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ZOOL 567 Animal Behaviour
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Topic Summary

Killer whales *(Orcinus orca)* have multiple ecotypes, each with specialized prey specific hunting strategies, which are typically dependent on their geographical location and pod (Riesch and Barrett-Lennard, 2012). Cultural transmission is prominent as calves must learn these specializations to survive (Riesch and Barrett-Lennard, 2012). In the Norweigian and Icelandic herring-eating orcas, researchers have observed a highly vocal cooperative feeding behaviour is observed, noted as "carousel foraging" (Simila and Ugarte, 1993). Simila and Ugarte (1993) characterized this behaviour into two phases, using underwater video footage, where in the first "herding" phase, orcas swim uniformly with their white underside towards the herring, gathering the school in a tight ball towards the surface (Simila and Ugarte, 1993). During the second phase, "feeding", killer whales form large air bubbles adjacent to the school and slap the school with the under-side of their fluke, stunning the herring which are eaten one-by-one (Simila and Ugarte, 1993). Nottestad and Simila (2001), further investigated this herding behaviour, focusing on the herring formation using an echo-integrator. These researchers found that orcas split herring into smaller groups and herded from depths as great as 160 m to the surface, which poses as a barrier against herring escape. Herding to the surface energetically favours tail-slap performance as the effect of power and hunting decrease significantly in deeper depths (Nottestad and Simila 2001). Both studies observed distinct loud sound pulse coinciding with the tail-slap, though the mechanism and cause behind such was undescribed (Simila and Ugarte, 1993; Nottestad and Simila, 2001).

Domenici et al. (2000) explored this gap of knowledge, using hydrophones and underwater footage to provide a kinematic analysis of the carousel-specific tail-slap. They discovered efficiency of tail-slaps increased with whale length, as higher tail-slap velocities are achieved and a larger surface-area allows debilitation of more prey per successful hit (Domenici et al., 2000). Their analysis suggests the weaponization of tail-slaps to increase efficiency in two ways: 1) mobilizing a smaller body-segment combats against inertia forces, allowing fast acceleration to high velocities and 2) as a tactic against the confusion effect of the herring school (Domenici et al., 2000). Simon et al. (2005) further addressed the acoustic characteristics of the tail-slap and the causes for herring debilitation beyond physical contact using similar methods. Tail-slap acoustic signals and the zone of performance were found to be consistent with the cavitation phenomenon, debilitating herring in the immediate vicinity via overstimulation (Simon et al., 2005). Cavitation by tail-slaps consists of a drastic drop in ambient pressure and a sudden release of dissolved gases bubbles which collapse upon return to typical ambient pressure, producing the loud distinguishable sound observed (Simon et al., 2005). This suggests contact alone is then unlikely the sole cause of debilitation as steep pressure gradients, high levels of water acceleration, particle movements, and contact with other fish, contribute to sensory overload and loss of buoyancy control (Simon et al., 2005).

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Tail-slaps are not the only acoustic-signalling that occurs, as both communicative and herding calls significantly correlated with tail-slaps have been observed (Simon et al., 2006; Richard et al., 2017). Researchers explored audiotory signalling used hydrophones to observe sound and the distinguishable peak frequencies from tail-slap as cues for carousel feeding (Simon et al., 2006; Richard et al., 2017). They identified and named I36, a unique low frequency call which is noncommunicative as it does not fall within the optimal frequency for orca hearing (Simon et al., 2006; Richard et al., 2017). Simon et al. (2006) suggested as it is within the sensitive hearing range for herring and the resonance frequency of their bladder, it serves to inhibit herring mobility and optimize tail-slap success. These vocalizations were suggested to increase foraging success under low light conditions, particularly in the winter, as their white under-sides used in herding are not visible (Samarra 2015; Richard et al. 2017). Due to limited visibility, foraging under low light conditions also requires heavier reliance on acoustic signalling and echolocation (Van Opzeeland et al., 2005; Samarra and Miller, 2015). Through reviewing these five articles, it is apparent the reasoning for variance in vocalizations and which orca individuals and groups differ is unknown and should be explored to determine fitness advantages and whether cultural transmission determines group usage.

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