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The *hafstramb* and *margygr* of the *King's Mirror*: an analysis

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ABSTRACT. Greenland and Iceland are described with unusual scientific accuracy in the *King's Mirror*. However this thirteenth-century manuscript contains a few 'wonders' that appear more mythological than rational. They include the *hafstramb* and the *margygr*, commonly translated respectively as merman and mermaid. The mermaid has a long history in western civilisation. The commonly accepted theory that it evolved from the classical Greek siren is critically examined here. The *margygr* is shown to be a distinct creature based on independent observation in northern Europe. The characteristics of these observations actually modified the siren of the Physiologus, a bird-woman, into the fish-woman known today. Observations of *hafstramb* and *margygr* are explained as superior mirages. These are caused by atmospheric refraction, which distorts and magnifies distant objects. Computer simulations and photographs show that mirages of an orca, a walrus, or even a boulder match almost point for point the descriptions in the *King's Mirror*. Thus the apparently mythical components in the Greenland account are in fact careful scientific observations.

Contents

Introduction

The mid-thirteenth-century *King's Mirror* (*Konungs Skuggsjá*) is well-known for its accurate and rational description of the natural history of Iceland and Greenland (Nansen 1911: II, 242ff; Nordgård 1921; Whitaker 1985). Three anomalies, referred to as 'marvels,' were described as existing in the Greenland Sea. They are the *hafstramb* and *margygr* (merman and mermaid), and the *hafgerdingar* (sea hedges). To the modern reader these marvels are out of place, because, unlike all of the other descriptions, they have defied identification and have thus been dismissed as legends bordering on the supernatural. Recently, a careful analysis of the description of the *hafgerdingar* has allowed it to be identified as a mid-range superior mirage (Lehn and Schroeder 2003). This paper examines the two other marvels: the *hafstramb* and the *margygr*. The objective is to identify them as short-range mirages of common Arctic sea mammals, and to track their historical evolution into the modern merman and mermaid.

Hafstramb and *margygr*

The *King's Mirror* described these two beasts as follows. The quotations are taken from Larson's English translation, in which he replaced the old Norse names (Jónsson 1920: 64, 65), given in brackets, by what he considered to be the modern English equivalents.

hafstramb (Larson 1917: 135–136):

> It is reported that the waters about Greenland are infested with monsters, though I do not believe that they have been seen very frequently. Still, people have stories to tell about them, so men must have seen or caught sight of them. It is reported that the monster called merman [*hafstrambr*] is found in the seas of Greenland. This monster is tall and of great size and rises straight out of the water. It appears to have shoulders, neck and head, eyes and mouth, and nose and chin like those of a human being; but above the eyes and the eyebrows it looks more like a man with a peaked helmet on his head. It has shoulders like a man's but no hands. Its body apparently grows narrower from the shoulders down, so that the lower down it has been observed, the more slender it has seemed to be. But no one has ever seen how the lower end is shaped, whether it terminates in a fin like a fish or is pointed like a pole. The form of this prodigy has, therefore, looked much like an icicle. No one has ever observed it closely enough to determine whether its body has scales like a fish or skin like a man. Whenever the monster has shown itself, men have always been sure that a storm would follow. They have also noted how it has turned when about to plunge into the waves and in what direction it has fallen; if it has turned toward the ship and has plunged in that direction, the sailors have felt sure that lives would be lost on that ship; but whenever it has turned away from the vessel and has plunged in that direction, they have felt confident that their lives would be spared, even though they should encounter rough waters and severe storms.

margygr (Larson 1917: 136–137):

> Another prodigy called mermaid [*margygr*] has also been seen there. This appears to have the form of a woman from the waist upward, for it has large nipples on its breast like a woman, long hands and heavy hair, and its neck and head are formed in every respect like those of a human being. The monster is said to have large hands and its fingers are not parted but bound together by a web like that which joins the toes of water fowls. Below the waist line it has the shape of a fish with scales and tail and fins. It is said to have this in common with the one mentioned before, that it rarely appears except before violent storms. Its behavior is often somewhat like this: it will plunge into the waves and will always reappear with a fish in its hands; if it then turns toward the ship, playing with the fishes or throwing them at the ship, the men have fears that they will suffer great loss of life. The monster is described as having a large and terrifying face, a long sloping forehead and wide brows, a large mouth and wrinkled cheeks. But if it eats the fishes or throws them into the sea away from the ship, the crews have good hopes that their lives will be spared, even though they should meet severe storms.

The evolution of the classical siren into a mermaid

The commonly accepted source for the mermaid is the siren. Its origin lies in the tale of Ulysses, within which it is said that by their hypnotic singing the three sirens would lure sailors to their deaths. However these sirens, while fatally attractive, were unlike today's image of mermaids: they possessed the upper bodies of beautiful women, and, below the navel, the bodies of birds.

This classical concept was introduced into the Christian tradition possibly as early as the second century by a writer in Alexandria. His Physiologus, a book describing the animals mentioned in the Bible, was translated into Latin in the fifth century and thus became part of the European (western) tradition. The word 'siren' appeared in the Vulgate, the Latin Bible, but there was no physical description of the 'animal.' It was the Physiologus that defined the siren as a distinct species, half woman, half bird, as described in the Greek legends. Although many copies of the original appear to have been made, the popularisation of this work in Europe can be traced to Isidore of Seville (ca 570–636). A copy of the Latin Physiologus, with additions and omissions to improve the existing text, which was included in his *Etymologies*, became the direct source for most subsequent bestiaries (Mermier 1992: xi).

Another medieval text that had a profound effect on the concept of the siren was the *Liber monstrorum*. This book, based on classical sources including the Vulgate, Virgil, and St Augustine, was written in the seventh or eighth century in Anglo-Saxon England. The author had some of the same source material as Isidore, but there is no direct evidence that he actually saw any of Isidore's work (Faral 1953: 452). It differed from the Physiologus in that it was simply a description of monsters, with no accompanying moral lesson. Here was the first record of a siren described as half woman, half fish (Faral 1953: 441). She had become a beautiful aquatic creature, with neither wings nor birds' feet, and her tail with which she hid in the sea was described as scaly. The only characteristic she retained from the Ulysses legend was her beautiful voice. The description of the siren was very brief and there was no mention of her as a threat to sailors in any way (Bologna 1977: 42). An English version of the original Latin is as follows:

> Sirens are marine girls who deceive sailors with their very beautiful form and with the sweetness of their song. And from the head to the umbilicus they are of a girl's (virgin's) body, and very like the human species: however they have scaly fish-tails (lit: tails of fish) with which they always hide in the sea.

This brief description gained in significance because the author himself drew attention to it in his preface. Even medieval readers did not take all the descriptions seriously or believe in all the various monsters portrayed (Clark and McMunn 1989: 6). In his preface the author expressed doubt about many of the mythical beasts that he included, but accepted the existence of the siren because 'there is too much evidence to doubt its existence' (Bologna 1977: 36). Whatever this evidence was, it convinced the author that the siren must be a creature of the sea and not a bird. Since it was the official policy of the church at that time to incorporate local traditions into church life wherever possible, the author would have been free to include this local information in his book on monsters. The *Liber monstrorum* was frequently copied and widely distributed until the eleventh century, after which there is no evidence of new copies being made. Its influence is, however, clearly evident in the bestiaries that superseded it (Faral 1953: 480–488).

Bestiaries, which became extremely popular from the eleventh century onward, were expanded versions of the Physiologus (McCulloch 1962: 7) illustrating the animals of the world (and a few not of this world). Each was accompanied by a descriptive text that included a morality message based on the supposed characteristics of the beast. Although they were largely based on the work of Isidore, the various authors felt free to explain or expand the original text in the light of their own experience, knowledge, or imagination. The siren, however, continued to be portrayed as a bird until the twelfth century. The first bestiary to show the siren with a fish's tail (albeit still having the feet of a falcon) was written between 1121 and 1135 by Philippe de Thaön, a descendant of the Norman Vikings who did his work in England (Mann 1884). The oldest of the French bestiaries, it was probably the closest to its Latin source (Mermier 1992: xi), yet it gave the siren two new characteristics (Mann 1886). In defiance of tradition, Thaön gave the siren a tail; he also included for the first time a connection between the siren's behaviour and the weather. His siren sang happily at the approach of a storm, and wept in fine weather. Faral indicated that the

tail would suggest familiarity with the *Liber monstrorum* (Faral 1953: 484). The authors have been unable to find any suggested source for the second modification. Thaön's easy acceptance of the siren as a fish-woman and his association of sirens with storms reflected his Viking heritage. There can be little doubt that he would have heard Norse tales of *hafstramb* and *margygr*, although the precise relationship to storms was obviously lost to him. Both the fish tail and the association with a storm are Anglo-Norman adaptations first documented in England, no doubt to make the siren more consistent with northern experiences and folk legends. In bestiaries written after the twelfth century, sirens were portrayed in various ways. In some they retained their Greek form, that of the bird-woman; in others they were depicted in the new form, the fish-woman of the *Liber monstrorum*. With a surfeit of different sources, confusion resulted. Given that in the original tale there were three sirens, some authors described both types — two fish-women and one bird-woman, while others like Thaön described a hybrid form. To complicate matters further, the illustrations did not always match the written descriptions[1] (White 1954: 135).

Other sources of information from medieval times are the illuminations and church sculptures that have survived. Gransden pointed out that pictures were generally carefully copied when the plants and animals were unknown to the artist. However when artists were familiar with their subject matter, for example swans or pigeons, these were portrayed in a realistic fashion. At times both writers and artists clearly demonstrated that they closely observed the world around them (Gransden 1972). The fish-siren did not appear in church architecture until well after the *Liber monstrorum* was written, but before Thaön first introduced the fish-tailed siren into the bestiaries. Druce identified an eleventh-century sculpture in the Norman chapel of Durham Castle as the oldest example of a fish-siren scupture known to him. After the twelfth century, the fish-siren became an increasingly popular subject in church art throughout medieval Europe (Druce 1915: 174–177). In an illiterate society these visual reminders would very quickly have established the fish-woman as the siren of the Physiologus.

The only Nordic country to have its own vernacular version of the Physiologus is Iceland. Translated in the late twelfth century, it testified not only to the widespread popularity of the book but the extent to which Nordic, specifically Icelandic, culture was integrated into that of the rest of Europe (Dahlerup 1889: 228). The author translated only the 'lessons,' while the descriptions of the animals were presented pictorially. It is important to note that the translation was totally consistent with the accepted concept of the siren. The translator did not use a vernacular equivalent but retained the word *sirena* in his Icelandic translation. Nowhere was she given any of the attributes of a *margygr*; she simply was referred to in the traditional way, with a beautiful voice that seduced people, leading them to their deaths. The picture of the siren was rather poorly drawn and somewhat unusual. Like the Anglo-Norman siren, she was shown with a fish's tail; unusual were the human feet and strangely bearded face, neither of which fit the existing descriptions of the Norse *margygr*. Contrary to popular belief, there is no evidence of confusion in the mind of the translator between the *sirena* of the Physiologus and the *margygr* that inhabited the northern seas.

The best descriptions of the *hafstramb* and the *margygr* as perceived in the twelfth and thirteenth centuries, are those of the *King's Mirror*. The author described the upper body of the *hafstramb* as it was described to him, but resisted all temptation to speculate on the shape of the lower half, which according to his sources had never been seen. A basic correlation between observation (a monster) and effect (a storm) was carefully documented. This type of knowledge was based on the accumulation of data that indicated repeated sightings under the same circumstances. He finally reported that sailors had attempted to correlate the direction in which the monster had disappeared into the waves with their chances of survival. He pointed out that sailors *felt* they had identified some correlation. This is a much more tentative statement from the first 'Whenever the monster has shown itself, men have always been sure that a storm would follow' (Larson 1917: 136). Sightings were reported in the Greenland Sea, an area with which the Norwegians were familiar, for at this time they were still in regular contact with their Greenland colonies. This very careful description is in stark contrast to the plethora of monsters that populated the northern seas by the sixteenth century.

Another description of the *hafstramb* was included in the *Historia Norvegiae*, a Latin document from approximately 1170 (Munch 1850: 3). The monster, along with whales, walruses, and icebergs, was said to exist in the seas of northern Norway off Hålogaland, in the northern gulf. As in the *King's Mirror*, the description reads like an observation of a phenomenon rather than a tale or legend. An English translation would read approximately thus:[2]

> there is the *hafstramb*, the largest wild beast, but without head or tail, so that it appears like a [tree]trunk as it springs up and down, and it shows itself not without promising peril for seafarers.

The general theory that the merman owed its existence to the Greek triton (Druce 1915: 177; Benwell and Waugh 1961: 41) must surely be questioned here. Neither the *King's Mirror* nor the *Historia Norvegiae* employed the well-known classical terms for similar apparitions: triton or siren; nor were they prepared to give the *hafstramb* a tail, which, according to their information, had never been seen. These parallels with Greek mythology, established by Renaissance scholars, have generally been accepted with little debate in modern literature. The hypothesis must be considered that the concept of *hafstramb* as described in these early sources was based on the independent observations of Norse mariners.

The *King's Mirror* gave the *margygr* a somewhat more imaginative description than the *hafstramb*. Unlike the

mythical siren it was described as ugly, a woman, but hardly a beautiful one, and certainly not a virgin. The *margygr* had basically the same shape as the *hafstramb* and like the *hafstramb* had a somewhat deformed face described as terrifying. The tail and fins, like those in the *Liber monstrorum*, were described as having scales. She did not sing but her presence predicted a severe storm. Little wonder that the sailors again tried to correlate her behaviour with their chance of survival. The only other description of a *margygr* from this era added nothing to its image. In *Olaf's saga* it is described very briefly as a monster with the shape of a woman on top and the tail of a fish or whale (Heinrichs and others 1982: 58–59). Two sightings were also documented in the *Íslenzkir Annálar* (1847), one in 1305 on the open sea and one in 1329 off the shore of Iceland, but no descriptions were given.

Certainly the Norse drew a very clear distinction between the *sirena* of the Physiologus and the *margygr* as described in the *King's Mirror*. There is no doubt that the author of the *King's Mirror* would have known the Physiologus in the Latin form, and possibly, even the Icelandic version. Yet he rejected both the word 'siren' and the descriptions of the Physiologus, even though many had already accepted the fish-woman as a siren. By the thirteenth century, the Norse were very aware of Greek mythology as a separate body of knowledge; they simply did not confuse it with their own observations and unique body of knowledge based on familiarity with Arctic regions. A careful reading of the description in the *King's Mirror* indicates that the *margygr* and the Greek siren had very little in common. It will be shown that, contrary to popular belief, this confusion entered Scandinavian literature, both in Norway and in Iceland, only after they ceased to be seafaring nations.

A European text from this time is a scientific treatise, *De natura rerum*, written in Paris by Thomas de Cantimpré about 1260 (Boese 1973: 246). Unlike the bestiaries, this encyclopedic text attempted to collect and integrate all the existing information about the known animals into an accurate description of each. Because this work contains some interesting and relevant points, it will be discussed in some detail. Faral (1953: 470–476), in his analysis of the complete entry entitled 'De syrenis,' discovered some anomalous features that could not be accounted for from the standard sources. He broke the entry down into its phrases and numbered them, after which he attempted to identify the origin of each. A translation of the first five phrases is given here:

1. Sirens are harmful animals, as the Physiologus says, which have the shape of a woman from the head to the navel,
2. tall/long in size, of horrible face, with very long unkempt hair.
3. They appear with babies that they hold in their arms, and they feed the babies with large breasts that they have on their chests.
4. When sailors see sirens they are very afraid. And then they throw them an empty jar, and they [the sirens] play with that jar, so that meanwhile the ship should pass by. This has been testified by people who testify that they have seen them.
5. Sirens have the remaining part of the body, as Audelinus writes, like an eagle, and talons on their feet capable of tearing apart; at the end of the body they really have scaly fish tails, with which they swim in the oceans as if with paddles.

Phrase 1 referred directly to the Physiologus and defined the siren as a dangerous animal with the form of a woman from the head to the navel. The mystery lies in phrases 2, 3, and 4, which deviated from the usual pattern. Neither Faral nor Wedner (1994: 135) were able to trace any source for line 2, yet its similarity to the Norse *margygr* of the *King's Mirror* is unmistakable. The siren, like the *margygr*, was described as terrifying and ugly, with a horrible face and shaggy hair. A Norse source would hardly be surprising in late medieval times. The Norse had become a powerful trading nation, the influence and prestige of which had stretched far beyond their borders into continental Europe. They had established a large empire across the North Atlantic to Greenland and their knowledge of the northern territories was accepted as definitive in Europe. For Thomas to ignore available Norse sources would certainly have been regarded as negligent. By the thirteenth century the bestiaries had already established the concept of the siren as a marine animal, probably with a tail. Thomas would have felt perfectly justified in adding the Norse descriptions of the *margygr* as a way of augmenting the existing image of the siren. The introduction of the infant in line 3 is interesting: it may be based on Pliny, as suggested, but equally may have come from Norse sources. Although not described in the *King's Mirro*r the 'marmennil' was mentioned in a number of classical Norse sources. According to Norse tales it was the bastard child of a *margygr* and *hafstramb* and was considered to have the ability to predict the future (Cleasby and Vigfusson 1969). This Nordic concept had become sufficiently widespread in Europe to inspire artists in Freiburg and Basel to carve siren children on the capitals in their cathedrals some 50 years earlier (Cahier 1874: I, 152). Line 4 described the behaviour of the siren, which according to this source, could be distracted by throwing an empty jar at her to play with. Precisely this story reappears in 1786 in Iceland. Mohr, a Danish scientist working in Iceland, includes a dangerous monster, the stokkhvele (*stokkull*), which according to the Icelanders could be distracted by throwing a bottle or keg at it (Mohr 1786: 17). A similar story existed in Norway where it was a sea serpent that could be frightened in this way (Pontoppidan 1755: II, 203).

Lines 2–4 gave a coherent description of an animal: its appearance, offspring, and behaviour. They appear to be lifted directly from a single unknown source. They were simply inserted between lines 1 and 5. Line 5, which returned to classical sources, was a rather clumsy attempt to reconcile the contradictory information. It described 'the rest of the body' as an eagle, and the 'extremity'

of the body as the tail of a fish. Faral demonstrated that Thomas relied heavily on the *Liber monstrorum* and attributed this inconsistency to superimposing two mutually exclusive traditions, the Anglo-Saxon and the Greek, on one another. The intermingling of the *Liber monstrorum* and the Physiologus led to a fundamental change in the concept of the siren, from a bird-woman to a fish-woman (Faral 1953: 476). The authors would suggest that, in addition to the usual sources, Thomas had access to an entirely new source for his information, one based on Norse tradition. Although the description of line 2 is strikingly similar to that in the *King's Mirror*, it is highly unlikely that Thomas had access to it, since the two texts were virtually contemporary. More likely is that Thomas lifted his lines directly from an earlier source, no longer extant, which may also have served as the basis of the *King's Mirror*. Because Thomas continued to include the traditional characteristics of the siren, his description became inconsistent within itself, with no unifying vision. This led Wedner to conclude that his was not an independent work but simply a slavish copy of existing texts (Wedner 1994: 136). However his work, when viewed in its entirety, provides an excellent insight into the attitudes and world concepts of the people of the thirteenth century (Boese 1969). Evidence of Norse influence has already been seen in the bestiaries and in the popularity of the fish-siren in church carvings. This is, however, the earliest example the authors have found of a description of the classical *margygr* along with the traditional concept of the siren. Since his encyclopedia became an important source for subsequent works, this integration of the *margygr* into the siren became part of the accepted image of the European mermaid. The intermingling of southern and northern traditions in the Middle Ages, particularly in England and France, led to the evolution of the Greek siren into the legendary mermaid of Europe by the thirteenth century.

Sightings of man-like creatures that continued to be reported, by both sailors and fishermen, fuelled the many folk legends that developed. An interesting account of a cross-cultural beast that had evolved by the seventeenth century was described by John Swan (Swan 1643: 368–371). He claimed that the mermaids and men-fish were known for their loud whooping noises, as if they had the power to raise the storms with which they were associated. He also reported that many supposed these monsters to be spirits or devils, a point of view he did not quite endorse. He then turned to the classical sources and referred briefly to the Ulysses legend and later to Pliny. Here, without any attempt at justification, he simply stated that '*Plinie* telleth us of *Tritons*, and *Nereides* which were Mermen, or Men-fish of the sea' (Swan 1643: 369). He further referred to the ever-popular medieval Alexander Romance, hardly a reliable source, which had included sightings of both mermaids and mermen. He specifically quoted Olaus Magnus as an accepted authority on the subject, who claimed that mermen sometimes climbed onto ships and sank them. Two stories of captured merfolk were also included: a sea-woman caught in Holland in 1403, and a merman who resembled a mitered bishop caught in Norway in 1526. Swan's account reflected the variety and disparity of the cultures that had influenced English culture through the centuries. Greek legends, the Christian Physiologus, the old Norse descriptions, and no doubt Celtic legends were all jumbled together to create the mermaid and the merman, which seemed to Swan 'the most strange fish in the waters' (Swan 1643: 368).

The new hybrid siren did not enter Norse literature until after the Norse had lost their supremacy of the northern seas. The unification of the Scandinavian countries under the Danish crown and the deterioration of Norse maritime power due to increasing pressure from the Hanseatic League in the fourteenth century marked the end of Norwegian supremacy in the North Atlantic. When the Hansa finally took control of Bergen in 1428 the Norse were effectively shut out of their northern trade routes. With both Iceland and Norway reduced to coastal trading, they eventually lost the navigational skills needed for ocean travel (Gad 1970: 182). In 1613 Friis reported that the Norse had even lost their traditional whaling ability and were forced to rely on whales being washed ashore (Nansen 1911: II, 178). Although Norway and the Danish crown continued to regard Greenland as part of their realm, there is no record of ships being dispatched after the fourteenth century.

The knowledge and skills that the early Norse had developed remained unparalleled for centuries. For example the first map to show Greenland was drawn by Claudius Clavus, a Danish geographer, in the 1420s. Whether he based his information on personal experience as he claimed, or on existing literature and oral tradition, is unknown (Gad 1970: 174). In spite of its errors and forgeries of place-names it is the first map to show Greenland and its relationship to the rest of Europe. It was therefore used to form the basis for all subsequent maps that were used by explorers until the seventeenth century. Long after the decline of Norse expertise, European countries continued to turn to Nordic sources for information, even though it had become increasingly unreliable. In the mid-sixteenth century, the works of the exiled Swedish bishops, Johannes and Olaus Magnus, were the main sources of information about the Scandinavian countries. Although highly unreliable by modern standards, they were accepted as definitive until the discovery of old Icelandic sources more than a century later (Olaus Magnus 1998: xxxvi). Since Olaus Magnus was not personally familiar with the Norwegian maritime tradition, he relied heavily on oral information that he was incapable of assessing (Olaus Magnus 1998: liii, liv). He therefore indiscriminately presented factual material alongside any folk legend that would appeal to his readers. This highly popular, but hardly accurate, book was translated into all the major European languages and did much to propagate the concept of a sea filled with dangerous monsters.

More than a hundred years later (1752), Pontoppidan, the bishop of Bergen, published his *Natural history of*

Norway. In his preface he stated that he specifically wrote this book to provide accurate information about Norway, which was seriously lacking even in Denmark (Pontoppidan 1755: I, x). In it he dedicated one chapter to 'sea monsters, or strange and uncommon animals' (Pontoppidan 1755: II, 183–195). Pontoppidan indicated that the existence of mer-folk was sometimes questioned because of its chimeric nature, yet, like so many before him, he accepted their existence because of the prevalence of credible sightings. In his attempt to collect physical evidence he was only able to get reports of unidentified corpses that had been washed ashore, but no actual specimens that could be analysed. In spite of his scepticism, he included a number of anecdotes that vary little in substance from those of Swan. Fragments of knowledge had survived in the coastal legends related by Pontoppidan but they were totally masked by more recent experiences and superstitions. He suggested looking for animals that could be mistaken for mer-folk. His choice, the tropical dugong or manatee, which he had never seen, was made because he felt that its description was consistent with those of credible mermaid sightings.[3]

When, in the eighteenth century, the Danes were finally able to re-establish a meaningful presence in Iceland and Greenland they reported that, as in Norway, Icelanders continued to report mermaid sightings. Both Ólafsson and Pálsson (1752–57) (1975: 127) and Mohr (1786: 16–17) in their reports gave descriptions of unidentified corpses that the Icelanders had accepted as mer-folk to substantiate these claims. Like Pontoppidan they were clearly uncomfortable with the concept of identifying an animal based on sightings alone. Mohr recorded and classified, according to the new Linnaean system, all the animals known to Icelanders; in addition he listed 10 animals where, like the mer-folk and the *stokkul*, insufficient evidence existed for positive identification.

Of particular interest are the standard eighteenth-century words used for these animals: the Danish used Haf-Manden and Haf-Fruen, which the English translated as mer-man and mer-maid in their 1755 translation of Pontoppidan's book. In a footnote Pontoppidan gave the equivalent old Norse terms as *Hafstrambe* and *Maryge*. He explained that he had this information from a secondary source, since he had only just been informed of the existence of an extant version of the *King's Mirror* in the Copenhagen Library. Since he had no access to the descriptions in the *King's Mirror*, he could not compare his findings with those of the old Norse text. His analysis was a study of the mer-folk as they were perceived in Norway in 1750 and not an analysis of the report in the 500-year-old *King's Mirror*.

It has already been demonstrated that both the Icelandic translator of the Physiologus and the author of the *King's Mirror* perceived the *margygr* and the *sirena* as two distinct animals. By the eighteenth century this distinction no longer existed. Pontopiddan used the terms mermaid and siren interchangeably: as in 'a common Sirene, or Mer-maid' (1755: II, 193). Torfaeus, the Icelandic expert on old Norse sources who had recently collected and published many of the old Icelandic manuscripts, also did not distinguish between the two. In his Latin text of 1711, he referred to *margygr* as 'Sirenes,' although he did not give a modern equivalent for the term *hafstrambe* (Torfaeus 1711: IV, 416). The total integration of the Norse *margygr* into the bestiaries of western Europe effectively gave it the endorsement of the church and guaranteed widespread distribution. Eventually even the Scandinavian clerics, more familiar with classical tradition and church dogma than with natural phenomena, had popularised the *margygr* as the siren of the Physiologus. When the seafaring culture of the Norse was lost, the *margygr* survived, but only as a coastal mermaid heavily influenced by the mythical siren of the Physiologus, with nothing to differentiate her from the mer-folk that were said to inhabit the European shores. Even in Iceland and Bergen, where efforts had kept the Greenland tradition alive for centuries, the observations on which the existence of the *margygr* and *hafstramb* were based and their significance to the early mariners had been lost.

The premise established by Torfaeus and Pontoppidan, equating the medieval *margygr* with the modern mermaid, went unchallenged by later scholars. Dahlerup (1889: 26) assumed that the tail on the siren in the Icelandic Physiologus was a Norse adaptation, and attributed this to an error on the part of the artist who confused the siren with the *margygr*. He appeared to be unaware that by the thirteenth century the commonly held concept of the siren in western Europe actually was that of a fish-woman. Jónsson (1920: 58) accepted this premise without question since, in his opinion, the description in the *King's Mirror* was reminiscent of the picture in the Physiologus, a claim that does not withstand closer scrutiny. Hermannsson (1938: 9) equated the *margygr* with the siren on the basis of Jónsson's rather casual remarks. In general the marvels of the Greenland Sea have been accepted as just that: legends, products of an over-active medieval imagination, heavily influenced by the Physiologus and Greek mythology.

By careful analysis of the description in the *King's Mirror* it has been possible to identify the *hafgerdingar* as a mid-range mirage (Lehn and Schroeder 2003). In the same way it is possible to identify the *hafstramb* and the *margygr* as a variation of the same natural phenomena. The excellent descriptions of the twelfth and thirteenth centuries that have survived would certainly support such a hypothesis. Because the *Landnámabók* reports that in 986 Herjolf 'came into *hafgerdingar*' on his way to Greenland (Benediktsson 1974: 81v), it is possible to identify the *hafgerdingar* as a pre-Christian concept. But since no such direct evidence can be found in the case of the *hafstramb* and the *margygr*, it has been easy for scholars to attribute the existence of these animals to composite creatures in the Greek and Christian tradition.

In order to understand the underlying information that established the *margygr* and the *hafstramb* as a

distinct species in the northern seas in medieval times it is necessary to analyse the images sailors would have seen on their voyages. These images, both simulated and photographed, can then be compared to the descriptions found in the *King's Mirror*.

Explanation based on atmospheric refraction

The creation of mirages through the effects of atmospheric refraction was summarised in a previous paper (Lehn and Schroeder 2003); the concepts will be briefly reviewed. A stratified atmosphere within which there are significant temperature changes between the layers has the power to bend light rays to a noticeable degree. Nearly everyone has noticed this on hot sunny days, when flat surfaces like roads and runways look wet. This is the familiar 'desert mirage,' where hot layers of air just above the surface bend light rays sharply upwards, so that the road appears to reflect objects above it as if it were a mirror. Less familiar, noticed by very few, is the superior mirage. In this case the warm layers lie above the cool ones, a configuration known as a temperature inversion. Refraction occurs at the interface between cool and warm, with the result that upward propagating light rays are bent back downwards. A ray can thus originate from a source point near the ground, travel upward and refract at the interface, finally to travel downward into the eye of an observer. The human brain assumes that all light entering the eye has travelled purely in straight lines. Therefore the downward heading ray is perceived as coming from an elevated point, even though the true source point is near the ground. This mirage is called the superior mirage because the source is perceived above its true position.

The atmospheric layers are rarely structured to give a perfect mirror-like reflection. As a result, the image of an object seen under these conditions is generally distorted as well as elevated, much the way an object is distorted by a mirror of complex curvature. Inversions are often caused when relatively warm air drifts over cold water or ice; cases of this sort, called advection inversions, are not uncommon in mid-latitudes.[4] Since such inversions are quite common in the Arctic, the superior mirage is common as well. Legends based on distorted images produced by this effect abound not only in European cultures but also in Japan (Sweeney 1972: 49) and the west coast of North America (Clark l953: 197–201).

To see a monster, an observer should have his eye at low elevation, for example, he should be standing right at the water's edge, or perhaps be seated in a Viking ship. If the inversion is just overhead, and if it is sufficiently strong, then objects that under normal conditions are easily recognisable to the naked eye will become distorted beyond recognition. The distortion takes the form of a vertical distension, to an apparent height perhaps four or five times higher than the original object. Further, the distension is generally not uniform, so that some parts of the object may be highly distended, and others very little. The result is a distortion that completely masks the nature of the original. An excellent example was given by Scoresby (1820: I, 442), in which an inversion fog 'appears to magnify men into giants, hummocks of ice into mountains, and common pieces of drift ice into heavy floes or bergs.'

Common mammals such as the walrus and the orca (also known as the killer whale) make ideal sources that the mirage can convert into monsters. The orca has a behaviour pattern that lends itself to excellent merman mirages. On occasion it will poke its snout vertically out of the water until its eye is in the air. Shackleton (1920: 22, 35, 323) reported this behaviour, called spy-hopping, in the Antarctic seas, where it was an element of the whale's hunting technique. By experimenting with different temperature distributions in the layered atmosphere, one can discover numerous situations that convert an orca or a walrus into a merman. Several examples will now be presented, to demonstrate the different appearances that are possible; subsequently these will be compared with the descriptions in the *King's Mirror*.

As the first example, consider the temperature profile shown as the solid curve, marked 'a' in Figure 1. It gives the temperature of each air layer as a function of its elevation. It is clearly an inversion because the temperature increases with elevation. The lowest air layer takes on the same temperature as the surface of the sea, which is assumed to be at 5°C. The air temperature varies from this value up to a maximum of 10.6°C. The difference of 5.6°C between the two extremes could be called the 'strength' of the inversion. Now consider an observer, such as one on a Norse ship, whose eye is about 2 m above the sea, just below the level at which the temperature is increasing most rapidly. When light rays entering his eye follow strongly curved paths as described above, the source of the rays will be perceived to be elevated, with the most strongly curved rays producing the greatest lift. The perceived image will then be vertically distended. Typical examples that show the paths of light rays under such conditions can be found in numerous references (Lehn and Schroeder 2003; Lehn and Friesen 1992; Lehn and Schroeder 1981) and are not reproduced here.[5]

The appearance of the orca under these conditions can be computed (Lehn and Friesen 1992). The programme takes an original undistorted image of the animal and calculates its appearance when seen as a mirage due to the curved light rays. Figure 2(a) is a photograph of an orca carrying out its spy-hopping manoeuvre.[6] The corresponding calculated mirage image is given in Figure 2(b). This mirage is about 12 arcminutes high and 4 arcminutes wide, a size clearly visible, and within which details can be seen, to anyone with good eyesight.[7]

A second example of a distorted orca is calculated from the original image of Figure 3(a). Here the animal rises higher out of the water, exposing part of a flipper. This pose can produce a different image, as seen in Figure 3(b). This case requires a significantly stronger temperature inversion of 14.3°; it is plotted as the dashed

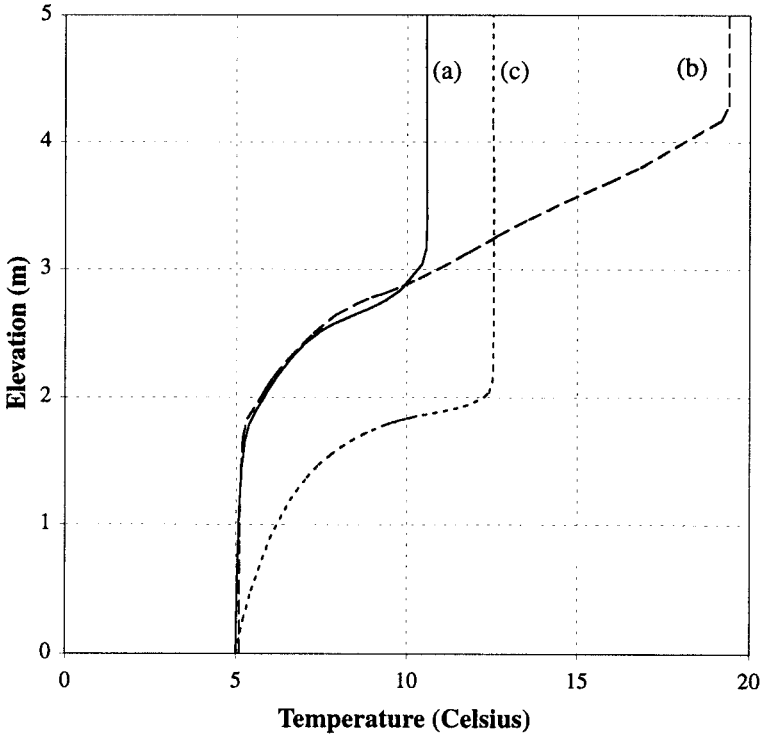

Fig. 1. Atmospheric temperature profiles for the three calculated mirages. In each case the temperature of the sea, and hence the lowest layer of the air, is assumed to be 5°C, a reasonable value for the Greenland Sea. Profile (a) produces the mirage of the orca in Figure 2; (b) produces Figure 3; and (c) gives the mirage of the walrus in Figure 4.

line 'b' in Figure 1. The angular size of the image is correspondingly greater, 20 arcminutes in height and 6 arcminutes in width, again clearly visible to the naked eye.

A walrus processed in a similar way yields a rather terrifying picture. Because the walrus is a smaller animal than the orca, it must be somewhat closer to the observer to have the same visibility. It is here assumed to be 770 m distant. The observer's eye, 1.8 m above the sea in this case, has been lowered by a small amount to permit a slightly weaker temperature inversion. The required inversion has a strength of 7.5°; it is the dotted line marked 'c' in Figure 1. The original walrus is shown in Figure 4(a), and its mirage image in Figure 4(b). Similar images were calculated in Lehn and Schroeder (1981).

Mirages of this sort have been observed and photographed on the shores of Lake Winnipeg. This is a very large lake, of which the South Basin alone is 90 km long and 30 km wide. In the cold continental winter, the lake freezes deeply, and the surface usually remains ice-covered to the end of April. At this time the temperature of the surrounding land can easily exceed 20°C. If some of this warm air drifts over the icy surface, very strong temperature inversions develop. In the present example, the inland temperature was 28°C. This kind of temperature difference when confined to a narrow range of elevations produces powerful refraction; as seen in the simulations above, a much weaker inversion is already adequate to produce the necessary refraction. The source object for the mirage was a simple boulder lying on the shore of the lake. Its size, 68 cm wide and 30–35 cm high, was somewhat smaller than that of an orca's snout. It is shown in Figure 5(a). The mirage, photographed on 2 May 1980 from a distance of 1100 m, is in Figure 5(b). Again it bears striking resemblance to the *King's Mirror* description. Interestingly, with its height of 6 arcminutes, it is the same size as a man seen at that distance through a normal atmosphere.

Whereas this 'merman' was photographed over ice, it would make little difference if the lake had been freshly thawed. Water at the temperature of the Greenland Sea would be just as effective in creating an optically powerful inversion.

When the above computed and observed images are compared to the descriptions of the *King's Mirror*, a remarkable consistency is seen.[8] Descriptions of the monster will by necessity vary depending on the animal seen and the extent to which it has been distended. In addition it must be remembered that any motion of the animal will also be greatly distorted. Further, even minor changes in the layering of the inversion will be perceived as strange motions on the part of the monster. It is remarkable, given all these variables, that Norse sailors were able to isolate sufficient information from these images to give a detailed description, from which the author of the *King's Mirror* could assemble a coherent picture.[9]

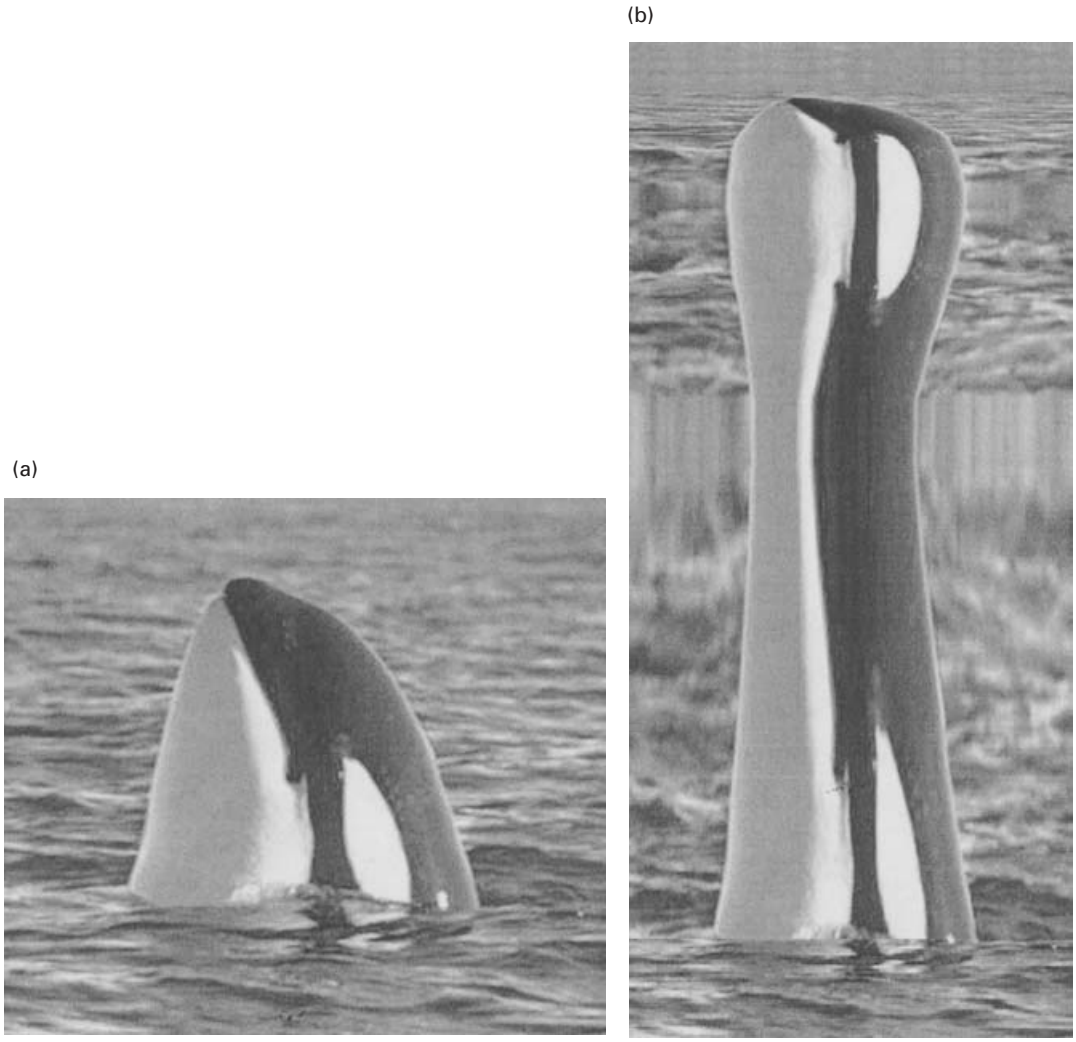

Fig. 2. (a) Normal view of an orca. The tip of the snout is assumed to be 1.5 m above the water. Given that a typical male orca is 9 m long, this is a reasonable value. (b) Mirage image of the orca, calculated for a distance of 1500 m using the temperature profile of Figure 1(a).

The images, both observed and calculated, agree almost point by point with the *King's Mirror*. Consider the *hafstramb*, and examine its individual properties as listed in the *King's Mirror*.

1. 'This monster is tall and of great size and rises straight out of the water:' all of the images have this form, because the superior mirage always produces a vertical magnification while not changing the lateral dimensions.
2. 'neck and head . . . like those of a human being;' 'shoulders like a man's but no hands:' these attributes are clearly visible in Figures 2 and 5, in which the images have an upper thickening that makes a head, then a narrowing neck, and sloping shoulders without limbs.
3. 'eyes and mouth, and nose and chin like those of a human being:' the prominent white spot on the orca's head is easily interpreted as an eye (Fig. 2). But features of smaller detail corresponding to mouth, nose, and chin would not be visible at the distances under consideration. They would have to be interpolated by the observer's mind, a not unnatural action under the circumstances.
4. 'like a man with a peaked helmet on his head:' the peaked appearance of the orca's snout is reproduced to greater or lesser degree at the top of the image. This can be seen in both Figures 2 and 3. Thus the peaking is a natural consequence of the shape of the source object. The head of a walrus, being round, would not exhibit this peak.
5. 'no one has ever seen how the lower end is shaped:' all of the mirages remain vertical without exposing the lower part of the body. To create such an image, the orca's position must be as in Figure 2(a), where only the snout and not the flipper is exposed. An exposed flipper would give the appearance of a fish's tail (see point 4 of the *margygr*, below).
6. 'looked much like an icicle:' mirage images look like this if there are disturbances in the air layers,

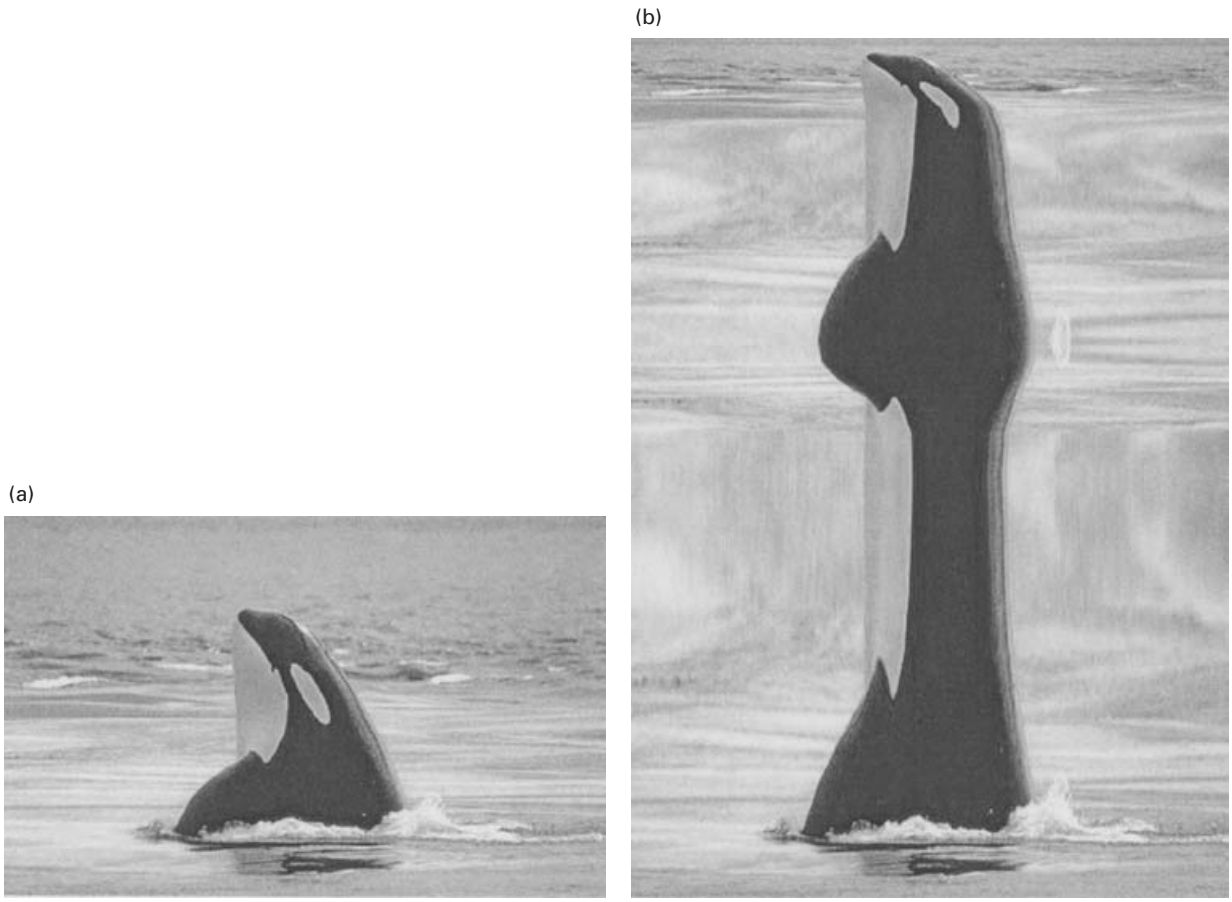

Fig. 3. (a) Normal view of an orca emerging far enough to show its flipper. The tip of the snout is estimated to be 2.4 m above the water. (b) Mirage of the orca, showing the form of the *margygr*, with breast and fish tail. The mirage is calculated for a distance of 1500 m using the temperature profile of Figure 1(b).

too small to affect the overall nature of the image, but just large enough to blur its outline. One then sees a shimmering corrugated image like that of an icicle. Note also that the word 'icicle' again emphasizes the vertical nature of the image.

7. 'how it has turned when about to plunge into the waves:' plunging into the waves was doubtless observed, as a result of the orca's sinking beneath the waves. It is however highly questionable whether one could really distinguish the direction it was facing.
8. 'a storm would follow:' this prediction is correct; the correlation between storms and mirages is explained below.

A similar point by point comparison can be made for the *margygr*. It shares a number of properties with the *hafstramb*, which need not be repeated. The distinguishing features are the following.

1. 'it has large nipples on its breast like a woman:' Figure 3 shows this effect; the refracted image of the orca's flipper has the appearance of a woman's breast.
2. 'heavy hair:' this impression is seen in Figure 4, where the roughness of the walrus hide is distended to resemble shaggy hair. With the orca image, one could interpret the black half of the image as a mane of black hair, usually smooth but possibly roughened by slight irregularities of refraction as in point 6 above.
3. 'said to have large hands:' lateral projections from the body, that look like arms or hands, would be seen if Figure 3 were slightly modified. A small change in the atmospheric temperature profile could make the apparent breast shrink into a thin horizontal projection like an arm. Fingers could never be discernible at the distance involved; this is consistent with the webbed fingers of the description. However a supposed fish in the hands could not be resolved. Note that hands and breasts are mutually exclusive; only one form can be seen at a given time. The description of these features thus appears to be a composite.
4. 'Below the waist line it has the shape of a fish with scales and tail and fins:' the fish tail is clearly visible in Figure 3. The orca's flipper shows at the bottom of the image, widening the body out into an apparent fish tail. Because breasts or arms, and fish tail are all caused by an image of the flipper, they always occur together, and the apparition was identified as female. Thus the image of the

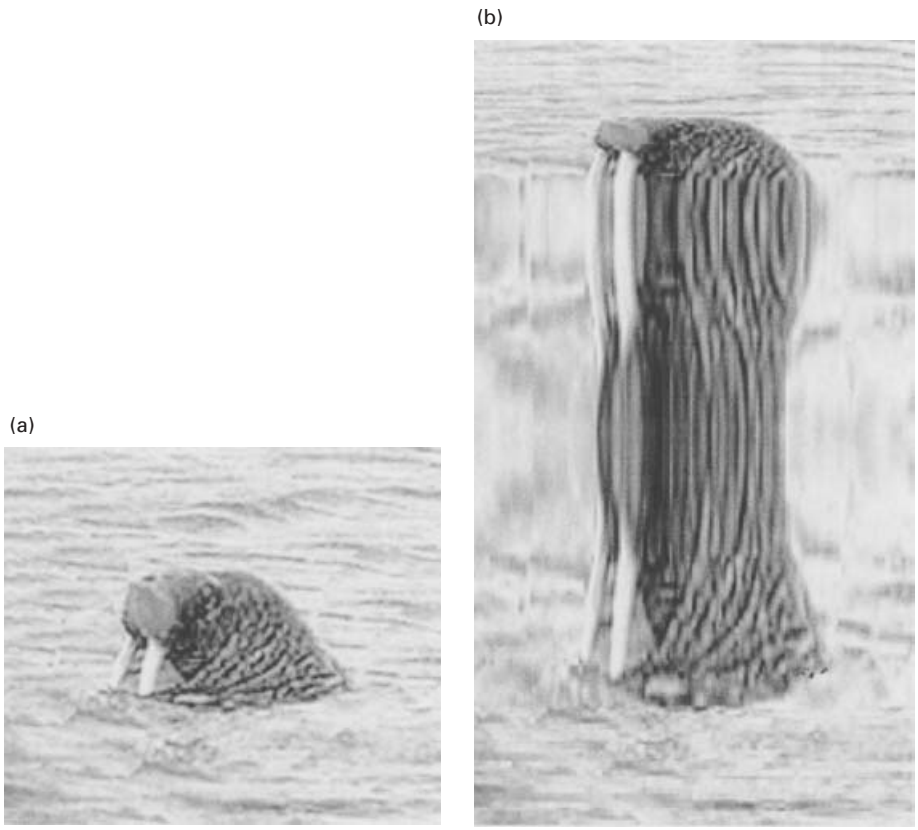

Fig. 4. (a) Normal view of a walrus. The top of its head is taken to be 0.5 m above the water. (b) Mirage calculated for a distance of 770 m using the temperature profile of Figure 1(c).

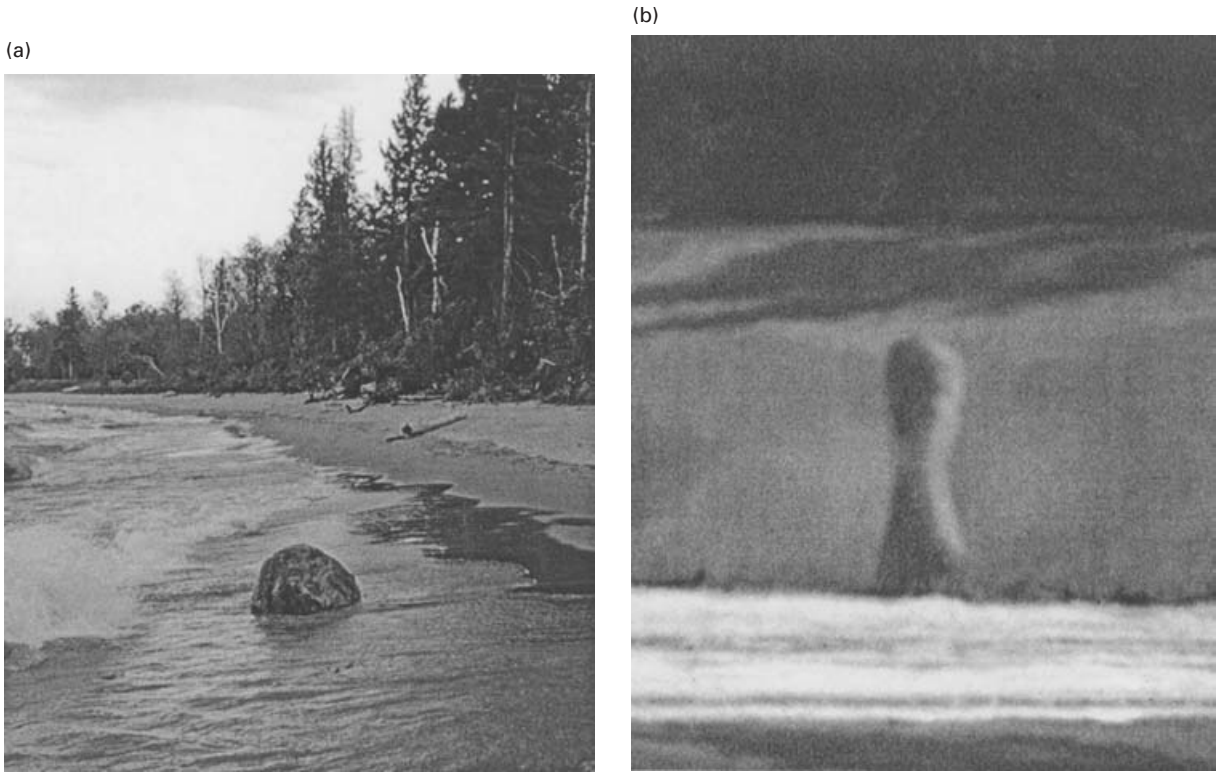

Fig. 5. Mirage photographed on Lake Winnipeg, Canada. (a) This boulder on the shore is the source for the mirage. (b) The mirage was photographed from a distance of 1100 m, using a 1500-mm lens, the elevation of which was 2.5 m above the lake.

margygr is clearly distinguished from that of the *hafstramb*.

5. 'it rarely appears except before violent storms': a correct prediction, as in point 8 above.
6. 'it will plunge . . . if it then turns toward the ship': plunging is a natural motion, while the impression of turning is easily gained. If such a figure turned toward or away from the observer, the breast would no longer be seen in profile. This happens immediately if the orca's flipper becomes submerged. The direction in which the *margygr* was finally looking would however not be identifiable.
7. 'playing with the fishes or throwing them at the ship': such details would not be visible at the distance of 1500 m. Perhaps some motion of the mirage could have been so interpreted.
8. 'having a large and terrifying face': this effect is quite obvious from Figures 3 and 4.

The correlation of mirages with storms was first described by Wegener (1926). Temperature inversions often accompany the advance of a warm front in the standard cyclone model of the atmosphere. As the core of the cyclone passes, the cold front of a high-pressure zone follows, generally accompanied by a squall line that brings violent and destructive winds. Wegener referred to these as high-pressure storms (Koch and Wegener 1930). The movements of the weather fronts and the accompanying *hafgerdingar* that appears at mid-range around the ship have been described by Lehn and Schroeder (2003). In the case of a *hafstramb* or a *margygr*, the temperature inversion is steeper and the wall or *hafgerdingar* appears directly behind the image. This distortion of the background can be clearly seen both on the simulation and on the photograph, yet, because it is totally featureless and non-threatening, it probably went unnoticed by the sailors and was not included in the *King's Mirror*.

One must conclude that the Norse mariners had seen the *hafstramb*, *margygr*, and *hafgerdingar* sufficiently often to describe them accurately and to correlate the sightings with approaching storms. These mirages, although not recognised as such, were placed in different categories as independent phenomena of the Greenland Sea.

Conclusion

Mirages have all the necessary attributes to become the source of legends. Interesting, man-like sightings with many different characteristics were made sufficiently often to convince people of the existence of mer-folk. The strong inversions necessary to create these images exist particularly in northern latitutes where warm land air overrides the cold sea air in coastal regions. Legends that reflect such observations existed among sailors and fishermen around the world. These legends gained particular significance and widespread acceptance in Europe because they became incorporated into church art and literature in medieval times.

Because such sightings were identified with the siren of the Physiologus, they changed the nature of the siren in Anglo-Saxon England from a bird-woman to a fish-woman by the eighth century. As Norse influence increased in continental Europe, the siren, now a mermaid, took on more and more of the characteristics of a Norse *margygr*. The *hafstramb*, although equally important in classical Norse literature, was not incorporated into the Physiologus and was therefore largely ignored except as a mate for the mermaid. With the disappearance of the Norse seafaring tradition, this knowledge was lost and the *margygr* became a coastal mermaid, very much like the mermaids that were said to inhabit the shores of western Europe.

On the open sea, similar inversions can occur due to severe frontal activity. Norse sailors carefully observed and described this phenomenon and its relationship to weather. Because this information was preserved in the *King's Mirror*, it has been possible to identify and analyse these sightings as mirages. Of all the marvels and mythical animals that were accepted in thirteenth-century Europe, the author of the *King's Mirror* chose only three that he described as existing in the Greenland Sea. The *hafgerdingar* have already been identified as a mirage in a previous paper. The identification of the *hafstramb* and *margygr* as mirages establishes the *King's Mirror* as a reliable account, not only of thirteenth-century Greenland, but also of natural phenomena that have gone largely unobserved by modern man. It demonstrates the level of sophistication achieved by the medieval Norse, and their influence on European culture.

Acknowledgements

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Notes

1. It should be noted that the fish tail was strictly a northern adaptation. The Ethiopian (Hommel 1890) and the Armenian (Cahier 1874: I, 126–127) translations retained their bird form. The Ethiopian translation actually confused the siren with the onocentaur and gave the siren a horse's face and the feet of a bird while the onocentaur had the face of a man and the lower half of an ass. The Armenian translation is more accurate in that the siren was described as a creature of the sea with the body of a woman to the navel, while the lower half was a bird, an ass, or an ox; however, it omitted the onocentaur entirely. The German translations retained the bird-woman (Maurer 1967: 16, 17, 92) but the concept of the fish-siren existed in German legends and church art.
2. The original Latin text used *hafstrambus* to name the monster, and *truncus* to describe its appearance. The two existing Norwegian translations differ slightly in their rendering of these terms. Koht (1921: 13) used *havmannen* and *bul*, respectively, while Salvesen (1969: 20) used *draugen* and *trestamme*. In using *draugen* she took the closest approximation to be

found in modern Norwegian dictionaries, where *draug* is defined as sea monster, or ghost of the sea. This legend is widespread along the northern shores of Norway; it is, however, a coastal phenomenon, while the *hafstramb* was consistently associated with the open sea. The origin of the *draugen* legend is explained below in Note 8. This is an excellent example of the problems with translation, where concepts can actually shift because they are not fully understood.

3. This new rational approach, of matching known animals to descriptions and legends, has survived the centuries; scientists and historians alike continue to suggest suitable animals that could have given rise to mermaid sightings. A few examples are Oudemans (1892), Lum (1952), Heuvelmans (1968), George and Yapp (1991), and Higgins (1995). The inconsistencies are simply blamed on the over-active imagination of seamen, and their tendency to exaggerate.
4. Vince (1799) described a mirage of rare quality that he observed in the English Channel; this was most likely an advection inversion. The Fata Morgana, often seen in the Straits of Messina, has a similar origin (Pernter and Exner 1922: 170–179).
5. It is sufficient in this analysis to think of the Earth and the air layers as flat, because the Earth's curvature has very little effect over the short distances involved; however, the computer program does account for the curvature. The calculation procedure is given in detail in Lehn (1985), while alternate algorithms can be seen in Fraser (1977) and van der Werf (2003).
6. The web site *http://www.orcahome.de* has many excellent pictures of orca groups.
7. The standard eye chart used to test visual acuity provides a scale by which the images can be evaluated. Anyone who can read the 20/20 line on the chart is correctly identifying alphabetic characters that are 6 arcminutes high. A small fraction of the population actually has 20/10 vision; in this case characters that are 3 arcminutes high are being read. It is likely that such acute vision would have been reasonably common among Norse mariners. In any case most of the mirage images presented here are significantly larger than either of these sizes.
8. The same consistency exists in the more modern *draugen* legend. The coast around Tromsø is strewn with boulders of varying size, which are covered by fibrous seaweed that from a distance looks like coarse hair. A boulder of this type would produce a mirage just like the one in Figure 5(b), with the addition that it would appear to be hairy. The *draugen* is so represented in common picture books.
9. It is, for example, easy to see from the orca simulation why legends would develop that described the mermaid as very white with black hair. Henry Hudson reported such a sighting in his log (Asher 1809: 28).

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