# Supplementary information

## The effects of CdSe/ZnS quantum dots on autofluorescence properties and growth of algae *Desmodesmus communis*: dependence on cultivation medium

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**Table S1**. Chemical characteristics of deep-well water (DWW).

| Metals (μg/L) | | Cations (mg/L) | | Anions (mg/L) | |
|---|---|---|---|---|---|
| Zn | 0.0122 | $Na^+$ | 3.8 | $Cl^-$ | 3.9 |
| Cu | <0.001 | $K^+$ | 1.3 | $SO_4^{2-}$ | 19.5 |
| Cr | <0.001 | $Ca^{2+}$ | 67.6 | $HCO_3^-$ | 286 |
| Ni | <0.002 | $Mg^{2+}$ | 17.7 | $CO_3^-$ | 0.91 |
| Pb | <0.001 | $Fe_{total}$ | 0.01 | $NO_2^-$ | <0.05 |
| Cd | <0.0003 | $NH_4^+$ | 0.05 | $NO_3^-$ | <0.1 |

**Table S2**. Chemical characteristics of the Lake Balsys (Vilnius district, Lithuania) water collected in winter.

| Metals (μg/L) | | Cations (mg/L) | | Anions (mg/L) | |
|---|---|---|---|---|---|
| Zn | <40 | $NH_4^+$ | 0.09 | $NO_2^-$ | <0.05 |
| Cu | <1 | | | $NO_3^-$ | 0.58 |
| Cr | <1 | | | $P_{mineral}$ | <0.01 |
| Ni | <2 | | | | |

Cations ($K^+$, $Na^+$, $Ca^{2+}$, $Mg^{2+}$) and anions ($Cl^-$, $F^-$, $NO_3^-$, $SO_4^{2-}$) in deep-well water and Lake Balsys water (Balsys) were determined following the standardized procedures established in ISO guidelines (ISO 14911:1998 and ISO 10304-1:2007, respectively). The physico-chemical characteristics of the lake water such as dissolved $O_2$, pH, and conductivity were measured using a hand-held multimeter (WTW Multi 340i/SET, Germany). Additionally, according to the procedure set up in LST EN 12260:2004 and LST EN ISO 6878: 2004, the amount of $N_{total}$ (0.72 N mg/L), $N_{mineral}$ (0.20 N mg/L), $P_{total}$ (0.01 P mg/L) were determined in Lake Balsys water. Also, various forms of carbon (TC (45.85 mg $L^{-1}$), IC (43.09 mg $L^{-1}$), and TOC (2.76 mg $L^{-1}$)) were measured in the lake water using an analyzer Shimadzu TOC-L CSH/TMN-L (Japan).

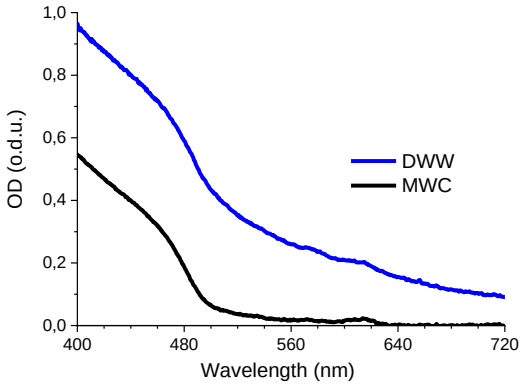


*Fig. S1. The initial optical density of QDs (concentration 40 nM) in DWW and MWC.*

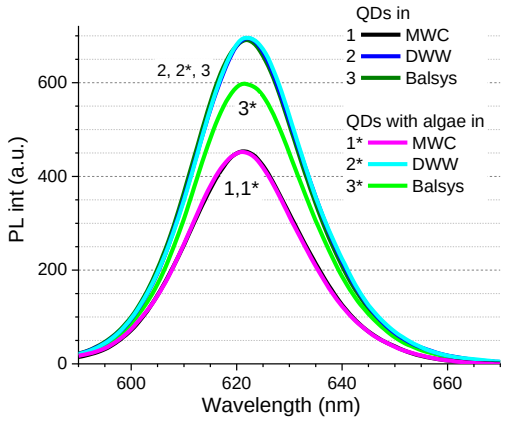


*Fig. S2. The photoluminescence intensity of QDs (4 nM) in Balsys, DWW and MWC media without and with D.communis algae cells (initial concentration ~$10^4$ cells/mL) at the initial (0) day. Excitation was at 405 nm. The excitation slit was 10.0 nm, and the emission slit was 2.5 nm.*

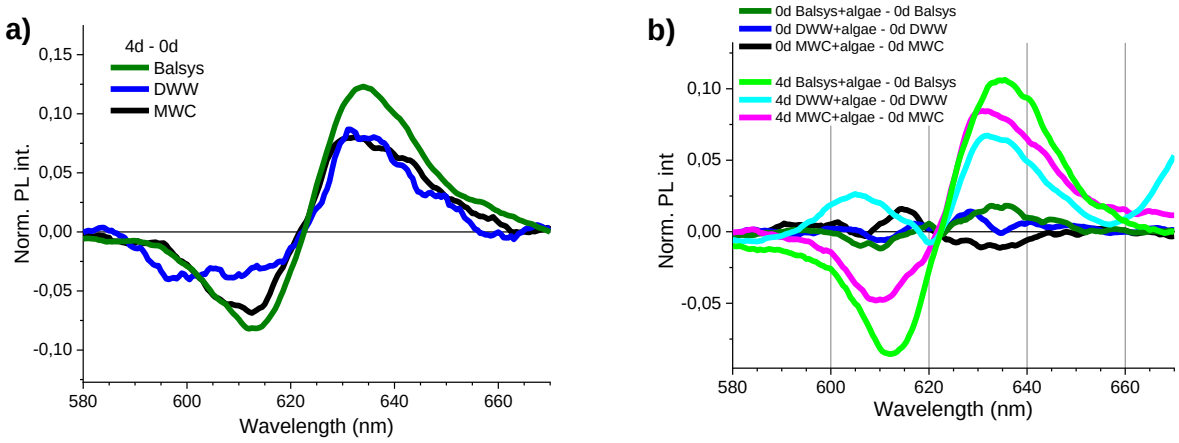


*Fig. S3. The normalized differential PL spectra of QDs (4 nM) are shown in three different media without (a) and with D.communis algae (b) (initial concentration ~$5{\cdot}10^5$ cells/mL) at the initial (0) day and after 4 days (96 h) under white light 100 µmol/$m^2$s relative to normalized PL spectra of QDs in media without algae at the initial day. Excitation was at 405 nm. The excitation slit was 10.0 nm, and the emission slit was 2.5 nm.*

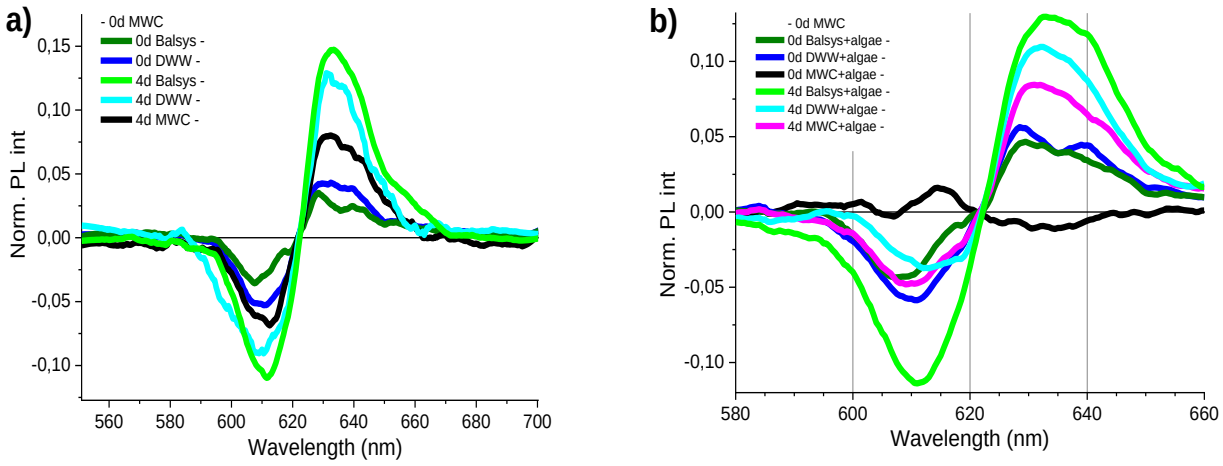


***Fig. S4. The normalized differential PL spectra of QDs (4 nM) are shown in three different media (a) and with D.communis algae (b) (initial concentration ~5·10$^5$ cells/mL) at the initial day (0d) and after 4 days under white light 100 µmol/m$^2$s relative to the normalized PL spectrum of QDs in MWC without algae at the initial day. Excitation was at 405 nm. The excitation slit was 10.0 nm, and the emission slit was 2.5 nm.***

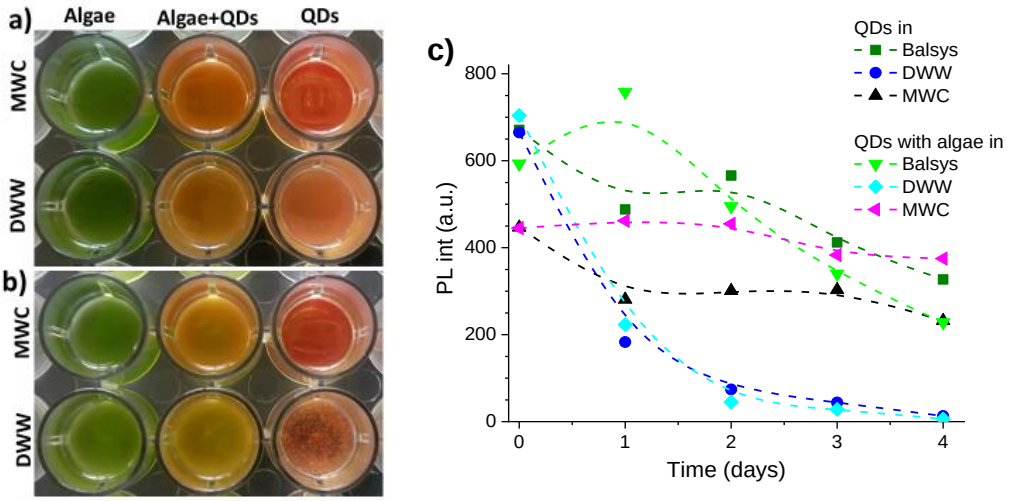


***Fig. S5. Photographs of samples of algae, algae with QDs and QDs (40 nM) in natural (DWW) and artificial (MWC) media immediately after preparation (a) and after 96 h (b). The changes of PL intensity (c) at a peak value of the band (at about 620 nm) of QDs (4 nM) observed in three different media (Balsys, DWW and MWC) with and without algae cells (initial concentration ~10$^4$ cells/mL) during 4 days under 100 µmol/m$^2$s white light. Excitation was at 405 nm. The excitation slit was 10.0 nm, and the emission slit was 2.5 nm. The dashed line represents the variation trends, not the experimental results.***

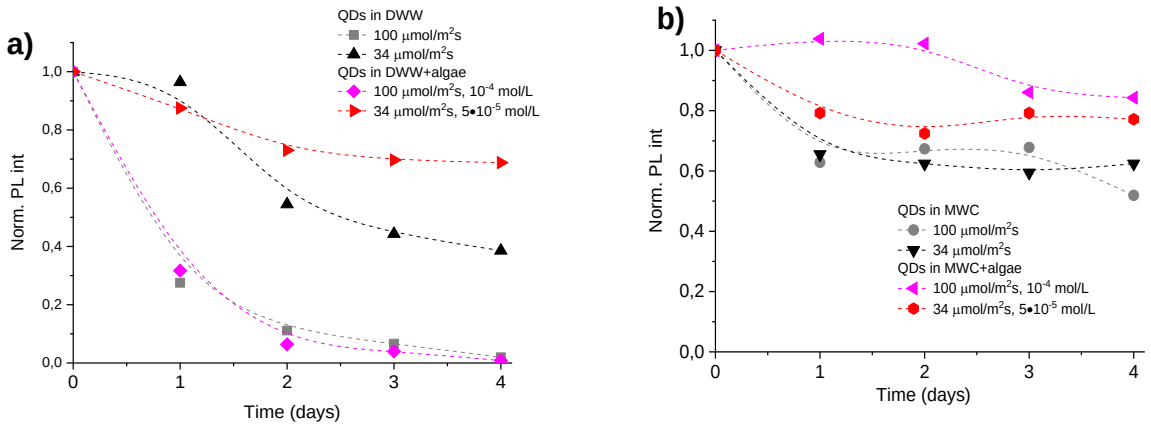


***Fig. S6. The normalized changes in PL intensity of QDs (4 nM) measured at a peak value of the band (at about 620 nm) in MWC (a) and DWW (b) media with and without algae cells (initial concentrations: ~5·10$^5$ cells/mL or ~10$^4$ cells/mL) during 4 days under under white light (34 µmol/m$^2$s or 100 µmol/m$^2$s). Excitation was at 405 nm. The excitation slit was 10.0 nm, and the emission slit was 2.5 nm. The dashed line represents the variation trends, not the experimental results.***

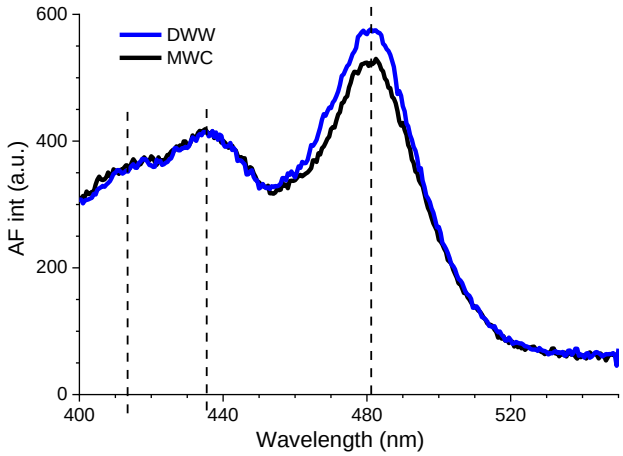


***Fig. S7. Normalised (at about 450 nm) initial AF excitation spectra of algae (initial concentration ~5·10$^5$ cells/mL) in DWW and MWC. Registered at 683 nm. The excitation and emission slits were 7 nm.***

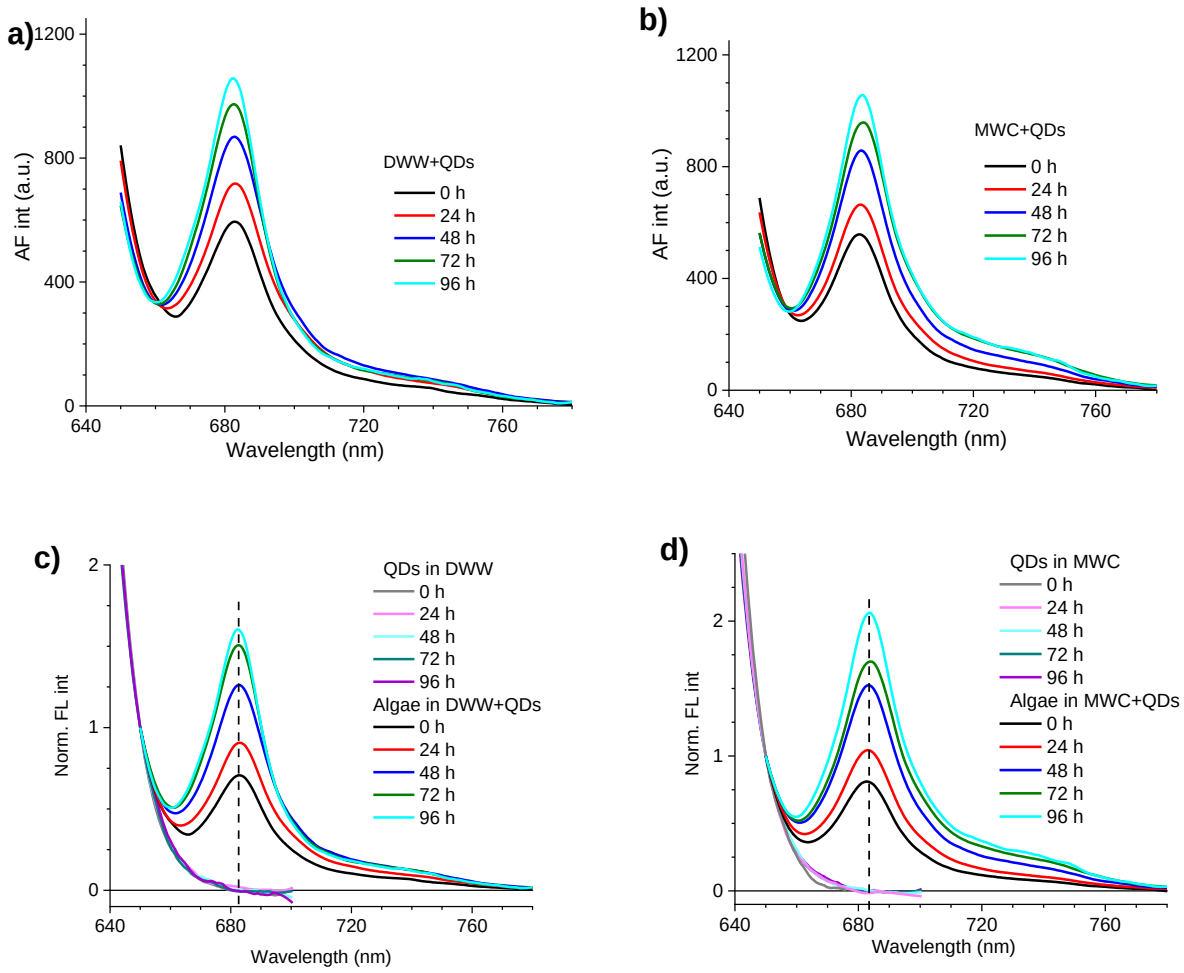


***Fig. S8. The AF spectra of algae (initial concentration ~5·10$^5$ cells/mL) registered in DWW (a) and MWC (b) media with QDs (4 nM) over 96 hours, and the normalised AF spectra are shown together with normalised QDs PL spectra in DWW (c) and MWC (d). Excitation at 480 nm. The excitation and emission slits were 7 nm.***

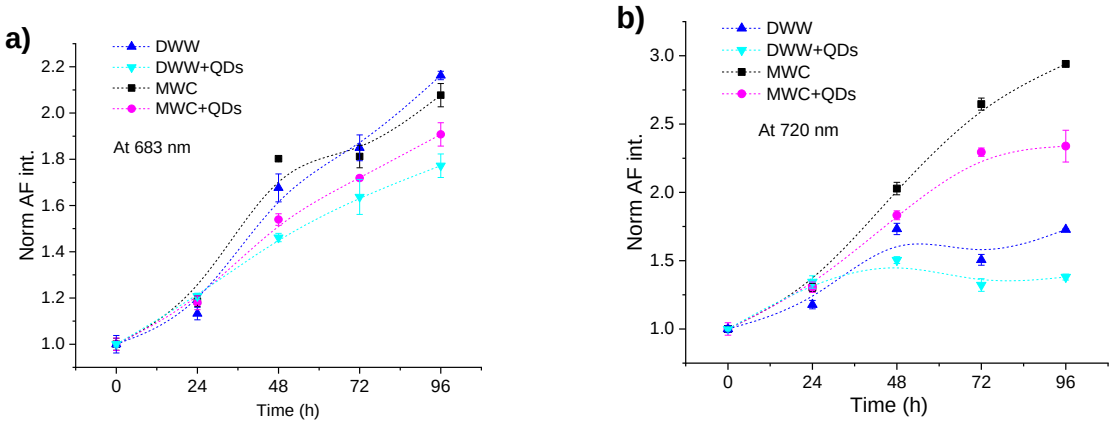


***Fig. S9. The normalized changes in AF intensity of algae (initial concentration ~5·10$^5$ cells/mL) measured at about 683 nm (a) and 720 nm (b) in different media with and without QDs (4nM) over 96 hours under white light (34 µmol/m$^2$s). Excitation was at 480 nm. The excitation and emission***

*slits were 7 nm, N=3, mean ±SD. The dashed line represents the variation trends, not the experimental results.*

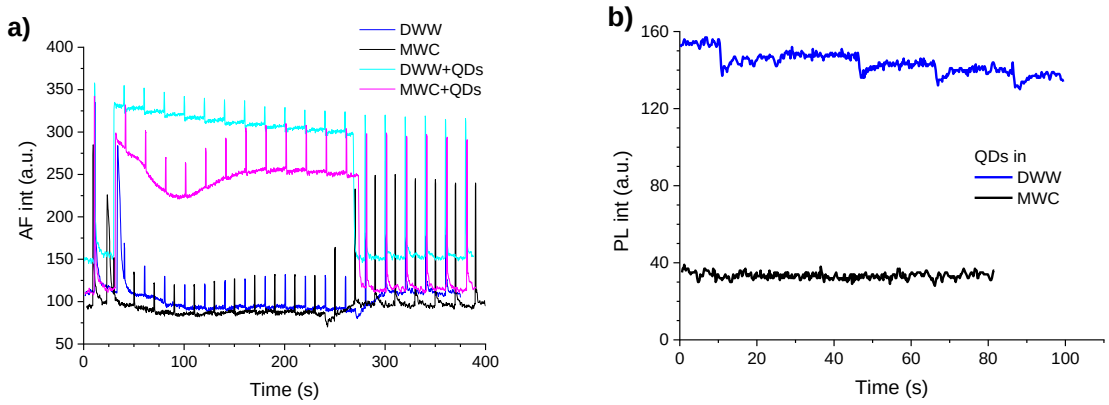


*Fig. S10. Autofluorescence induction and recovery curves of D. communis (initial concentration ~5·10$^6$ cells/mL) (a) and photoluminescence of CdSe/ZnS-COOH quantum dots (concentration of 40 nM) (b) in DWW and MWC media after 24 hours under 34 µmol photons/m$^2$s light conditions.*

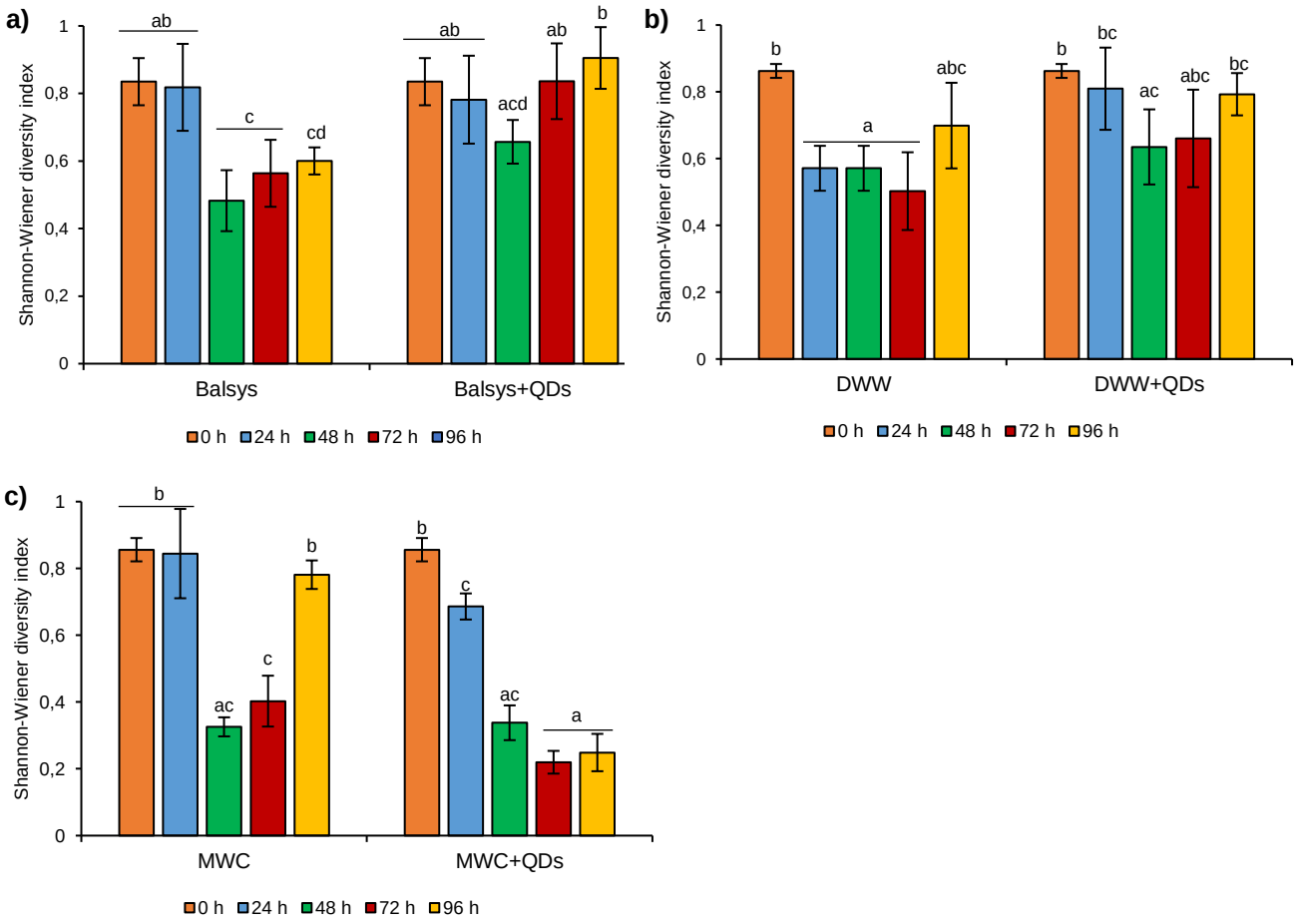


*Fig. S11. Diversity of the population of the algae D. communis in three different growth media (Balsys, DWW, MWC) without and with QDs (4 nM) under white light (100 µmol photons/m$^2$s) at the beginning of the experiment (0 h), after 24 h, 48 h, 72 h and 96 h. Different letters for data in*

***each medium indicate significant differences between groups with QDs and without QDs after different exposure durations; identical letters in doublets and triplets indicate the absence of significant differences for the corresponding pair of groups (two-way ANOVA, $p < 0.05$, mean ± SD).***

In Lake Balsys water the Shannon-Wiener diversity index of algae decreased significantly after 48-96 h of exposure compared to 0-24 h (in all cases $p<0.01$). Interestingly, exposure to QDs in Balsys for 96 h resulted in a significant increase in the Shannon-Wiener diversity index compared to 48 h ($p<0.001$). Moreover, after 72 h, the Shannon-Wiener diversity index of algae in Balsys was significantly different from that of the Balsys+QDs exposure group ($p<0.01$) (Fig. S11a). Similarly, in DWW this index significantly decreased after 24-72 h of exposure compared to the index at the initial point (0 h) (in all cases $p<0.01$) (Fig. S11b). In contrast, in the DWW+QDs group, this index decreased significantly only after 48 h of exposure compared to 0 h ($p=0.001$). Additionally, after 24 h, the Shannon-Wiener diversity index of algae in DWW was significantly different from that of the DWW+QDs exposure group ($p=0.024$) (Fig. S11b). In MWC media, the Shannon-Wiener diversity index significantly decreased after 48 and 72 h of exposure compared to 0 h, 24 h, and 96 h exposures ($p<0.001$) (Fig. S11c). Similarly, in the MWC+QDs group, this index decreased significantly after 72 h and 96 h of exposure compared to 0 h and 24 h exposures ($p<0.001$). Furthermore, this index in the MWC+QDs group was significantly different from that of the MWC without QDs group after 24 h, 72 h, and 96 h exposures ($p<0.001$) (Fig. S11c).