Bite Force in Four Pinniped Species from the West Coast of Baja California, Mexico, in Relation to Diet, Feeding Strategy, and Niche Differentiation

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Abstract

Behavioral foraging differences are known to aid in food resource partitioning in pinniped communities, but it is not known whether skull biomechanical efficiency also contributes to dietary niche partitioning. We tested this hypothesis in a community of four sympatric species of pinnipeds that co-occur along the coast of Baja California: California sea lion (Zalophus californianus), northern elephant seal (Mirounga angustirostris), harbor seal (Phoca vitulina), and Guadalupe fur seal (Arctocephalus townsendi). We tested whether their preferred prey items differed in resistivity to puncture and whether those differences were linked to the mass of the muscles of mastication and the biomechanical efficiency with which they can puncture prey items. For each prey species, we measure resistivity to puncture using texture profile analysis. We found that M. angustirostris consumes the most resistant prey and that A. townsendi consumes the least resistant. We estimated physiological cross-sectional area of the muscles of mastication for each pinniped and found that the same pair of species respectively has the largest and smallest theoretical value of muscular force. Finally, we estimated the bite force that each pinniped species requires to puncture its prey by solving Euler-Lagrange equations based on biomechanical lever model parameters measured from 3D digital models of the skulls. We also found differences in efficiency between the species. These data allowed us to classify the three ecomorphological types. Type 1 features a hydrodynamic skull with relatively low mandibular forces, characteristic of pelagic carnivore feeders such as A. townsendi. Type 2, represented by Z. californianus and M. angustirostris (both opportunistic feeders), is characterized by broad insertion areas for the mandibular muscles and strong teeth, permitting these predators to vary the prey target species as a function of prey availability. Type 3 features a less robust skull and a lower muscle efficiency, characteristic of benthic feeders such as P. vitulina. This evidence indicates that biomechanical differences between the species contribute to dietary niche construction.

Palabras clave

Palabras clave de autor: Cranial-mandibular morphology; Pinnipeds; Skull biomechanics; Physiological cross-sectional area; California Sea lion; Elephant seal; Harbor seal; Guadalupe fur seal
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