food source for many vertebrates, including fish and fish larvae. There are many different copepods species and they differ in size and shape, but also in behaviour. One important type of behaviour for its survival is escape behaviour from predators. We can investigate this behaviour to determine what copepod species would serve as a good prey for fish in a production system.

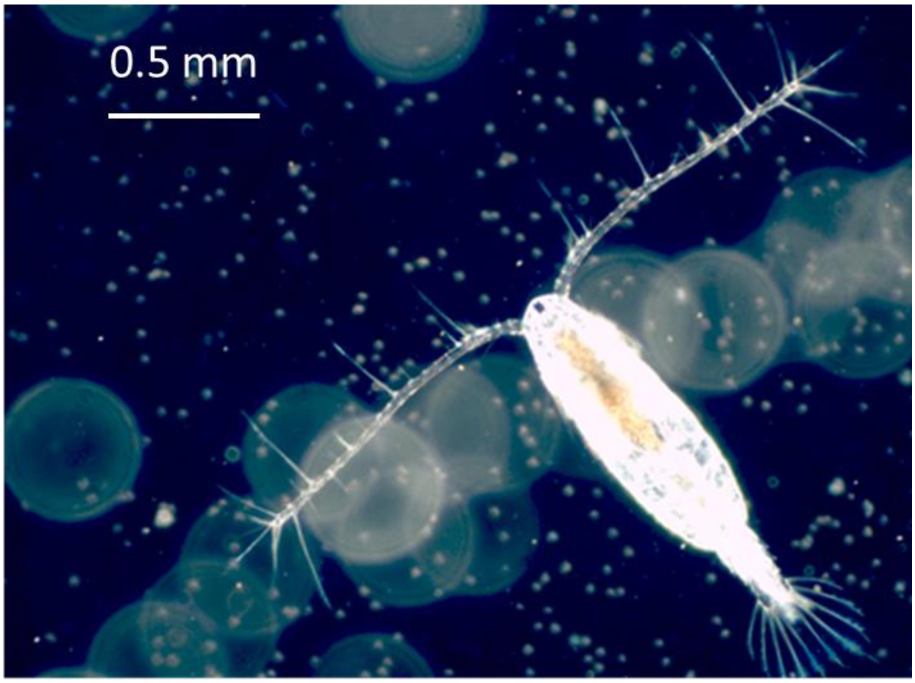


Figure C1. Copepod (Acartia tonsa) with mechanosensory hair on the antennae.
The small hair can pick up disturbances in the water and in that way the copepod can perceive its environment, including detecting approaching.

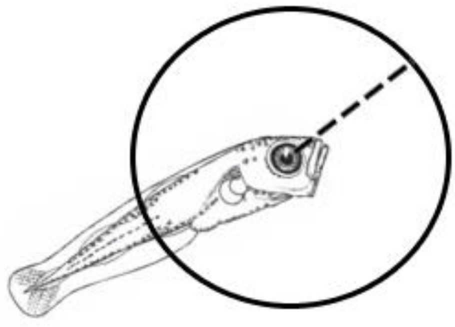


Figure C2 Fish can perceive prey and start their attack at a certain distance, called the ´reaction distance´, R.

Most fish use vision to remotely locate and catch their prey. The distance at which they can detect and start an attack, measured from the centre of their eyes, is called the ´reaction distance´ or R (see figure2). Copepods do not use vision, but use ´hydrodynamic cues´ to remotely detect their predators. They can perceive these hydrodynamic cues generated by their predators with their highly sensitive sensory setae on the antenna´s (see figure 1).

There are differences between copepods in the distance at which they can perceive predators, but also in the velocity at which the copepod can escape from predators. Consequently, differences in ´detection distance´ and ´escape velocity´ predict differences in escape success between copepods and thus difference in suitability as a prey for fish. The worse the copepod is in escaping from predators, the better!

OCEAN Appendix C2

Experimental setup and filming setup.

To determine what copepod species is a good prey in an aquaculture system, we experimentally investigate the 'predator detection distance' and 'escape velocity' for two different copepod species. Because copepods escape at very high velocities, we use high-speed video filming. Our set-up (figure 3) consists of a high-speed camera facing a square aquarium, which contains a diagonally placed mirror. The frame rate we´re filming at is 500 images per second.

Because of the mirror, we can observe the copepods movement in three dimensions. (This is equivalent to using two cameras viewing the aquarium from two directions at a right angle to each other, namely from the front and from the right side.) The 'real' copepod is on the right of the image and shows us the copepods movement in x- and y-direction (figure C4 part A). The mirror image of the copepod, on the left, shows us the copepods movement seen from the side. The movement in the horizontal direction of this mirror image gives us the movement of the copepod in the z-direction. The movement in the y-direction should be the same as for the direct image of the copepod.

For example, at time t=0 the location of the copepod in the aquarium is as in figure C4 part A. If the copepod moves upwards (in the y-direction) and to the left (x-direction), but not in the z-direction, the image could look like figure C4 part B. If the copepod would move towards or away from the camera, the movement in the x-direction of the mirror image would give us the movement in the z-direction as shown in figure C4 part C.

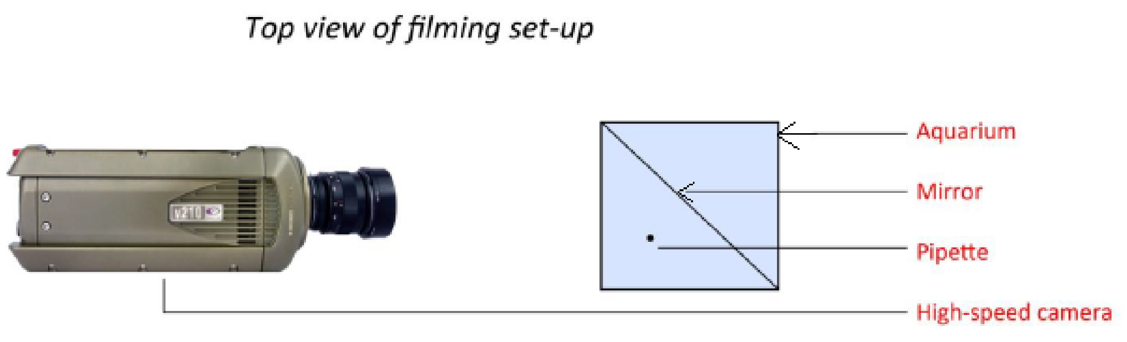


Figure C3 Filming set-up, top view.

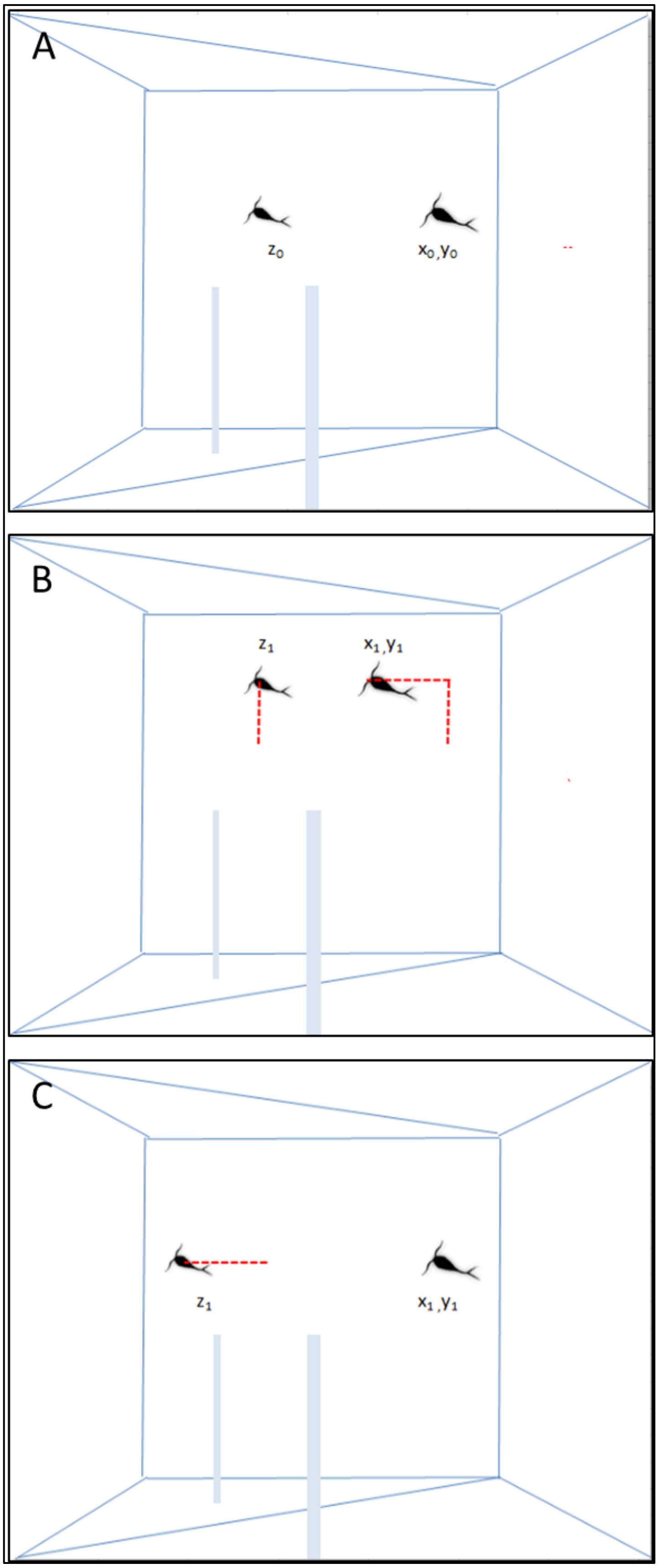


Figure C4. Front view of the aquarium, as recorded by the high-speed camera. The two copepods seen is actually one individual and its mirror image. **Part A** shows the position of a copepod at $\boldsymbol{t = 0}$. **Part B** shows movement in x-and y-direction at $\boldsymbol{t = 1}$, and **Part C** shows movement of the copepod in the z-direction.

We do not put actual predators in the aquarium, but to simulate the hydrodynamic cues that are generated by fish we create a hydrodynamic cue by sucking water from the aquarium with a pipette. We define the ’predator detection distance’ as the distance at which the copepod starts its escape jump, measured from the middle of the tip of the pipette and the middle of the copepod. Equation 1 describes the calculation of the ’predator detection distance’. By measuring changes in x-, y- and z-position of the copepod during an escape response over time, we can also calculate its’ ‘jump distance’ and ´escape speed’, see equation 2 and 3.

Equation 1: ´Predator detection distance´

$$d_{predator} = \sqrt{\left(x_{start} - x_{pipette}\right)^2 + \left(y_{start} - y_{pipette}\right)^2 + \left(z_{start} - z_{pipette}\right)^2}$$

Equation 2: ´Jump distance´

$$d_{jump} = \sqrt{(x_{start} - x_{end})^2 + (y_{start} - y_{end})^2 + (z_{start} - z_{end})^2}$$

Equation 3: ´Escape speed´

$$V_{escape} = \frac{d_{jump}}{\Delta t}$$

x_{start}, y_{start}, z_{start} are respectively the x, y and z position of the copepod at the start of the jump, and x_{end}, y_{end}, z_{end} are the x, y and z position of the copepod at the end of the jump.

OCEAN Appendix D

List of physical constants

Specific heat capacity, water	C_{water}	$4{,}18 \cdot 10^{3}$	J kg^{-1} K^{-1}
Density, water at 0 °C	ρ_{water}	$9{,}998 \cdot 10^{2}$	kg m^{-3}
Density, ice at 0 °C	ρ_{ice}	$9{,}17 \cdot 10^{2}$	kg m^{-3}
Density, air (1 atm, 20 °C)	ρ_{air}	1,22	kg m^{-3}
Velocity of light	c	$3{,}00 \cdot 10^{8}$	m s^{-1}
Avogadro's number	N_A	$6{,}022 \cdot 10^{23}$	mol^{-1}
Planck's constant	H	$6{,}63 \cdot 10^{-34}$	J s
Electron charge	e	$1{,}60 \cdot 10^{-19}$	C
Gas constant	R	8,314	J mol^{-1} K^{-1}
Boltzmann's constant	k_{B}	$1{,}38 \cdot 10^{-23}$	J K^{-1}
Proton mass	m_p	$1{,}673 \cdot 10^{-27}$	kg
Neutron mass	m_n	$1{,}675 \cdot 10^{-27}$	kg
Electron mass	m_e	$9{,}11 \cdot 10^{-31}$	kg
Atomic mass unit	u	$1{,}661 \cdot 10^{-27}$	kg

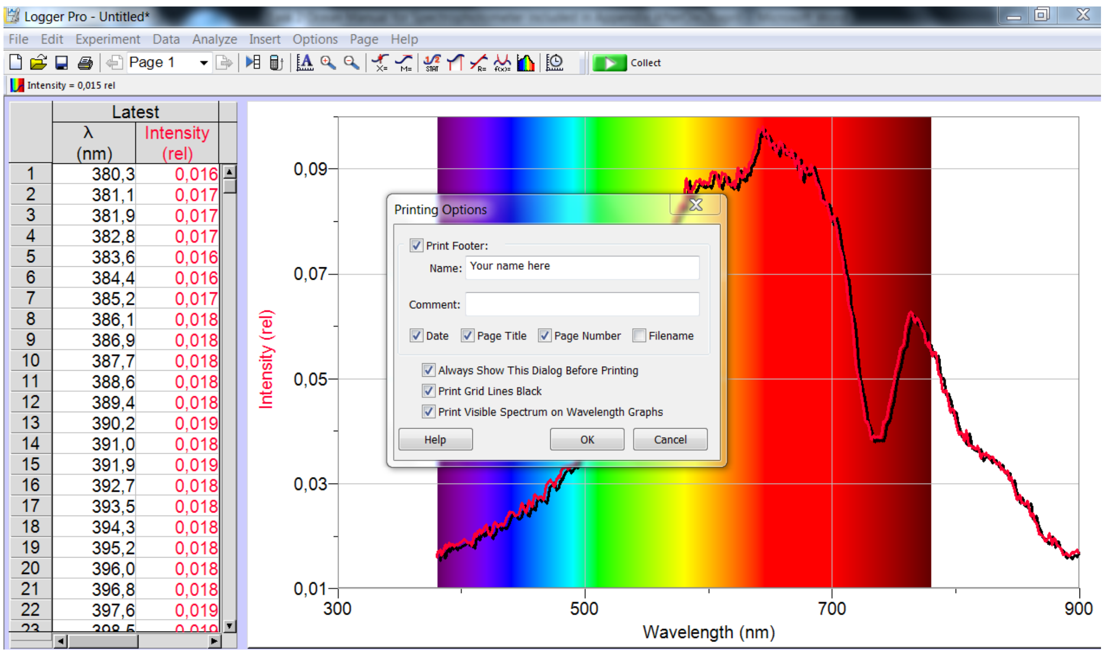
OCEAN Appendix E

User manual for the Vernier spectrophotometer in absorbance mode.

- Log into the computer with the given username and password
- Double click on the “Logger Pro” icon
- Place the cuvette containing the blank solution in the spectrophotometer
- Click “Experiment” and under “Calibrate” click “Spectrophotometer: 1”
- Let the spectrophotometer warm up (90 s)
- Click “Finish Calibration”
- After 5 s, click “OK”
- Replace the cuvette containing the blank solution with a cuvette containing the solution you want to measure.
- Click the green button “Collect”
- Read off the absorbances at the wavelengths you need

Printing out from Logger Pro

- Choose “print” under File in Logger Pro.
- “Printing Options” will pop-up.
- Tick “Print Footer”.
- Write your COUNTRY and TEAM (you will NOT get your print if there is no footer to identify it).
- In the figure below, you see an example for the spectrophotometer in emission mode. (The spectrum shown is from a different light source than used in the experiments).
- Tick “Print Visible Spectrum on Wavelength Graphs”, if you want the coloured background in the graph.



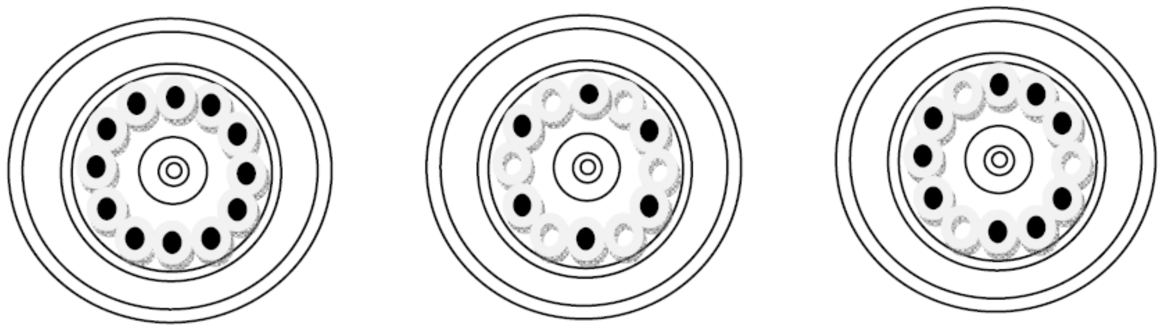
NB: For the Video analyses you also need to have your COUNTRY and TEAM in the Footer (you will NOT get your print if there is no footer to identify it).

OCEAN Appendix F

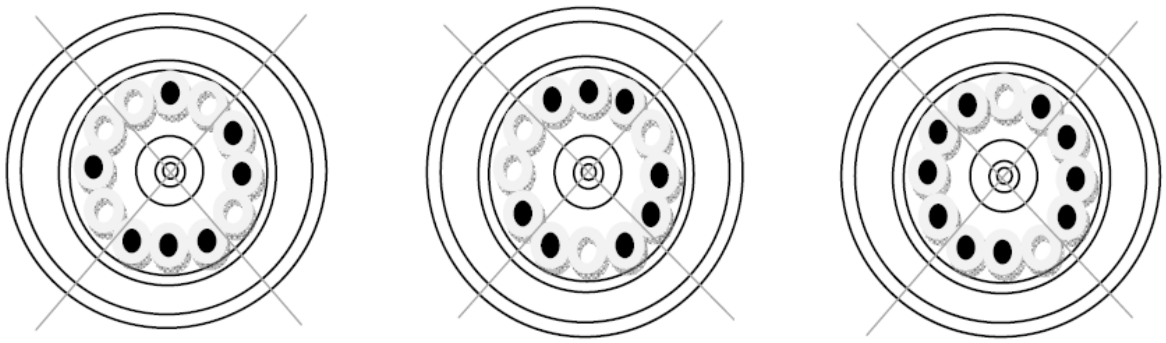
User manual for Balancing of Centrifuges

See drawing below on how to balance tubes in a centrifuge. Balancing is important not to spoil the centrifuge – and to avoid accident. (The centrifuge has rapid rotation giving large centrifugal forces, which must be balanced.)

Always balance the rotor before centrifugation. Following are symmetrical loading of centrifuge tubes to rotor:



Incorrect method of loading tubes in centrifuge rotor:



NOTE: Incorrect method of loading tubes can lead to an accident.

Drawings and texts from: LLG Labware, Operating Manual Centrifuge.

Periodic table of the elements

Periodic Table of the Elements

Atomic Number
Symbol
Name
Atomic Mass

1 IA 1A	2 IIA 2A	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8	9 VIII 8	10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 84.798
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown

Lanthanide Series	57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]

Alkali Metal | Alkaline Earth | Transition Metal | Basic Metal | Semimetal | Nonmetal | Halogen | Noble Gas | Lanthanide | Actinide