Electronic supplementary information

S1. Optical measurements

DLS patterns were recorded on a Microtrac Nanotrac Wave II -UT151. UV-vis absorption spectra were recorded on a JASCO V-670 spectrophotometer. CD spectra were recorded on a JASCO J-1500 spectrometer. Emission and excitation spectra were recorded on a HORIBA Fluorolog-3 spectrofluorometer and corrected for the response of the detector system at room temperature. Emission quantum yields were recorded on a Hamamatsu Photonics C11347-01 absolute photoluminescence quantum yield measurement system. Emission lifetimes were recorded on a fluorescence lifetime measurement system (C11200, Hamamatsu) equipped with picosecond light pulser (C10196), spectrograph (C11119–02), and streak scope (C10627). CPL spectra were recorded on a JASCO CPL-300 spectrofluoropolarimeter. Temperature-dependent CPL spectra were recorded on the CPL-300. MCPL spectra recorded on the CPL-300 equipped with a JASCO permanent magnet (1.6 T).

S2. Preparation of Zinc 3-devinyl-3-methoxymethylpyropheophorbide-*a* tetraethylene glycol monoester (ZnChl)

ZnChl was prepared with reference to the reported procedure. UV-vis, ^{1}H-NMR and HRMS (FAB) were satisfactory.[29]

S3. Preparation of the ZnChl monomer and the chiral J-aggregates of ZnChls[29]

The aqueous solutions of ZnChl were prepared by diluting the methanol solution of ZnChl (2000 μM) with a 99-fold volume of water. The aggregation state was controlled by changing the concentration of Triton X-100 (3000 μM and 180 μM for the monomer and J-aggregate formations, respectively). The obtained J-aggregates of ZnChls showed sharp J-band and the characteristic inverse-S shaped CD signal (Figure S1).[29] In the DLS measurement, we observed two maximum frequency sizes (d_{MF}) of J-aggregates at around 120 and 410 nm (Figure S2).

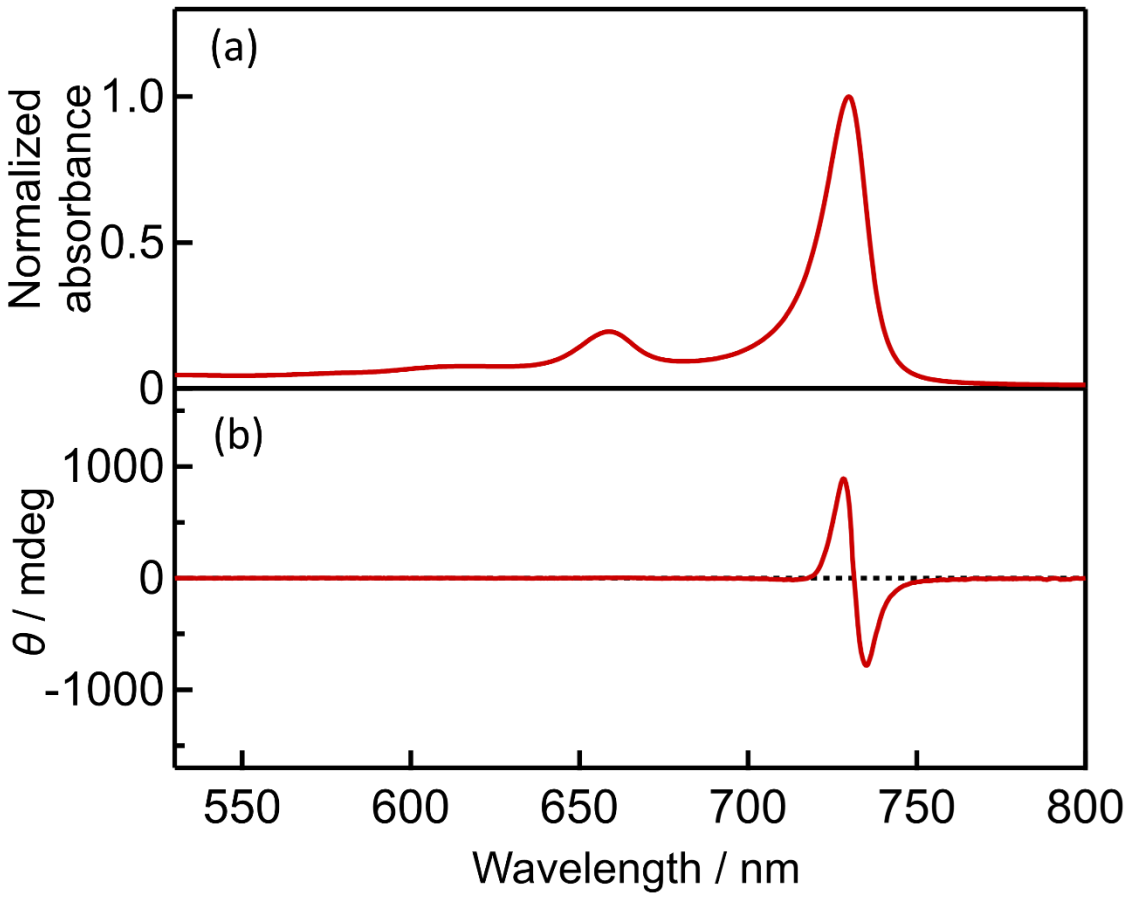

Figure S1. (a) Electronic absorption and (b) CD spectra of ZnChl J-aggregates.

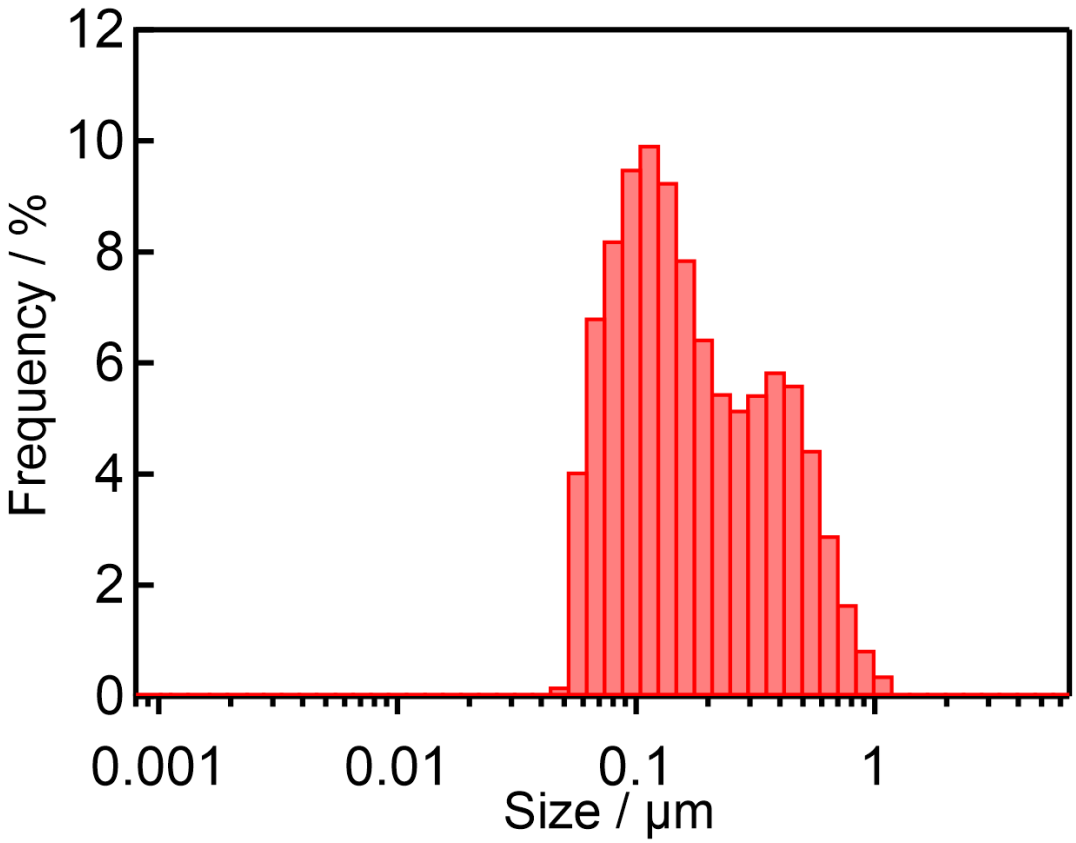

Figure S2. DLS pattern of ZnChl J-aggregates (ZnChl 20 mM and Triton-X100 180 mM).

S4. Size-dependent CD properties of ZnChl J-aggregates

We also prepared the ZnChl J-aggregates by changing the concentration of ZnChl (4000 μM) and Triton X-100 (270 μM) several years ago. Under the equilibrium J-aggregates state, we observed one d_{MF} at around 580 nm (Figure S3). The electronic absorption and CD spectra are shown in Figure S4a and b, respectively. The ZnChl aggregates show sharp strong J-band, which is almost the same as that of previous experimental J-aggregates with smaller sizes (d_{MF} = 120, 420 nm). On the other hand, the ZnChl J-aggregates exhibit asymmetric dispersion typed CD signals.

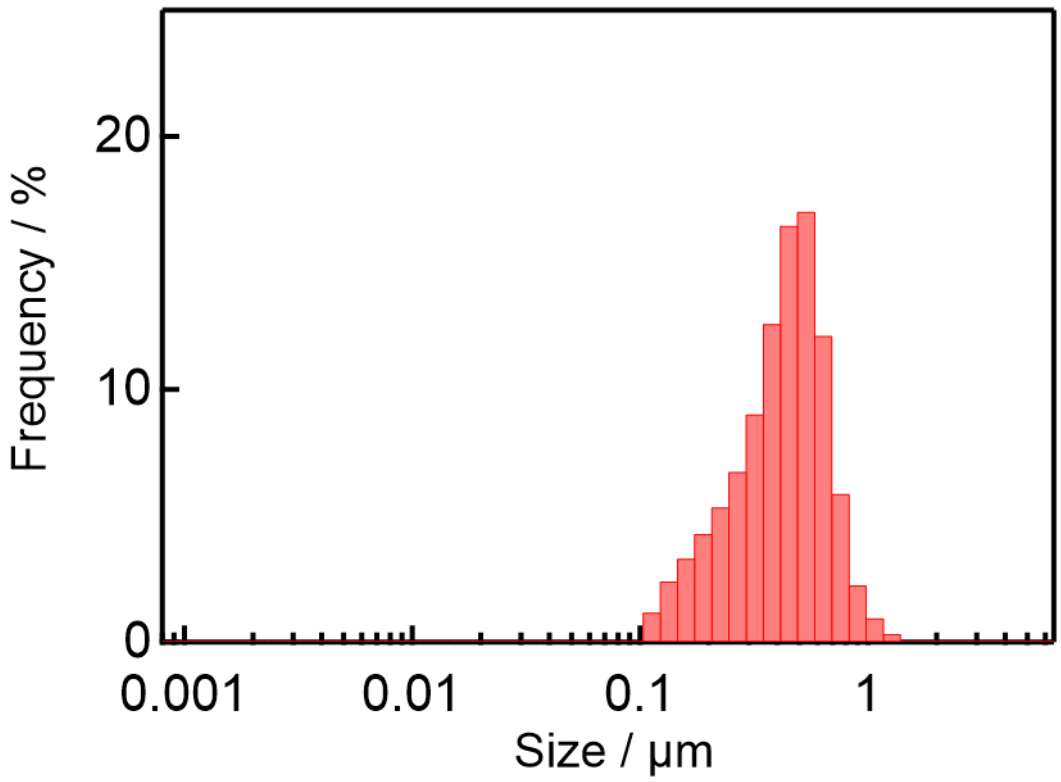

Figure S3. DLS pattern of ZnChl J-aggregates (ZnChl 40 mM and Triton-X100 270 mM).

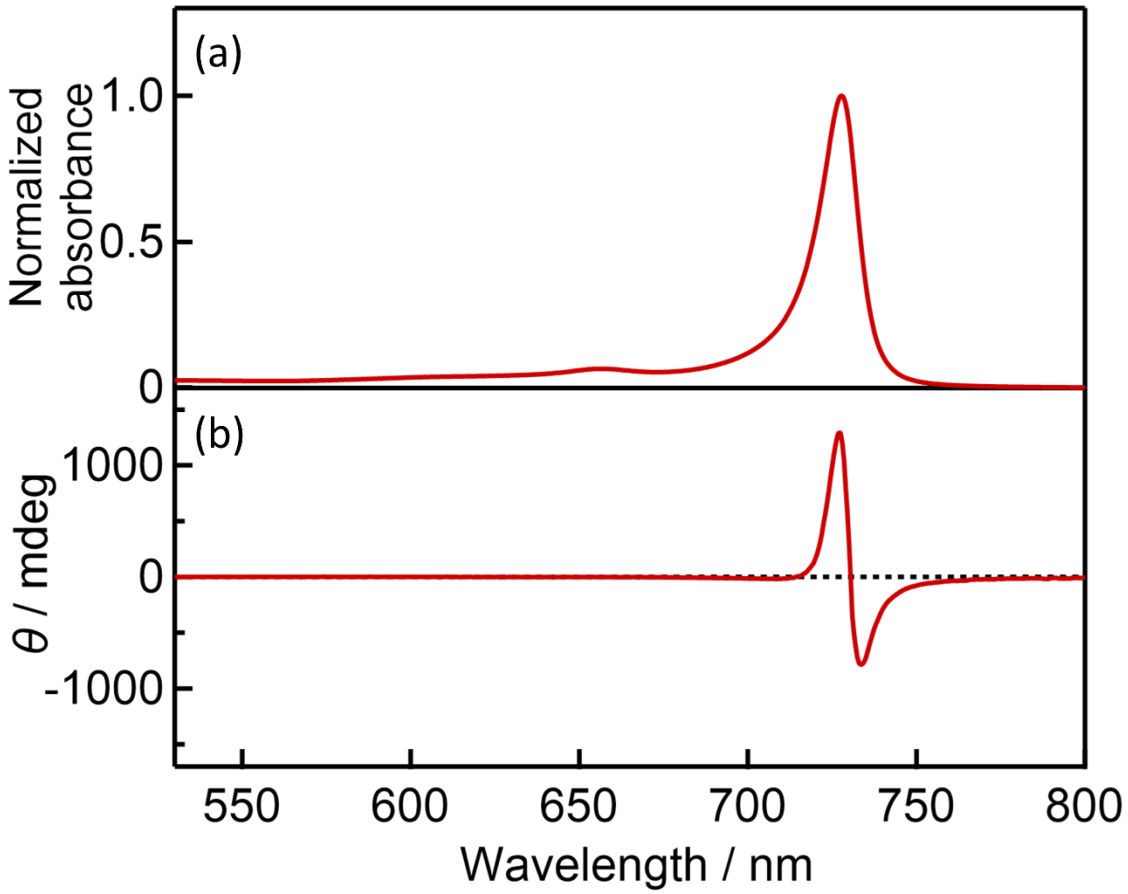

Figure S4. (a) Electronic absorption and (b) CD spectra of ZnChl J-aggregates (ZnChl 40 mM and Triton-X100 270 mM).