Persistence of skin marks on killer whales (Orcinus orca) caused by the parasitic sea lamprey (Petromyzon marinus) in Iceland

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Lampreys have long been thought to be a cetacean ectoparasite, due to the observation of round marks on the skin of whales caught during whaling operations. Pike (1951), Nemoto (1955), and van Utrecht (1959) compared such marks on the skin of various cetacean species caught in the Pacific and Atlantic Oceans with the dentition of lampreys and concluded that most round marks had been caused by this parasite. However, lampreys were never collected from captured whales and, due to the lack of direct evidence, some discussion emerged as to the origin of these wounds. Jones (1971) later argued that crescent-shaped marks previously attributed to lampreys were in fact caused by cookie-cutter sharks (Isistius brasiliensis). However, he agreed that other round marks were undoubtedly caused by lampreys. Recently, photographs of sea lampreys (Petromyzon marinus) attached to northern right whales, Eubalaena glacialis (Nichols and Hamilton 2004), and minke whales, Balaenoptera acutorostrata (Nichols and Tscherter 2011), in the western North Atlantic conclusively showed that lampreys do associate with those species. Similar evidence for other cetaceans is still lacking.

The anadromous sea lamprey is found in North Atlantic waters, off the east coast of North America and the west coast of Europe (Hubbs and Potter 1971, Beamish 1980, Halliday 1991). Sea lampreys spend a juvenile feeding period at sea, during which they feed on hosts to which they attach by means of the oral disk (Beamish 1980). Petromyzon marinus is commonly observed attached to various species of marine teleosts (e.g., Atlantic salmon, Salmo salar; Beamish 1980, Halliday 1991) and elasmobranchs (e.g. basking shark, Cetorhinus maximus, Halliday 1991; Greenland shark, Somniosus microcephalus, Gallant et al. 2006). Although it may attach to hosts simply for transport, the sea lamprey is known to feed on at least some of the fish species to which it attaches (e.g., Atlantic salmon, Beamish 1980). In minke whales, sea lamprey attachments cause bloody lesions, suggesting the lampreys could be feeding on blood in the vascular networks of the skin (Nichols and Tscherter 2011). While killer whales (Orcinus orca) exhibit skin marks known to be caused by conspecifics (e.g., Scheffer 1969, Visser 1998), cookie-cutter sharks (Isistius sp.; Baird et al. 2006, Renner and Bell 2008, Foote et al. 2011), and remoras (Echaenidae; Lockyer 1979, Fertl and Landry Jr. 1999, Guerrero-Ruiz and Urb´an 2000), to our knowledge, lamprey attachment or marks have not been observed to date.

We collected photographs of killer whales around the Vestmannaeyjar archipelago off southwestern Iceland, in July 2008, 2009, and 2010, where they feed on Icelandic summer-spawning herring (Clupea harengus). Weather was the main limiting factor affecting effort each year. Photographs were taken using various digital single-lens reflex cameras and lenses. Photographs of killer whales were taken primarily for use in photo-identification (Bigg 1982) and typically were of the left sides of animals including dorsal fin and saddle patch, a lightly colored area below and behind the dorsal fin. All photographs of identified individuals were inspected for evidence of attached lampreys and lamprey marks. Killer whales were identified based on the size and shape of the dorsal fin, the presence of nicks and scars, saddle patch pattern, and body scars. Individuals were classified as adult male, adult female, juvenile, or calf based on morphological characteristics (body size and size and shape of the dorsal fin), since the year of birth is unknown.

We identified a total of 26 individuals in 2008 (in 6 d of effort with killer whale sightings), 91 individuals in 2009 (in 16 d of effort with killer whale sightings), and 72 individuals in 2010 (in 6 d of effort with killer whale sightings). Lampreys were observed attached to two adult male killer whales in 2009. In both cases, only one lamprey was observed attached to each adult male, and the lamprey species was identified as P. marinus based on morphological characteristics. This is the only lamprey species known to occur in these waters.

The first lamprey attachment was observed on the posterior ventral part of the body of an adult male, which is not commonly exposed when the whales surface. Although this animal was resighted on five subsequent days and again in 2010, it was not possible to clearly view the same part of the body to investigate if the lamprey was still attached or if it had left a mark on the whale's skin. The second lamprey attachment was observed on the dorsal part of the body of another adult male, posterior to the saddle patch (Fig. 1). This male was followed for approximately 2 h, and the sea lamprey was attached for the entire duration of the follow. This male had been sighted on multiple days prior and did not have a lamprey attached. However, it was not seen for the remainder of the field season, making it impossible to confirm the duration of the lamprey attachment or the presence of a fresh skin mark. It was resighted in 2010, and it did not exhibit any mark in the location of the lamprey attachment.

In 2009, we also identified skin marks on three other killer whales (two adult females and one juvenile) that resembled the dentition patterns of sea lampreys, suggesting these could have been caused by previous lamprey attachments (see Fig. 2A for an example). These marks were different from other skin marks of North Atlantic killer whales, including those caused by known parasites such as cookie-cutter sharks (Foote et al. 2011), strongly suggesting lamprey attachments as the cause. Lamprey marks were superficial and did not have the central hole in the skin previously described in the literature for marks attributed to lamprey attacks (e.g., Pike 1951; Fig. 2A). The marks show a pattern of skin abrasion in a round shape (Fig. 2A), resembling the arrangement of the teeth in the oral disk of sea lampreys (see Fig. 5 of Hubbs and Potter 1971 for a detailed view of the dentition of feeding-stage P. marinus). This might be expected from an attachment where the rasping tongue is not used for feeding attempts but where the lamprey is using the oral disk simply to maintain the attachment.

Two of those three individuals exhibited fresh lamprey marks: one was observed without a lamprey mark on 15 July and then with a fresh lamprey mark on 16 July; another individual sighted on 20 July without a lamprey mark exhibited a fresh mark on 22 July. These marks appeared superficial and were surrounded by white coloration, the same pattern as shown in Fig. 2A.White coloration surrounding fresh scars has been previously observed in killer whales, which later seems to disappear leaving only the black scar (Simil¨a and Lindblom 1993). This appears to apply to the lamprey marks as well, as the white coloration disappeared within a few days (Fig. 2B). All three individuals were again sighted in 2010 and no longer exhibited lamprey marks (Fig. 2C), indicating that those marks disappeared within one year in both adults and juveniles. These resightings suggest lamprey marks are not permanent and consequently not useful for long-term identification (Bigg 1982, Lockyer and Morris 1990). Short-term marks such as these can, nevertheless, aid in identification of poorly marked individuals within a season.

The skin marks on three killer whales and the two actual lamprey attachments described here suggest the incidence of lamprey attachment to killer whales in 2009 was of five of 91 identified individuals. However, observed marks are likely to underestimate the proportion of whales to which lamprey attach. While we were only able to confirm that round skin marks resembled the dentition pattern of sea lampreys on three animals, we found round marks on different parts of the body

of several additional individuals during the three field seasons. Confirming this dentition pattern requires high-quality close-up photographs, which are difficult to obtain. Identification of marks can depend on lighting conditions (Simil¨a and Lindblom 1993), camera focus, and the orientation of the whale in the frame, further restricting our ability to confirm and resight lamprey marks. In addition, lamprey marks are easier to identify in the saddle patch due to its lighter coloration. Moreover, and because only a small portion of a whale's body is visible when it surfaces, any marks or lamprey attachments on, for example, the ventral side of the body are likely to go unnoticed. Finally, the likelihood of observing a lamprey attachment or confirming a lamprey mark is greatly reduced if the time spent observing the whales is limited. This may explain why we could only confirm lamprey marks and attachments in 2009, when we completed 16 d of effort, but not in 2008 or 2010 when our field effort was reduced to only 6 d.

The sea lamprey P. marinus has only recently been more commonly found in Icelandic waters, and this change in distribution seems to be due to a gradual increase in water temperatures around Iceland (Astthorsson and Palsson 2006). For example, lamprey wounds were first observed on sea trout (S. trutta trutta) in south Iceland rivers in 2006 and the number of sea trout with wounds has been increasing since.2 We inspected the Icelandic photo-identification catalog, including photographs dating back to the 1980s, and none of the individuals showed lamprey attachments ormarks such as those described here. Our observations of fresh lamprey marks on individuals sighted 1–2 d prior without marks, suggest the attachments occurred in Icelandic waters. Therefore, it is likely that lamprey attachments on Icelandic killer whales are a recent phenomenon resulting from the increased occurrence of lampreys in this area, possibly due to changing conditions in the local environment.

Sea lampreys feed on the blood and tissue of some of their hosts, but may also attach only for transport. In some situations, sea lampreys alternate burst swimming with periods of motionless rest during which they simply attach to convenient structures using their oral disk (Quintella et al. 2004). We observed a sea lamprey attached to one of our research vessels (a rigid-hull inflatable boat) in 2010, which suggests that in this study area, sea lampreys may occasionally attach to objects in the environment only for resting or transport purposes. Given that we only observed superficial fresh lamprey marks on killer whales, and we never observed bloody lesions such as those reported from minke whales (Nichols and Tscherter 2011), it is possible that lampreys attach to killer whales but do not feed on blood or tissue. If so, this association possibly represents a small cost for the whales.

However, with the increasing occurrence of sea lampreys in Icelandic waters, attachments to killer whales may become more common and could involve lampreys actively feeding. Feeding lampreys could represent a higher cost for the whales with the increased risk of infection in the open wounds. To our knowledge, this study is the first description of sea lampreys attaching to killer whales and causing skin marks that apparently disappear within 1 yr. It suggests that sea lampreys are not feeding on the blood or tissues of killer whales but further observations will be necessary to confirm this, to understand whether the incidence of lamprey attachments to killer whales increases and to determine the implications of this association.

References

Astthorsson, O. S., and J. Palsson. 2006. New fish records and records of rare southern species in Icelandic waters in the warm period 1996–2005. International Council for the Exploration of the Sea C.M. 2006/C:20.
Baird, R. W., D. F. McSweeney, C. Bane, et al. 2006. Killer whales in Hawaiian waters:

Information on population identity and feeding habits. Pacific Science 60: 523–530.
Beamish, F.W. H. 1980. Biology of the North American anadromous sea lamprey, Petromyzon marinus. Canadian Journal of Fisheries and Aquatic Sciences 37:1924–1943.
Bigg, M. 1982. An assessment of killer whale (Orcinus orca) stocks off Vancouver Island, British Columbia. Report of the InternationalWhaling Commission 32:655–666.
Fertl, D., and A. M. Landry, Jr. 1999. Sharksucker (Echeneis naucrates) on a bottlenose dolphin (Tursiops truncatus) and a review of other cetacean-remora associations. Marine Mammal Science 15:859–863.
Foote, A. D., J. T. Vilstrup, R. De Stephanis, et al. 2011. Genetic differentiation among North Atlantic killer whale populations. Molecular Ecology 20:629–641.
Gallant, J., C. Harvey-Clark, R. A. Myers, and M. J. W. Stokesbury. 2006. Sea lamprey attached to a Greenland shark in the St. Lawrence Estuary, Canada. Northeastern Naturalist 13:35–38.
Guerrero-Ruiz, M., and J. R. Urb´an. 2000. First report of remoras on two killer whales (Orcinus orca) in the Gulf of California, Mexico. Aquatic Mammals 26:148–150.
Halliday, R. G. 1991. Marine distribution of the sea lamprey (Petromyzon marinus) in the Northwest Atlantic. Canadian Journal of Fisheries and Aquatic Sciences 48: 832–842.
Hubbs, C. L., and I. C. Potter. 1971. Distribution, phylogeny and taxonomy. Pages 1–65 in M. W. Hardisty and I. C. Potter, eds. The biology of lampreys 1. Academic Press, London, U.K.
Jones, E. C. 1971. Isistius brasiliensis, a squaloid shark, the probable cause of crater wounds on fishes and cetaceans. Fishery Bulletin 69:791–798.
Lockyer, C. H. 1979. Responses of orcas to tagging. Carnivore 2:19–21.
Lockyer, C. H., and R. J. Morris. 1990. Some observations on wound healing and persistence of scars in Tursiops truncatus. Report of the International Whaling Commission (Special Issue 12):113–118.
Nemoto, T. 1955. White scars on whales (I) lamprey marks. Scientific Reports of theWhales Research Institute, Tokyo 10:69–77.
Nichols, O. C., and P. K. Hamilton. 2004. Occurrence of the parasitic sea lamprey, Petromyzon marinus, on western North Atlantic right whales, Eubalaena glacialis. Environmental Biology of Fishes 71:413–417.
Nichols, O. C., and U. T. Tscherter. 2011. Feeding of sea lampreys Petromyzon marinus on minke whales Balaenoptera acutorostrata in the St Lawrence Estuary. Canadian Journal of Fish Biology 78:338–343.
Pike, G. C. 1951. Lamprey marks on whales. Journal of the Fisheries Research Board of Canada 8:275–280.
Quintella, B. R., N. O. Andrade, A. Koed, and P. R. Almeida. 2004. Behavioural patterns of sea lampreys' spawning migration through difficult passage areas, studied by electromyogram telemetry. Journal of Fish Biology 65:961–972.
Renner, M., and K. Bell. 2008. A white killer whale in the Central Aleutians. Arctic 61:102–104.
Scheffer, V. B. 1969. Marks on the skin of a killer whale. Journal of Mammalogy 50:151.
Simil¨a, T., and L. Lindblom. 1993. Persistence of natural markings on photographically identified killer whales (Orcinus orca). International Council for the Exploration of the Sea C.M. N:12.
van Utrecht, W. L. 1959. Wounds and scars in the skin of the common porpoise, Phocoena phocoena (L.). Mammalia 23:100–122.
Visser, I. N. 1998. Prolific body scars and collapsing dorsal fins on killer whales (Orcinus orca) in New Zealand waters. Aquatic Mammals 24:71–81.

Figure 1. Sea lamprey (*Petromyzon marinus*) attached to an adult male killer whale with location of attachment on body shown in the lower left corner.

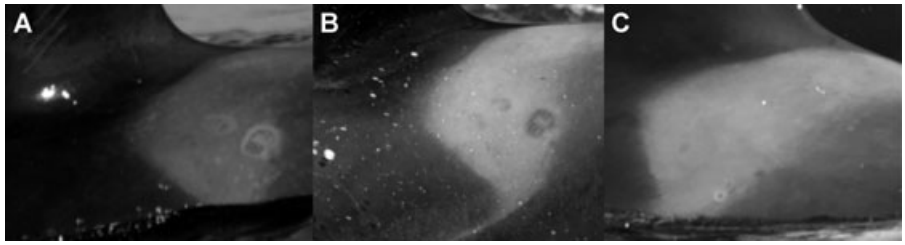

Figure 2. Juvenile killer whale exhibiting a lamprey mark. (A) Fresh lamprey mark, (B) same individual resighted 8 d later, (C) same individual resighted 1 yr later.