Spatial and temporal analysis of commuting routes in Adélie penguin

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Adélie penguins commute between the colony on land and foraging sites at sea during breeding season. Their body form is highly specialized to aquatic movement, while the cost of walking is higher compared to other birds due to their short legs. They tend to travel by swimming in most colonies across Antarctica. But in our study site, which is located in fast sea-ice area, they need to travel over sea-ice or land. Breeding penguins must come back to the colony to feed their chicks within a certain amount of time. To perform foraging trips efficiently, their commuting routes should reflect the movement strategies, e.g. walking vs. swimming. Here, we compared their movement parameters in terms of duration and distance travelled between outward travels and inward travels. Field survey was conducted at Hukuro Cove colony, Lützow-Holm Bay, Antarctica from December 2012 to January 2013 as a part of JARE54. We obtained location and depth data every 1 second and 3-axis acceleratin data every 1/20 second from 13 adult penguins during 14 foraging trips. From the location data, we derived area restricted search (ARS) zones with first-passage time analysis, then defined outward travels and inward travels as routes which consist from start to the first ARS zone and from the last ARS zone to end, respectively. Outward and inward travels were divided into 5 categories which consist of swimming, traveling over sea-ice, traveling over land, resting at night and unclassifiable behaviour. Resting at night was removed from the data because only one event was detected in an outward travel. Outward and inward travels accounted for 9.6 and 9.2 % in duration, 15.9 and 18.1 % in distance traveled, of each foraging trip, respectively. In terms of duration, penguins swam along cracks and travelled over sea-ice for 47.8 and 41.7 % during outward travels and 54.0 and 28.0 % during inward travels. In terms of distance traveled, penguins swam and travelled over sea-ice for 63.6 and 31.6 % during outward travels and 68.0 and 22.7 % during inward travels (Figure 1). During inward travels, traveling speed and straightness index (calculated as the ratio between distance travelled and beeline distance) were 0.78 m/sec and 0.72 in swimming, and 0.44 m/sec and 0.88 in travel over sea-ice. Penguins were able to travel faster by swimming, even though their traveling routes along cracks were more sinuous than that of traveling over sea-ice. They spent more time and travelled longer distance by swimming during inward travels than outward travels. We suggest penguins chose to swim along cracks during inward trips where cracks were available, or walked straight over sea-ice if no cracks were available, to deliver food to their chicks quickly.

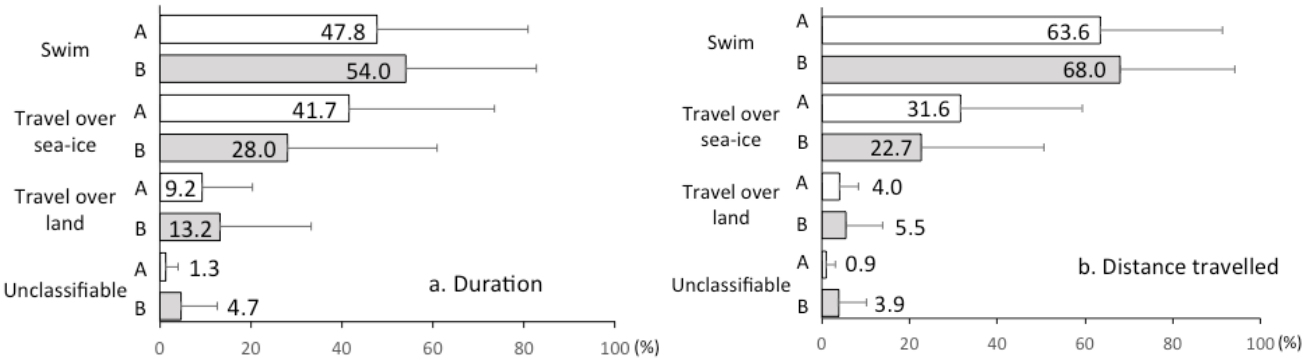

Figure 1. Behavioural time budget and distance covered by each behavioural category during outward (A) and inward travels (B). Means + SD were shown.