18 Do Aquatic Mammals Provide Support for the Aquatic Ape Theory?

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SUMMARY
Palaeontology and evolutionary biology suggest that sea mammals have needed many millions of years to become fully adapted to a marine environment. Compared to their long evolutionary history, the relatively short period of 1 to almost 2 million years for a supposed aquatic phase of pro-hominids suggests that only minor adjustments could have occurred in the latter. If there was a Miocene aquatic ape, it might have lived only partially in the water.

INTRODUCTION

In the AAT debate, both advocates and opponents of the theory refer to comparisons of man with aquatic mammals. Because general knowledge about the latter is not widespread, a short survey of their evolution and specific water adaptations may be useful. It may illustrate the various transitional stages between terrestrial life and an existence in the sea.

EVOLUTION AND THE WATER ADAPTATIONS OF AQUATIC MAMMALS

About 300 million years ago amphibians left the sea and became adapted to a permanently terrestrial life; and about 150 million years later various land animals started to return to a life near and in the sea. But the loss of gills was irreversible; they and all their descendants remained dependent on the use of lungs for breathing.

Whales Fifty-five to sixty-five million years ago a wolf-sized primitive ungulate lived along the shores of the Tethys Sea, located in the area of the present-day Mediterranean and Persian Gulf. The abundantly present fish and crustaceans may have caused selection pressures that led to its wading through the waters; slowly but persistently its descendants – the primeval whales (Archaeoceti) – adapted to a marine life. Around 30–40 million years ago – most probably as a reaction to extreme geological changes, including a drastic drop in sea level and the development of a cold gulf stream in the southern hemisphere – they evolved into the more modern baleen whales (Mysticeti) and the even more recent

toothed whales (Odontoceti). Some species stopped evolving several millions of years ago. The smaller toothed whales, the dolphins, are known to have evolved about 12 million years ago.

Numerous findings of fossils, preserved in the sediments of former shallow seas, illustrate the long route that cetaceans have taken in adjusting to an increasingly permanent aquatic life. Their modern adaptations include a streamlined body shape: anterior extremities reduced to flippers and the disappearance of the hind legs; a specific pattern of locomotion including a highly developed diving capacity, facilitated by various strategies for super-efficient breathing and feeding; the adaptation of eyes and kidneys to the salinity level of the sea; loss of almost all fur; non-protruding penis and mammary glands; birth and suckling under water, during which the thick, concentrated milk spouts into the mouth of the young; dorsally shifted nostrils; an auditory apparatus able to hear under water, and echo-location systems. Cetaceans' increased body size has reached such extremes that larger species die after being stranded, because their own body mass squeezed their lungs (partly as a result of the absence of a sternum) (Slijper, 1958, 1979; van Bree, 1986; Fordyce, 1988).

The constancy of the body temperature is remarkable (35.5°–37°C), even though the thermal conduction of the surrounding water is 20 times higher and the thermal capacity 2000 times greater than that of air. In temperate regions surface sea-water temperature rarely exceeds 17°–18°C, and for many months it is just a few degrees above freezing point. For large parts of the year whales stay in much colder regions still. Also, they dive to great depths for prolonged periods; with increasing depth, the water temperature decreases rapidly to 5°C.

Certain adaptations are connected with their survival in (often cold) water. Increased body size effectively reduces the heat-losing body surface as compared to body mass. Yet the largest whales also have to keep moving most of the day in order to produce heat from muscle activity. However, the subcutaneous adipose tissue (or 'blubber') contributes to insulation – albeit to a lesser extent than previously suggested (see Pond, this volume, chapter 12) – but sufficient to endanger stranded animals by heat accumulation (Wheeler, this volume, chapter 13, page 229). For this reason even the smaller dolphins and porpoises have to be kept cool by keeping them wet when out of the water (during transport by man, for instance), though this is done partly to protect the sensitive skin against drying up. Overheating during normal activities, as well as loss of body heat from the extremities, is prevented by an efficient variant, present in numerous mammals, of the 'counterflow system' (that is, arteries to the limbs are surrounded by veins): in whales, a plexus of veins optimises the temperature exchange (Slijper, 1958, 1964, 1979; Harrison and Bryden, 1988; Wheeler, this volume, chapter 13, page 224).

The permanently aquatic Sirenia or sea-cows (that is, the naked dugong and the three almost naked manatee species) are slow-moving vegetarians. Their evolution started 50 million years ago, when an elephant-like mammal returned to the sea. Their adaptations include a massive, cigar-shaped body, fin-shaped front legs and the loss of hind legs.

The smallest sea mammal, the sea-otter (*Enhydra lutris*), is also permanently aquatic; neither mating nor birth happens on land. They have no isolating blubber, but float and keep warm by means of air trapped in their thick fur. During the day they wander out into open sea; during the night they rest in beds of the thick sea-weed, kelp. Like the freshwater otter (*Lutra lutra*), they are supplied with well-developed webbed feet.

Pinnipeds Their evolution started about 30 million years ago, with a coastally foraging dog-like carnivore. Nowadays they are almost permanently aquatic. They may rest and sunbathe on land or on ice-floes, and their young are born on land. They are smaller than cetaceans, and their body temperature is higher. Like the cetaceans, they produce an efficiently water-reduced milk for their young. They have thick fur and a streamlined body, and the legs have evolved fin-paws at the front and fins at the back. The oldest family, the true seals, has no external ears and cannot bend their hind legs forwards; as a consequence, they move on land in a caterpillar-like way; in water, the fins are mainly used for stabilisation. The later-evolved sea-lions (with external ears) and walruses (without external ears) can move their hind legs forwards and backwards, so their locomotion on land is fast.

It might be relevant to the AAT debate to consider the polar bear, *Thalarctos maritimus*. Less than one million years ago its ancestors were still purely terrestrial. They now stay on land or pack-ice, and spend a lot of their time swimming and diving, though they cannot stay under water for more than 1.5–2 minutes (Slijper, 1958; Bryden, 1988). Compared to the real aquatic mammals, their adaptations to water and fishing are minor: a smaller head, a longer neck and a more streamlined body than other bears. Mating, birth and suckling are land activities, but they rarely go further than 50 km inland.

Only a small number of the numerous terrestrial mammal species lives partially in or near fresh water. Mostly they live on land, but frequently go into the water to get food. Their fur is thick, the air among the hairs preventing the skin from getting wet. Apart from some freshwater dolphins, only the hippopotamus sleeps and rests practically all the time in or near the water. Normally, they stay under water four to five

minutes; like the dolphins, they have lost their fur (see also Leghausen, this volume, chapter 10).

DIVING

Among the spectacular adaptations of sea mammals to the aquatic environment are those for diving, such as a most efficient system of oxygen supply and locomotion – though relative to their size the lungs are not large, and in some species even rather small. The respiration rate and volume and the breathing interval is related to the diving depth and the frequency of dives. In whales, diving capacity is at its greatest, though there is a marked interspecific variability.

It has been recorded that the sperm whale (*Physeter catodon*) can dive for more than 90 minutes, down to a depth of 1000–2000 m, but usually sperm whales stay under the water for some 50 minutes. Fin-whales (Balaenopteridae) rarely dive for more than 40 minutes; true whales (*Balaenidae*), foraging on phytoplankton just under the surface, in normal circumstances (that is, when not endangered) dive for 4 to 20 minutes. Dolphins generally make frequent dives of only 3 minutes, going no further down than 30 m; the beloved bottle-nose (*Tursiops truncatus*) dives for 15 minutes at most. A special blood supply automatically keeps the pressure in the middle ear cavity similar to that of the immediate surroundings; whales do not suffer from earache as a result of diving. It is, however, still not fully understood how they cope with the other effects of diving that in humans cause caisson disease.

Of the pinnipeds, the true seals and sea-lions dive for periods of between 5 and 15 minutes; the Weddell seal, for instance, has been recorded as diving to 600 m. Fur seals do not dive as deep or as long; walruses can stay under water for only 12 minutes, and dive to 80 m. Sea-cows dive for periods of up to 16 minutes and sea-otters for 5 minutes.

In contrast, terrestrial mammals are not adapted for prolonged stays under water. For instance, dogs do not survive an immersion of more than 4 minutes; for cats and rabbits the limit is 3 minutes (Slijper, 1958). Normally, humans can stay under water about 1 minute. Yet, with training, diving time (without equipment) can be prolonged to up to 2.5 minutes, and in extreme cases, even up to 5 minutes (see also Patrick, chapter 14). Only professional human divers are able to dive to 20 m, even down to 30, without equipment (see Roede, this volume, chapter 20).

CONCLUSION

There is some point in Morgan's remark (1982) that, time after time, during evolutionary history, mammals of divergent families have returned

to the sea and adapted to an aquatic life. The possibility, in a primate species, of an initial impetus towards adaptation for a marine environment should therefore not, *a priori*, be rejected. However, the changes described above and other remarkable anatomical and physiological adaptations have taken many millions of years of aquatic life. In contrast, the Aquatic Ape Theory covers only the relatively brief Miocene period 5 to 3.5–4 million years ago, after the split between the apes' and the hominids' lineages and before the first appearance of Australopithecines. Even if it were true that ape-like creatures became isolated on land that was still emerging when large parts of Africa were temporarily submerged, there does not seem to have been enough time for complete water adaptation to have evolved. The alleged aquatic ape can only have been semi-aquatic – or, more probably, just coastally foraging.

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