Historical biogeography and phylogenetic relationships among modern monk seals, *Monachus* spp.

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There are three recent species of monk seals: the Hawaiian monk seal (*Monachus schauinslandi*), the Caribbean monk seal (*M. tropicalis*) and the Mediterranean monk seal (*M. monachus*). The Hawaiian monk seal is an endangered species (IUCN 1996), currently numbering some 1300-1400 animals (T. Ragen, pers. comm.) and declining at about 5 per cent per year (Ragan and Lavigne, *in press*). The Caribbean monk seal has recently been declared extinct (IUCN 1996). The Mediterranean monk seal, a critically endangered species (IUCN 1996), is now thought to number less than 500 animals, following a mass mortality during the summer of 1997, which claimed some 70% of the largest surviving population along the coast of the Western Sahara near Mauritania (Hernandez et al. 1997).

Conflicting descriptions of the historical biogeography of pinnipeds (fur seals, sea lions, walrus and true seals) include quite different explanations to account for how the three recent monk seals came to live in such widely separated places as the North Pacific Ocean – around the Hawaiian Island chain – and throughout the Caribbean and Mediterranean Seas. Repenning (1981) assumed that monachine seals originated in the Atlantic basin and that *Monachus* radiated from the Caribbean region. The Hawaiian monk seal, he suggested, may have reached the Hawaiian Islands (as they were then constituted) as early as 15 million years ago (also see Árnason et al. 1995). More recent evidence, which suggests that all pinnipeds are monophyletic, originating in the North Pacific (Berta et al. 1989), raises the possibility that the monachine lineage first arose in the Pacific basin and moved toward Hawaii prior to becoming established in the Caribbean.

Neither of the above hypotheses is refuted by the anatomical evidence that modern Hawaiian monk seals are "living fossils," retaining a number of traits that are more primitive than those observed in the earliest fossil monachines (e.g. *Monotherium*) found in the Atlantic basin along the eastern seaboard of North America some 14-16 million years ago (Ray 1976; Barnes et al. 1985). Repenning et al. (1979, also see Repenning 1981) further suggest that monachines probably crossed the Atlantic, following the warm Gulf Stream, some ten million years ago.

In marked contrast, de Muizon (1982, p. 202) concluded that "the original homeland of the Monachini must have been in Europe" where they eventually gave rise to a number of species, including the Mediterranean monk seal. He postulated that the lineage later crossed the Atlantic from East to West, following the warm equatorial currents in the southern North Atlantic. He speculated that the most probable migration route for the Monachini was from Europe, along the West coast of northern Africa (Mauritania and Senegal), following equatorial currents across the Atlantic to Brazil.

From there, he suggests, the Monachini moved northward to the Caribbean, where they gave rise to the Caribbean monk seal. Eventually, some animals crossed into the Pacific, via the Central American Seaway, possibly as recently as 3.5 to 4 million years ago, and gave rise to the Hawaiian monk seal. Supporting his hypothesis, de Muizon (1982, p. 204) cites King

(1956) and Scheffer (1958) to the effect that the Caribbean monk seal and the Hawaiian monk seal "are closer to each other than either is to" the Mediterranean monk seal. What King (1956) actually said was, "…the skull of *M. schauinslandi* is more like that of *M. tropicalis* than *M. monachus*" (p. 229), an observation Scheffer (1958, p. 112) described as curious.

Regardless, there clearly remain differences of interpretation and opinion between Repenning et al. (1979) and de Muizon (1982), both about the centre of origin of the Monachini and the subsequent radiation of *Monachus*.

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