

Three-dimensional positioning during underwater group behaviour of Adélie penguins

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Organisms live commonly in groups, and group behaviour provides various advantages and/or disadvantages to members of the group. Penguins are known to associate and dive synchronously with conspecifics at sea. There is nonetheless little knowledge about the underwater group behaviour of penguins due to the limitation of monitoring methods in the wild. We recently developed an advanced biotelemetry system (Takagi et al. 2018) to examine a fine-scale positioning of multiple individuals simultaneously. Using this system, we monitored the 3-dimensional positions of foraging Adélie penguins *Pygoscelis adeliae*, to examine their underwater group behaviour. The field survey was carried out near Hukuro Cove colony of Adélie penguins, Lützow-Holm Bay, Antarctica, during 2018–2019 breeding season. Penguins were observed to dive along leads and tidal cracks, as fast sea-ice covered the sea around the breeding colony. An acoustic monitoring array consisting of three receivers and three transmitters (AquaSound Inc., Kobe, Japan) was deployed along the coastline near a tidal crack where the penguins dove into the sea to forage repeatedly. An acoustic transmitter with a pressure sensor was set to emit a signal at an interval of ~1 sec, and these transmitters were attached on the back feathers of 20 penguins. Three-dimensional positions of the tagged penguins that foraged near the acoustic monitoring array were computed by a hyperbolic positioning algorithm based on TDOA (Time Difference of Arrival). We successfully reconstructed the 3-dimensional diving trajectories of multiple penguins foraging simultaneously in a group. The 3-dimensional positioning would provide a new insight into underwater group behaviour of penguins.

References

Takagi, J., Ichikawa, K., Arai, N., Miyamoto, Y., Uchida, K., Shoji, J., and Mitamura, H., Simultaneous observation of intermittent locomotion of multiple fish by fine-scale spatiotemporal three-dimensional positioning. *PloS one*, 13(7), e0201029, 2018.