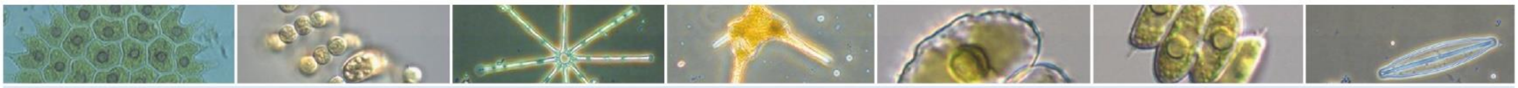
EQAT PHYTOPLANKTON

External Quality Assessment Trials Phytoplankton

DAkkS Deutsche Akkreditierungsstelle D-EP-18224-01-00

LANDESTALSPERREN VERWALTUNG SACHSEN



Final report proficiency test phytoplankton 2019/2020

Revised version: October 2022

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In collaboration with Andreas Meybohm and Tilo Hegewald

State Reservoir Administration of Saxony (LTV)

In collaboration with Working Committee of Drinking Water Reservoirs (ATT e.V.)

Arbeitsgemeinschaft Trinkwassertalsperren e.V. ATT

Freistaat Sachsen

Content

1. Organisation

1.1. Organisers

Phytoplankton EQAT (External Quality Assessment Trials) is a joint project organised by the Working Committee of Drinking Water Reservoirs (ATT) and the State Reservoir Administration of Saxony (LTV). The ATT is a non-profit association that involves about 40 water supply companies, water boards, reservoir companies and administrative bodies, universities as well as inspection and research institutes in Germany and Luxembourg.

The LTV is a state-run company, for which the Saxon State Ministry for Energy, Climate Protection, Environment and Agriculture is responsible. The LTV operates, administers and monitors the state's 115 reservoirs and water storage facilities. The biology working group of the ATT has been conducting phytoplankton quality assessment trials since the early 1990's. This 2019/2020 proficiency test was the **seventh** in row. The LTV plays the leading role in the organisation, execution and assessment of the trials and is a certified laboratory for the analysis of phytoplankton according to DIN EN ISO/IEC 17025:2017 and for proficiency tests according to DIN EN ISO/IEC 17043:2010 since June 2013.

The following personnel has been involved in the proficiency test phytoplankton 2019/2020 (Table 1):

Table 1. Distribution of tasks.

Task	Name	Organisation	Task
Coordinator	Andreas Meybohm	LTV	Planning, execution, report
Dept. coordinator	Dr. Tilo Hegewald	LTV	Statistics
Test executive	Dr. Elly Spijkerman	LTV	Execution, communication, report
Expert committee	Anita Nienhüser	ATT	Consultant
	Dr. Gabriele Packroff	ATT	Consultant
	Wolf-Henning Kusber	BGBM, FU Berlin	Taxonomy

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Written by:	QM- approved	QM- approved
Dr. Elly Spijkerman (test executive)	Dr. Tilo Hegewald (Dept. coordinator)	Andreas Meybohm (coordinator)
Date: 28.10.2022	Date: 28.10.2022	Date: 28.10.2022

1.2. Participants

We had 69 registrations for this test, but unfortunately, two participants had to cancel their participation during the run. From the 67 participants from 12 countries all delivered their results, even under the harsh conditions during the COVID19 pandemic. Thirty-three registrations originated from Germany, the other were mainly from other European countries.

1.3. Design of the trial

This proficiency test checks the analytical performance of the participants in counting phytoplankton according to DIN EN 15204:2006 using inverted microscopy (Guidance standard using Utermöhl technique), calculation of the biovolume (possibly according to DIN EN 16695:2015) and the taxonomic determination of limnetic algae (Fig. 1).

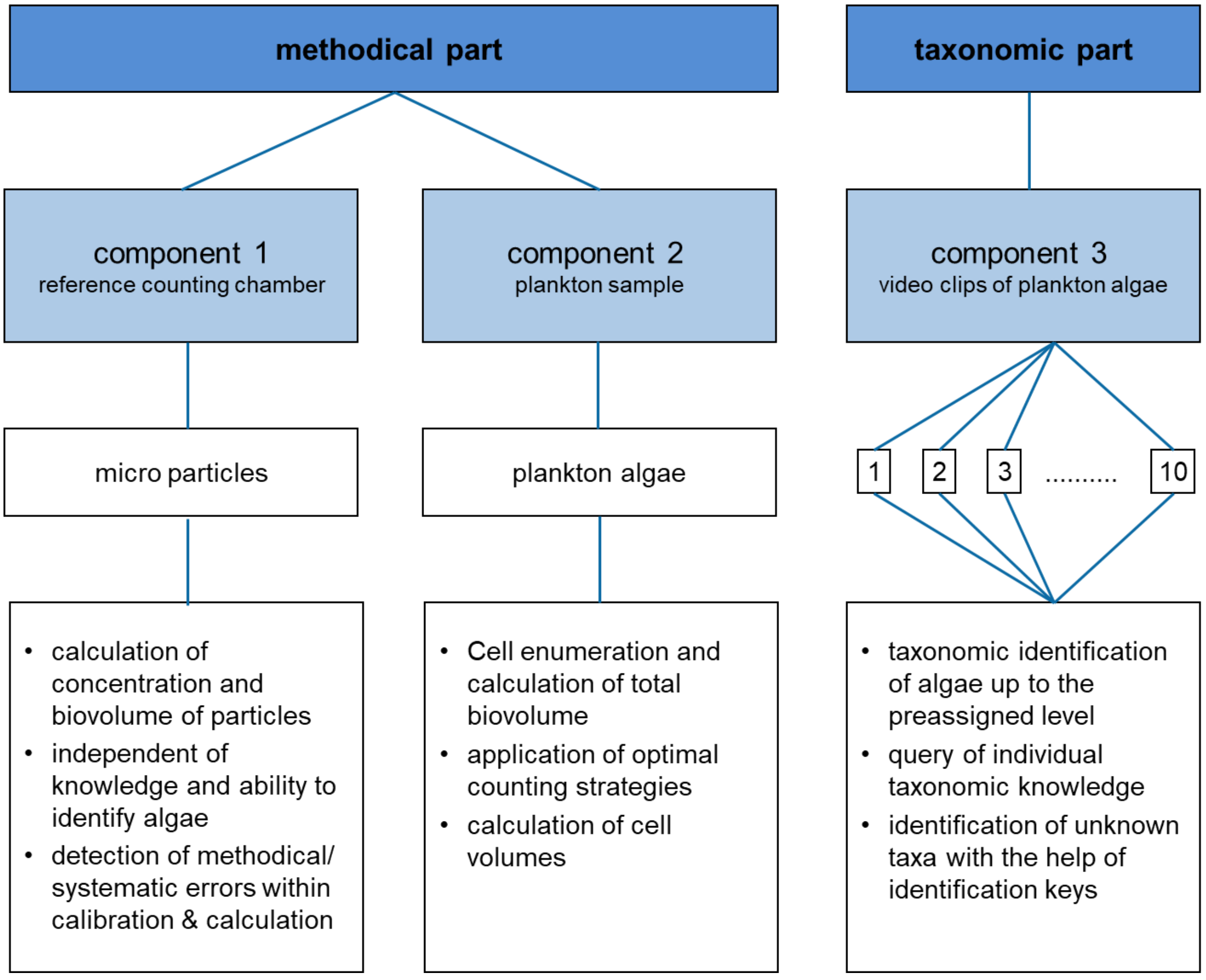


Figure 1: Visualisation of the proficiency test 2019/2020.

1.4. Procedures for the Proficiency test Phytoplankton

The proficiency test phytoplankton was first announced at the end of April 2019. Interested parties were able to register on our web portal from May 2nd until June 30th 2019. The samples were sent to the participants on January 15th 2020. Two participants did not receive their (first delivery -) package, and therefore it took until the end of January before everyone could start the analyses. Due to unforeseen and tedious problems with the web-portal, the delivery of the results was only possible from February 5th.

The participants were given until March 20th and all participants submitted their results until that time. On May 14th, we released the preliminary results on the web site and sent them individually to every participant. On October 13th 2020 the certificates and result sheets were sent around to every participant. The final report was completed in March 2021 and is available on our web-site: www.planktonforum.eu. A revised version of the final report was published in October 2022 in order to meet with the requirements in the DIN EN ISO/IEC 17043:2010.

2. Production of samples

Figures and statistical analyses were done in R (R Core Team, 2017).

2.1. The reference counting chamber

The numbers, size and distribution of the particles on bottom coverslip of the reference counting chamber were set by the LTV. The production was carried out by TSO Thalheim Spezialoptik GmbH, Pulsnitz on the basis of subcontracting. The reference counting chamber consists of a counting chamber embedded in a base plate. The counting chamber consists of a bottom coverslip mounted to the base plate by a threaded metal ring (Fig. 2). The bottom coverslip has a defined number of differently sized, micro particles engraved as set by the LTV. The numbers and sizes of particles on the reference counting chamber are true target values and the chamber can support future internal quality assessment in the testing laboratory.

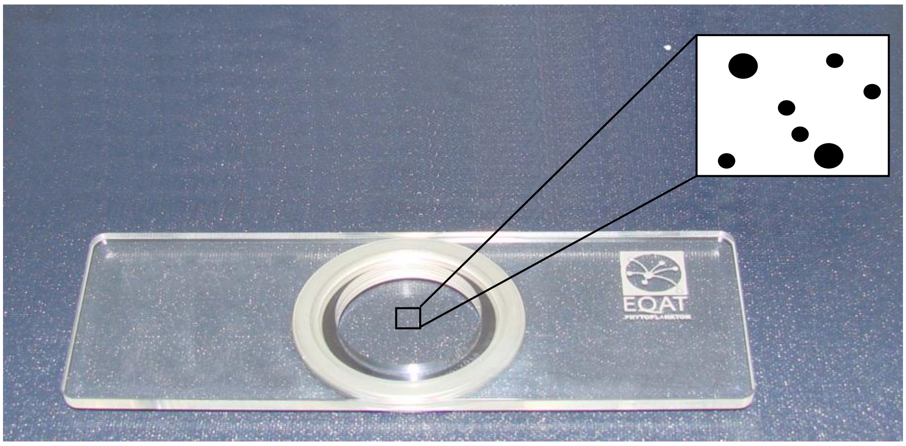


Figure 2: Reference counting chamber for the enumeration and the calculation of volume concentration of the micro particles, which are engraved on the bottom coverslip.

The LTV set the number, size and distributionof three different size-classes of micro particles (Table 2).

Table 2. Diameter and particle concentration (assuming 1 mL sedimentation volume) set to be engraved in the bottom coverslip of the reference counting chamber.

	Particles big	**Particles medium**	**Particles small**
Diameter	51 µm	18 µm	8 µm
Number	9 $*ml^{-1}$	17,550 $*ml^{-1}$	10,020 $*ml^{-1}$

The distribution of the particles on the bottom coverslip were pre-set for every single chamber using a Poisson distribution. After this, every distribution was checked for overlapping particles. Seven randomly selected reference counting chambers were subjected to a quality check by the LTV (Table 3).

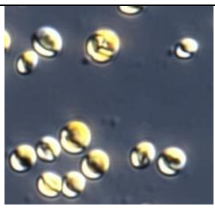
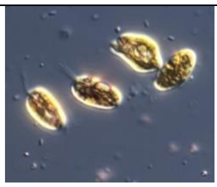
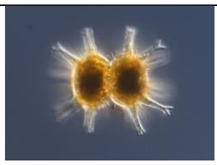
Table 3. Diameter and particle concentration (assuming 1 mL sedimentation volume) engraved in the bottom coverslip of the reference counting chamber as counted and measured by the LTV. Mean of seven different chambers for particle number and of three different chambers for particle diameter.

	Particles big	**Particles medium**	**Particles small**
Diameter	50 µm	15 µm	6 µm
Number	9 $*ml^{-1}$	17,039 $*ml^{-1}$	10,007 $*ml^{-1}$

2.2. Phytoplankton sample

The aim was to provide an almost "natural phytoplankton sample", which we made of mixing five different mono-algal cultures (Table 4). Approximate target concentrations were set before homogeneously mixing the culture and subsequently fixing with Lugol's solution according to DIN EN 15204:2006. Several control counts were made for every single algal culture before mixing them together in a large vessel in the desired density.

Table 4. Taxonomic composition of the phytoplankton sample, with a photo and the origin of the culture.

No.	Photo	Name	Strain No.	Origin
1		*Chlorella* sp.	BfUL	BfUL Nossen
2		*Cryptomonas obovoidea*	CCAC0181B	CCAP University of Cologne
3		*Monoraphidium griffithii*	CCALA372	CCAP University of Cologne
4		*Nitzschia communis*	CCAC1762B	CCAP University of Cologne
5		*Staurastrum actiscon*	CC10D11bI	CCAP University of Cologne

From this large vessel, the 100 mL sample bottles were filled by using five different, and shifted starting point, runs with well-mixed suspension. After filling all necessary sample bottles, 10 were randomly selected for homogeneity inspection and three bottles were selected for stability.

2.2.1.Homogeneity test

To ascertain that the variability between phytoplankton samples was smaller than that within, the number of *Staurastrum arctiscon* (No. 5) was checked in the 10 randomly selected sample bottles (Fig. 3). On 13.1.2020, all 10 homogeneity samples were counted in 3-fold. This means that for every single bottle, 3 times 10 mL was sedimented and the whole chamber was counted at a 40-fold magnification. The mean value found from these 30 counts was 21.5, whereas the minimum was 14 and the maximum 34 (Fig. 3).

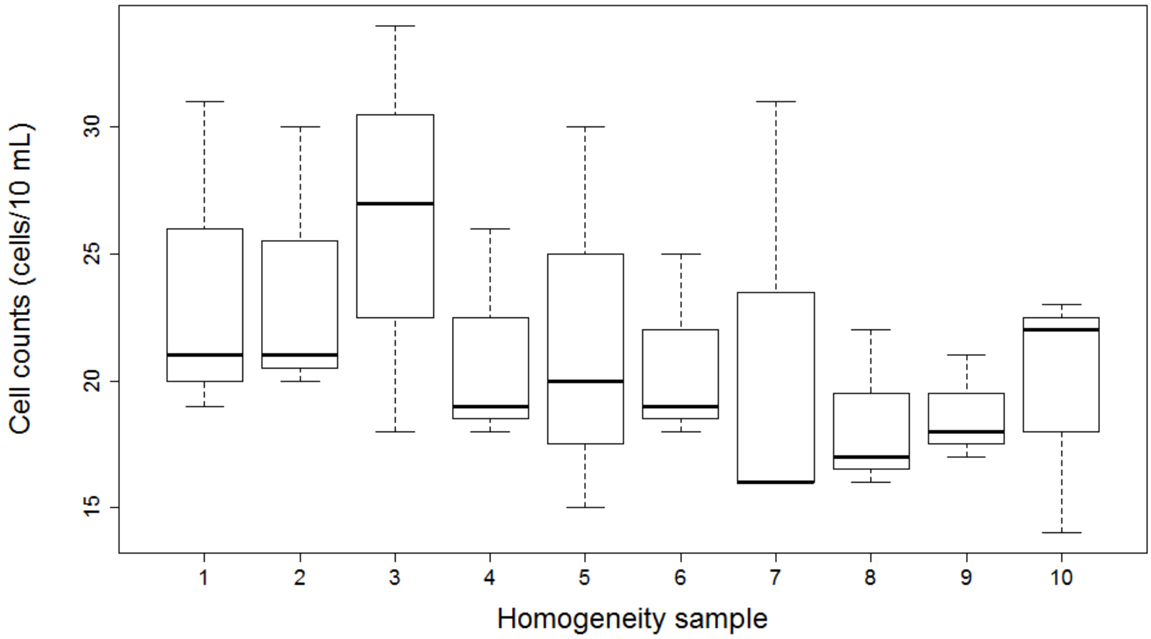


Figure 3: Cell counts of *Staurastrum arctiscon* in the 10 sample bottles (n=3). Please note that the y-axis does not start at zero.

The analysis of the data in R with an one-way analysis of variance revealed that there were no differences between the 10 sample bottles for *Staurastrum arctiscon* density (F = 0.44, df = 9, p = 0.87) and therefore homogeneity was confirmed. We subsequently sent the samples and the reference counting chambers to the participants on January 15th, 2020. There are no reasons why the homogeneous distribution of *Staurastrum* cannot be transferred to the other algae species.

2.2.2. Stability test

Three sample bottles were randomly selected after filling all sample bottles, and these were used to ascertain stability of the cell concentration and biovolume of the phytoplankton sample over the course of the test-period. The three sample bottles were analysed in 3-fold on 20.1., 10.2., and 16.3.2020. On every occasion, the same counting strategy was used and the mean counts done on the sample are shown in Fig. 4. The concentration of the species did not change over time (ANOVA, $F_{2,30}$=0.19, p=0.83; Fig. 4).

From every stability sample, 30 cells per species were measured and these measurements were used to calculate a cell volume for every species using the appropriate geometric formula (following DIN EN 16695:2015; Fig. 5). These cell volumes remained the same during the examination period (ANOVA, $F_{2,30}$=0.01, p=0.99; Fig. 5).

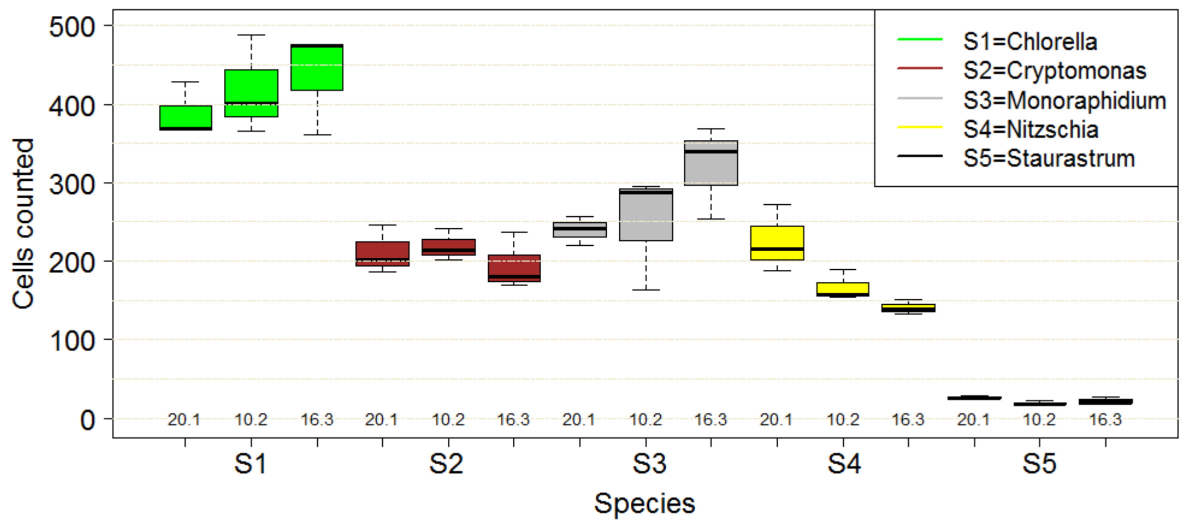


Figure 4: Stability counting of the five species in the phytoplankton sample. The three boxplots for every species represent the numbers of three independent enumerations done within a certain counting strategy. The date of counting is indicated above the x-axis (all in 2020).

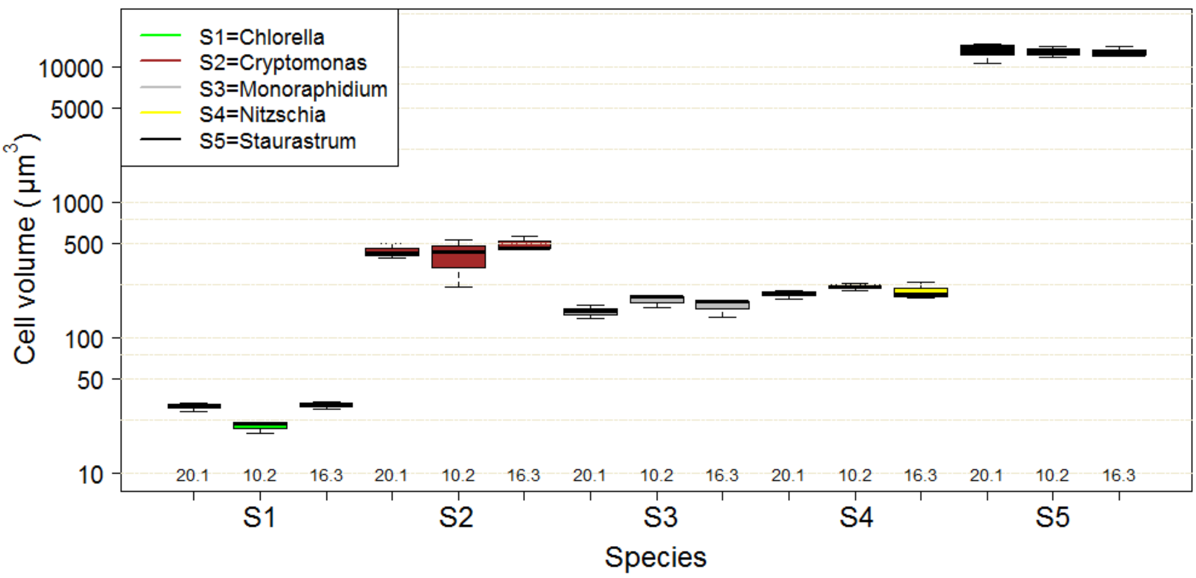


Figure 5: Stability cell volume of the five species in the phytoplankton sample. The three boxplots for every species represent the calculations of three independent cell volume measurements. The date of the measurement is indicated above the x-axis. Please notice the logarithmic scale of the y-axis.

An additional stability test was performed by using a returned package that had been in the post for 4 weeks. In the tracking software of DHL it could be seen that it had visited several package stations and it was likely not stored under the preferred conditions. It therefore represented a "worst-case-scenario". Upon its return to the LTV in Plauen (12.2.2020), the sample was counted identically as the stability samples described above (on 14.2.2020). The results were compared to the stability sample analysed at the closest date (i.e. 10.2.2020). The concentration of the species did change by being 4 weeks in the post (ANOVA, $F_{1,20}$=6.02, $p<0.05$; Fig. 6). The interaction was also significant ($F_{4,20}$=3.23, $p<0.05$), meaning that some cell concentrations remained the same, while others decreased. Microscopic examination revealed that species 1 (*Chlorella*) and 3 (*Monoraphidium*) clumped more in the postal sample. Nevertheless, cell concentrations (S1: 6.22 10^6 and S3: 5.19 10^4 cells/L) were well within the tolerance limits (for S1: 3.34 – 12.0 10^6; see Fig. 17, and for S3: 4.31 – 12.8 10^4 cells/L; see Fig. 19).

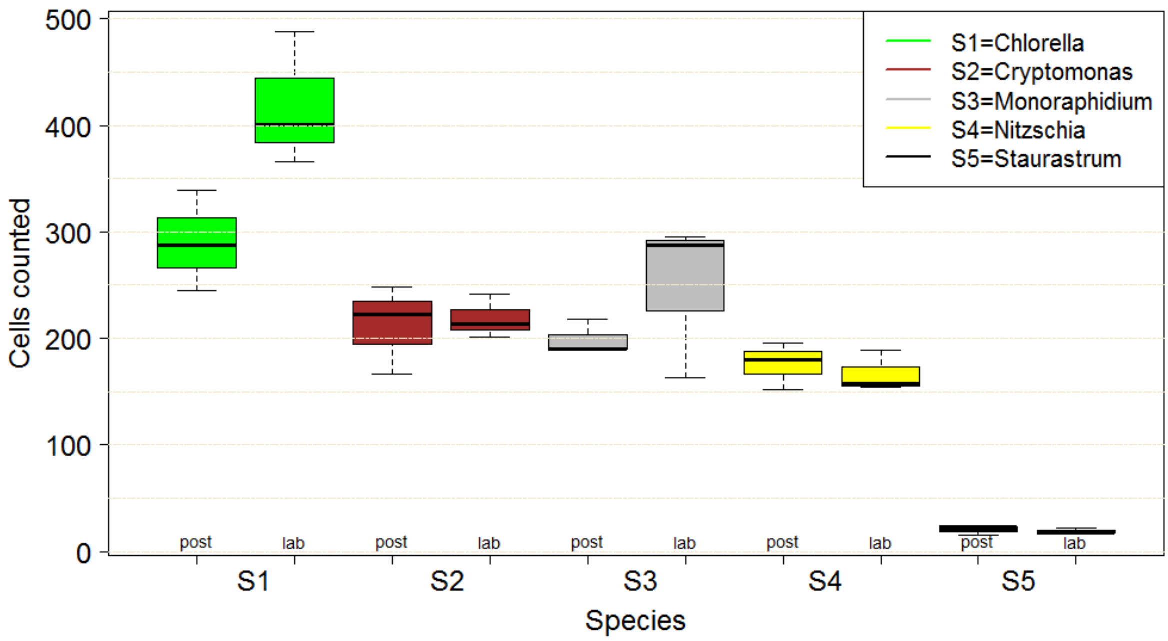


Figure 6: Stability counting of the five species in the phytoplankton sample. The two boxplots for every species represent the numbers of three independent enumerations done within a certain counting strategy. Above the x-axis, the indication “post” is for the returned postal package and “lab” for the stability sample counted on 10.2.2020.

Similar to the stability sample, 30 cells per species were also measured from the “post” sample and calculated into a cell volume for every species (Fig. 7). The ANOVA revealed that the cell volumes in the postal package and the laboratory stored, stability sample were the same (ANOVA, $F_{1,2}$=0.98, p=0.34; Fig. 7).

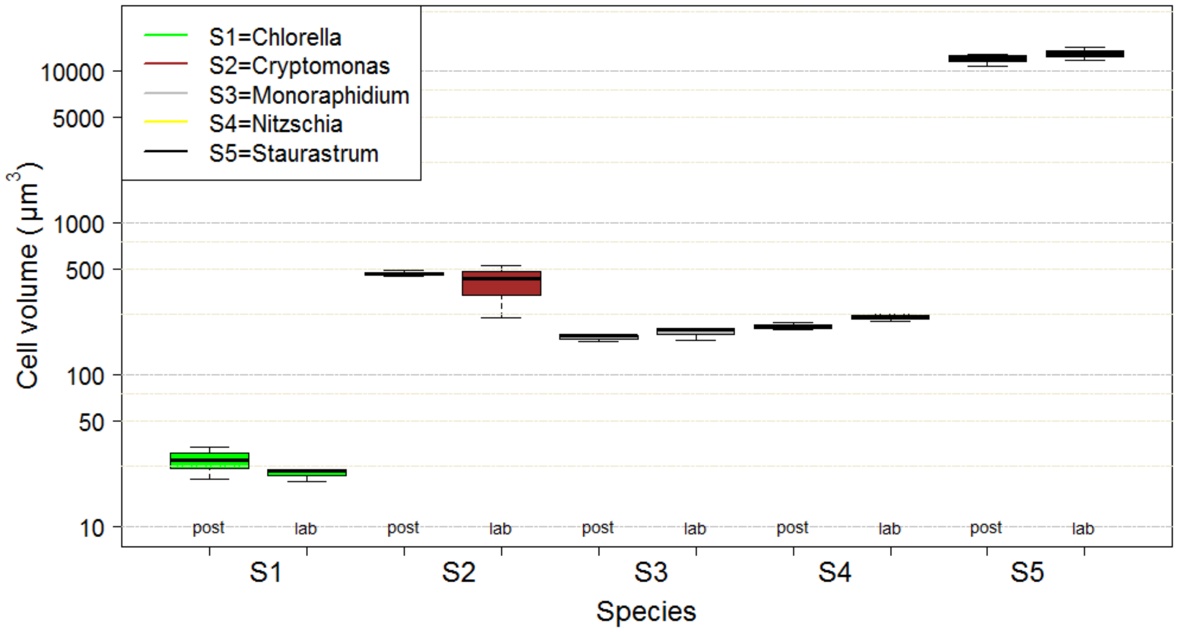


Figure 7: Stability cell volume of the five species in the phytoplankton sample. The two boxplots for every species represent the calculations of three independent cell volume measurements. Above the x-axis, the indication "post" is for the returned postal package and "lab" for the stability sample counted on 10.2.2020. Please notice the logarithmic scale of the y-axis.

2.3. Video clips

A great number of video clips from individual phytoplankton species were made by the LTV. A selection of 35 videos were sent to Wolf-Henning Kusber for taxonomic evaluation (on a subcontract basis). Based on his evaluation report (received 22.11.2019) we made a selection of 10 taxa. Six taxa were pre-assigned for determination on the species level and four taxa for determination at the genus level.

3. Results & Discussion

Results were analysed by calculating the robust mean and standard deviation, tolerance limits and Z_u-scores by Q-method and Hampel estimator in the A45-excel sheet of © AQS Baden-Württemberg Stuttgart. This method follows the norms defined in the DIN EN ISO/IEC 17043:2010, DIN ISO 13528:2015 and DIN EN 38402-45:2014. Before analysis, outliers were removed (following DIN ISO 13528:2015). We defined an outlier when the value was >25-fold different from the mean. Outliers removed before the analysis are provided as a number in the figures. Outliers included into the analysis but off-scale in the figure are provided as a number between brackets in the figures. Figures were done in R (R Core Team, 2017).

For counting a reliable number of particles, the norm asks us to count at least 40 units for every dominant organism, but up to 200 units is considered optimal to comply with a maximum of 20% measurement uncertainty. For every parameter we calculated the specific measurement uncertainty (U) as follows (in which Sl is the standard deviation of reproducibility (variation between participants), Sr the repeatability standard deviation (variation within one participant) and m is the number of replicates:

$$U = 1.96 \ * \ \sqrt{(Sl^2 + \left(\frac{Sr^2}{m}\right))}$$

3.1. Component 1: Reference counting chamber

The reference counting chamber contained spherical micro-particles in 3 different size classes. The participants had to count and calculate the particle concentration, measure the diameter of 12 particles (when present) and calculate the particle volume and total biovolume per litre. To calculate a concentration a sedimentation volume of 1mL had to be assumed. For every parameter description, we will first focus on the large particles, then the medium and the small at last. In every figure we show the results as box plots for every laboratory consisting of the mean value and 95% confidence intervals (orange boxes), the robust mean value (bold black line), the lower and upper tolerance limits (blue and red dashed lines, respectively). If laboratory results were regarded as outliers (value >25-fold different from the robust mean), mean results are given in numbers centred on the laboratory code grid line. Numbers in brackets are results enclosed in the analysis, but out of scale.

3.1.1. Particle counts

For the proper counting of the large particles, the whole chamber had to be counted, which was applied by most of the participants (Table 5). Most of the participants reported the pre-assigned value (9,000) as the robust mean was also 9,000 Particles/L, although there were some exceptions (Fig. 8). Participants 54 and 66 counted the large particles in fields, and participant 69 in transects, thereby overestimating the concentration. The 1,000-fold too low value for participant 30 was caused by the incorrect assumption that values were expressed on mL, not L basis (which is also reflected in the values for the medium and small particles). Participants 27, 46 and 10 counted the correct number of particles, but calculated the wrong particle density. The applied strategies are summarized in Table 5.

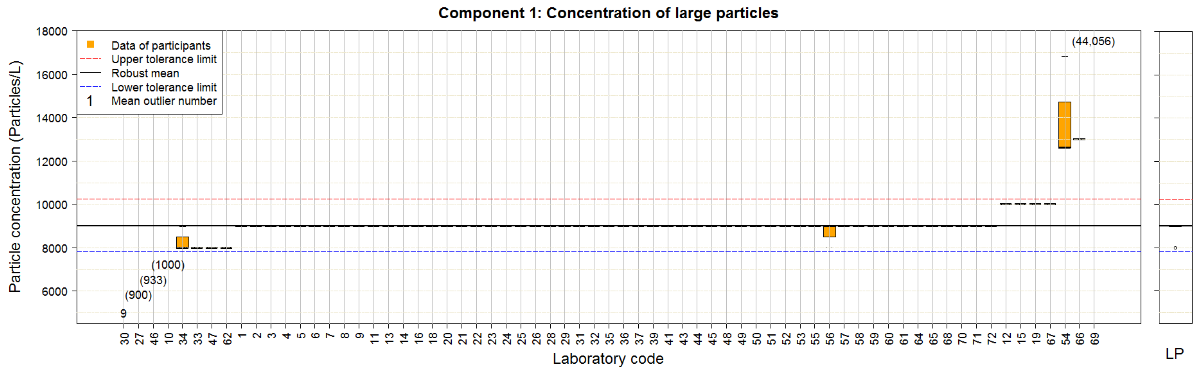


Figure 8: Large particle concentration in the reference counting chamber. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 9.0 10^3, 7.83 10^3, and 10.25 10^3 Particles/L, respectively. The standard deviation of reproducibility was 7.79% and the repeatability standard deviation could not be determined.

Table 5. Summary of counting strategies used for the large particles.

counting areas	number of counting areas			investigated area (mm^3)			used magnification			counted particles			number of labs
	min	mean	max	min	mean	max	min	mean	max	min	mean	max	
chamber	1	1	3	0.03	522	531	40	103	400	8	9	10	64
transect	4	4	4	12	12	12	400	400	400	4	4	4	1
fields	40	270	500	0.23	1.7	3.1	100	150	200	3	3	4	2

For the proper counting of the medium particles, 2 transects at a 600-fold magnification or 40 fields at a 200-fold magnification were more than sufficient for counting, which was applied by most of the participants (Table 6). With this method between 272 and 317 particles were captured. Most of the participants reported the pre-assigned value (17.55 10^6) as the robust mean was 17.41 10^6 Particles/L, although there were some exceptions (Fig. 9). Participants 48, 30, 46, 10 and 21 underestimated the particle concentration. Participant 48 responded to us that unfortunately something went wrong with the entry of the data. Participant 46 counted too many (1538) particles in four transects, and participant 10 counted 270 particles in a very large, but also strange number of 86.67 fields. Participant 21 counted a high number (650) of particles in a large number (100) of fields.

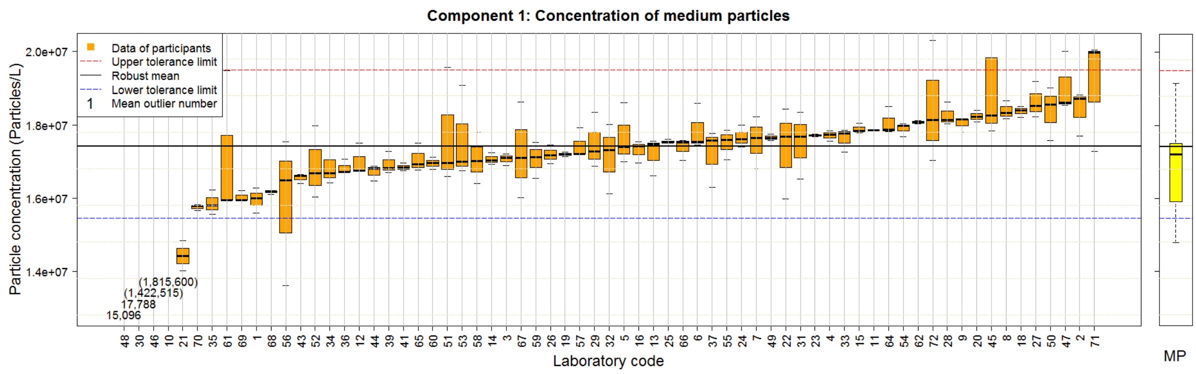


Figure 9: Medium particle concentration in the reference counting chamber. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 17.41 10^6, 15.44 10^6, and 19.50 10^6 Particles/L, respectively. The standard deviation of reproducibility was 5.81% and the repeatability standard deviation 0.85%. The specific measurement uncertainty (U) was 11.4%.

Table 6. Summary of counting strategies used for the medium particles.

counting areas	number of counting areas			investigated area (mm³)			used magnification			counted particles			number of labs
	min	mean	max	min	mean	max	min	mean	max	min	mean	max	
chamber	0.25	0.25	0.25	530	530	530	200	200	200	4552	4552	4623	1
transect	1	2.1	6	4	27.9	530	40	277	600	194	630	1538	37
fields	2	52	300	0.03	0.9	11.7	100	315	640	12	389	1065	29

For the proper counting of the small particles, two transects at a 400 magnification or 40 fields at a 200 magnification were sufficient for counting, which was applied by most of the participants (Table 7). Most of the participants reported the pre-assigned value (10.0 10^6) as the robust mean was 9.7 10^6 Particles/L, although there were some exceptions (Fig. 10). Participants 11, 13 and 36 overestimated and participants 30, 46 and 10 underestimated the particle concentration. Possible reason for the overestimation by participant 11 could well be caused by counting only 40 particles in 100 fields and by participant 36 of only observing 10 fields. When using fields, a minimum of 20 is required. Participant 46 counted a large number (860) of particles in 4 transects, and participant 10 counted 145 particles, again, in a very large, but also strange number of 86.67 fields. For participant 13 the reason for the deviation remains unknown. The Z_u-score of participant 6 was <2 because they reported a too large deviation between the 3 replica's. This was most likely a result of a typing error in one of the values. The applied strategies are summarized in Table 7.

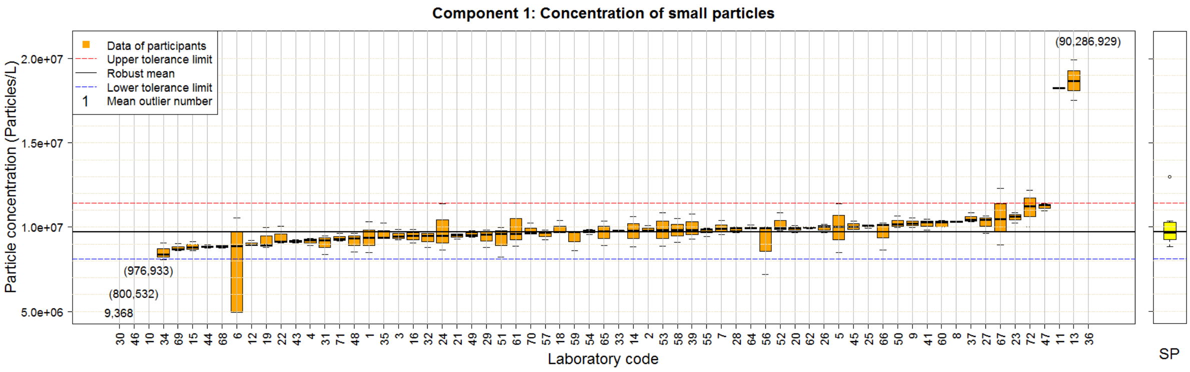


Figure 10: Small particle concentration in the reference counting chamber. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 9.7 10^6, 8.1 10^6, and 11.4 10^6 Particles/L, respectively. The standard deviation of reproducibility was 8.59% and the repeatability standard deviation 1.94%. The specific measurement uncertainty (U) was 17%.

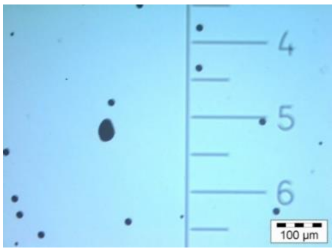
Table 7. Summary of counting strategies used for the small particles.

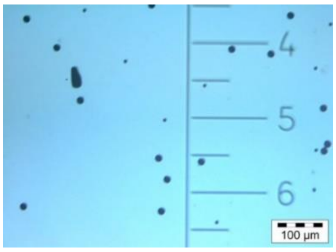
counting areas	number of counting areas			investigated area (mm³)			used magnification			counted particles			number of labs
	min	mean	max	min	mean	max	min	mean	max	min	mean	max	
chamber	0.25	0.25	0.25	530	530	530	200	200	200	2417	2424	2596	1
transect	1	2.3	6	4	25.2	530	40	307	600	108	324	871	38
fields	2	58.9	300	0.03	0.9	7.8	200	368	640	40	235	584	28

In conclusion: Deviations for the robust mean were predominantly caused by choosing an improper counting strategy (participants 54, 66 and 69). Participants 46 and 10 should check if their microscopy calibration or their calculations as they underestimated the concentrations of particles in all three cases. Participants 27, 21, 11, 13 and 36 should critically evaluate their results for improvement.

3.1.2. Diameter

Although we intensively checked seven reference counting chambers before sending the packages to the participants, and although we checked for overlapping particles in our calculations, there were some participants who observed particles that were not totally round. Based on the photos sent, these were overlapping particles or small smears during processing (see photos below). Nonetheless, these minor exceptions were no problem to count and determine the diameter of the three particle sizes properly.





Only three participants measured a too small diameter (Nos 25, 2 and 8) and one participant a too big diameter (No. 69) for the large particles (Fig. 11). The pre-assigned value (49) was very close to the robust mean of 49.4 µm. Participant 25 acquired a new microscope with measuring software and did not have time to calibrate the system properly (also seen in their results for small particles). Also participant 69 wrote that the deviation of the diameter was likely a result of wrongly calibrated internal microscope software (also seen in their results for medium particles). This emphasizes the need to calibrate your microscope every time something has been changed or even when newly acquired. For participants 2 and 8 the reasons for the deviation remains unknown. The Z_u-score of participant 56 was >2 because the deviation in the data was too large (ranging between 49.4 and 60.1).

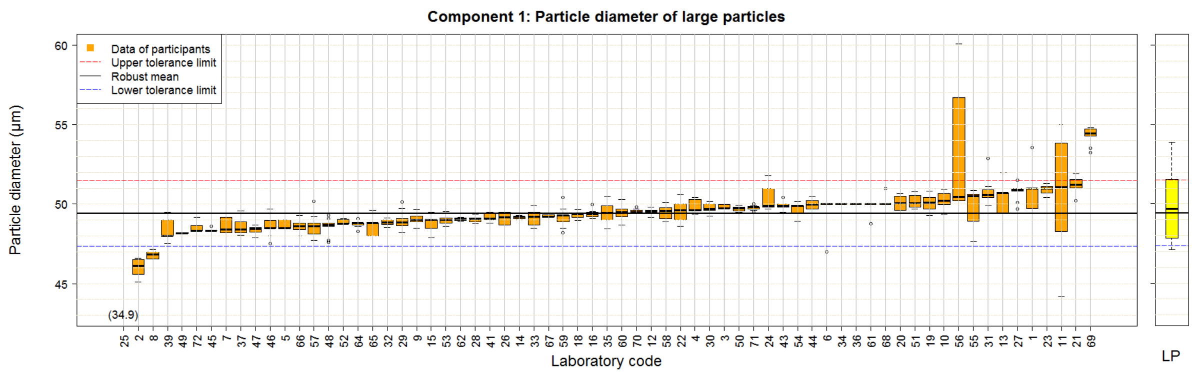


Figure 11: Diameter of the large particles in the reference counting chamber. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 49.4, 47.4, and 51.5 µm, respectively. The standard deviation of reproducibility was 2.1% and the repeatability standard deviation 0.22%. The specific measurement uncertainty (U) was 4.12%.

Three participants (Nos 2, 8 and 47) measured a too small diameter and two participants (23 and 69) a too big diameter for the medium particles (Fig. 12). The pre-assigned value (15) was very close to the robust mean of 15.12 µm. For participants 2, 8, 47 and 23 the reasons for the deviation remains unknown.

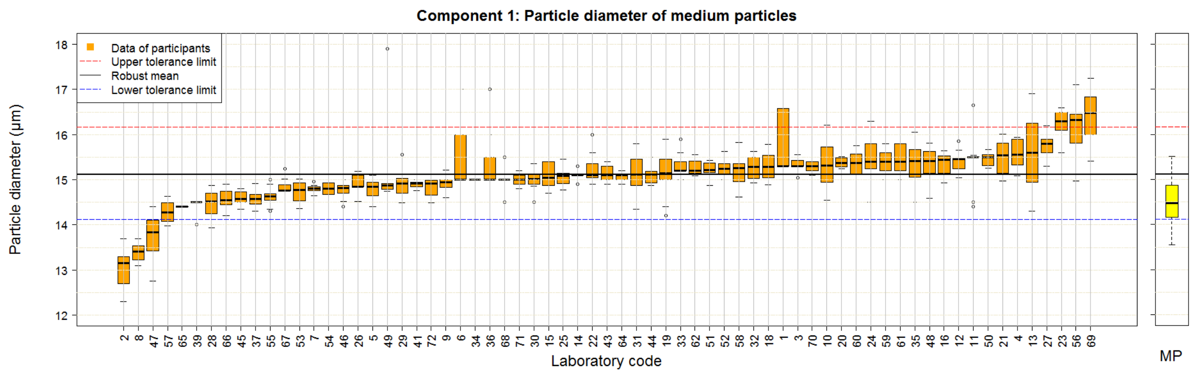


Figure 12: Diameter of the medium particles in the reference counting chamber. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 15.1, 14.1, and 16.2 µm, respectively. The standard deviation of reproducibility was 3.38% and the repeatability standard deviation 0.47%. The specific measurement uncertainty (U) was 6.6%.

For the small particles, three participants (Nos 2, 25 and 8) measured a too small diameter and one participants (56) a too big diameter (Fig. 13). The pre-assigned value (7) was very close to the robust mean of 6.81 µm. For participants 2, 8, and 56 the reasons for the deviation remains unknown.

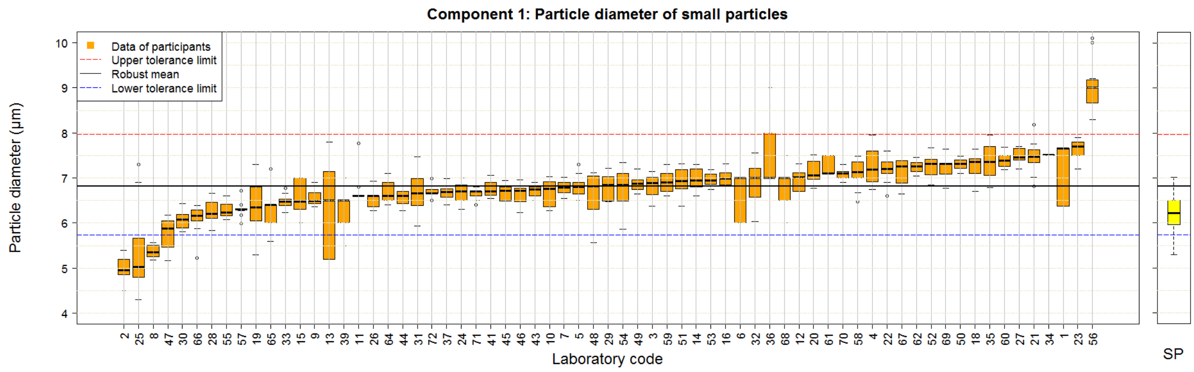


Figure 13: Diameter of the small particles in the reference counting chamber. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 6.8, 5.7, and 8.0 µm, respectively. The standard deviation of reproducibility was 8.22% and the repeatability standard deviation 1.16%. The specific measurement uncertainty (U) was 16.1%.

In conclusion: participants 2 and 8 should check if their microscopy calibration as they underestimated the diameter of all particles. Participants 23 and 56 should critically evaluate their results for improvement. In general, it is important to state: Calibrate your microscope every time something has been changed in the setup, after a maintenance, cleaning or even when it is newly acquired (participants 25 and 69).

3.1.3. Biovolume concentration

From the particle concentration and the particle volume, participants calculated the total biovolume in mm³ per litre. For the large particles (Fig. 14), the robust mean was 0.567 mm^3/L and four participants calculated an 100-fold too low value (Nos 25, 46, 27 and 10). Also participants 2 and 47 had lower entries. For participant 25, the lower diameter measured with a new microscope, was amplified here by the use of a wrong formula for the sphere (also reflected in the biovolume of the medium and small particles). The COVID19 pandemic played a part in this mistake.

Participants 66, 23, 69, 3, 11 and 36 overestimated the total biovolume. Participant 3 wrote us to explain that a wrong conversion factor was used to calculate the total biovolume. This factor was also used for the medium and small particles. For participants 11 and 36 a calculation error appears to be the reason of this result. The Z_u-score of participant 54 was >2 as a result of the large deviation between replicates (varying between 0.61 and 0.81).

As seen above, some deviations in the results origin from the deviating particle density (participants 27, 46, 10, 66 and 54), some from deviating particle diameter (participants 25 and 2), or from both (participant 69). Participants 47 and 23 should critically evaluate their results.

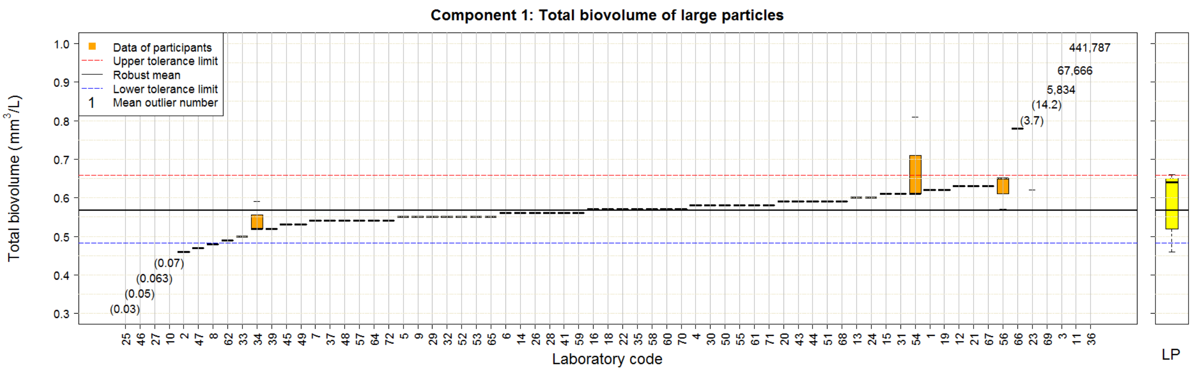


Figure 14: Total biovolume concentration of large particles in the reference counting chamber. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 0.567, 0.482, and 0.659 mm^3/L, respectively. The standard deviation of reproducibility was 7.79% and the repeatability standard deviation could not be calculated.

For the medium particles (Fig. 15), the robust mean was 31.25 mm^3/L and 5 participants calculated a lower value (Nos 46, 10, 25, 2, and 8). Participants 23, 56, 11, 3, and 36 overestimated the total biovolume concentration. As seen above, some deviations in the results origin from the deviating particle density (participants 46 and 10), some from deviating particle diameter (participants 2, 8 and 23).

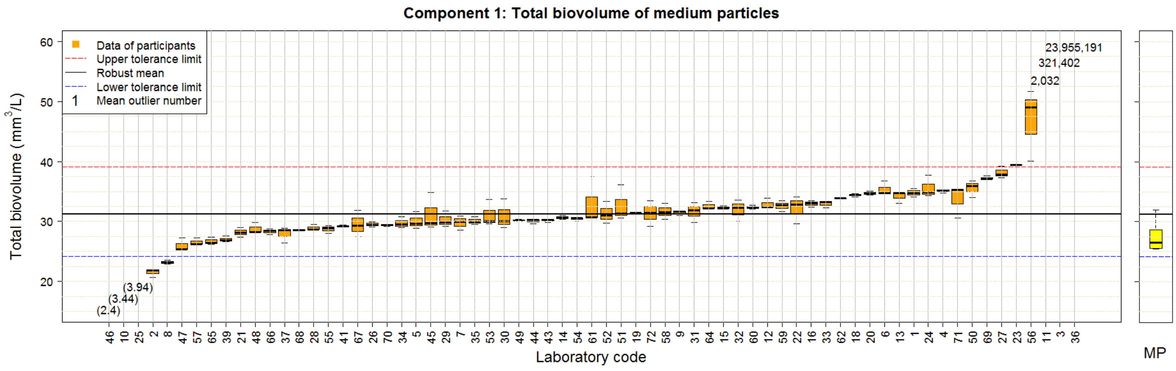


Figure 15: Total biovolume concentration of medium particles in the reference counting chamber. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 31.25, 24.23, and 39.16 mm^3/L, respectively. The standard deviation of reproducibility was 11.85% and the repeatability standard deviation 0.95%. The specific measurement uncertainty (U) was 23.1%.

For the small particles (Fig. 16), the robust mean was 1.624 mm^3/L and four participants calculated a lower value (Nos 25, 46, 10, and 2). Participants 13, 56, 3, 11, and 36 overestimated the total biovolume. As seen above, some deviations in the results origin from the deviating particle density (participants 46, 10, 13, 11 and 36), some from deviating particle diameter (participants 25, 2 and 56).

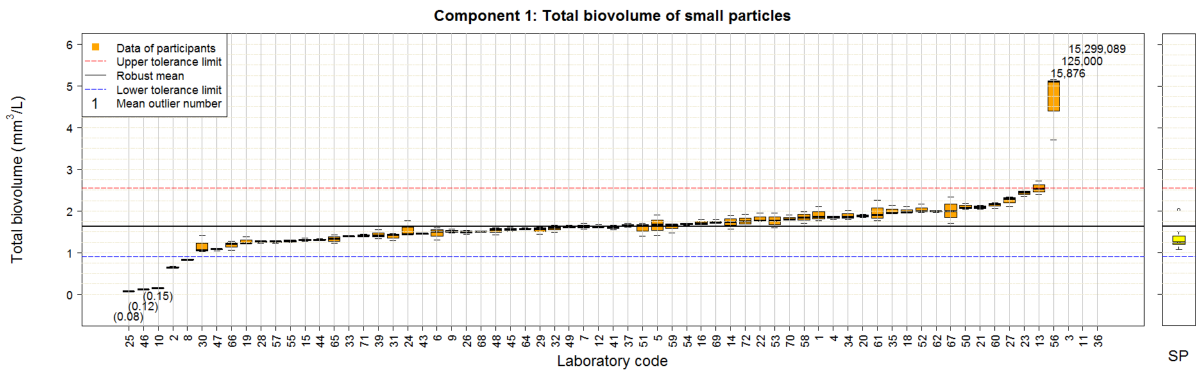


Figure 16: Total biovolume concentration of small particles in the reference counting chamber. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 1.624, 0.898, and 2.554 mm^3/L, respectively. The standard deviation of reproducibility was 24.73% and the repeatability standard deviation 1.94%. The specific measurement uncertainty (U) was 48.5%.

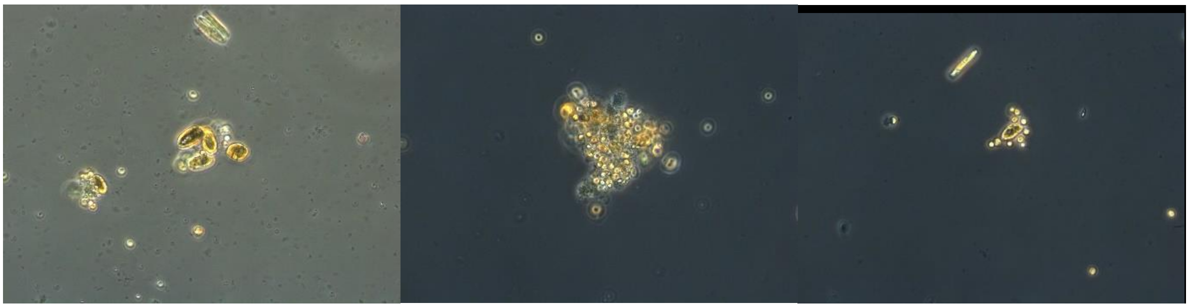
In conclusion: Most deviations in the total biovolume calculations originated from a deviation in either the particle density or the particle diameter. Participant 3 had to check the conversion factor for calculating $µm^3$ to mm^3, and participants 11 and 36 should check their calculations for total biovolume. Participants 47 and 23 should critically evaluate their data for improvement.

The majority of participants performed very well in component 1. Only 9 participants of 67 failed this component (13%). In total 9 points could be scored, and we set the success level on 67%. This means that three deviations over a Z_u-score of |2| from the robust mean were tolerated to pass this component. The major problems for not passing this component have been discussed above (choice of counting strategy, calibration of measuring software, calculation mistakes, and wrong entry of the data).

3.2. Component 2: Phytoplankton sample

In the mixed algal sample, the total cell number and the total biovolume from five phytoplankton species is evaluated. The participants also reported the cell counts, geometric shape, cell volume and counting strategy for every species in the sample. We advised to sediment 10 mL sample volume. In every figure we show the results as box plots for every laboratory consisting of the mean value and 95% confidence intervals (orange boxes), the robust mean value (bold black line), the lower and upper tolerance limits (blue and red dashed lines, respectively). If laboratory results were regarded as outliers (value >25-fold different from the robust mean), mean results are given in numbers centred on the laboratory code grid line. Numbers in brackets are results enclosed in the analysis, but out of scale. Results were analysed according to DIN 38402-45:2014.

We made an almost 'natural' phytoplankton sample from five species of algae (Table 4). The sample was fixed with basic lugol solution and should be stored in a cool place. Incorrect storage would result in clumping of cells as was shown in the stability countings (see paragraph 2.2.2. post sample). Nonetheless, results would not deviate too far from the robust mean. Some impressions of the reported clumps in the sample are provided below.



3.2.1. Cell density

The species No. 1 was *Chlorella* sp. and the robust mean was 7.05 10^6 cells/L (Fig. 17). Participants 64, 61, 69, 6, 34, 11, 23 and 67 reported a too low cell density for reaching the lower tolerance limit. Participant 69 wrote us that they unfortunately forgot to account for the 10 mL sedimentation in their calculation (also seen in the results for species 2, 3 and 4). This raised the cell density of species 1 to 1.5 10^6 cells/L, which is still below the lower tolerance limit (Fig. 17). When the data of participant 69 would be corrected, then the cell densities of species 2 and 4 would be embedded within the tolerance limits, but the value for species 3 would not reach the lower tolerance limit (discussed there).

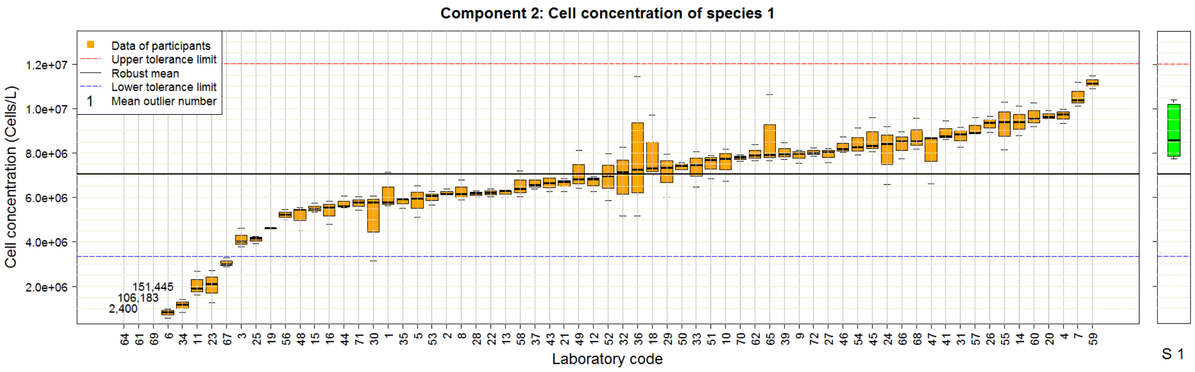


Figure 17: Cell density of species 1: *Chlorella* sp. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 7.05 10^6, 3.34 10^6, and 1.20 10^7 cells/L, respectively. The standard deviation of reproducibility was 33.38% and the repeatability standard deviation 3.07%. The specific measurement uncertainty (U) was 65.5%.

To check if these deviations were related to the choice for a certain counting strategy we summarized the counting strategies in Table 8. Most of the participants counted species 1 in fields, which is the preferred strategy. Some participants only counted 2 fields, which is too little. Although the number of counted particles can be sufficient, the distribution of the fields over the chamber cannot be random enough. Quite a number of participants choose to count in transects. There a minimum of 2 is required for the same reason as for fields. For both strategies, there were participants who counted thousands of algae. Although this does not necessarily result in a wrong estimation of cell density, the effort is too large and it is therefore unfavourable. One participant (number 64) counted the whole chamber, but this participant unfortunately mixed up the species when filling in the results (also seen in the results for species 3 and 5). Participants 61 and 69 counted just 4 or 8 fields; and participant 23 just 1 transect. On the other side of the spectrum, there are participants 6, 34 and 11 who counted 105, 100 and 100 fields respectively. Such high number might lead to mistakes after short distractions. For participant 67 it is not clear why their values deviate.

Table 8. Summary of counting strategies used for species 1: *Chlorella* sp.

counting areas	number of counting areas			investigated area (mm^2)			used magnification			counted algae			number of labs
	min	mean	max	min	mean	max	min	mean	max	min	mean	max	
chamber	1	1	1	531	531	531	400	400	400	21	24	29	1
transect	1	2.1	6	0.64	7.18	16.3	40	483	1500	50	952	2388	21
fields	2	45.6	105	0.02	0.39	5.72	100	538	1500	42	379	2254	45

The species No. 2 was *Cryptomonas obovoidea* and the robust mean was 3.64 10^5 cells/L (Fig. 18). Only participants 69 and 36 reported a too low cell density for reaching the lower tolerance limit.

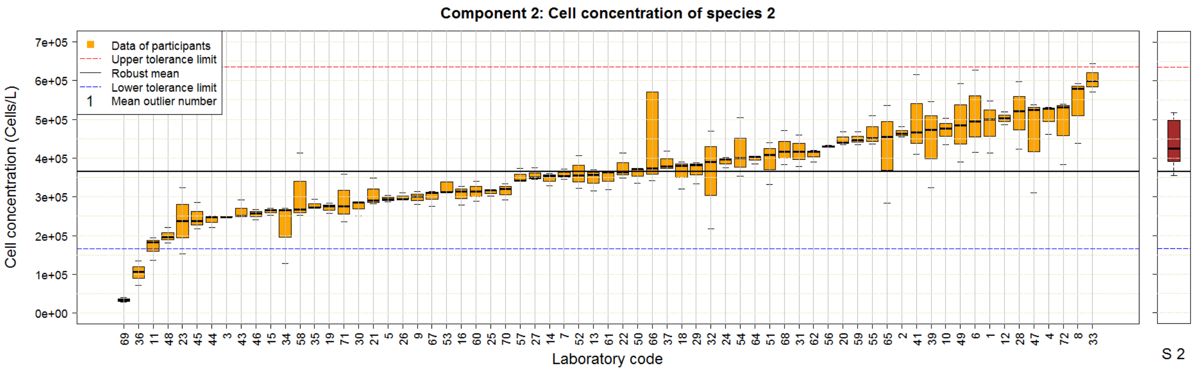


Figure 18: Cell density of species 2: *Cryptomonas obovoidea*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 3.64 10^5, 1.66 10^5, and 6.35 10^5 cells/L, respectively. The standard deviation of reproducibility was 30.77% and the repeatability standard deviation 4.03%. The specific measurement uncertainty (U) was 60.5%.

To check if these deviations were related to the choice for a counting strategy we summarized the counting strategies in Table 9. Most of the participants counted species 2 in transects, which is the preferred strategy. Although participant 36 used transects, they counted just one transect. Two transects is always a minimum for a proper estimation, because cells are never truly randomly distributed.

Table 9. Summary of counting strategies used for species 2: *Cryptomonas obovoidea*.

counting areas	number of counting areas			investigated area (mm^2)			used magnification			counted algae			number of labs
	min	mean	max	min	mean	max	min	mean	max	min	mean	max	
chamber	0.2	0.4	0.5	530	530	531	200	400	600	797	1295	1635	2
transect	1	3.5	12	3.93	18.8	159	40	324	1500	39	219	870	45
fields	2	96.1	325	0.03	1.81	15.6	200	396	640	3	154	825	20

Species No. 3 was *Monoraphidium griffithii* and the robust mean was 80,319 cells/L (Fig. 19). Participants 69 and 67 reported a too low cell density for reaching the lower tolerance limit. Participants 1, 56, 33 and 64 reported a too high density.

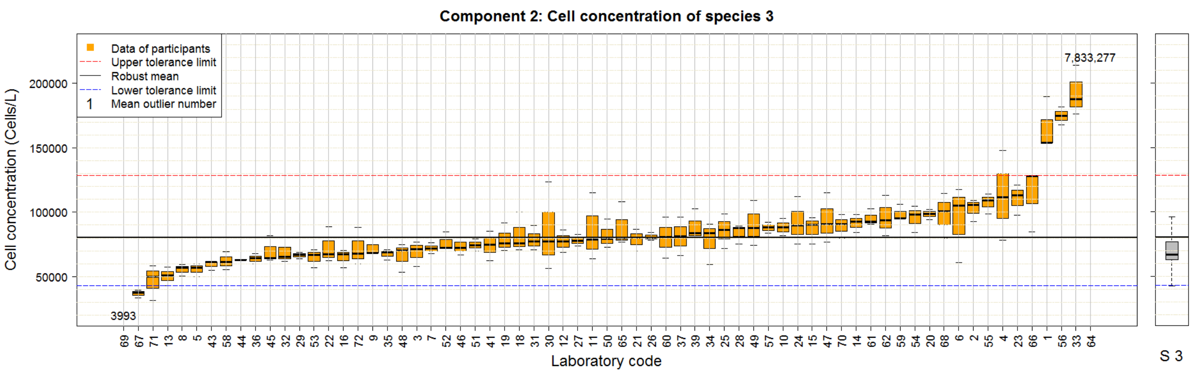


Figure 19: Cell density of species 3: *Monoraphidium griffithii*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 80,319, 43,112, and 128,418 cells/L, respectively. The standard deviation of reproducibility was 27.51% and the repeatability standard deviation 6.31%. The specific measurement uncertainty (U) was 54.4%.

This species was the most difficult one to count properly, because the size was rather small, but it was present in low numbers. Therefore a relatively high number of counting areas was required for counting, which was applied by many participants (Table 10). Most of the participants counted species 3 in at least four transects, which is the preferred strategy. Participants 69, 67, 1 and 33 used fields, which strategy on average resulted in a Z_u-score of 14.7. Participant 56 counted 5 transects with 308 to 333 objects, which was probably a too large number.

Table 10. Summary of counting strategies used for species 3: *Monoraphidium griffithii*.

counting areas	number of counting areas			investigated area (mm²)			used magnification			counted algae			number of labs
	min	mean	max	min	mean	max	min	mean	max	min	mean	max	
chamber	0	0.8	1.5	265	487	531	100	268	600	177	473	840	8
transect	1	4.1	12	3.93	17.9	57.2	40	292	1500	9	69	333	38
fields	2	90.9	325	0.03	2.51	31.3	200	342	640	4	56	495	21

The species No. 4 was *Nitzschia communis* and the robust mean was 1.52 10^5 cells/L (Fig. 20). Participants 69 and 43 reported a too low cell density for reaching the lower tolerance limit. The Z_u-scores of participants 6 and 1 were above 2.

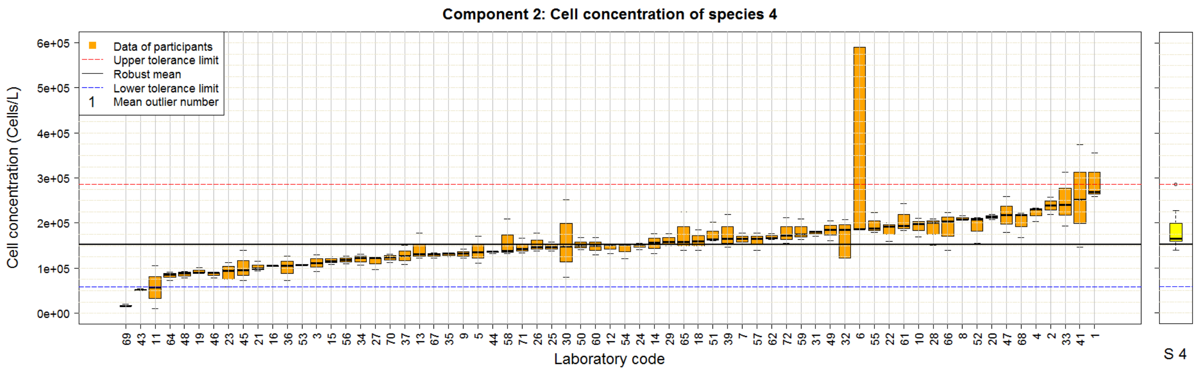


Figure 20: Cell density of species 4: *Nitzschia communis*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 1.52 10^5, 0.59 10^5, and 2.86 10^5 cells/L, respectively. The standard deviation of reproducibility was 35.43% and the repeatability standard deviation 5.25%. The specific measurement uncertainty (U) was 69.7%.

To check if these deviations were related to the choice for a counting strategy we summarized the counting strategies in Table 11. Most of the participants counted species 4 in transects, which is the preferred strategy. Although participant 43 counted transects only 59 objects were captured. Participant 1 only counted 28 to 37 objects in 27 fields. A number between 100 and 200 would be preferred. Although other participants counted even less objects (Table 11), you can be lucky (not preferred).

An interesting deviation was observed by participant 6, where the mean was within the confidence limits, but the deviations between the three counts was so large, that the Z_u-score was higher than 2. Examining the results revealed that participant 6 unfortunately miscalculated one of the counting events.

Table 11. Summary of counting strategies used for species 4: *Nitzschia communis*.

counting areas	number of counting areas			investigated area (mm^2)			used magnification			counted algae			number of labs
	min	mean	max	min	mean	max	min	mean	max	min	mean	max	
chamber	0.2	0.7	1.5	228	392	531	200	323	600	354	575	769	6
transect	1	3.9	12	3.9	16.2	57.2	40	297	1500	15	100	286	41
fields	2	98.2	325	0.03	2.59	31.3	200	375	640	7	72	322	20

The species No. 5 was *Staurastrum actiscon* and the robust mean was 2,170 cells/L (Fig. 21). Participants 45, 16, 1 and 64 reported a too high cell density exceeding the higher tolerance limit.

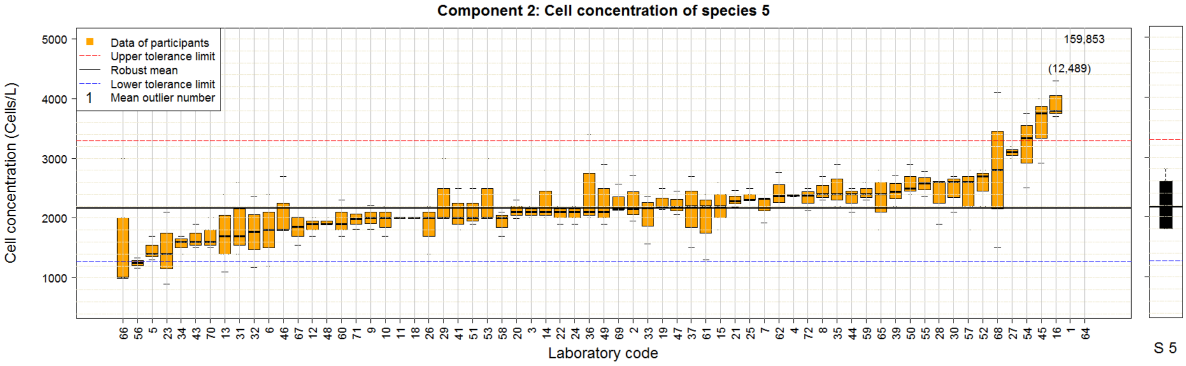


Figure 21: Cell density of species 5: *Staurastrum actiscon*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 2,170, 1,272, and 3,297 cells/L, respectively. The standard deviation of reproducibility was 24.29% and the repeatability standard deviation 6.41%. The specific measurement uncertainty (U) was 48.2%.

To check if these deviations were related to the choice for a counting strategy we summarized the counting strategies in Table 12. Most of the participants counted species 5 in the whole chamber, which is the preferred strategy. Participant 1 used 27 fields, capturing 1 or 2 objects. Participant 45 used only one field, capturing 7 to 10 objects. Participant 16 counted one chamber in which too many objects were captured (37-43). Interestingly, participant 67 also captured too many objects in one chamber (54-76), wrote an unusual 0.315 mL mean sedimentation volume, but calculated an accepted cell density (1,845 cells/L). Counting fields gave a mean Z_u-score of 5, and transects, 129.

Table 12. Summary of counting strategies used for species 5: *Staurastrum actiscon*.

counting areas	number of counting areas			investigated area (mm^2)			used magnification			counted algae			number of labs
	min	mean	max	min	mean	max	min	mean	max	min	mean	max	
chamber	0.5	1.2	4	0.03	503	531	40	185	600	6	23	87	61
transect	4	6	8	6.93	9.48	12.03	400	400	400	5	77	190	2
fields	1	142	500	0.23	27.53	101	100	335	640	1	6	10	4

In conclusion: Most deviating results from the robust mean in the algal density determination resulted from choosing an incorrect counting strategy. Participants that should evaluate their strategies are participants 1, 6, 11, 23, 33, 34, 36, 43, 45, 56, 61, 67 and 69. Participant 1 is an interesting example here as they used 27 fields for every single species. A single counting strategy can never suit for every species. Summarizing counting strategies: For large, low density species the whole chamber should be counted. When counting transects, a minimum of 2 is required. When counting fields a minimum of 20. To optimize the counting reliability, between 100 and 200 items should be counted. The DIN EN 15204:2006 states that the total number of counted objects should be >400. From the dominant taxa one should count at least 60 cells/objects at a strong magnification (e.g. 400-fold) or 20 cells/objects at a weaker magnification (e.g. 100-fold).

3.2.2. Cell volume

All participants provided a cell volume for every species and most values were quite similar (Fig. 22). Next to the cell volume, all participants described a geometric shape used to calculate the cell volume, which will be included in our evaluation below.

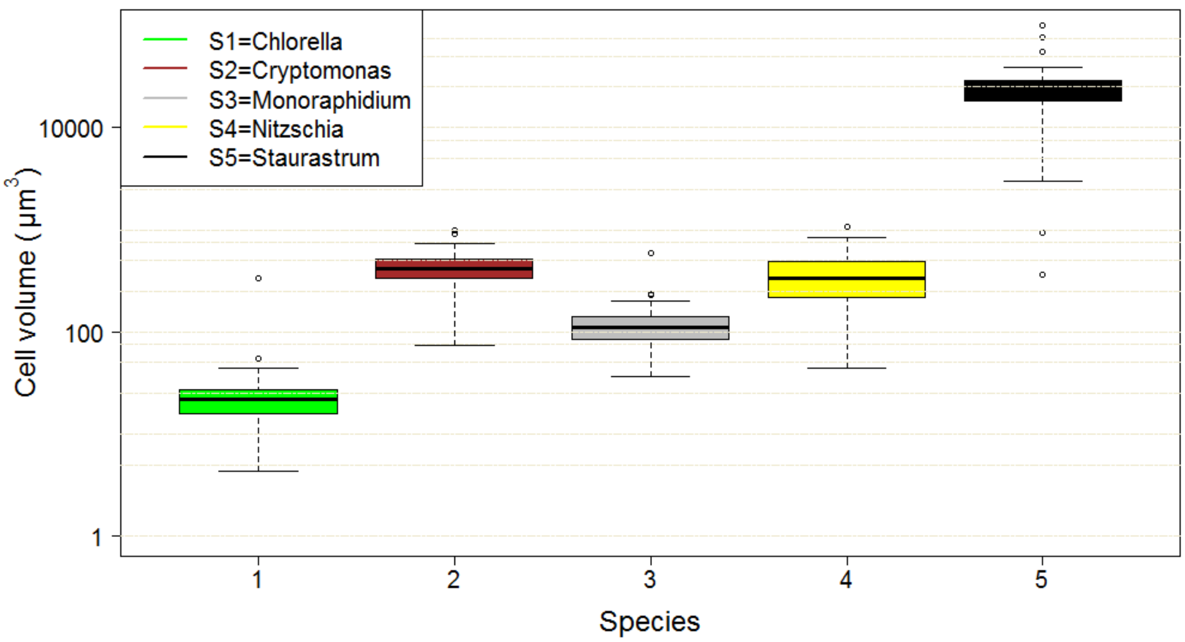


Figure 22: Mean cell volume (in µm^3/cell) of all species in the natural phytoplankton sample (component 2. N=67). Please notice the logarithmic scale on the y-axis.

For species 1: *Chlorella* the cell volume ranged between 4.3 and 27,648,666 µm^3 (Fig. 23)

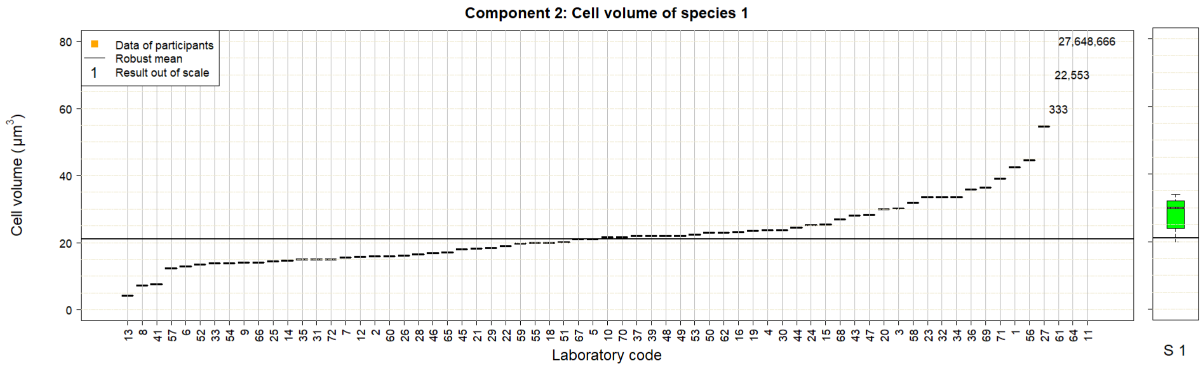


Figure 23: Cell volume of species 1: *Chlorella* sp. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean was 21.08 µm^3.

The deviating cell volume measured by participant 13, 56 and 27 might be caused by only measuring 10 or 12 cells. A minimum of 20 is preferred. Participant 64 unfortunately mixed up the species when filling in the results, and the cell volume (double ellipsoid in Table 13) fits well into the results for species 5: *Staurastrum*. Other deviating results cannot be explained and should be evaluated by the participants 11 and 61 themselves. A quarter of the participants used the preferred formula of a spheroid or ellipsoid, whereas the sphere is also acceptable (Table 13).

Table 13. Used geometric shape used to calculate cell volume and the mean for species 1: *Chlorella* sp. The bold formula is the preferred following DIN EN 16695:2015.

Formula	Number of participants	Mean cell volume
Spheroid /Ellipsoid	**14**	**40**
Flattened ellipsoid	3	18.4
Sphere	47	23.3
Double ellipsoid	1	22,553

For species 2: *Cryptomonas* the cell volume ranged between 74 and 48,525,200 µm^3 (Fig. 24).

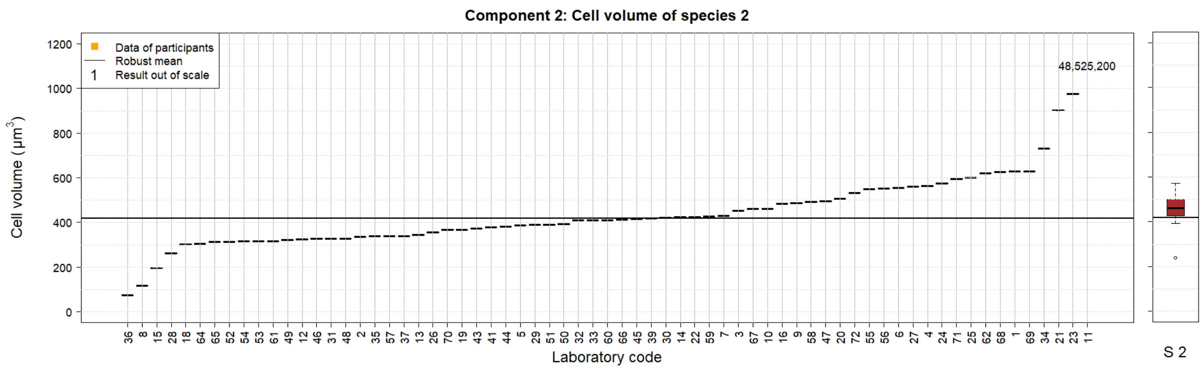


Figure 24: Cell volume of species 2: *Cryptomonas obovoidea*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean was 419 µm^3.

The deviating cell volume measured by participant 8 and 34 might be caused by only measuring 10 or 12 cells. Participant 21 reported that in calculation the cell volume of species 2, the length and width were exchanged. If corrected, a proper cell volume of 546 µm^3 is calculated. Other deviating results cannot be explained and should be evaluated by the participants 36, 15, 23 and 11 themselves. Many participants used the preferred formula of a flattened ellipsoid, although the used factors were sometimes different or not mentioned (Table 14). If an ellipsoid without factors is used, the cell volume is slightly overestimated (Table 14).

Table 14. Used geometric shape used to calculate cell volume and the mean for species 2: *Cryptomonas obovoidea*. The bold formula is the preferred following DIN EN 16695:2015.

Formula	Number of participants	Mean cell volume
Flattened ellipsoid (d2=0.8*d1)	**8**	**417.1**
Flattened ellipsoid (with other factors)	16	352.8
Flattened ellipsoid (no factor provided)	17	470.1
Ellipsoid	25	464.1

For species 3: *Monoraphidium* the cell volume ranged between 36.1 and 948,300 µm³ (Fig. 25).

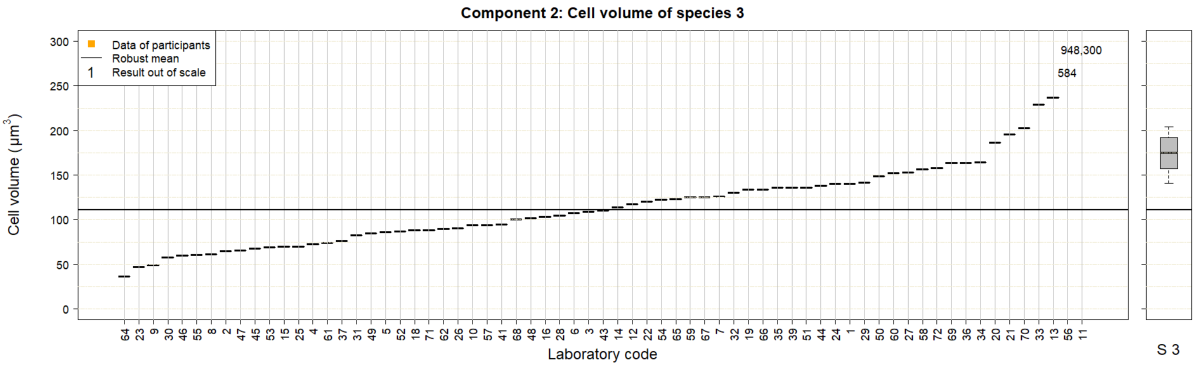


Figure 25: Cell volume of species 3: *Monoraphidium griffithii*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean was 111 µm³.

The deviating cell volume measured by participant 33 and 13 might be caused by only measuring 6 or 10 cells. Many participants used the preferred formula of a spindle, although participant 56 used the formula for a cylinder with 2 cones that overestimated the cell volume (Table 15).

Table 15. Used geometric shape used to calculate cell volume and the mean for species 3: *Monoraphidium griffithii*. The bold formula is the preferred following DIN EN 16695:2015.

Formula	Number of participants	Mean cell volume
Spindle	**48**	**119.1**
Double cone	10	76.9
Cone	1	47.1
Discus	2	179.7
Ellipsoid	2	137.1
Cylinder with 2 cones	1	583.6
Kugel	1	36.1
Cuboid x 0.6	1	163.9

For species 4: *Nitzschia* the cell volume ranged between 43.8 and 21,894,366 µm³ (Fig. 26).

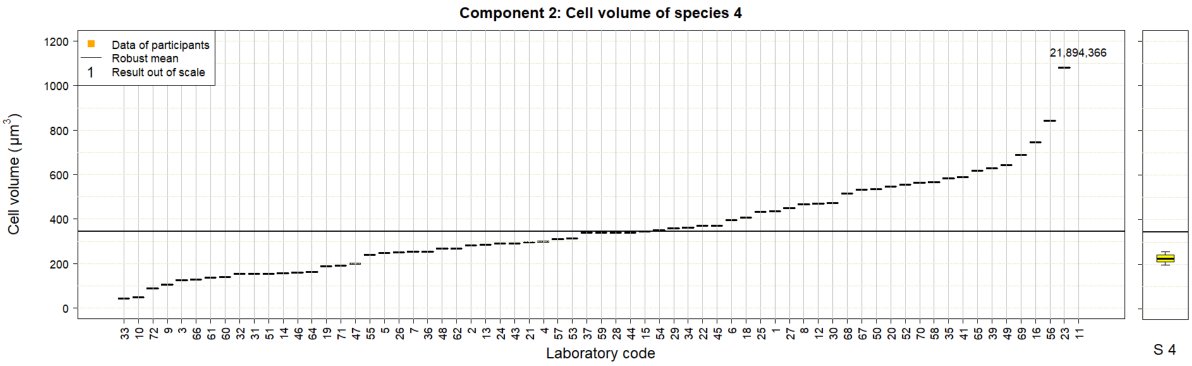


Figure 26: Cell volume of species 4: *Nitzschia communis*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean was 346 µm^3.

The deviating cell volume measured by participant 33 and 23 might be caused by only measuring 6 or 15 cells, respectively. For participants 10 and 11 the deviation from the robust mean cannot be explained and should be evaluated by themselves. Many participants used the preferred formula of a rhombic prism / cuboid, although not always with factors (Table 16). A flattened cylinder was also a correct choice (depending on the considered diatom species). In the formula factors had to be used to properly calculate the cell volume, as the volume was overestimated when no factors were used (Table 16).

Table 16. Used geometric shape used to calculate cell volume and the mean for species 4: *Nitzschia communis*. The bold formula is the preferred following DIN EN 16695:2015.

Formula	Number of participants	Mean cell volume
Rhombic prism (with factors) *1.15 (h=0.5*d2)	**3**	**155.8**
Rhombic prism (no factors)	11	229
Cuboid (with factors)	6	370
Cuboid (no factors)	23	461
Cylinder (with factors/ellipsoid)	16	356
Cylinder (no factors)	2	564
Prism, triangular	3	276
Spindel	2	145

For species 5: *Staurastrum* the cell volume ranged between 365 and 25,025,333 µm^3 (Fig. 27).

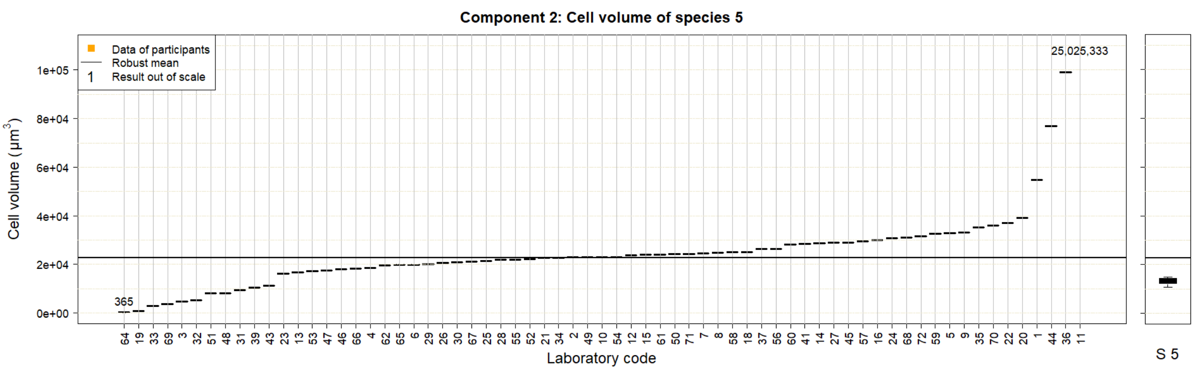


Figure 27: Cell volume of species 5: *Staurastrum actiscon*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean was 22,645 µm^3.

Participants 3, 69, 33 and 32 probably measured just a single semi-cell (tetrahedron or Pyramid + cones (for spines), respectively; Table 17). For *Staurastrum*, and some other desmids, the geometric shape is based on one semi-cell that should be multiplied by two for the whole cell measurement. Participant 44 miscalculated the volume under high working pressure for which we unfortunately could not correct. For participants 1 and 36 the deviation from the robust mean cannot be explained and should be evaluated by themselves. Although the DIN suggests to use a double tetrahedron for the genus *Staurastrum*, a double flattened ellipsoid (d2=0.6*d1, as for *Cosmarium*) would fit better for *Staurastrum actiscon* (Table 17). To compare the difference between the two formulas, we calculated the cell volume using both. The double tetrahedron resulted in 8,835 μm^3/cell and the double flattened ellipsoid gave 12,864 μm^3/cell (latter was used in Fig. 27, n=60 cells). From our own results and Table 17 it is clear that the double tetrahedron results in a smaller cell volume. Nonetheless, the volume measured as a double tetrahedron will also result in a correct calculation of the cell volume. The inclusion of the spines in the cell volume is not recommended, as the relative contribution is small (as seen in Table 17).

In general, the mean cell volume of the participants was double the size of that of our calculation. This was the result of using a double ellipsoid that was not flattened. When we calculate the cell volume based on a double ellipsoid, it resulted in a value very close to the robust mean: i.e. 21,439 μm^3. If you see the *Staurastrum* from the top, it is however clear that the used ellipsoid shape should be flattened and that most participants overestimated the cell volume of *Staurastrum*.

Table 17. Used geometric shape used to calculate cell volume and the mean for species 5: *Staurastrum actiscon*. The bold formula is the preferred following DIN EN 16695:2015.

Formula	Number of participants	Mean cell volume
2* Tetrahedron	**4**	**9,195**
2* Spheroid /Ellipsoid	26	25,558
2* Truncated cones	1	99,104
2* Ellipsoid + cones (for spines)	7	29,104
2* Ellipsoid + cylinder (for spines)	7	24,201
Pyramid + cones (for spines)	2	4,089
Ellipsoid + cylinder (for spines)	3	29,889
Tetrahedron	2	4,242
Cone	1	23,000
Ellipsoid	4	17,262
Flattened ellipsoid	4	25,195

In conclusion: The majority of participants performed very well in this part of the proficiency test. Participant 11 provided serious deviations in the cell volume of all taxa and should check their measurements and calculations. Most deviations from the cell volume possibly resulted from measuring less than 20 cells (participants 8, 13, 23, 27, 33, 34 and 56). Measuring at least 20 cells for estimating cell volume is required. For species 5 some participants only measured the volume of 1 semi-cell, whereas the cell is shaped by two (participants 3, 32, 33 and 69).

3.2.3. Total biovolume of the phytoplankton

The participants calculated the total biovolume per litre for every species.

For species No. 1 the robust mean was 0.138 mm^3/L (Fig. 28). Participants 69, 6 and 13 reported a too low total biovolume to reach the lower tolerance limit, whereas participants 27, 36 and 11 gave a too high biovolume exceeding the higher tolerance limit.

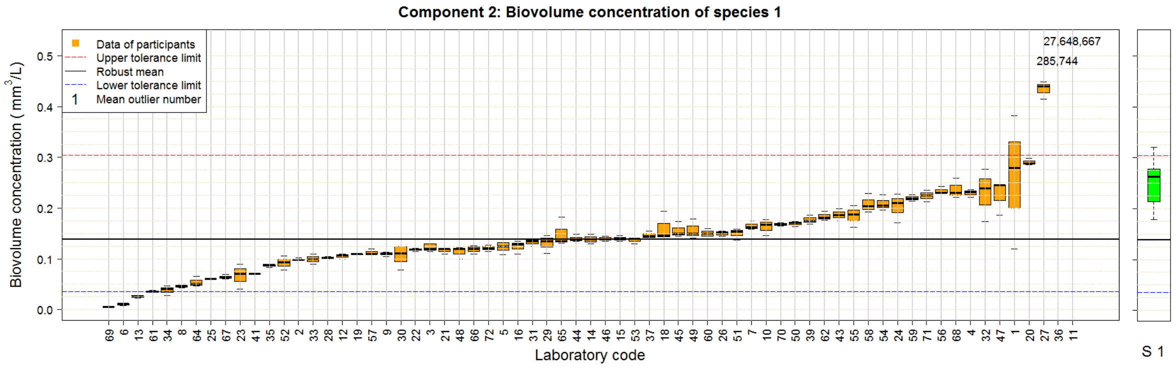


Figure 28: Total biovolume of species 1: *Chlorella* sp. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 0.138, 0.036, and 0.304 mm^3/L, respectively. The standard deviation of reproducibility was 52.37% and the repeatability standard deviation 3.49%. The specific measurement uncertainty (U) was 102.7%.

Participants 69 and 6 reported a too low cell density (Fig. 17) that translated into the too low total biovolume. Participant 13 reported a too low cell volume (Fig. 23) that translated into the too low total biovolume. Participants 27 and 11 reported a too high cell volume (Fig. 23) that translated into the too high total biovolume. For participant 36 it is not clear why the total biovolume was overestimated.

For species No. 2 the robust mean was 0.157 mm^3/L (Fig. 29). Participant 69 reported a too low total biovolume to reach the lower tolerance limit, whereas participants 36 and 11 gave a too high biovolume exceeding the higher tolerance limit.

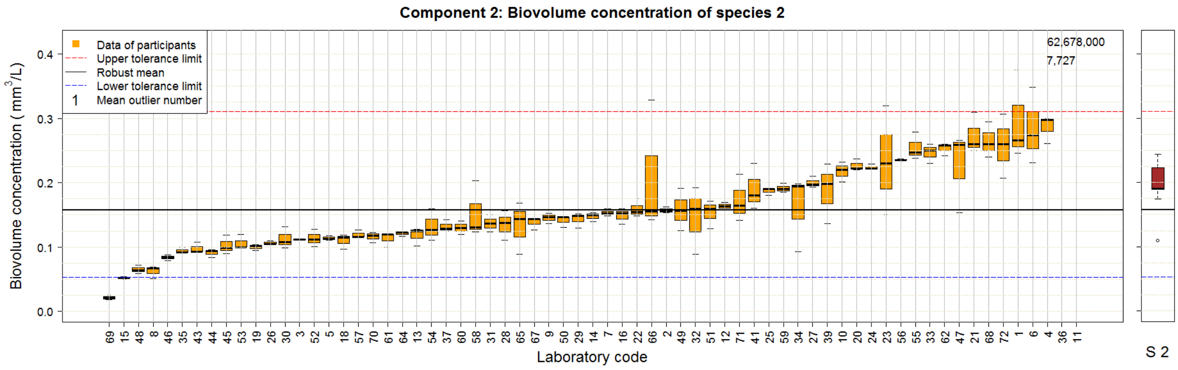


Figure 29: Total biovolume of species 2: *Cryptomonas obovoidea*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 0.157, 0.053, and 0.311 mm^3/L, respectively. The standard deviation of reproducibility was 42.64% and the repeatability standard deviation 4.28%. The specific measurement uncertainty (U) was 83.7%.

Participant 69 reported a too low cell density (Fig. 18) that translated into the too low total biovolume. Participant 11 reported a too high cell volume (Fig. 24) that translated into the too high total biovolume. For participant 36 it is again not clear why the total biovolume was overestimated.

For species No. 3 the robust mean was 0.0086 mm^3/L (Fig. 30). Participant 69 reported a too low total biovolume to reach the lower tolerance limit, whereas participants 21, 1, 33, 56, 64, 36 and 11 gave a too high biovolume exceeding the higher tolerance limit.

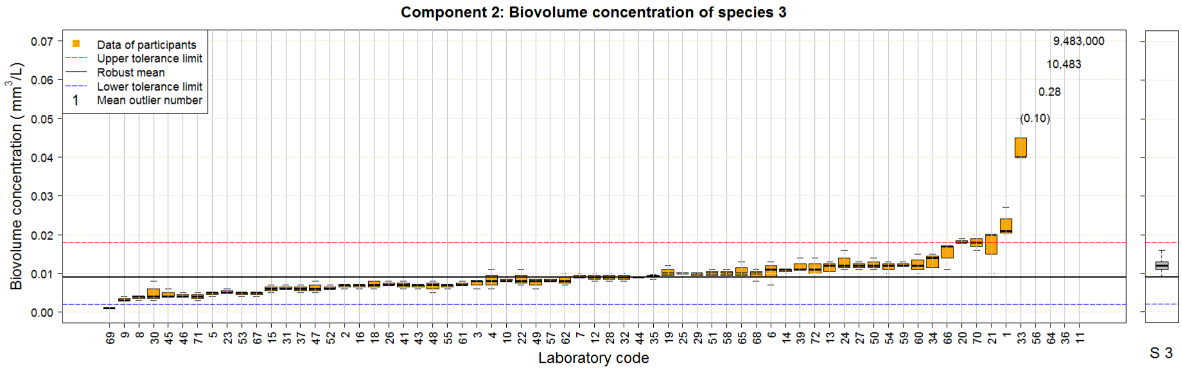


Figure 30: Total biovolume of species 3: *Monoraphidium griffithii*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 0.0086, 0.0024, and 0.0184 mm^3/L, respectively. The standard deviation of reproducibility was 44.38% and the repeatability standard deviation 7.0%. The specific measurement uncertainty (U) was 87.3%.

Participant 69 reported a too low cell density (Fig. 19) that translated into the too low total biovolume. Participants 1, 33 and 56 reported a too high cell density (Fig. 19) that translated into the too high total biovolume. Participants 33, 56 and 11 reported a too high cell volume (Fig. 25) that translated into the too high total biovolume. Participant 64 mixed up the entry of the data for the different species. For participants 21 and 36 it is not clear why the total biovolume was overestimated.

For species No. 4 the robust mean was 0.053 mm^3/L (Fig. 31). Participants 41, 10, 36 and 11 provided a too high biovolume exceeding the higher tolerance limit.

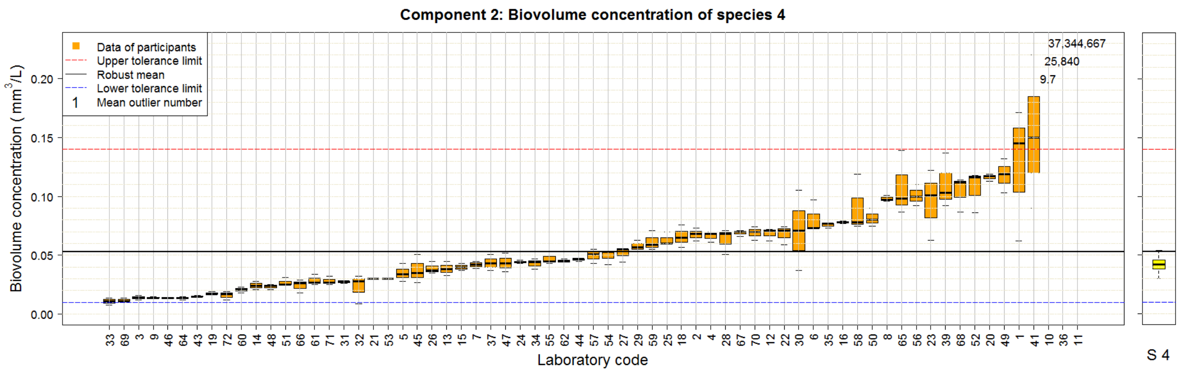


Figure 31: Total biovolume of species 4: *Nitzschia communis*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 0.053, 0.010, and 0.140 mm^3/L, respectively. The standard deviation of reproducibility was 66.65% and the repeatability standard deviation 4.45%. The specific measurement uncertainty (U) was 130.7%.

Participant 11 reported a too high cell volume (Fig. 26) that translated into the too high total biovolume. For participants 10 and 36 it is not clear why the total biovolume was overestimated. We advise that these participants check their calculations. The Z_u-score of participant 41 exceeded 2 as caused by the large deviation in the data (0.09-0.22).

For species No. 5 the robust mean was 0.049 mm^3/L (Fig. 32). Participants 19, 33, 69, 32 and 3 reported a too low total biovolume to reach the lower tolerance limit, whereas participants 44, 1, 36 and 11 gave a too high biovolume exceeding the higher tolerance limit.

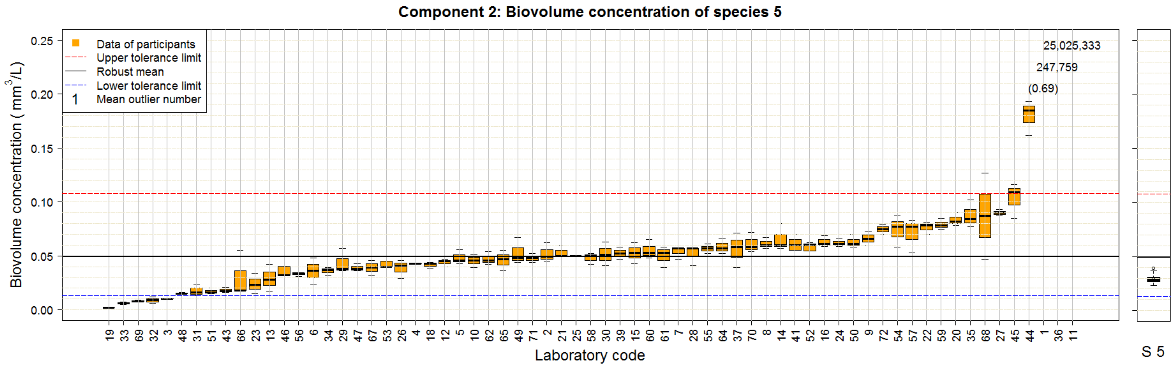


Figure 32: Total biovolume of species 5: *Staurastrum actiscon*. The right panel is the result of the LTV, whereas the left panel shows the results of the participants. The robust mean, lower and upper tolerance limits were 0.049, 0.013, and 0.108 mm^3/L, respectively. The standard deviation of reproducibility was 44.32% and the repeatability standard deviation 7.4%. The specific measurement uncertainty (U) was 87.3%.

Participants 19, 33, 69, 32 and 3 reported a too low cell volume (Fig. 27) that translated into the too low total biovolume. Participants 1, 44, 36 and 11 reported a too high cell volume (Fig. 27) that translated into the too high total biovolume.

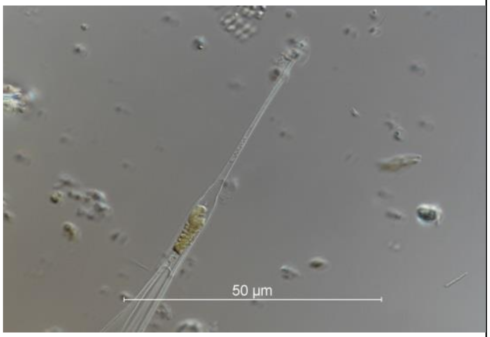
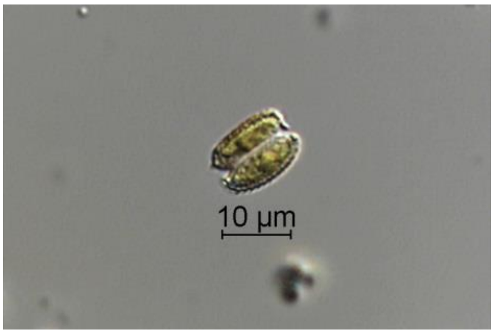
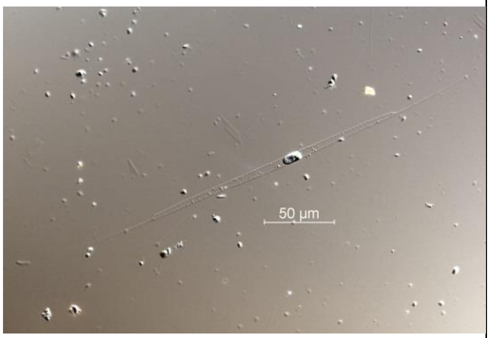
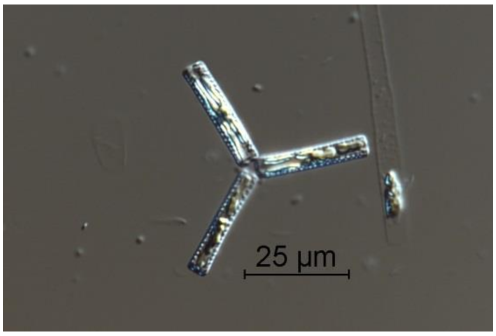
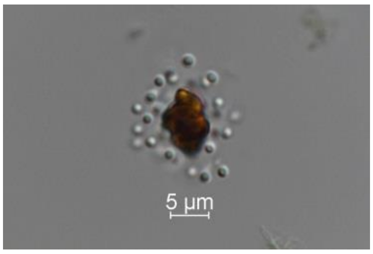
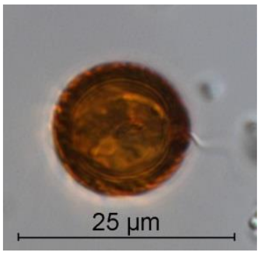
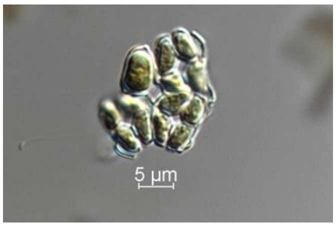
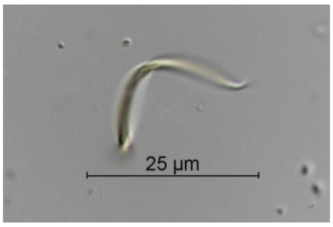
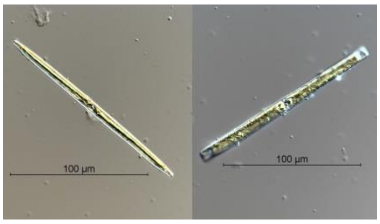
In conclusion: Many deviations in the total biovolume, in mm^3/L, from the robust mean resulted from deviations in cell density (participants 6, 69, and 1) or from deviations in the cell volume (participants 3, 11, 13, 19, 27, 32, 33, 44, and 56). One participant should check their calculations (participant 36).

The majority of participants performed very well in component 2. Only 5 participants of 67 failed this component (7.5%). In total 10 points could be scored, and we set the success level on 67%. This means that three deviation over a Z_u-score of |2| from the robust mean were tolerated to pass this component. The major problems for not passing this component have been discussed above (choice of counting strategy, choice of geometric formula, calculation mistakes, and entry of the data).

3.3. Component 3: Video clips / Taxonomy

This component requests the taxonomic determination of 10 limnetic algal taxa on the basis of video clips to the pre-assigned determination level. For this component, only 66 laboratories participated. Most videos have been recorded on Lugol's fixed material and full information (e.g. about size) is provided. In component 3 we asked for the following species or genus names (Table 18).

Table 18. List of the preassigned, taxonomic determination levels, the preferred name and a screen shot of the video consisting of component 3.

No.	Determination level & preview	No.	Determination level & preview
1	Species: *Dinobryon bavaricum* 	**6**	Species: *Desmodesmus brasiliensis* 
2	Species: *Rhizosolenia longiseta* 	**7**	Genus: *Diatoma* 
3	Species: *Cyanogranis libera* 	**8**	Species: *Trachelomonas rugulosa* 
4	Genus: *Crucigeniella* 	**9**	Genus: *Monoraphidium* 
5	Species: *Closterium dianae* 	**10**	Genus: *Nitzschia* 

The overall success rate in component 3 demonstrated excellent phytoplankton identification skills by most participants (91%). Only 4 participants failed to reach 80% of the maximum score (10 points), as can been seen in Fig. 34.

3.3.1. Accepted synonyms and other species names

Additional to the preferred taxonomic names presented in Table 18, there were some alternative synonyms and species that cannot be distinguished from the preassigned name that we also considered correct.

For video 2. As an objective synonym *Urosolenia longiseta* (Zacharias) Edlund & Stoermer is also accepted. This name is accepted in some databases.

For video 4. We also accept *Crucigenia* and *Willea*. Although we only asked for the genus, many participants recognised that the video recorded *Crucigeniella apiculata*. According to AlgaeBase in 2014 *Crucigeniella apiculata*, or also called *Crucigenia apiculata* was renamed *Willea apiculata* (John et al., 2014). It is obvious that the taxonomic organisation of the green algae has not been settled satisfactory, and therefore we decided to acknowledge all the three genus names. On a side note, if the taxonomy is determined via the identification literature, *Willea* is not officially accepted as the genus name and only on the species level *Willea apiculata* would be considered correct.

For video 6. *Scenedesmus brasiliensis*. Because *Desmodesmus serratus* ≡ *Scenedesmus serratus* cannot be totally excluded based on the literature, it was accepted.

For video 8. *Trachelomonas stokesiana* is also accepted because under the light microscope with DIC, the ridged structure of *Trachelomonas rugulosa* cannot be distinguished from *Trachelomonas stokesiana*.

3.3.2. Description of the taxonomy of the species

The species in video No. 1 could be determined as *Dinobryon bavaricum* Imhoff with Starmach (1985: p. 237, Fig. 478). Alternatively, the identification was also possible using John et al. (2011: p. 291, plate 75, Fig. N). The smallest diameter of the lorica in the video was only 0.1 µm smaller than the range provided in Starmach (1985), and therefore still within the range (including error probability). The lorica length and morphology followed the description in Starmach (1985). The characteristic undulation in the lorica wall and the very prolonged, stalk-like posterior part of the lorica were well visible in the video.

The species in video No. 2 could be determined as *Rhizosolenia longiseta* Zacharias with Krammer & Lange-Bertalot (1991: p. 85, plate 86, Fig. 1-4). Cells extremely elongated in the pervalvar direction. Cells have many girdle bands (2-3 in 10 µm). Spines projecting more or less from the centre of the valve that terminates in a few small teeth. Genus: Delicate structure typically seen in girdle view (visible). Species: Projection of the long spines and number girdle bands (visible).

The species in video No. 3 could be determined as *Cyanogranis libera* Hindák with Hindák (2008: Fig. 172) or Komárek & Anagnostidis (1999: p. 52, Fig. 35). The species in the video has the same characteristics as in Hindák (2008: Fig. 172). Genus: Unicellular-colonial; colonies free-floating, microscopic, to 40-celled, mucilaginous, spherical to irregular, embedded by a fine, homogeneous, colourless and more or less diffluent slime, with irregularly localized cells in the centre. In the centre of the cell cluster is one large, more or less spherical grain, usually brownish with iron oxide precipitate or several small precipitates spread through the colony; colonies without precipitations rare (visible). Species: Cells distributed around iron oxide precipitate (visible), which differs from *Cyanogranis ferruginea* (iron precipitate on the surface of cell clusters). According to Hindák (2008) *Cyanogranis libera* contains aerotopes, whereas *Cyanogranis ferruginea* has none.

The cells of *Cyanogranis* are slightly smaller than those of *Aphanocapsa*, *Coelosphaerium*, *Microcystis*, *Snowella* or *Synechococcus*, but the most important difference with the above genera was the visibility of the iron-oxide cluster in the centre of the colony.

The genus in video No. 4 could be determined as *Crucigeniella* (*apiculata* (Lemmermann) Komárek) with Komárek & Fott (1983: p. 782, plate 217, Fig. 5, or as *Crucigeniella pulchra*) or with John et al. (2011: p. 479 as *Crucigeniella apiculata* with *Crucigeniella pulchra* as its taxonomic synonym). Because the identification keys and papers are conflicting, we required only the genus level. The shape of the cells characterising the genus is well visible.

The species in video No. 5 could be determined as *Closterium dianae* Ehrenb. ex Ralfs with Růžička (1977: p. 134, plate 13), Lenzenweger (1996: p. 37, plate 3, Fig. 6) or Coesel & Meesters (2007: p. 42, plate 14, Fig. 1). Although the cell in the video is about 10% longer than the size provided in Růžička (1977: p. 134); the length is well within the range given in Coesel & Meesters (2007: p. 42). Genus: curved cell with two halves mirroring each other (visible). Species: appearance of no true girdle bands, pyrenoid organisation, Length: breadth 10-14, cells strongly curved (visible).

The species *Closterium dianae* can be distinguished from *Closterium parvulum*, by its larger size (length (160-)180-300(-380) µm compared to (75-)90-130(-160) µm, respectively). The variety *Closterium parvulum* var *maius* has an overlapping length with *Closterium dianae*, but the length: breadth factor is only 5-8 for the variety whereas video 5 depicts a factor of 11 (Coesel & Meesters 2007).

The species in video No. 6 could be determined as *Desmodesmus brasiliensis* (Bohlin) Hegewald with John et al. (2011: p. 441, plate 112, Figs. E, F) or under its objective synonym in Komárek & Fott (1983: p. 870, plate 235: 2). The cells in the centre have one ridge, whereas the marginal ones have two (visible). One ridge could be a row of dull-edged teeth. Each cells on the outside has two small spines; one directed outward, and one apical. Each cell is granulated, and contains a pyrenoid (visible).

The determination following John et al. (2011): 1->linear cells, walls with granules, teeth or ribs->12 with one row of teeth= *Desmodesmus brasiliensis.*

The determination following Komárek & Fott (1983): Within the Armati group -> 2b spines present -> 5b cell orientation-> 15b coenobia linear-> 19b short spines and fine granules->23b cells rounded -> 25b *Scenedesmus brasiliensis*.

In the original description of *Desmodesmus serratus* are the teeth more sharp and cone-shaped. When determined via the key in Komárek & Fott (1983) it is possible to determine video 6 as *Desmodesmus serratus*, although the figure looks different. According to John et al. (2011), the determination to *Desmodesmus serratus* is improbable, as a second row of sagittal teeth would have had to be visible. Because the determination of *Desmodesmus serratus* cannot be totally excluded based on the literature, we decided to grant full points.

The presence of teeth, ridges and spines in video 6 renders the determination of *Desmodesmus costato-granulatus* or *Desmodesmus granulatus* impossible.

The genus in video No. 7 could be determined as *Diatoma* Bory, 1824. The species was likely *Diatoma tenuis* C. Agardh with Krammer & Lange-Bertalot (1991, 2/3: p. 97, plate 96, Fig. 9), or with Cox (1996: p. 41, Fig. 14f). On a genus level, a confusion is possible with *Tabellaria*, but only in the unlikely event that the lateral structures were considered the septum. The dimensions for both genera are similar. In addition, *Tabellaria* should have wider frustules at mid-valve, but this is not visible in video 7. Another difference is the robust structure at the border of the scales and transapical ribs in *Diatoma* that are missing in *Tabellaria*.

The species in video No. 8 could be determined as *Trachelomonas rugulosa* F.Stein with John et al. (2011: p. 224, plate 57, Figs. I, J) or Huber-Pestalozzi (1955: p. 263, plate 58, Figs. 401, 402). The video shows an Euglenophyceae that has an envelope with a sharply defined neck surrounding an apical pore through which a long flagellum emerges (visible). The lorica has unbranched ridges. Under the light microscope with DIC, the ridged structure of *Trachelomonas rugulosa* cannot be distinguished from *Trachelomonas stokesiana*, and therefore both names have been considered correct.

The species in video 8 is not *Trachelomonas volvocina* because this species has a smooth lorica structure and two chloroplasts (John et al. 2011).

The genus in video No. 9 could be determined as *Monoraphidium* cf. *contortum* (Thur.) Kom.-Legnerova with Komárek & Fott (1983: p. 638, plate 178: 4, p. 636, plate 179: 1) or John et al. (2011: p. 458, plate 117, Fig. J). The species could either be identified as *Monoraphidium contortum*, or *Monoraphidium irregulare*. Therefore, we asked for the genus level only.

The genus *Monoraphidium* is a unicellular, straight or lunate, or sigmoid to helically twisted Chlorophyceae. Colonial cells remained in the genus *Ankistrodesmus*.

The genus in video No. 10 could be determined as *Nitzschia* cf. *linearis* W.Smith with Hoffmann et al. (2013: p. 452, plate 106, Figs. 1-3) or with Krammer & Lange-Bertalot (1988: p. 8). The genus can be well distinguished: Excentrically positioned raphe, with a distinct central nodule. Fibulae vary in size and number 11-14 in 10 µm. Two plate-shaped chromatophores on every side of the cell (visible).

The genus in video 10 is not *Synedra* nor *Ulnaria* because then striae on both sides of the cell would be visible on one focus level. Instead, the structures are fibulae that are not visible within one focus level: first on the epitheca at the border of one side and in the video a few seconds later on the hypotheca at the border of the other side.

3.3.3. Scores

The scores given for the classification of the 10 videos followed the qualitative analysis in Schilling et al. (2006), which we extended with a qualification when only the genus level was required (Table 19).

Table 19. Qualitative scores used for the taxonomy component (3).

Points	Qualification
1	Species or genus correct
0.83	Species required, genus correct. Species not specified („sp.“)
0.67	Species required, genus correct. Species wrong
0.5	Genus required, but wrong. Next taxonomic level correct
0.33	Species required, species and genus wrong. Next taxonomic level correct
0	Next taxonomic level wrong (or not provided)

In the following Table 20 we show the classification results of the taxonomy component and their approved score (following the qualitative analysis in Table 19).

Table 20. Classification results of the taxonomy component (3) and their approved score.

Video number	Determination of the participant	Number of participants	Score
1	*Dinobryon bavaricum*	66	1
2	*Rhizosolenia longiseta*	40	1
2	*Urosolenia longiseta*	24	1
2	*Rhizosolenia* sp.	1	0.833
2	*Rhizosolenia setigera*	1	0.667
3	*Cyanogranis libera*	20	1
3	*Cyanogranis ferruginea*	32	0.667
3	*Aphanocapsa conferta*	1	0.333
3	*Aphanocapsa elachista*	2	0.333
3	*Aphanocapsa incerta*	2	0.333
3	*Aphanocapsa nubilum*	1	0.333
3	*Aphanocapsa planctonica*	1	0.333
3	*Aphanocapsa* sp.	1	0.333
3	*Coelosphaerium minutissimum*	1	0.333
3	*Microcystis natans*	1	0.333
3	*Snowella atomus*	1	0.333
3	*Snowella litoralis*	1	0.333
3	*Synechococcus mucicolus*	1	0.333
3	*Tetraedriella jovetii*	1	0
4	*Crucigeniella*	36	1
4	*Crucigenia*	6	1
4	*Willea*	23	1
4	*Scenedesmus*	1	0.5
5	*Closterium dianae*	59	1
5	*Closterium costatum*	1	0.667
5	*Closterium nematodes*	1	0.667
5	*Closterium parvulum*	3	0.667
5	*Closterium ralfsii*	1	0.667
5	*Closterium striolatum*	1	0.667
6	*Desmodesmus brasiliensis*	3	1
6	*Scenedesmus brasiliensis*	1	1
6	*Desmodesmus serratus*	22	1
6	*Scenedesmus serratus*	14	1
6	*Desmodesmus armatus* var. *brevicaudatus*	2	0.667
6	*Desmodesmus costato-granulatus*	8	0.667
6	*Desmodesmus granulatus*	6	0.667
6	*Scenedesmus costato-granulatus*	4	0.667
6	*Scenedesmus granulatus*	6	0.667
7	*Diatoma*	52	1
7	*Fragilaria*	1	0.5

Video number	Determination of the participant	Number of participants	Score
7	*Tabellaria*	10	0.5
7	*Thalassionema*	2	0.5
7	*Fragilariaceae*	1	0
8	*Trachelomonas rugulosa*	54	1
8	*Trachelomonas stokesiana*	5	1
8	*Trachelomonas volvocina*	4	0.667
8	*Trachelomonas granulata*	1	0.667
8	*Trachelomonas volvocinopsis*	1	0.667
8	*Cyclotella ocellata*	1	0
9	*Monoraphidium*	64	1
9	*Ankistrodesmus*	1	0.5
9	*Koliella*	1	0
10	*Nitzschia*	42	1
10	*Ulnaria*	11	0.5
10	*Fragilaria*	7	0.5
10	*Synedra*	6	0.5

In Fig. 33 we show the success rate per video, revealing that video 3 was the most difficult species to determine (69%). Only for this video the success rate was below 80%. The next difficult video was number 10 (82%) followed by number 6 (87%).

All participants recognised the species in video 1 (100%) and nearly all (99%) the species in video 2 as well as the genus in video 4. Also the score for the genus in video 9 was very high (98%).

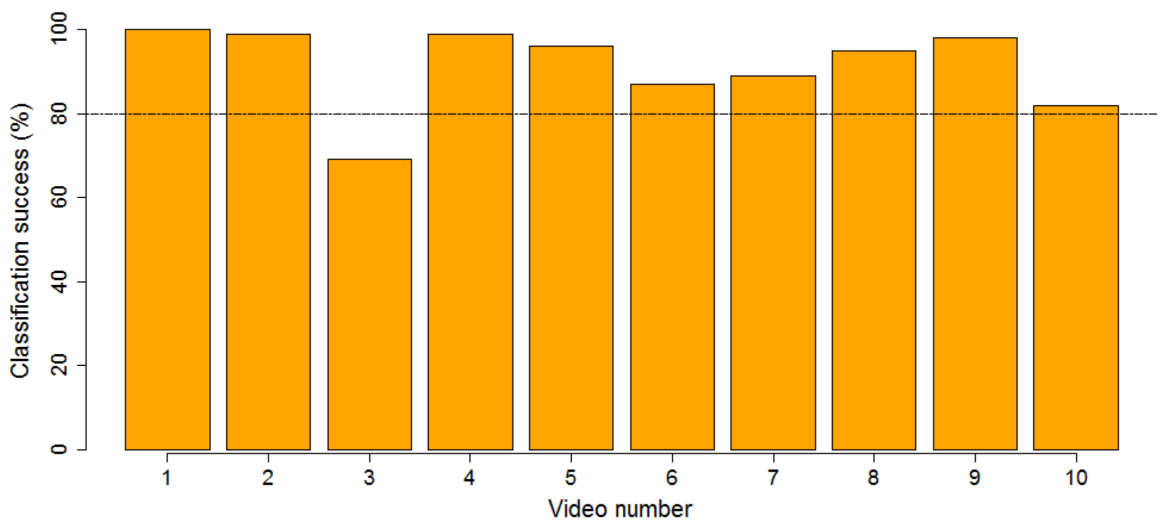


Figure 33: Success rate for every video in component 3. The 80% success rate is indicated by the dashed black line.

The total score for component 3 for every participant is shown in Fig. 34. The 80% success rate is indicated by a red, dashed line and the 100% score by a dashed black line. The scores are ordered by ascending laboratory code, showing that only 4 of the 66 participants who participated in the part of the test failed to reach the 80% quality target.

There were 7 participants that reached the maximum score of a 100%. Sixteen participants managed a score of 97% (only 1 mistake).

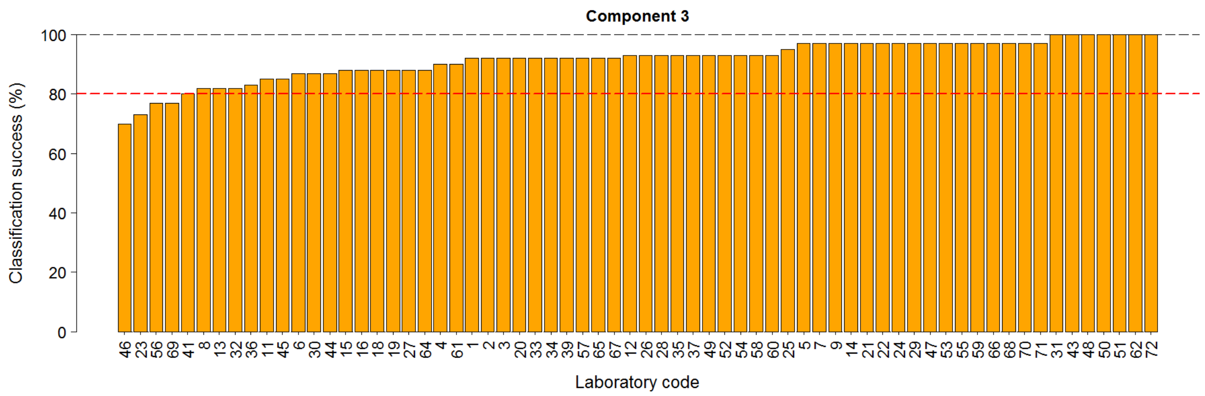


Figure 34: The total score for the taxonomy component (3) for every participant. In the figure also the maximum score (100%, dashed black line) and the quality target (80%, dashed red line) is depicted.

The majority of participants performed very well in component 3. Only 4 participants of 66 failed this component (6%). In total 10 points could be scored, and we set the success level on 80%. This means that a minimum of 8 points was tolerated to pass this component. The main problem with recognizing species 3 was that many people were not familiar with the species and the latest taxonomic literature.

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5. Results of component 1

Table 21. Results of the particle concentration (PC) of the large particles (LP), medium particles (MP) and small particles (SP) with their associated zu-scores (Zu) in the reference counting chamber.

LC	PC_ LP	PC_ LP	PC_ LP	PC_LP_Zu	PC_ MP	PC_ MP	PC_ MP	PC_MP_Zu	PC_ SP	PC_ SP	PC_ SP	PC_SP_Zu
1	9000			**0.00**	1627193	1558823	1599845	**-1.48**	10305	93529	84869	**-0.40**
2	9000	9000	9000	**0.00**	1770200	1870900	1881500	**0.96**	98050	10096	98050	**0.23**
3	9000	9000	9000	**0.00**	1689052	1709133	1720289	**-0.35**	92373	94381	98621	**-0.23**
4	9000	9000	9000	**0.00**	1773423	1782565	1755141	**0.28**	89128	93241	92327	**-0.68**
5	9000	9000	9000	**0.00**	1860000	1700000	1740000	**0.25**	11400	10030	84800	**0.31**
6	9000	9000	9000	**0.00**	1745327	1753841	1858844	**0.43**	88884	10122	10567	**-3.59**
7	9000	9000	9000	**0.00**	1680700	1763903	1822145	**0.14**	95683	99011	10400	**0.30**
8	9000	9000	9000	**0.00**	1816256	1832767	1865790	**0.93**	10322	10280	10364	**0.71**
9	9000	9000	9000	**0.00**	1814391	1780390	1814391	**0.59**	99915	10547	10200	**0.63**
10	1000	1000	1000	**-13.70**	1829200	1734000	1883600	**-15.85**	10064	97240	95200	**-10.90**
11	9000	9000	9000	**0.00**	1784600	1784600	1784600	**0.42**	18260	18260	18260	**9.82**
12	10000	10000	10000	**1.60**	1674840	1672800	1750320	**-0.42**	89352	92208	88944	**-0.85**
13	9000	9000	9000	**0.00**	1754612	1660761	1746451	**-0.21**	18656	19928	17525	**10.33**
14	9000	9000	9000	**0.00**	1724096	1692168	1702811	**-0.35**	97911	10642	88333	**0.06**
15	10000	10000	10000	**1.60**	1803794	1778269	1782523	**0.45**	85935	91466	88062	**-1.06**
16	9000	9000	9000	**0.00**	1753240	1696000	1740520	**-0.11**	94764	98792	90524	**-0.29**
18	9000	9000	9000	**0.00**	1820000	1840000	1850000	**0.92**	97000	97000	10400	**0.27**
19	10000	10000	10000	**1.60**	1713075	1725268	1719172	**-0.22**	87787	99980	89616	**-0.57**
20	9000	9000	9000	**0.00**	1821596	1808235	1839411	**0.79**	99569	10089	96907	**0.24**
21	9000	9000	9000	**0.00**	1400942	1441096	1483481	**-3.04**	92801	97262	95032	**-0.25**
22	9000	9000	9000	**0.00**	1767900	1597500	1842450	**-0.05**	91430	90584	10041	**-0.36**
23	9000	9000	9000	**0.00**	1774850	1767150	1771000	**0.29**	10241	10857	10626	**1.00**
24	9000	9000	9000	**0.00**	1740000	1760000	1800000	**0.25**	95000	86400	11400	**0.17**
25	9000	9000	9000	**0.00**	1752110	1752110	1760056	**0.14**	10081	10081	99488	**0.39**
26	9000	9000	9000	**0.00**	1694654	1744619	1717555	**-0.22**	10180	10013	96599	**0.29**
27	900	1000	900	**-13.80**	1917569	1851319	1821875	**1.17**	10667	10430	96487	**0.63**
28	9000	9000	9000	**0.00**	1862921	1812780	1803138	**0.82**	99317	10028	96617	**0.20**
29	9000	9000	9000	**0.00**	1727400	1833600	1686600	**0.08**	95770	98420	87800	**-0.37**
30	9	9	9	**-13.31**	18933	17525	16907	**-16.67**	7997	9025	11081	**-11.70**
31	9000	9000	9000	**0.00**	1768053	1651569	1834615	**0.10**	92354	94850	83618	**-0.84**
32	9000	9000	9000	**0.00**	1611111	1801587	1730158	**-0.27**	97685	87962	94907	**-0.43**
33	8000	8000	8000	**-1.70**	1785263	1725182	1776680	**0.20**	98193	96980	97708	**0.07**
34	8984	7986	7986	**-1.20**	1642146	1741241	1667627	**-0.58**	90601	83806	80691	**-1.49**
35	9000	9000	9000	**0.00**	1579807	1622615	1555346	**-1.58**	93565	10253	93361	**-0.06**
36	9000	9000	9000	**0.00**	1706713	1672000	1672000	**-0.58**	95151	84060	91649	**92.43**
37	9000	9000	9000	**0.00**	1628645	1775868	1757465	**-0.21**	10857	10305	10428	**0.95**
39	9000	9000	9000	**0.00**	1727656	1668864	1682432	**-0.49**	10786	98368	92940	**0.31**
41	9000	9000	9000	**0.00**	1682720	1695200	1674400	**-0.58**	98252	10474	10271	**0.56**
43	9000	9000	9000	**0.00**	1661474	1639197	1663330	**-0.88**	91520	92634	90777	**-0.67**
44	9000	9000	9000	**0.00**	1687647	1679279	1645805	**-0.71**	89390	87721	88277	**-1.07**
45	9000	9000	9000	**0.00**	2140176	1825083	1783319	**1.68**	96983	10353	10033	**0.38**
46	900	900	900	**-13.90**	1414779	1424991	1427776	**-16.25**	79650	80857	79650	**-11.12**
47	8000	8000	8000	**-1.70**	1853771	1861216	2000260	**1.57**	11390	11316	10959	**1.75**
48	9000	9000	9000	**0.00**	14730	15563	14994	**-16.68**	93312	96287	85254	**-0.67**
49	9000	9000	9000	**0.00**	1757436	1764157	1774238	**0.23**	93936	95298	98020	**-0.16**
50	9000	9000	9000	**0.00**	1854776	1901145	1757821	**0.93**	10664	99904	10159	**0.66**
51	9000	9000	9000	**0.00**	1659345	1696495	1956542	**0.29**	95871	82105	99805	**-0.55**
52	9000	9000	9000	**0.00**	1667461	1602230	1797923	**-0.53**	99526	10842	97908	**0.57**
53	9000	9000	9000	**0.00**	1698900	1907100	1674400	**0.18**	98280	88690	10867	**0.18**
54	12622	12622	16830	**8.00**	1802104	1768262	1797028	**0.46**	97635	95773	98819	**0.05**

55	9000	9000	9000	**0.00**	1785461	1704913	1758612	**0.08**	99341	98670	94642	**0.06**
56	9000	9000	8000	**-0.60**	1754004	1361316	1649287	**-1.55**	99480	10013	71992	**-0.81**
57	9000	9000	9000	**0.00**	1720000	1792000	1720000	**0.03**	92400	96800	98400	**-0.14**
58	9000	9000	9000	**0.00**	1640326	1700929	1779713	**-0.35**	98342	10527	90997	**0.14**
59	9000	9000	9000	**0.00**	1711500	1654450	1752250	**-0.36**	97512	86088	97104	**-0.43**
60	9000	9000	9000	**0.00**	1711801	1678882	1695341	**-0.46**	97523	10287	10410	**0.52**
61	9000	9000	9000	**0.00**	1947441	1594108	1594108	**-0.30**	11421	88744	96135	**0.31**
62	8000	8000	8000	**-1.70**	1806646	1802251	1811042	**0.63**	99783	10022	98904	**0.30**
64	9000	9000	9000	**0**	1786100	1780800	1849700	**0.62**	99337	10124	98955	**0**
65	9000	9000	9000	**0.00**	1750270	1675650	1692610	**-0.35**	10379	97690	89210	**-0.01**
66	13000	13000	13000	**6.40**	1703400	1756700	1752500	**-0.04**	86450	10118	10246	**-0.04**
67	10000	10000	10000	**1.60**	1862381	1709831	1601775	**-0.17**	10477	89543	12304	**1.01**
68	9000	9000	9000	**0.00**	1618946	1618946	1610728	**-1.27**	88754	89165	87521	**-1.06**
69	44057	44057	44057	**56.10**	1594846	1620178	1594846	**-1.40**	90095	86130	86791	**-1.16**
70	9000	9000	9000	**0.00**	1565538	1581846	1577769	**-1.69**	95807	96215	10233	**0.13**
71	9000	9000	9000	**0.00**	2003584	1727810	1997956	**1.62**	96239	92862	91737	**-0.42**
72	9000	9000	9000	**0.00**	2031250	1703125	1812500	**1.03**	11250	10000	12187	**1.66**

Table 22. Results of the diameter of the large particles (LP), medium particles (MP) and small particles (SP) with their associated zu-scores (Zu) in the reference counting chamber.

LC	**LP**	**LP**	**LP**	**LP**	**LP**	**LP**	**LP**	**LP**	**LP**	**LP**	**LP**	**LP**	**LP-Zu**
1	54	51	51	51	51	50	51	50	50				**-14.16**
2	47	47	46	46	46	47	45	46	46				**-0.80**
3	50	50	50	50	50	50	50	50	50				**0.35**
4	50	50	50	50	50	49	50	50	50				**-0.06**
5	49	49	49	49	49	49	49	49	49				**-0.65**
6	50	50	50	47	47	50	50	50	50				**1.27**
7	48	48	48	48	49	48	49	49	49				**0.53**
8	47	47	47	47	47	47	47	47	47				**0.42**
9	49	48	49	49	49	49	49	50	49				**-0.38**
10	49	50	50	50	50	51	51	51	51	51			**0.43**
11	55	51	44	52	54	55	48	48	48				**-0.41**
12	50	49	49	50	49	49	50	50	50	49			**0.51**
13	52	49	49	51	51	49	52	49	51				**3.50**
14	49	49	49	49	49	49	49	49	49				**-0.54**
15	49	49	49	48	49	50	49	49	49	50			**-0.34**
16	50	49	49	49	49	50	49	49	49				**0.63**
18	49	50	49	50	49	49	49	49	49				**-0.09**
19	50	51	49	51	50	50	37	50	50	50			**0.30**
20	51	50	50	50	50	51	49	50	50				**-0.93**
21	50	52	52	51	52	51	51	51	51				**-0.76**
22	51	49	50	50	49	49	50	50	50				**0.84**
23	51	51	51	51	51	51	51	50	51				**-0.20**
24	50	51	50	50	50	51	52	50	50				**-0.34**
25	35	35	35	35	35	35	35	35	35	35	35	35	**0.31**
26	49	50	50	49	49	50	49	49	50				**-2.50**
27	50	51	51	51	52	52	51	51	50				**-0.72**
28	49	49	49	49	49	49	49	49	49				**0.58**
29	49	49	49	48	50	50	49	49	48	49	49	49	**0.07**
30	50	50	50	50	50	50	49	50	49	50	50	50	**0.45**
31	50	51	50	50	53	51	51	51	51				**-0.34**
32	49	49	49	49	49	49	49	49	49	49	49	49	**-0.24**
33	49	50	49	49	49	50	50	49	49	49	49	49	**1.40**
34	50	50	50	50	50	50	50	50	50	50	50	50	**0.79**

35	50	49	49	48	49	49	50	50	50	49	50	50	**0.09**
36	50	50	50	50	50	50	50	50	50				**-0.77**
37	48	48	49	48	49	48	48	49	50				**-0.52**
39	48	50	49	49	48	48	49	48	48				**-3.29**
41	49	49	50	49	49	49	49	49	49				**1.34**
43	50	50	50	50	50	50	50	50	50				**-0.57**
44	49	50	50	50	50	50	50	50	50				**-0.74**
45	48	48	48	49	48	49	48	48	48				**0.97**
46	48	49	48	48	48	48	49	49	50	48	48	48	**0.93**
47	49	49	48	48	48	48	49	48					**-0.83**
48	49	49	49	48	49	48	49	49	49				**-0.29**
49	48	48	48	48	48	48	48	48	48				**0.15**
50	50	50	50	50	50	50	50	50	50				**0.12**
51	50	51	51	50	50	50	51	50	50				**-0.22**
52	49	49	49	49	49	49	49	49	49				**0.13**
53	49	49	49	49	50	49	49	49	49				**1.75**
54	50	50	50	50	50	49	49	50					**0.75**
55	51	51	51	50	48	48	50						**0.16**
56	50	49	51	50	50	50	59	57	60	57	58	55	**0.01**
57	48	50	49	49	48	48	49	49	48				**-0.80**
58	50	49	50	49	50	49	50	49	50				**-0.79**
59	49	48	49	49	50	50	49	49	49				**4.69**
60	50	49	50	50	49	49	49	50	50				**1.34**
61	50	50	49	50	50	50	50	50	50				**-0.98**
62	49	49	49	49	49	49	49	49					**-1.19**
64	49	49	49	49	49	49	48	49	49				**0.36**
65	48	49	49	49	48	48	49	48	50				**-0.15**
66	48	48	48	49	49	49	49	49	49	49			**-0.99**
67	49	49	49	49	49	49	49	49	49	49	49	49	**-0.66**
68	50	51	50	50	50	50	51	50	50				**-5.09**
69	53	55	54	54	55	54	55	55	54	55	54		**0.58**
70	49	50	50	49	50	50	50	50	50				**-0.18**
71	50	50	50	50	50	50	50	50	50				**-0.84**
72	48	48	49	48	48	48	49	49	49				**1.44**

C	**MP**	**MP**	**MP**	**MP**	**MP**	**MP**	**MP**	**MP**	**MP**	**MP**	**MP**	**MP**	**MP-Zu**
1	15.3	15.3	16.6	16.6	15.3	15.3	16.6	16.6	15.3	15.3	15.3	16.6	**-0.13**
2	13.3	13.5	13.3	12.3	12.6	13.3	13.1	13.7	13.0	12.7	12.7	13.2	**0.42**
3	15.3	15.1	15.1	15.3	15.6	15.3	15.6	15.3	15.3	15.6	15.3	15.3	**-0.29**
4	15.8	15.4	15.9	15.3	15.9	15.9	15.5	15.9	15.1	15.4	15.6	15.1	**0.88**
5	14.8	14.4	15.1	14.5	14.6	14.9	14.9	15.1	14.8	14.9	15.0	14.7	**-0.11**
6	15.0	15.0	16.0	17.0	16.0	15.0	15.0	15.0	15.0	17.0	16.0	15.0	**0.58**
7	14.8	14.8	14.7	15.0	14.8	14.9	14.9	14.8	14.8	14.7	14.7	14.8	**-0.07**
8	13.6	13.2	13.6	13.5	13.4	13.5	13.7	13.2	13.2	13.1	13.3	13.5	**0.87**
9	15.0	14.9	14.8	15.0	15.2	15.0	14.6	14.8	14.9	15.0	15.1	14.8	**-0.78**
10	14.6	14.7	14.8	15.1	15.2	15.3	15.3	15.6	15.7	15.8	15.8	16.2	**0.38**
11	16.7	15.5	15.5	15.5	15.5	15.5	14.4	15.5	15.5	15.5	15.5	14.5	**0**
12	15.0	15.5	15.5	15.7	15.5	15.3	15.1	15.5	15.2	15.5	15.9	15.5	**0.05**
13	14.3	15.6	15.6	16.9	14.3	15.6	16.9	15.6	16.9	15.6	15.6	14.3	**2.02**
14	15.1	15.1	15.1	15.1	15.1	15.1	14.9	15.1	14.9	15.1	15.3	15.1	**0.29**
15	15.4	15.1	14.7	15.4	14.7	14.7	15.4	15.4	15.1	15.4	15.1	15.1	**-1.32**
16	15.6	15.0	15.5	15.6	15.5	15.5	15.3	14.9	15.4	15.4	15.6	15.0	**0.49**
18	15.5	15.3	14.9	15.6	15.3	15.3	15.1	15.6	15.8	14.9	15.0	15.3	**0.32**
19	15.9	15.7	15.3	15.1	15.1	15.3	15.6	15.2	15.1	14.9	14.2	14.4	**0.65**

20	15.2	15.4	15.3	15.3	15.3	15.5	15.4	15.5	15.5	15.4	15.3	15.5	**-1.40**
21	16.0	15.4	15.8	15.3	15.8	15.9	15.0	15.2	15.7	15.7	15.1	15.0	**0.05**
22	16.0	15.2	15.6	15.0	15.3	15.4	14.9	15.1	15.1	15.1	15.0	15.1	**0.41**
23	16.6	16.1	16.4	16.6	16.6	16.4	15.7	15.6	16.1	16.1	16.3	16.3	**0.36**
24	15.8	15.4	15.5	14.5	15.3	16.3	15.0	15.3	16.3	15.2	15.8	15.4	**0.29**
25	15.0	14.9	15.1	15.0	15.2	15.1	15.5	15.3	15.1	15.1	14.8	14.8	**-0.97**
26	14.5	14.5	15.2	14.9	14.9	15.0	14.9	15.2	15.0	15.2	14.9	14.9	**-3.44**
27	15.8	15.6	15.8	15.4	16.0	16.2	15.3	16.0	15.8	15.6	15.7	15.8	**-0.68**
28	14.7	14.4	14.0	14.8	14.4	14.9	13.9	14.6	14.1	14.8	14.6	14.4	**0.40**
29	14.9	14.7	14.9	14.9	15.1	15.6	14.9	14.5	14.7	14.7	14.7	15.1	**0.44**
30	15.0	15.1	14.5	15.0	15.2	15.2	14.9	15.4	15.1	14.5	15.0	15.0	**0.60**
31	14.4	15.4	15.4	14.9	15.1	14.5	15.0	14.8	15.5	15.1	15.5	15.8	**-0.39**
32	14.9	15.1	15.3	15.5	15.5	15.3	15.5	15.0	14.9	15.6	15.1	15.6	**-0.45**
33	15.9	15.4	15.2	15.2	15.4	15.0	15.6	15.0	15.4	15.2	15.2	15.2	**1.36**
34	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	**-0.24**
35	14.8	15.7	15.2	14.5	14.9	15.3	15.7	15.6	15.7	15.4	16.1	15.4	**0.21**
36	15.0	15.0	15.0	15.0	16.0	15.0	15.0	15.0	15.0	15.0	16.0	17.0	**-1**
37	14.7	14.9	14.6	14.3	14.4	14.3	14.6	14.6	14.8	14.5	14.6	14.6	**0.25**
39	14.5	14.5	14.5	14.5	14.5	14.0	14.5	14.5	14.5	14.0	14.5	14.5	**-4.10**
41	14.9	14.9	15.0	14.9	15.0	14.8	15.0	14.8	14.9	14.9	14.9	14.8	**1.20**
43	15.4	15.3	15.0	15.3	15.3	15.2	15.0	15.0	15.0	15.4	14.9	15.0	**-0.03**
44	14.9	14.9	15.1	15.3	14.9	15.5	15.1	15.0	15.1	15.0	15.1	15.3	**-1.67**
45	14.5	14.5	14.8	14.8	14.4	14.7	14.5	14.7	14.8	14.7	14.5	14.5	**0.92**
46	14.8	14.5	14.9	14.8	14.4	14.9	14.8	14.6	14.9	15.0	14.9	15.0	**0.69**
47	13.9	14.2	13.7	12.9	13.6	13.3	13.8	13.9	14.4	14.0	12.8	14.3	**-1.08**
48	15.0	15.4	15.8	14.6	15.4	15.5	15.5	15.3	15.4	15.7	15.8	14.7	**-0.43**
49	14.9	14.8	14.9	14.9	17.9	14.9	14.9	14.9	14.8	14.9	14.8	14.8	**0.29**
50	15.3	15.6	15.5	15.3	15.3	15.5	15.4	15.4	15.5	15.7	15.5	15.6	**0.47**
51	15.2	15.4	15.4	14.9	15.1	15.4	15.2	15.4	15.4	15.2	15.2	15.3	**-0.08**
52	15.1	15.4	15.6	15.1	15.3	15.0	15.3	15.2	15.0	15.3	15.2	15.4	**0.56**
53	14.7	14.8	14.4	14.9	14.7	14.9	14.5	15.0	14.6	14.4	14.9	15.0	**0.73**
54	14.7	14.9	14.7	14.9	14.9	14.9	14.7	14.9	14.7	14.9	14.7	14.7	**0.21**
55	14.3	14.7	14.6	14.6	14.5	14.4	14.9	15.0	14.7	14.6	14.7	14.6	**0.21**
56	16.4	15.6	16.7	15.8	16.4	15.0	16.4	17.1	15.8	16.5	16.2	16.3	**0.46**
57	14.6	14.3	14.1	14.0	14.4	14.0	14.1	14.5	14.5	14.3	14.1	14.5	**-0.56**
58	14.9	15.0	15.3	15.3	14.6	15.4	15.3	15.4	15.3	15.8	14.9	15.8	**-1.09**
59	15.0	15.5	15.4	15.6	15.0	15.2	15.4	15.4	15.2	15.8	15.6	15.7	**2.52**
60	15.5	15.1	15.8	15.4	15.6	15.4	15.1	15.1	15.6	15.3	15.1	15.4	**-0.01**
61	15.8	15.8	15.0	15.4	15.4	15.8	15.4	15.0	15.8	15.0	15.4	15.4	**-1.04**
62	15.1	15.1	15.5	15.4	15.3	15.6	15.2	15.1	15.4	15.2	15.2	15.2	**-0.04**
64	15.0	15.1	15.0	15.1	15.2	15.1	14.9	15.1	15.0	15.0	15.1	15.2	**-0.24**
65	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	**-0.56**
66	14.2	14.4	14.4	14.5	14.5	14.5	14.6	14.6	14.7	14.8	14.8	14.9	**-2.81**
67	15.0	15.0	15.3	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	**-0.63**
68	15.0	15.0	15.0	15.0	15.0	15.5	14.5	15.0	15.0	15.0	15.0	15.0	**-0.63**
69	16.9	16.6	16.4	15.9	15.9	16.8	16.1	16.4	16.5	17.1	17.2	15.4	**-0.24**
70	15.1	15.3	15.2	15.4	15.3	15.4	15.2	15.4	15.3	15.2	15.4	15.1	**0.53**
71	14.9	15.0	14.9	14.9	15.2	15.1	15.1	15.1	15.1	15.0	14.8	14.9	**-1.44**
72	15.0	14.5	14.7	14.8	15.0	15.0	14.7	15.0	15.0	15.0	14.7	14.8	**2.13**

.C	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP-Zu
1	7.65	7.65	6.38	7.65	7.65	6.37	6.38	7.65	7.65	7.65	6.37	7.65	**-2.68**
2	5.40	5.30	4.50	4.90	4.60	4.90	5.10	5.30	4.80	4.90	5.00	5.10	**-0.33**
3	6.38	6.89	7.14	6.89	7.14	6.38	6.63	6.89	7.14	6.89	6.63	6.89	**-1.36**
4	7.20	7.56	7.64	6.75	7.95	6.79	7.17	7.11	7.73	6.77	7.03	7.31	**-0.26**
5	7.10	6.50	6.60	6.80	6.80	6.80	6.70	6.90	6.60	6.80	7.30	6.90	**-0.26**
6	6.00	7.00	7.00	7.00	6.00	7.00	7.00	7.00	6.00	7.00	7.00	6.00	**-0.17**
7	7.02	6.86	6.79	6.63	6.79	6.63	6.79	6.86	6.71	6.55	6.94	6.94	**-0.45**
8	5.57	5.36	5.29	5.20	5.54	5.18	5.49	5.46	5.36	5.57	5.24	5.26	**0.76**
9	6.70	6.66	6.42	6.90	6.74	6.44	6.46	6.40	6.52	6.36	6.44	6.66	**0.28**
10	6.27	6.29	6.35	6.36	6.58	6.71	6.82	6.84	6.86	6.96	7.00	7.03	**0.03**
11	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.80	7.77	**0**
12	7.00	7.11	6.71	7.12	6.71	6.91	7.11	7.05	7.32	6.71	6.71	7.03	**-0.17**
13	5.20	7.80	6.50	7.80	5.20	6.50	6.50	6.50	5.20	5.20	6.50	7.80	**3.83**
14	6.60	7.10	6.80	7.30	6.60	6.80	6.80	7.10	6.80	7.10	7.30	7.30	**0.11**
15	6.65	7.00	6.00	7.00	6.30	7.00	6.30	6.30	6.65	7.00	6.00	6.30	**-1.04**
16	7.01	6.97	6.85	6.82	6.85	7.05	7.25	7.32	7.18	6.85	7.05	6.93	**0.56**
18	7.33	6.70	7.39	7.37	7.24	7.19	7.02	7.42	7.64	7.60	6.98	7.43	**0.80**
19	6.40	7.10	7.30	6.80	6.80	6.30	6.50	5.30	6.10	6.00	5.60	6.10	**0.86**
20	7.06	7.44	7.42	6.96	6.88	7.52	7.10	6.78	7.32	7.00	7.04	7.05	**-0.96**
21	7.35	7.45	7.76	7.34	6.81	7.42	7.61	8.18	7.63	7.49	7.61	7.01	**-0.83**
22	7.40	7.10	7.30	6.60	7.10	7.40	7.20	7.60	7.20	7.10	6.90	7.20	**-0.25**
23	7.70	7.70	7.60	7.90	7.80	7.40	7.60	7.90	7.20	7.80	7.20	7.80	**-0.60**
24	6.80	6.40	6.80	6.60	6.90	6.60	6.70	6.30	6.30	7.00	6.90	6.70	**0.75**
25	5.99	7.30	6.90	4.79	5.01	4.82	5.03	5.13	5.34	4.74	4.30	5.03	**-0.95**
26	6.27	6.60	6.27	6.60	6.77	6.60	6.27	6.44	6.93	6.60	6.60	6.44	**-2.66**
27	7.40	7.20	7.70	7.50	7.70	7.70	7.30	7.40	7.40	7.40	7.50	7.60	**-0.33**
28	6.18	6.19	6.54	5.84	6.03	5.89	6.29	6.21	6.55	6.39	6.66	6.20	**1.19**
29	6.49	6.48	6.85	6.49	6.49	6.85	6.67	6.85	7.03	7.21	7.03	7.02	**0.93**
30	5.86	6.34	5.87	5.81	6.04	6.24	6.07	6.09	6.14	6.11	6.44	5.91	**0.73**
31	6.17	6.57	6.68	5.94	6.63	6.73	6.68	6.51	7.45	7.47	7.24	6.28	**-0.46**
32	7.20	6.79	7.25	6.51	6.63	6.92	7.08	7.13	6.15	7.23	6.03	7.55	**-0.09**
33	6.49	6.35	6.43	6.24	6.35	6.45	6.52	6.53	6.66	6.78	6.53	6.44	**0.72**
34	7.52	7.52	7.52	7.52	7.52	7.52	7.52	7.52	7.52	7.52	7.52	7.52	**0.12**
35	7.08	7.44	7.16	7.05	6.83	6.79	7.83	7.78	7.95	7.61	7.31	7.39	**0.51**
36	7.00	7.00	7.00	8.00	7.00	7.00	8.00	8.00	7.00	7.00	8.00	9.00	**0**
37	6.95	6.75	6.99	6.65	6.63	6.77	6.55	6.60	6.72	6.74	6.40	6.53	**0.78**
39	6.50	7.00	6.50	6.50	6.50	6.50	5.50	5.50	6.50	6.50	5.50	6.50	**-3.39**
41	6.64	6.70	7.06	6.58	6.60	6.85	6.66	6.54	6.95	6.72	6.76	7.05	**1.16**
43	6.80	6.80	6.60	6.80	6.60	6.50	6.60	6.80	6.60	6.90	6.90	6.70	**-0.49**
44	6.38	6.32	6.59	6.62	6.73	6.67	6.52	6.27	6.73	6.82	6.62	6.49	**-0.92**
45	6.80	6.49	6.80	6.80	6.80	6.49	6.49	6.95	6.64	6.49	6.49	6.80	**-0.77**
46	6.48	6.24	6.72	6.84	6.48	6.72	6.96	6.72	6.84	6.72	6.36	6.48	**-0.26**
47	6.12	6.18	6.07	5.60	5.82	5.30	5.70	5.17	5.32	6.01	5.94	6.02	**-0.22**
48	6.08	5.57	7.00	6.32	7.02	6.29	6.39	7.06	7.11	7.09	6.82	6.81	**-0.51**
49	6.69	6.72	7.00	6.98	6.87	6.94	6.79	6.87	6.88	7.20	6.65	6.77	**0.46**
50	7.32	7.45	7.24	7.20	7.19	7.42	7.38	7.49	7.24	7.32	7.35	7.10	**1.00**
51	7.28	6.76	7.19	6.77	7.31	7.18	6.37	7.10	6.74	6.92	6.84	6.93	**0.27**
52	7.42	7.30	7.67	7.27	7.46	7.42	7.13	6.85	6.85	7.01	7.33	7.42	**0.26**
53	7.18	6.93	7.10	7.00	6.74	6.93	7.06	6.87	6.97	6.85	6.86	7.13	**1.14**
54	6.12	5.87	6.36	6.61	7.10	7.10	7.10	6.85	7.34	7.10	6.85	6.85	**0.24**
55	6.45	6.60	6.40	6.20	6.17	6.13	6.08	6.21	6.15	6.27	6.44	6.41	**0.63**
56	8.75	8.90	9.14	8.62	8.30	9.15	9.10	10.10	9.20	8.70	8.60	10.00	**0.35**
57	6.32	6.18	6.28	6.29	5.99	6.31	6.31	6.40	6.72	6.31	6.31	6.32	**-0.19**

58	7.20	6.99	7.33	7.37	7.11	7.02	7.38	6.47	7.15	6.68	7.04	7.48	**-1.29**
59	6.60	6.60	6.60	7.20	7.10	7.30	7.00	7.10	6.90	6.80	6.80	6.90	**0.74**
60	7.44	7.32	7.19	7.57	7.44	7.32	7.44	7.69	7.19	7.19	7.57	7.32	**-0.20**
61	7.50	7.10	7.10	7.50	7.10	7.10	7.50	7.50	7.10	7.10	7.10	7.10	**-0.25**
62	7.04	7.30	7.16	7.45	7.40	7.18	7.28	7.12	7.12	7.38	7.24	7.29	**0.10**
64	6.60	6.40	6.50	6.50	6.90	6.40	6.90	6.50	6.90	7.10	6.60	6.70	**-0.31**
65	6.40	5.60	6.40	6.40	6.40	6.40	7.20	5.60	6.40	6.40	5.60	6.40	**0.56**
66	5.23	5.88	6.02	6.09	6.15	6.17	6.17	6.25	6.28	6.31	6.38	6.39	**-1.92**
67	6.64	6.64	6.89	6.89	7.13	7.13	7.38	7.38	7.38	7.38	7.38	7.38	**0.02**
68	7.00	6.00	7.00	7.00	6.50	7.00	7.00	6.50	7.50	7.50	6.50	7.00	**-0.07**
69	7.52	7.33	6.91	6.77	7.33	7.64	7.20	7.30	7.33	7.08	7.33	7.10	**1.22**
70	7.10	6.90	7.00	6.90	7.10	7.10	7.30	7.00	7.00	7.20	7.20	7.10	**0.17**
71	6.80	6.70	6.40	6.60	6.50	6.70	6.70	6.70	6.70	6.60	6.60	6.70	**-1.00**
72	6.66	6.83	6.66	6.66	6.66	6.99	6.66	6.66	6.50	6.66	6.83	6.66	**1.42**

Table 23. Results of the total biovolume concentration of the large particles (LP), medium particles (MP) and small particles (SP) with their associated zu-scores (Zu) in the reference counting chamber.

LC	BV_LP	BV_LP	BV_LP	BV_LP_Zu	BV_MP	BV_MP	BV_MP	BV_MP_Zu	BV_SP	BV_SP	BV_SP	BV_SP_Zu
1	0.62			**1.16**	35.48	34.79	34.07	**0.89**	2.11	1.86	1.77	**1**
2	0.46	0.46	0.46	**-2.51**	20.69	21.87	21.99	**-2.77**	0.65	0.67	0.65	**-2.42**
3	5834	5834	5834	**10247**	318179	321962	324064	**73269**	15416	15752	16459	**30585**
4	0.58	0.58	0.58	**0.29**	35.13	35.31	34.77	**0.97**	1.79	1.88	1.86	**0.44**
5	0.55	0.55	0.55	**-0.39**	31.64	28.92	29.6	**-0.34**	1.9	1.67	1.41	**0.09**
6	0.56	0.56	0.56	**-0.16**	34.6	34.7	36.8	**1.04**	1.3	1.5	1.6	**-0.37**
7	0.54	0.54	0.54	**-0.63**	28.53	29.94	30.93	**-0.41**	1.57	1.62	1.71	**0.04**
8	0.48	0.48	0.48	**-2.04**	22.93	23.14	23.56	**-2.29**	0.83	0.83	0.84	**-1.98**
9	0.55	0.55	0.55	**-0.39**	31.6	31.01	31.6	**0.04**	1.48	1.56	1.51	**-0.25**
10	0.07	0.07	0.07	**-11.67**	3.46	3.28	3.57	**-8**	0.16	0.15	0.15	**-3.70**
11	67666	67666	67666	**11886**	2032	2032	2032	**456**	12500	12500	12500	**240839**
12	0.63	0.63	0.63	**1.38**	32.38	32.34	33.84	**0.41**	1.62	1.67	1.61	**0.04**
13	0.6	0.6	0.6	**0.72**	34.87	33.01	34.71	**0.75**	2.54	2.72	2.39	**1.80**
14	0.56	0.56	0.56	**-0.16**	30.96	30.38	30.58	**-0.17**	1.74	1.89	1.57	**0.23**
15	0.61	0.61	0.61	**0.94**	32.6	32.14	32.22	**0.27**	1.27	1.35	1.3	**-0.78**
16	0.57	0.57	0.57	**0.07**	33.51	32.42	33.06	**0.44**	1.71	1.79	1.64	**0.19**
18	0.57	0.57	0.57	**0.07**	34.09	34.46	34.65	**0.80**	1.96	1.96	2.1	**0.76**
19	0.62	0.62	0.62	**1.16**	31.28	31.5	31.39	**0.03**	1.21	1.38	1.23	**-0.86**
20	0.59	0.59	0.59	**0.51**	34.68	34.43	35.02	**0.87**	1.89	1.92	1.84	**0.52**
21	0.63	0.63	0.63	**1.38**	27.37	28.15	28.98	**-0.88**	2.04	2.14	2.09	**0.92**
22	0.57	0.57	0.57	**0.07**	32.8	29.6	34.1	**0.23**	1.77	1.76	1.95	**0.41**
23	0.62	39.51	2.35	**296**	39.51	39.34	39.42	**2.07**	2.35	2.5	2.44	**1.57**
24	0.6	0.6	0.6	**0.72**	34.3	34.8	37.7	**1.10**	1.45	1.44	1.77	**-0.16**
25	0.03	0.03	0.03	**-12.61**	3.93	3.93	3.95	**-7.78**	0.08	0.08	0.08	**-3.88**
26	0.56	0.56	0.56	**-0.16**	29.06	29.91	29.45	**-0.51**	1.53	1.51	1.45	**-0.30**
27	0.06	0.07	0.06	**-11.83**	39.23	37.87	37.27	**1.74**	2.34	2.29	2.11	**1.22**
28	0.56	0.56	0.56	**-0.16**	29.5	28.7	28.55	**-0.67**	1.27	1.28	1.23	**-0.90**
29	0.55	0.55	0.55	**-0.39**	29.89	31.72	29.18	**-0.28**	1.57	1.61	1.44	**-0.19**
30	0.58	0.58	0.58	**0.29**	33.75	28.96	30.09	**-0.09**	1.02	1.06	1.41	**-1.14**
31	0.61	0.61	0.61	**0.94**	31.9	29.8	33.1	**0.09**	1.42	1.46	1.29	**-0.57**
32	0.55	0.55	0.55	**-0.39**	30.04	33.59	32.26	**0.18**	1.66	1.49	1.6	**-0.08**
33	0.5	0.5	0.5	**-1.57**	33.39	32.27	33.23	**0.43**	1.4	1.38	1.39	**-0.57**
34	0.59	0.52	0.52	**-0.55**	29.02	30.77	29.47	**-0.43**	2.01	1.86	1.79	**0.52**
35	0.57	0.57	0.57	**0.07**	29.940	30.750	29.470	**-0.34**	1.950	2.130	1.940	**0.76**
36	441787	441787	44178	**77610**	2428447	2379055	2379055	**54615**	16123	14243	15529	**2947726**
37	0.54	0.54	0.54	**-0.63**	26.44	28.83	28.53	**-0.95**	1.71	1.62	1.64	**0.08**

39	0.52	0.52	0.52	**-1.10**	27.58	26.64	26.86	**-1.20**	1.55	1.41	1.34	**-0.46**
41	0.56	0.56	0.56	**-0.16**	29.2	29.42	29.06	**-0.58**	1.55	1.66	1.62	**-0.01**
43	0.59	0.59	0.59	**0.51**	30.26	29.85	30.29	**-0.32**	1.46	1.47	1.44	**-0.40**
44	0.59	0.59	0.59	**0.51**	30.37	30.22	29.62	**-0.34**	1.33	1.3	1.31	**-0.76**
45	0.53	0.53	0.53	**-0.86**	34.85	29.72	29.04	**-0.01**	1.51	1.61	1.56	**-0.14**
46	0.05	0.05	0.05	**-12.14**	2.39	2.41	2.41	**-8.22**	0.12	0.12	0.12	**-3.78**
47	0.47	0.47	0.47	**-2.27**	25.29	25.39	27.28	**-1.50**	1.09	1.09	1.05	**-1.36**
48	0.54	0.54	0.54	**-0.63**	28.25	29.85	28.18	**-0.71**	1.55	1.6	1.42	**-0.23**
49	0.53	0.53	0.53	**-0.86**	30.07	30.19	30.36	**-0.30**	1.59	1.61	1.66	**0.01**
50	0.58	0.58	0.58	**0.29**	35.89	36.79	34.01	**1.09**	2.18	2.04	2.08	**0.94**
51	0.59	0.59	0.59	**0.51**	30.63	31.32	36.12	**0.36**	1.64	1.4	1.7	**-0.09**
52	0.55	0.55	0.55	**-0.39**	30.98	29.77	33.4	**0.03**	1.99	2.17	1.96	**0.82**
53	0.55	0.55	0.55	**-0.39**	30.02	33.7	29.59	**-0.04**	1.77	1.59	1.95	**0.30**
54	0.61	0.61	0.81	**2.39**	30.67	30.09	30.58	**-0.23**	1.69	1.66	1.71	**0.14**
55	0.58	0.58	0.58	**0.29**	29.3	28.01	28.89	**-0.72**	1.3	1.29	1.24	**-0.86**
56	0.65	0.65	0.57	**1.23**	51.7	40.1	49	**3.97**	5.11	3.7	5.15	**5.85**
57	0.54	0.54	0.54	**-0.63**	26.18	27.27	26.18	**-1.34**	1.22	1.27	1.29	**-0.90**
58	0.57	0.57	0.57	**0.07**	30.4	31.53	32.99	**0.10**	1.85	1.98	1.71	**0.45**
59	0.56	0.56	0.56	**-0.16**	32.69	31.6	33.47	**0.34**	1.68	1.48	1.67	**-0.01**
60	0.57	0.57	0.57	**0.07**	32.67	32.04	32.36	**0.28**	2.06	2.17	2.2	**1.02**
61	0.58	0.58	0.58	**0.29**	37.46	30.66	30.66	**0.42**	2.26	1.76	1.9	**0.69**
62	0.49	0.49	0.49	**-1.80**	33.86	33.77	33.94	**0.66**	1.99	1.99	1.97	**0.71**
64	0.54	0.54	0.54	**-0.63**	32.2	32.1	33.35	**0.33**	1.56	1.59	1.56	**-0.11**
65	0.55	0.55	0.55	**-0.39**	27.36	26.19	26.46	**-1.31**	1.42	1.34	1.22	**-0.73**
66	0.78	0.78	0.78	**4.64**	27.77	28.48	28.74	**-0.83**	1.06	1.21	1.28	**-1.09**
67	0.63	0.63	0.63	**1.38**	31.91	29.3	27.44	**-0.49**	1.99	1.7	2.34	**0.76**
68	0.59	0.59	0.59	**0.51**	28.59	28.59	28.45	**-0.77**	1.51	1.52	1.49	**-0.27**
69	3.7	3.7	3.7	**68.12**	37.05	37.63	37.05	**1.52**	1.79	1.71	1.72	**0.24**
70	0.57	0.57	0.57	**0.07**	29.22	29.52	29.45	**-0.53**	1.78	1.79	1.9	**0.40**
71	0.58	0.58	0.58	**0.29**	35.4	30.53	35.3	**0.63**	1.45	1.4	1.38	**-0.52**
72	0.54	0.54	0.54	**-0.63**	33.47	29.17	31.48	**0.03**	1.75	1.63	1.92	**0.29**

6. Results of component 2

Table 24. Results of the cell densities (CC) of phytoplankton species (sp) for every participant (LC) and the associated zu-score.

LC	CC-sp 1	CC-sp 1	CC-sp 1	CC sp 1 Zu-score	CC-sp 2	CC-sp 2	CC-sp 2	CC sp 2 Zu-score
1	7144231	5769231	5637931	**-0.47**	548077	500000	413793	**0.91**
2	6140307	6133255	6382556	**-0.45**	480836	454315	463096	**0.75**
3	4003906	4608888	3795998	**-1.57**	245913	248397	248148	**-1.18**
4	9317820	9738520	9953150	**1.05**	462020	527990	531380	**1.06**
5	6530000	5940000	5120000	**-0.64**	287000	304000	293000	**-0.70**
6	841811	987600	578451	**-3.37**	627183	414338	493800	**1.09**
7	10113952	11188000	10382464	**1.41**	345794	371096	354228	**-0.07**
8	5884560	6146096	6783590	**-0.42**	579483	438247	591945	**1.27**
9	8118072	7979751	7543329	**0.33**	314417	281138	300756	**-0.66**
10	6738800	7738400	8187200	**0.20**	503200	435200	476000	**0.79**
11	2682000	1909000	1601000	**-2.69**	136000	182000	195000	**-1.95**
12	6260700	6933100	6810100	**-0.21**	502250	518650	485850	**1.02**
13	6314542	6286226	6003064	**-0.46**	357438	369693	314545	**-0.17**
14	9383607	8775410	10100410	**0.95**	360234	328490	353333	**-0.17**
15	5329794	5738207	5493159	**-0.82**	264826	271207	253127	**-1.02**
16	5533200	4780600	5819400	**-0.90**	313379	278559	327717	**-0.58**
18	7300000	9700000	7000000	**0.38**	380000	390000	320000	**-0.01**
19	4647036	4606510	4602353	**-1.31**	283486	257746	274895	**-0.93**
20	9612627	9920008	9500853	**1.06**	435006	468468	439467	**0.62**
21	6837221	6700398	6276043	**-0.24**	348598	281569	290956	**-0.58**
22	6030000	6200000	6370000	**-0.46**	349000	413000	364000	**0.08**
23	1271400	2109900	2726100	**-2.71**	152100	237900	323700	**-1.27**
24	9190000	8410000	6580000	**0.41**	396000	375000	402000	**0.20**
25	4254583	3919405	4151867	**-1.59**	301909	316784	316784	**-0.53**
26	8914290	9359350	9634240	**0.91**	310550	294522	292518	**-0.66**
27	7580501	8214667	8022942	**0.36**	344424	350550	374374	**-0.08**
28	6190470	6285279	6014795	**-0.48**	423788	520695	596630	**1.10**
29	7340000	7940000	6010000	**0.02**	389000	333000	381000	**0.02**
30	3144862	6054532	5768940	**-1.11**	251320	285591	285591	**-0.91**
31	8251487	9168319	8834925	**0.68**	377846	459805	416742	**0.40**
32	8251473	7138179	5173543	**-0.10**	389289	218293	469330	**-0.05**
33	6483301	7465619	8055010	**0.12**	598321	570920	642972	**1.77**
34	834507	1185099	1427056	**-3.19**	270862	265189	127631	**-1.44**
35	5907100	5513800	5923300	**-0.68**	271600	271600	293900	**-0.86**
36	11433575	7258275	5161440	**0.36**	133940	106790	72400	**-2.62**
37	6552820	7033760	6372470	**-0.21**	417820	378740	366720	**0.17**
39	8456622	7701326	7944100	**0.40**	545001	472968	323467	**0.61**
41	8764140	8617800	9447060	**0.76**	409760	465920	615680	**0.98**
43	6263051	6645086	7085004	**-0.21**	250613	291454	248757	**-1.01**
44	5606026	5538480	6067907	**-0.71**	250853	220584	247741	**-1.25**
45	9588000	8330000	8069000	**0.65**	218000	238000	286000	**-1.18**
46	8710954	8174895	8018545	**0.50**	258077	241367	267979	**-1.09**
47	8672904	8694302	6603845	**0.38**	523695	310511	537522	**0.69**
48	4511356	5445779	5546254	**-1.02**	181120	196213	220185	**-1.66**
49	6399520	6808000	8128752	**0.03**	389876	483984	591536	**0.92**
50	7088543	7423303	7569761	**0.13**	334435	371905	371905	**-0.05**
51	7692308	6850962	7884615	**0.17**	331731	439904	408654	**0.21**
52	7960947	6947588	5853160	**-0.07**	322685	406419	355362	**-0.03**
53	6259000	6056000	5650000	**-0.57**	365000	312000	311000	**-0.35**
54	8272068	7927399	9133742	**0.56**	503638	400544	353223	**0.40**

55	10289261	9382411	8144211	**0.89**	436192	451408	509736	**0.75**
56	5453993	5007757	5230875	**-0.98**	432353	427395	429874	**0.48**
57	9582400	8904000	8861600	**0.83**	340000	374000	342000	**-0.12**
58	7180905	6029019	6372134	**-0.28**	252238	412939	266478	**-0.54**
59	11477620	10883950	11110110	**1.65**	446760	467160	434520	**0.63**
60	10255285	9178049	9544309	**1.05**	288043	314105	340166	**-0.51**
61	112903	100806	104839	**-3.36**	318548	362903	362903	**-0.16**
62	7642541	8382142	7874133	**0.37**	420039	390439	417028	**0.33**
64	2900	2200	2100	**-3.42**	403302	403302	385434	**0.24**
65	7666000	7913000	10633000	**0.68**	454000	284000	536000	**0.45**
66	8949000	8525000	7731000	**0.54**	342000	374000	768000	**0.96**
67	2896029	3297018	3007415	**-2.15**	275680	313272	311184	**-0.65**
68	8529920	8181760	9574400	**0.69**	416150	471500	383350	**0.44**
69	146149	150915	157269	**-3.34**	28238	33800	39362	**-3.33**
70	7637209	7792404	7923094	**0.30**	332852	292011	319578	**-0.50**
71	5433506	5767471	6037929	**-0.70**	236582	275038	358606	**-0.75**
72	8014706	7867647	8235294	**0.40**	531046	383987	539216	**0.89**

LC	**CC-sp 3**	**CC-sp 3**	**CC-sp 3**	**CC sp 3 Zu**	**CC-sp 4**	**CC-sp 4**	**CC-sp 4**	**CC sp 4 Zu**	**CC-sp 5**	**CC-sp 5**	**CC-sp 5**	**CC sp 5 Zu**
1	153846	153846	189655	**3.55**	269231	355769	258621	**2.12**	19231	9615	8621	**16.92**
2	92567	105835	108964	**0.92**	257132	219414	239720	**1.29**	2717	1948	2159	**0.16**
3	58125	76777	71538	**-0.62**	111779	92584	129663	**-0.87**	2100	2200	2000	**-0.16**
4	78540	111840	148050	**1.35**	233320	202870	230000	**1.04**	2358	2379	2374	**0.32**
5	60000	50000	57000	**-1.33**	111000	135000	171000	**-0.28**	1700	1300	1400	**-1.48**
6	117774	105003	61016	**0.59**	993309	185884	185884	**4.52**	1800	1200	2400	**-0.78**
7	76068	71842	67616	**-0.46**	177492	152136	164814	**0.19**	2323	2323	1919	**0.02**
8	50500	56800	59500	**-1.33**	216008	206662	207700	**0.87**	2400	2700	2300	**0.48**
9	80769	68571	67810	**-0.43**	132690	122093	141712	**-0.43**	2212	2000	1810	**-0.35**
10	95200	81600	88400	**0.34**	197200	170000	210800	**0.60**	1700	2000	2200	**-0.43**
11	79000	115000	64000	**0.24**	106000	57000	9800	**-2.02**	2000	2000	2000	**-0.36**
12	68600	77400	86400	**-0.15**	132800	150800	153800	**-0.14**	2000	1900	1700	**-0.64**
13	57190	51063	42893	**-1.61**	130720	177698	122550	**-0.18**	1100	2400	1700	**-0.92**
14	84193	97995	92474	**0.47**	155964	132500	176667	**0.04**	2000	2100	2800	**0.21**
15	90403	75513	95720	**0.29**	108483	125500	115928	**-0.76**	2600	2200	1800	**0.04**
16	70500	67500	56800	**-0.83**	103400	106400	104800	**-1.01**	3700	4300	3800	**2.88**
18	76000	100000	71000	**0.08**	160000	185000	140000	**0.14**	2000	2000	2000	**-0.36**
19	75596	70195	91631	**-0.06**	100795	89937	89341	**-1.26**	2181	2146	2492	**0.16**
20	94412	98855	102187	**0.76**	207464	218618	214157	**0.91**	1999	2099	2299	**-0.09**
21	80083	86817	69830	**-0.08**	94216	114974	100089	**-1.05**	2189	2280	2458	**0.22**
22	88700	67300	62200	**-0.41**	200000	192000	159000	**0.47**	1900	2200	2100	**-0.23**
23	97500	113100	120900	**1.25**	113100	58500	93600	**-1.36**	900	1400	2100	**-1.48**
24	89800	112000	75500	**0.50**	141000	155000	153000	**-0.05**	2100	2200	1900	**-0.23**
25	71621	86496	98616	**0.22**	147098	138283	157565	**-0.10**	2300	2300	2500	**0.32**
26	80142	84149	78138	**0.02**	146259	178316	138245	**0.03**	1400	2200	2000	**-0.64**
27	78000	83000	73800	**-0.11**	97400	122800	123400	**-0.80**	3000	3200	3100	**1.52**
28	75212	87506	89354	**0.15**	150423	201046	209001	**0.52**	2600	1900	2600	**0.32**
29	64000	67000	69000	**-0.73**	149000	177000	158000	**0.14**	3000	2000	2000	**0.26**
30	123375	77110	56547	**0.22**	148507	251320	79966	**0.12**	2700	2600	2100	**0.48**
31	77097	89599	70846	**-0.06**	170864	182325	181283	**0.39**	1400	1700	2600	**-0.57**
32	80041	61850	65488	**-0.60**	185549	58211	207378	**-0.04**	1768	2358	1179	**-0.85**
33	214324	176314	187533	**4.67**	312556	193105	241114	**1.44**	1572	2358	2161	**-0.30**
34	83669	90760	59561	**-0.12**	121959	130468	106359	**-0.70**	1600	1700	1400	**-1.27**
35	68900	62800	70900	**-0.69**	131800	131800	125700	**-0.48**	2900	2200	2400	**0.53**
36	59730	67875	64255	**-0.88**	104980	126700	72400	**-1.09**	2000	2100	3400	**0.53**

37	66130	96190	81160	**0.03**	150290	126250	108210	**-0.51**	2700	1500	2200	**-0.09**
39	102612	80187	83585	**0.35**	218816	146104	164452	**0.36**	2440	2200	2720	**0.46**
41	62400	74880	85280	**-0.33**	252030	146340	373980	**1.57**	2500	2000	1800	**-0.16**
43	61261	54764	61261	**-1.14**	51979	54764	51051	**-2.13**	1600	1900	1500	**-1.06**
44	63400	62500	63100	**-0.93**	137600	132000	137200	**-0.35**	2100	2500	2400	**0.26**
45	62900	64600	81600	**-0.57**	95200	73100	139000	**-1.06**	3750	2917	4000	**2.27**
46	72410	80765	66840	**-0.38**	90048	90048	78908	**-1.41**	1800	2700	1800	**-0.16**
47	114957	90566	76789	**0.57**	217142	258759	179174	**0.99**	2451	2185	2063	**0.10**
48	53270	74579	70139	**-0.77**	78130	87896	93223	**-1.40**	1900	1900	2000	**-0.50**
49	74508	87813	109101	**0.42**	161328	184855	205021	**0.47**	2100	2900	1900	**0.21**
50	72930	79173	94799	**0.08**	140650	148970	167722	**0.00**	2500	2900	2400	**0.70**
51	79327	69712	74519	**-0.31**	163462	161058	201923	**0.35**	2000	1900	2500	**-0.09**
52	71600	72400	84800	**-0.22**	208315	212400	155215	**0.59**	2700	2800	2200	**0.64**
53	71000	57000	67000	**-0.82**	107000	107000	109000	**-0.95**	3000	2000	2000	**0.26**
54	98023	104784	84503	**0.64**	121684	152105	153795	**-0.21**	3754	2503	3337	**1.68**
55	114120	109048	98904	**1.12**	180056	187664	223168	**0.67**	2371	2577	2784	**0.66**
56	181618	167983	174800	**3.93**	110171	127321	118746	**-0.71**	1333	1167	1250	**-1.93**
57	84000	92000	88000	**0.32**	178000	139000	165000	**0.13**	1800	2600	2800	**0.37**
58	69484	61428	55386	**-0.98**	132222	209521	138324	**0.12**	2100	1700	2000	**-0.50**
59	95200	106080	95200	**0.77**	163200	175440	209440	**0.46**	2400	2300	2600	**0.42**
60	64467	96014	80927	**0.01**	149508	128943	167340	**-0.08**	2300	1700	1900	**-0.43**
61	90726	102823	92742	**0.63**	193548	243952	183468	**0.82**	1300	2400	2200	**-0.43**
62	81908	113227	93831	**0.67**	176416	163984	166811	**0.25**	2759	2167	2365	**0.42**
64	7298202	9239409	962221	**298**	91892	86148	72747	**-1.47**	141666	181869	156024	**259**
65	77000	108000	80000	**0.33**	225000	140000	158000	**0.33**	2400	1800	2800	**0.26**
66	128000	85000	128000	**1.39**	203000	224000	139000	**0.55**	1000	3000	1000	**-1.06**
67	37593	33416	39681	**-2.33**	133663	131574	123220	**-0.48**	1857	1543	2171	**-0.66**
68	114800	100450	79950	**0.75**	168100	217300	221400	**0.75**	4100	1500	2800	**1.03**
69	3851	4278	3851	**-3.85**	15830	20109	15402	**-2.89**	2139	2567	2139	**0.18**
70	90871	98018	79639	**0.38**	124564	112312	130690	**-0.63**	2000	1600	1500	**-0.99**
71	31544	50007	58378	**-1.81**	141949	166690	133435	**-0.10**	1816	2167	1980	**-0.39**
72	60000	68000	88000	**-0.45**	155229	171569	212418	**0.41**	2375	2125	2500	**0.26**

Table 25. Results of the total biovolume concentrations (BV) of the phytoplankton species (sp) for every participant (LC) and the associated zu-score.

LC	**BV-sp 1**	**BV-sp 1**	**BV-sp1**	**BV sp1 Zu-Score**	**BV-sp 2**	**BV-sp2**	**BV-sp2**	**BV sp2 Zu-Score**
1	0.279	0.12	0.382	**1.48**	0.246	0.266	0.375	**1.80**
2	0.098	0.098	0.102	**-0.76**	0.162	0.153	0.156	**0.00**
3	0.12	0.139	0.114	**-0.26**	0.111	0.112	0.112	**-0.87**
4	0.221	0.231	0.236	**1.10**	0.261	0.298	0.3	**1.68**
5	0.138	0.125	0.108	**-0.28**	0.111	0.118	0.113	**-0.83**
6	0.011	0.013	0.008	**-2.50**	0.348	0.231	0.274	**1.65**
7	0.158	0.175	0.162	**0.33**	0.148	0.159	0.152	**-0.07**
8	0.043	0.045	0.05	**-1.81**	0.067	0.051	0.069	**-1.82**
9	0.113	0.111	0.105	**-0.55**	0.152	0.136	0.146	**-0.23**
10	0.146	0.167	0.177	**0.31**	0.232	0.201	0.22	**0.79**
11	38699000	25703000	18544000	**290598207**	47176000	66188000	74670000	**720707172**
12	0.099	0.109	0.107	**-0.64**	0.163	0.169	0.158	**0.08**
13	0.026	0.026	0.023	**-2.22**	0.102	0.128	0.125	**-0.74**
14	0.138	0.129	0.149	**0.01**	0.153	0.139	0.149	**-0.19**
15	0.135	0.146	0.139	**0.03**	0.052	0.054	0.05	**-2.02**
16	0.128	0.11	0.134	**-0.27**	0.152	0.135	0.159	**-0.16**
18	0.146	0.194	0.14	**0.27**	0.115	0.119	0.097	**-0.90**
19	0.109	0.109	0.108	**-0.57**	0.104	0.095	0.101	**-1.10**

20	0.288	0.298	0.285	**1.84**	0.22	0.237	0.222	**0.90**
21	0.12	0.12	0.11	**-0.41**	0.31	0.25	0.26	**1.51**
22	0.115	0.118	0.121	**-0.39**	0.148	0.175	0.154	**0.03**
23	0.04	0.07	0.09	**-1.40**	0.15	0.23	0.32	**0.99**
24	0.228	0.21	0.171	**0.79**	0.221	0.222	0.229	**0.87**
25	0.06	0.06	0.06	**-1.53**	0.18	0.19	0.19	**0.39**
26	0.144	0.151	0.155	**0.15**	0.11	0.105	0.104	**-0.97**
27	0.415	0.449	0.439	**3.58**	0.193	0.197	0.21	**0.56**
28	0.102	0.104	0.099	**-0.71**	0.111	0.137	0.156	**-0.43**
29	0.135	0.146	0.111	**-0.14**	0.151	0.13	0.148	**-0.27**
30	0.078	0.111	0.139	**-0.56**	0.099	0.108	0.132	**-0.85**
31	0.125	0.139	0.134	**-0.10**	0.124	0.15	0.136	**-0.39**
32	0.277	0.239	0.173	**1.11**	0.159	0.089	0.192	**-0.20**
33	0.09	0.1	0.11	**-0.74**	0.25	0.23	0.26	**1.16**
34	0.028	0.04	0.047	**-1.96**	0.198	0.194	0.093	**0.06**
35	0.089	0.083	0.089	**-1.00**	0.092	0.092	0.099	**-1.21**
36	410897	260846	185490	**3126271**	9915	7905	5360	**92091**
37	0.144	0.155	0.14	**0.10**	0.142	0.129	0.125	**-0.48**
39	0.186	0.169	0.175	**0.47**	0.229	0.198	0.136	**0.40**
41	0.07	0.07	0.07	**-1.33**	0.16	0.18	0.23	**0.43**
43	0.175	0.186	0.198	**0.59**	0.093	0.108	0.093	**-1.14**
44	0.137	0.135	0.148	**0.03**	0.096	0.084	0.094	**-1.26**
45	0.173	0.15	0.145	**0.22**	0.09	0.099	0.119	**-1.05**
46	0.145	0.138	0.135	**0.02**	0.084	0.079	0.088	**-1.41**
47	0.245	0.245	0.186	**1.06**	0.259	0.153	0.266	**0.90**
48	0.099	0.12	0.122	**-0.47**	0.059	0.064	0.072	**-1.77**
49	0.141	0.15	0.179	**0.23**	0.126	0.156	0.191	**0.01**
50	0.163	0.171	0.174	**0.38**	0.131	0.146	0.146	**-0.31**
51	0.154	0.137	0.158	**0.14**	0.129	0.171	0.159	**-0.07**
52	0.106	0.093	0.078	**-0.89**	0.101	0.128	0.112	**-0.83**
53	0.14	0.14	0.13	**-0.02**	0.12	0.1	0.1	**-0.97**
54	0.205	0.196	0.226	**0.86**	0.159	0.127	0.111	**-0.47**
55	0.205	0.187	0.162	**0.57**	0.238	0.247	0.279	**1.27**
56	0.243	0.23	0.23	**1.17**	0.237	0.234	0.235	**1.02**
57	0.119	0.11	0.11	**-0.49**	0.115	0.127	0.116	**-0.72**
58	0.229	0.192	0.203	**0.85**	0.124	0.203	0.131	**-0.08**
59	0.226	0.214	0.219	**0.99**	0.19	0.199	0.185	**0.45**
60	0.16	0.14	0.15	**0.15**	0.12	0.13	0.14	**-0.52**
61	0.038	0.034	0.035	**-2.01**	0.1	0.12	0.12	**-0.84**
62	0.176	0.193	0.181	**0.55**	0.26	0.242	0.258	**1.25**
64	0.065	0.05	0.047	**-1.65**	0.123	0.123	0.117	**-0.69**
65	0.131	0.135	0.182	**0.14**	0.143	0.089	0.168	**-0.45**
66	0.126	0.12	0.109	**-0.38**	0.142	0.155	0.328	**0.67**
67	0.061	0.069	0.063	**-1.45**	0.127	0.144	0.143	**-0.36**
68	0.23	0.221	0.259	**1.19**	0.26	0.295	0.24	**1.40**
69	0.005	0.005	0.006	**-2.61**	0.018	0.021	0.025	**-2.62**
70	0.165	0.168	0.171	**0.37**	0.123	0.107	0.118	**-0.79**
71	0.212	0.225	0.235	**1.04**	0.141	0.164	0.213	**0.21**
72	0.127	0.115	0.121	**-0.33**	0.26	0.207	0.307	**1.31**

LC	BV-sp 3	BV-sp 3	BV-sp 3	BV sp 3 Zu	BV-sp 4	BV-sp 4	BV-sp 4	BV sp 4 Zu	BV-sp 5	BV-sp 5	BV-sp 5	BV sp 5 Zu
1	0.02	0.021	0.027	**2.87**	0.062	0.145	0.171	**1.69**	1.071	0.485	0.504	**22**
2	0.006	0.007	0.007	**-0.63**	0.073	0.062	0.068	**0.33**	0.062	0.045	0.049	**0.11**
3	0.006	0.008	0.008	**-0.41**	0.014	0.012	0.016	**-1.81**	0.01	0.011	0.01	**-2.14**
4	0.006	0.008	0.011	**-0.09**	0.07	0.061	0.068	**0.30**	0.043	0.043	0.043	**-0.33**
5	0.005	0.004	0.005	**-1.28**	0.028	0.034	0.043	**-0.84**	0.056	0.043	0.046	**-0.03**
6	0.013	0.011	0.007	**0.35**	0.097	0.073	0.073	**0.64**	0.036	0.024	0.048	**-0.72**
7	0.01	0.009	0.009	**0.15**	0.045	0.039	0.042	**-0.52**	0.057	0.057	0.047	**0.16**
8	0.003	0.004	0.004	**-1.60**	0.101	0.096	0.097	**1.04**	0.06	0.067	0.057	**0.42**
9	0.004	0.003	0.003	**-1.71**	0.014	0.013	0.015	**-1.81**	0.073	0.066	0.06	**0.59**
10	0.009	0.008	0.008	**-0.09**	9.911	8.544	10.595	**206**	0.039	0.046	0.051	**-0.20**
11	10040	14810	35990	**1657960**	51501	21877	38656	**761507**	23371	22611	29094	**747929**
12	0.008	0.009	0.01	**0.08**	0.062	0.071	0.072	**0.35**	0.047	0.045	0.04	**-0.27**
13	0.012	0.013	0.009	**0.56**	0.033	0.045	0.038	**-0.67**	0.017	0.042	0.028	**-1.11**
14	0.01	0.011	0.011	**0.42**	0.024	0.021	0.028	**-1.33**	0.057	0.06	0.08	**0.57**
15	0.006	0.005	0.007	**-0.84**	0.037	0.043	0.04	**-0.61**	0.062	0.053	0.043	**0.13**
16	0.007	0.007	0.006	**-0.63**	0.077	0.079	0.078	**0.57**	0.059	0.069	0.061	**0.48**
18	0.007	0.009	0.006	**-0.41**	0.065	0.076	0.057	**0.29**	0.038	0.044	0.043	**-0.40**
19	0.01	0.009	0.012	**0.35**	0.019	0.017	0.017	**-1.64**	0.002	0.002	0.002	**-2.61**
20	0.018	0.018	0.019	**1.99**	0.113	0.119	0.117	**1.46**	0.078	0.082	0.09	**1.17**
21	0.02	0.02	0.01	**1.65**	0.03	0.03	0.03	**-1.07**	0.05	0.05	0.06	**0.15**
22	0.011	0.008	0.007	**0.01**	0.074	0.071	0.059	**0.34**	0.07	0.081	0.078	**0.94**
23	0.005	0.005	0.006	**-1.06**	0.122	0.063	0.101	**0.97**	0.015	0.023	0.034	**-1.38**
24	0.012	0.016	0.011	**0.90**	0.043	0.044	0.046	**-0.41**	0.061	0.066	0.059	**0.45**
25	0.01	0.01	0.01	**0.29**	0.06	0.06	0.07	**0.23**	0.05	0.05	0.05	**0.04**
26	0.007	0.008	0.007	**-0.41**	0.037	0.045	0.035	**-0.66**	0.029	0.046	0.041	**-0.57**
27	0.012	0.013	0.011	**0.69**	0.044	0.055	0.055	**-0.09**	0.087	0.093	0.09	**1.40**
28	0.008	0.009	0.01	**0.08**	0.051	0.068	0.071	**0.23**	0.057	0.041	0.057	**0.09**
29	0.009	0.01	0.01	**0.22**	0.053	0.063	0.057	**0.10**	0.057	0.038	0.036	**-0.29**
30	0.008	0.004	0.003	**-1.17**	0.071	0.105	0.037	**0.41**	0.063	0.051	0.041	**0.09**
31	0.006	0.007	0.006	**-0.73**	0.026	0.028	0.028	**-1.19**	0.013	0.016	0.024	**-1.74**
32	0.01	0.008	0.009	**0.08**	0.028	0.009	0.032	**-1.39**	0.009	0.012	0.006	**-2.22**
33	0.05	0.04	0.04	**7.09**	0.014	0.008	0.011	**-1.94**	0.005	0.007	0.006	**-2.39**
34	0.014	0.015	0.009	**0.83**	0.044	0.047	0.038	**-0.47**	0.037	0.039	0.032	**-0.72**
35	0.009	0.085	0.096	**0.12**	0.077	0.077	0.073	**0.52**	0.102	0.077	0.084	**1.33**
36	9790.9	11126.	10532	**1884974**	26762.	32300.	18457.	**554028**	19820	20811	33695	**809956**
37	0.005	0.007	0.006	**-0.84**	0.051	0.043	0.037	**-0.44**	0.071	0.039	0.058	**0.24**
39	0.014	0.011	0.011	**0.69**	0.137	0.092	0.103	**1.33**	0.052	0.047	0.058	**0.12**
41	0.006	0.007	0.008	**-0.52**	0.15	0.09	0.22	**2.32**	0.07	0.06	0.05	**0.38**
43	0.007	0.006	0.007	**-0.63**	0.015	0.016	0.015	**-1.75**	0.017	0.021	0.016	**-1.72**
44	0.009	0.009	0.009	**0.08**	0.047	0.045	0.047	**-0.32**	0.162	0.193	0.185	**4.47**
45	0.004	0.004	0.006	**-1.28**	0.035	0.027	0.051	**-0.72**	0.109	0.085	0.116	**1.86**
46	0.004	0.005	0.004	**-1.38**	0.014	0.014	0.013	**-1.82**	0.032	0.049	0.032	**-0.62**
47	0.008	0.006	0.005	**-0.73**	0.043	0.052	0.036	**-0.44**	0.043	0.038	0.036	**-0.55**
48	0.005	0.008	0.007	**-0.63**	0.021	0.024	0.025	**-1.38**	0.015	0.015	0.016	**-1.87**
49	0.006	0.008	0.009	**-0.30**	0.103	0.119	0.132	**1.50**	0.048	0.067	0.044	**0.14**
50	0.011	0.012	0.014	**0.76**	0.075	0.08	0.09	**0.66**	0.061	0.07	0.058	**0.48**
51	0.011	0.009	0.01	**0.29**	0.025	0.025	0.031	**-1.21**	0.016	0.015	0.02	**-1.77**
52	0.006	0.006	0.007	**-0.73**	0.116	0.118	0.086	**1.24**	0.06	0.062	0.049	**0.28**
53	0.005	0.004	0.005	**-1.28**	0.03	0.03	0.03	**-1.07**	0.05	0.04	0.04	**-0.31**
54	0.012	0.013	0.01	**0.63**	0.042	0.053	0.053	**-0.18**	0.087	0.058	0.077	**0.86**
55	0.007	0.007	0.006	**-0.63**	0.043	0.045	0.053	**-0.29**	0.052	0.057	0.061	**0.27**
56	0.105	0.096	0.1	**18.72**	0.092	0.11	0.1	**1.10**	0.034	0.031	0.034	**-0.88**
57	0.008	0.009	0.008	**-0.09**	0.055	0.043	0.051	**-0.17**	0.053	0.077	0.083	**0.75**

58	0.011	0.01	0.009	**0.29**	0.075	0.119	0.078	**0.87**	0.052	0.042	0.05	**-0.05**
59	0.012	0.013	0.012	**0.76**	0.055	0.059	0.071	**0.19**	0.078	0.075	0.085	**1.04**
60	0.01	0.015	0.012	**0.76**	0.021	0.018	0.023	**-1.50**	0.065	0.048	0.053	**0.22**
61	0.007	0.008	0.007	**-0.41**	0.027	0.034	0.025	**-1.13**	0.039	0.058	0.053	**0.04**
62	0.007	0.01	0.008	**-0.09**	0.047	0.044	0.045	**-0.37**	0.054	0.042	0.046	**-0.09**
64	0.263	0.333	0.251	**54.22**	0.015	0.014	0.012	**-1.82**	0.052	0.066	0.057	**0.32**
65	0.009	0.013	0.01	**0.42**	0.139	0.087	0.098	**1.27**	0.047	0.036	0.055	**-0.16**
66	0.017	0.011	0.017	**1.31**	0.026	0.029	0.018	**-1.33**	0.018	0.055	0.018	**-1.03**
67	0.005	0.004	0.005	**-1.28**	0.071	0.07	0.066	**0.36**	0.039	0.032	0.046	**-0.55**
68	0.011	0.01	0.008	**0.22**	0.087	0.112	0.114	**1.18**	0.127	0.047	0.087	**1.30**
69	0.001	0.001	0.001	**-2.46**	0.011	0.014	0.011	**-1.90**	0.008	0.009	0.008	**-2.26**
70	0.018	0.02	0.016	**1.92**	0.07	0.063	0.074	**0.36**	0.072	0.058	0.054	**0.42**
71	0.003	0.004	0.005	**-1.49**	0.027	0.032	0.025	**-1.16**	0.044	0.052	0.048	**-0.05**
72	0.009	0.011	0.014	**0.56**	0.012	0.017	0.019	**-1.71**	0.075	0.07	0.079	**0.88**

7. Results of component 3

Table 26. Results of the taxonomic determinations for every video and participant. The final %-score for every participant is also provided.

Lab-code	Video 1	Video 2	Video 3	Video 4	Video 5	Video 6	Video 7	Video 8	Video 9	Video 10	%-score
1	1	1	1	1	0.667	1	1	1	1	0.5	**92**
2	1	1	0.667	1	1	1	1	1	1	0.5	**92**
3	1	1	0.667	1	1	1	0.5	1	1	1	**92**
4	1	1	1	1	1	1	0	1	1	1	**90**
5	1	1	0.667	1	1	1	1	1	1	1	**97**
6	1	1	1	1	1	0.667	0.5	1	1	0.5	**87**
7	1	1	0.667	1	1	1	1	1	1	1	**97**
8	1	1	0.333	1	0.667	0.667	1	1	1	0.5	**82**
9	1	1	0.667	1	1	1	1	1	1	1	**97**
11	1	1	0.333	1	0.667	1	0.5	1	1	1	**85**
12	1	1	0.667	1	1	0.667	1	1	1	1	**93**
13	1	1	0.333	1	0.667	1	1	0.667	1	0.5	**82**
14	1	1	1	1	1	0.667	1	1	1	1	**97**
15	1	1	0.333	1	1	1	1	1	1	0.5	**88**
16	1	1	0.333	1	1	1	1	1	1	0.5	**88**
18	1	1	0.667	1	1	0.667	1	1	1	0.5	**88**
19	1	1	0.333	1	1	1	1	1	1	0.5	**88**
20	1	1	1	1	1	0.667	1	1	1	0.5	**92**
21	1	1	1	1	1	0.667	1	1	1	1	**97**
22	1	1	0.667	1	1	1	1	1	1	1	**97**
23	1	1	0	1	1	0.667	0.5	0.667	1	0.5	**73**
24	1	1	0.667	1	1	1	1	1	1	1	**97**
25	1	1	1	1	1	1	0.5	1	1	1	**95**
26	1	1	0.667	1	1	0.667	1	1	1	1	**93**
27	1	1	0.667	1	1	0.667	0.5	1	1	1	**88**
28	1	1	0.667	1	1	0.667	1	1	1	1	**93**
29	1	1	0.667	1	1	1	1	1	1	1	**97**
30	1	1	0.667	1	1	1	0.5	1	1	0.5	**87**
31	1	1	1	1	1	1	1	1	1	1	**100**
32	1	1	1	1	1	0.667	1	1	0	0.5	**82**
33	1	1	1	1	1	0.667	1	1	1	0.5	**92**
34	1	1	1	1	1	0.667	1	1	1	0.5	**92**
35	1	1	0.667	1	1	0.667	1	1	1	1	**93**
36	1	1	0.333	1	1	1	0.5	1	0.5	1	**83**
37	1	1	0.667	1	1	0.667	1	1	1	1	**93**
39	1	1	0.667	1	1	1	1	1	1	0.5	**92**
41	1	1	0.333	1	1	0.667	0.5	1	1	0.5	**80**
43	1	1	1	1	1	1	1	1	1	1	**100**
44	1	1	0.667	1	1	1	0.5	1	1	0.5	**87**
45	1	1	0.333	1	1	0.667	1	1	1	0.5	**85**
46	1	1	0.333	1	0.667	1	0.5	0	1	0.5	**70**
47	1	1	0.667	1	1	1	1	1	1	1	**97**
48	1	1	1	1	1	1	1	1	1	1	**100**
49	1	1	0.667	1	1	0.667	1	1	1	1	**93**
50	1	1	1	1	1	1	1	1	1	1	**100**
51	1	1	1	1	1	1	1	1	1	1	**100**
52	1	1	0.667	1	1	0.667	1	1	1	1	**93**
53	1	1	0.667	1	1	1	1	1	1	1	**97**
54	1	1	0.667	1	1	0.667	1	1	1	1	**93**
55	1	1	1	1	1	1	1	0.667	1	1	**97**

56	1	0.833	0.333	0.5	0.667	0.667	1	0.667	1	1	**77**
57	1	1	0.667	1	1	1	1	1	1	0.5	**92**
58	1	1	0.667	1	1	0.667	1	1	1	1	**93**
59	1	1	0.667	1	1	1	1	1	1	1	**97**
60	1	1	0.667	1	1	0.667	1	1	1	1	**93**
61	1	1	0.333	1	1	1	1	0.667	1	1	**90**
62	1	1	1	1	1	1	1	1	1	1	**100**
64	1	1	0.667	1	1	1	0.5	0.667	1	1	**88**
65	1	1	0.667	1	1	1	1	1	1	0.5	**92**
66	1	1	0.667	1	1	1	1	1	1	1	**97**
67	1	1	0.667	1	1	1	1	1	1	0.5	**92**
68	1	1	1	1	1	0.667	1	1	1	1	**97**
69	1	0.667	0.333	1	0.667	1	0.5	1	1	0.5	**77**
70	1	1	0.667	1	1	1	1	1	1	1	**97**
71	1	1	1	1	1	0.667	1	1	1	1	**97**
72	1	1	1	1	1	1	1	1	1	1	**100**