Glacier mice are ovoid-shaped conglomerations of bryophytes and mineral particles that are rarely found on glacier surfaces. They form colonies, host diverse organism communities and possess the ability to roll around on the glacier surface. Their movement on the glacier appears non-random, assuming a herd-like behaviour. This study is the first survey of the occurrence of radionuclides (\(^{137}\text{Cs}\), \(^{210}\text{Pb}\), \(^{238,239,240}\text{Pu}\)) and heavy metals (Pb, As, Hg, Cd) in glacier mice, cryoconite debris, and proglacial bryophytes at Austerdalsbreen, an outlet glacier from Jostedalsbreen ice cap, western Norway. Ongoing research on cryoconite shows that glacier surfaces host dynamic ecosystems capable of capturing and processing airborne contaminants. However, nothing is known about the role of glacier mice in the cycling of contaminants, particularly in relation to cryoconite.

The following objectives are pursued in this study:

- Determining and comparing radionuclide and heavy metal concentrations across glacier ecosystems in bryophytes (glacier surface vs. terminal moraine vs. proglacial forefield) and cryoconite.
- Identifying nuclear contamination sources in the investigated samples using the mass and activity ratios \((^{240}\text{Pu}/^{239}\text{Pu}\) and \(^{239+240}\text{Pu}/^{137}\text{Cs}\)).

The analysis of radionuclides was performed by alpha and gamma spectrometry, while mass ratio
and heavy metals quantification using ICP MS. We found that glacier mice are characterized by activity concentrations of radionuclides several times lower than those in cryoconite. There is no clear statistically significant difference between the activity of studied isotopes and bryophytes on a spatial scale. When concentrations of radionuclides in cryoconite from Austerdalsbreen are compared with data from other Scandinavian glaciers, plutonium and cesium signatures in the Austerdalsbreen samples show compatible levels for global fallout and Chernobyl accident, respectively. Regarding heavy metals, the highest concentrations were found in bryophytes from the glacier surface compared to samples from the forefield. Levels of Hg and Pb are elevated in bryophytes especially from the glacier surface (0.7 ppm and 30 ppm, respectively), whereas Cd and As (0.06 ppm and 0.49 ppm, respectively) are relatively similar to values reported for mosses in Norway. The concentrations of Hg and Pb in bryophytes from the glacier surface are similar to values found in cryoconite from Austerdalsbreen and Blåisen, an outlet glacier from Hardangerjøkulen ice cap located 120 km south of Austerdalsbreen.

The results show that concentrations of radionuclides and heavy metals are mainly influenced by atmospheric deposition from long-range transport, although potential local sources must also be considered. Increased concentrations of some heavy metals in bryophytes from glacier surfaces may suggest that the rolling of bryophytes (glacier mice) on glacier surfaces may absorb heavy metals from cryoconite. Additionally, glacier mice rolling from the melting glacier may serve as a secondary source of inorganic pollutants to newly developed proglacial ecosystems.