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Fast qualitative changes in zooplankton communities in a high-mountain lake in Slovenia (south-central Europe) – induced by earthquake and supported by increased temperature

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In the mesotrophic lake Krnsko jezero (Slovenia), located at the tree-line (1383 m a.s.l.) significant changes in zooplankton communities took place after the year 2000. The lake is 17 m deep with a surface of 4.5 ha. Water pH is neutral (pH $\geq$ 7.5), while alkalinity is between 1200 and 2100 μS. In the lake fish (Salvelinus alpinus and Phoxinus phoxinus) were introduced in 1927 and no manipulation was done afterwards. Survey of fish population indicated low but stable population of S. alpinus with a dominance of adult fish. Human activity in the last 30 years was minimal in the watershed of the lake.

The lake Krnsko Jezero is on seismic very active area. In the spring of 1998 a strong earthquake hit the area (EMS= 5.6). As a result there was significant change in landscape and increase of nutrients in the water column. However, late-autumn biomass of zooplankton dropped from 2.1 g m-2 in 1997 to 0.8 g 1 g m-2 in 1998 and has continue to stay low till present. Thermophilic cladoceran, Ceriodaphia quadrangula (filtrator), was for the first time recorded in the lake in 1998, while population of previous dominant cold-water Cyclops vicinus (predator) started to decline soon afterward. Six years after earthquake Cyclops viciunus completely disappeared from the lake and was completely replaced by Ceriodaphia quadrangula, which is an indication of a change of a trophic status of the lake.

Long term temperature records, 20 years for air-temperature on Kredarica (2600 m a.s.l.; 15 km from the lake) and 9 years for the surface water temperature in the lake Krnsko Jezero, indicate increase of temperature on both locations. A surface temperature of about 20 oC appears to be the threshold for change in zooplankton in the lake Krnsko Jezero.

As a conclusion we suggest a scenario, where earthquake re-suspended nutrients from the bottom of the lake and at the same time triggered a change in zooplankton structure. Cold-water copepod species zere replaced by successful colonization of the lake by thermophilic cladoceran species, supported by increased epilimnion temperatures of the lake. A similar scenario, where two cladoceran species were affected by earthquake about 100 years ago and afterward regulated by increased ambiental temperature, was noted from sediment records in a near-by lake Jezero v Ledvicah, too.