Dizygotic Twinning in the Hawaiian Monk Seal

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Abstract

Twinning is extremely rare in pinnipeds, likely due to the high energy demands of nursing and the difficulty in caring simultaneously for more than one pup. We explored the incidence of twinning in the Hawaiian monk seal (Monachus schauinslandi) over a period of 27 years. Seven sets of putative twins (14 pups of 4873 seal births were recorded between 1982 and 2009, for a minimum twining rate of 0.18%). Microsatellite genotyping of four of the seven mother and pup pairs revealed that all four dots tested were dizygotic twins, ruling out the possibility of alliparenting, with low probabilities of false assignment (π = 0.004-0.012). The twinning interval (33-44 days) was not significantly shorter for twins in comparison to singletons born of the same year and island, however twins had significantly smaller girths at weaning (1-4 standard deviations lower). Twins were less likely to survive to weaning and age one than their singletons counterparts. Eight of the 14 pups (57%) survived to weaning; five survived to age one (35%), and only one (7%) has been confirmed to survive past age one. Twinning appears to be a maladaptive trait in the Hawaiian monk seal, though captive supplemental feeding could increase the survival rate of twins and other unrelated pups.

Materials and Methods

• Annual population assessment activities occurred in the Northwestern Hawaiian Islands (NWHI) from 1982-2008 (Figure 1).
• Seal identities were determined by hind flipper tags, unique alpha marks, and/or natural identifying markings.
• Twinning was inferred when an isolated female was observed attending two young pups of similar size, often with attached umbilical cords and placenates.
• Weaned pups were tagged with hind flipper tags. Tissue plugs for genetic analysis were collected and measurements of dorsal straight length (DSL) and anteriolateral girth (AG) were collected during tagging.
• Dead pups were examined and tissue plugs were collected, with measurements of DSL and AG.
• Genomic DNA was extracted from all tissue plugs. Amplification were performed at 17 Hawaiian monk seal microsatellite loci (Schultz et al. 2009) and one grey seal locus (Allen et al. 1995).
• Genotypes of pups and putative mothers were compared to verify maternity and determine monzygotic or dizygotic twinning.
• Subsequent survival of pups was determined through population assessment monitoring.

Results

Confirming Maternity and Relatedness:

• Genetic analysis of the four twin dyads tested indicated that all are dizygotic twins. Assuming all observed dyads are twins (including those for which genetic data was unavailable), the minimum prevalence of twinning is 0.15% of the Hawaiian monk seal pups born over the past 27 years.

Size and Survival:

• Of 14 pups (seven sets of twins), five were found dead shortly after birth, eight survived to weaning, and one died shortly prior to weaning. Both twins of a dyad either died or survived to weaning with two exceptions. YE40 (FFS 2002) died from a shark bite after 33 days of nursing and KWX1 (Kure 2008) was found dead at one day old.
• Anteriolateral girth at weaning is a good predictor of survivorship to one year of age (Baker 2008). Of the eight pups that survived, seven had smaller AG at weaning than the average singleton born of that island and year. The only twin that weaned at weaning age (KWX1, AG = 115 cm) was raised as a singleton because its twin (KWX1) died at or soon after birth.
• Only five pups survived to year one. Twins surviving to weaning were less likely to survive to age one than their singleton counterparts (Table 1).

Discussion

• In three cases observers intervened to reunite one or both pups with the mother. The 2006 Midway twins were fed in a captive setting for 9.5 months past weaning. Without these interventions, survival to weaning and beyond may have been further decreased.
• Dizygotic twinning appears to be hereditary in mammals, such that mothers of twins are more likely to twin again (Hochstet al. 2008; Ely et al. 2006). To our knowledge, no female Hawaiian monk seal has produced multiple sets of twins.

Maternal Investment and Environmental Factors:

• Birth at weaning can be hereditary in mammals, such that mothers of twins are more likely to twin again (Hochstet al. 2008; Ely et al. 2006). To our knowledge, no female Hawaiian monk seal has produced multiple sets of twins.

Our results indicate that twinning is maladaptive in the Hawaiian monk seal. However, optimization of captive feeding programs may lead to increased survival of twins to age one. Due to its rarity, even successful twinning is unlikely to have a major impact on the overall reproductive rate of this critically endangered species.

Acknowledgements

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Literature Cited


Table 1: Putative twin dyads listed by mother and pup identification number, year, island, outcome, dorsal straight length (DSL) and anteriolateral girth (AG) at death or weaning compared to the average (and standard deviation) DSL and AG of singletons born for that island and year and twin survival rate in comparison to singleton survival rates by island and year.

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Figure 1: Observed incidence of twinning in Hawaiian Archipelago

The rate of twins declined from an estimated 2.6% during 1982-1985 to 0.16% during 1998-2007. Weaned pups were tagged with hind flipper tags. Tissue plugs for genetic analysis were collected and measurements of dorsal straight length (DSL) and anteriolateral girth (AG) were collected during tagging. Dead pups were examined and tissue plugs were collected, with measurements of DSL and AG. Genomic DNA was extracted from all tissue plugs. Amplification were performed at 17 Hawaiian monk seal microsatellite loci (Schultz et al. 2009) and one grey seal locus (Allen et al. 1995). Genotypes of pups and putative mothers were compared to verify maternity and determine monzygotic or dizygotic twinning. Subsequent survival of pups was determined through population assessment monitoring.