

# Mystery solved: mermaids exist

Sketchy VV<sup>1,2</sup>, Dodge Y<sup>3</sup>

<sup>1</sup>Museum of Bogologia, Timaeus, Utopia OMG69, Island of Atlantis

<sup>2</sup>Centre for Research and Applications into the Paranormal, School of Metaphysics, The University of Poseidon, Critias, Utopia OMG42, Island of Atlantis

<sup>3</sup>School of Cryptozoology, University of the Gold Coast, Mermaid Beach, Queensland QLD 4218, Australia

The **Mermaids** are friends of Peter Pan's, who appear in Disney's [1953](#) film [Peter Pan](#) and [its 2002 sequel](#).

## Abstract

Despite common anecdotal observations around the world over the past three millennia, mermaids are considered mythical. Based on a stranding of five mermaids on the Island of Lesbos (Greece) on 14 February 2018, we prove mermaids exist and assign them the scientific name *Hydronymphus obscura* sp. nov. Dissection of their respiratory system confirmed mermaids have well-developed gills and rudimentary lungs and are thus primarily aquatic. Stomach contents analysis showed mermaids primarily eat bottom-dwelling animals, and thus inhabit the deep ocean. Dissection of the reproductive system of the stranded mermaids, all of which were pregnant females, suggested an equal sex ratio at birth. However, male mermaids (mermen) are rarely seen as adults, implying they seldom visit surface waters. The low numbers of mermaids observed, declining population over the past century estimated by an abundance index derived from the literature, and the increasing exploitation of the deep sea through fishing and mining, raises concerns mermaids might be vulnerable to extinction. Their existence challenges our conventional view of human evolution and suggests both mermaids and humans evolved from a common aquatic ancestor, supporting the aquatic ape hypothesis. An integrated research program to explore the deep-sea habitat of mermaids, with a focus on their movement, population size and ecology, will provide the needed scientific information to underpin mermaid conservation.

## Introduction

### 1. The context. Why should you care?

The upper body of a mermaid resembles a human and the lower body resembles a fish. They are considered mythical, but have been graphically depicted in cave paintings, engravings, paintings, tapestries and statues by many cultures from ancient times to the present (Fig. 1). Mermaid legends are common in early Mediterranean and Mesopotamian civilisations, including Assyria (900 BC – 600 BC) and Greece (800 BC - 600 AD) (Fig. 2). Mermaid legends are prevalent in Celtic countries of Europe, and are depicted in churches of the Middle Ages, such as in Durham Castle, England (Wood 2010). Mermaids have been venerated in Africa (Drewal 2008), South America, and Pacific Island nations (Fig. 2).

Observations of mermaids are spread across the Atlantic, Indian, and Pacific Oceans, but have not been recorded from the Southern Ocean (Fig. 2). In the Caribbean, Columbus reported mermaids off Haiti in the 15<sup>th</sup> century (Columbus 1493), the pirate Blackbeard encountered them around the West Indies in the 18<sup>th</sup> century (Sparrow 2011), and a colonist in the 1740s reported sightings from Dutch Guiana (van Stipriaan 2005). There is

thought to be a colony off Denmark (Anderson 1837; Disney 1989). During World War II, Japanese soldiers observed mermaids off Indonesia (Man 2012). Sightings continue in the 21<sup>st</sup> century. In August 2009, mermaids were seen by dozens of people off the Israeli coastal town of Kiryat Yam (Anonymous 2009) and there have been recent documentaries and movies showing alleged footage of mermaids (Animal Planet 2012, 2013; Lego World 2014).

### 2. The problem/gap

Despite the legends and anecdotal observations from around the world over the past three thousand years, mermaids have evaded cryptozoologists. It is common for the scientific community to remain skeptical of the existence of a species until it is observed and described. For example, the prehistoric fish and close relative of the tetrapods, the coelacanth, was thought to have gone extinct 65 million years ago, until the collection of a specimen by a local fisherman off South Africa in 1938 (Smith, 1938). Since then, deep-water populations have been discovered dotted along the African east coast and in Indonesia. Species that are relatively rare and inhabit the deep ocean can elude scientific

discovery for many centuries (Gibbons et al. 2005).

### 3. Previous work/knowledge

The scattered sightings, depictions, and descriptions of mermaids, although sometimes contradictory, provide a glimpse into their life. Mermaids have been observed in freshwater (Rowling 2000; Short et al. 2001). Most sightings are of females, usually described as beautiful, with long flowing hair, but some are of male mermaids (mermen) that are wilder and uglier (Banse 1990). As mermaids have been seen for millennia in the Mediterranean Sea, breeding populations are presumed to exist in this area. They are considered predominantly marine because they are commonly sighted by sailors (Lewis 1952), but they are also seen on land along the coast (Fig. 1E). The longevity of mermaids is longer than any other mammal, living to 300 years (Anderson 1837). Many scientists have

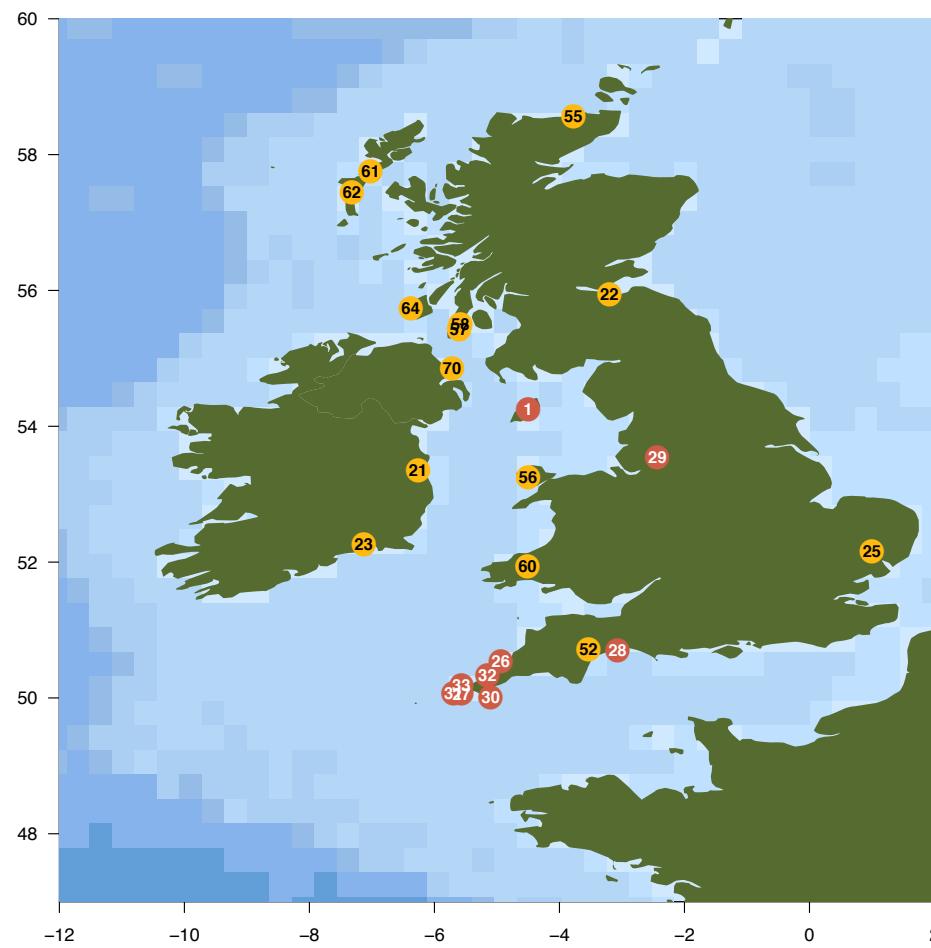
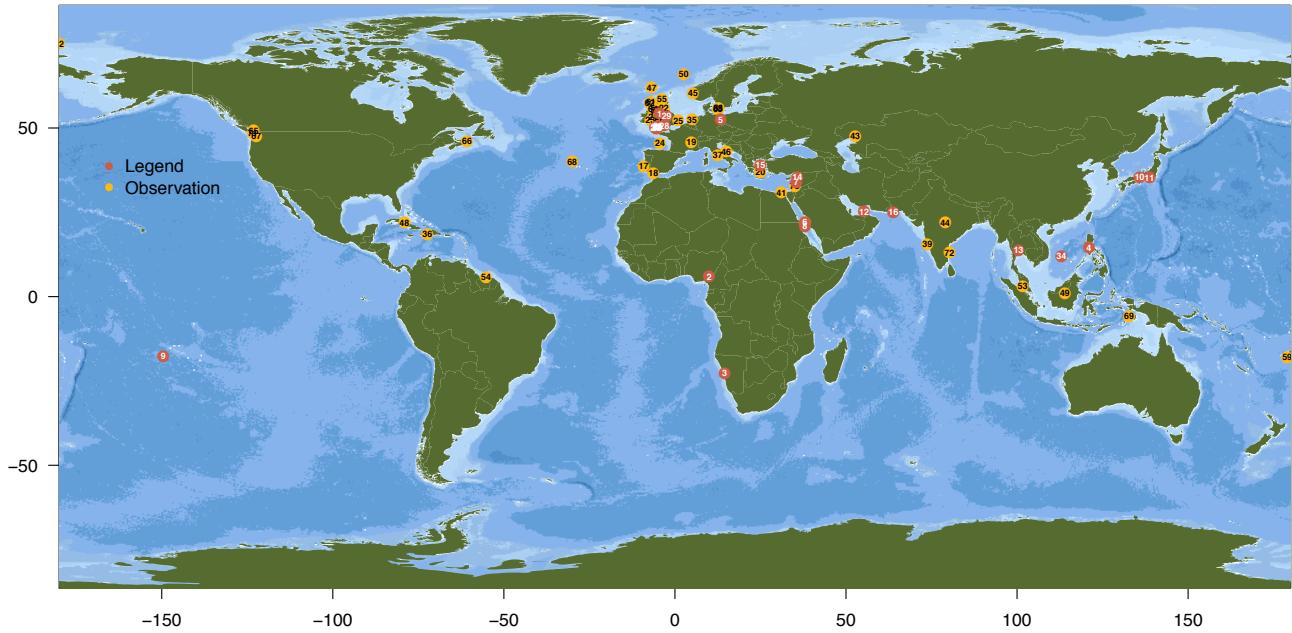
dismissed sightings of mermaids as misidentifications of dugongs or manatees, but intriguingly manatees are not found in the Atlantic further north than the Gulf of Guinea, and manatees and dugongs are not found in the Mediterranean Sea.

### 4. What we did

Here we document a stranding of five mermaids on the Greek island of Lesbos on 14 February 2018. We provide the first scientific description of mermaids, naming them *Hydronymphus obscura* sp. nov. We dissected each individual to investigate its anatomy, reproductive biology and diet. Now that the existence of mermaids has been confirmed, and it is likely that their population is small and could be threatened by deep-sea fishing and mining, it is critical we learn more about their biology and habitat preferences to support conservation.



**Fig. 1.** Some depictions of mermaids. A. Adorning sandstone cave in ancient Egypt (c. 2000 BC). B. A Greek coin from Demetrius III Eucaerus showing the goddess Atargatis as a mermaid (c. 100 BC). C. From the Chapel in Durham Castle (c. 1078). D. Portrait of mermaid and man by an unknown Russian artist (1866). E. The Mermaid by John William Waterhouse (1901). F. Statue of the Little Mermaid in Copenhagen, Denmark (built in 1913).



**Fig. 2.** Distribution of mermaid sightings. A. Globally and B. In the UK.

1. Mermaids from the Isle of Man are known as ben-varrey
2. Mami Wata are spirits, resembling mermaids, venerated in western, southern and central Africa (Drewal 2008)
3. Mami Wata are spirits, resembling mermaids, venerated in western, southern and central Africa (Drewal 2008)
4. Mermaids (sirena) and mermen (siyokoy) are part of Philippine folklore (English 1986)
5. Nixie or mermaids inhabiting German rivers and lakes (Grimm 1888)
6. Oannes, a merman, came out of the sea (Thompson 1930)
7. Dagon, a mermaid, was the main deity for Philistines and later Phoenicians
8. Sumerians believed a mermaid rose from the ocean depths to educate mankind
9. Polynesian folklore includes a half-human and half-porpoise god called Vatea
10. Japanese folklore mermaid Ningyo can grant immortality to the human who was worthy
11. A mermaid mummy, from Lake Biwa in 600 AD, is supposedly exhibited at the foot of Mount Fuji
12. In the 1001 Nights tale in 941 AD "Abdullah the Fisherman and Abdullah the Merman", Abdullah discovers a mermaid society
13. Suvannamaccha, a golden mermaid, appears in the famous poem Ramayana (Sastri 2006)
14. Atargatis, an Assyrian priestess, jumped into the sea and emerged as a fishtailed goddess
15. When Alexander the Great died, his sister, Thessalonike, tried to drown herself and became a mermaid (MacEwan 1978)
16. Pilot-scout of Alexander the Great heard that the Island of Astola had mermaids (Cary & Warmington 1929)
17. A deputation of persons from Olisipo (Lisbon) brought word to the Emperor Tiberius (14-37 AD)
18. The legatus of Gaul wrote to Emperor Augustus (27 BC - 14 AD) many nereids dead upon the seashore
19. Informants of equestrian rank reported to Pliny that they had seen a sea-man in the ocean of Gades (Pliny, The Elder, 77-79 AD)
20. Pliny the Elder, the Roman scholar, described a mermaid (Pliny, The Elder, 77-79 AD)
21. A mermaid was caught by a fisherman and was taken to the village and baptized in 558 (Davidson 1993)
22. A mermaid was cast ashore by the sea in 887 (Davidson 1993)
23. A mermaid taken by fisherman (Davidson 1993)
24. Knights going to the 2nd crusade observed sirens (Davidson 1993)
25. In the 12th century, a merman was caught off Orford Castle in Suffolk and held for 6 months but then escaped
26. Mermaid legends in Cornwall (Hunt 1865)
27. Mermaid legends in Cornwall (Hunt 1865)
28. Mermaid legends in Cornwall (Hunt 1865)
29. Mermaid legends in Cornwall (Hunt 1865)
30. Mermaid legends in Cornwall (Hunt 1865)
31. Mermaid legends in Cornwall (Hunt 1865)
32. Mermaid legends in Cornwall (Hunt 1865)
33. The legend of Zennor concerns a mermaid that visits St Senara's Church (Bottrell 1873)
34. A Chinese legend tells of a mermaid who "wept tears which became pearls" (Donkin 1998)
35. A mermaid was taken ashore and lived in a village for 15 years (Davidson 1993)
36. Christopher Columbus spotted 3 mermaids on 9 January 1493 (Columbus 1493)
37. A merman was seen on 3 November 1523 (Davidson 1993)
38. A mermaid was taken to the king of Denmark (Davidson 1993)
39. Bosquez, aide to the Viceroy of Goa, performed autopsies on 7 mermen and mermaids in Ceylon in 1560 (Davidson 1993)
40. Mermaid skin in local market (Davidson 1993)
41. A mermaid and her mate embraced in the Nile River delta in 1599 (Aldrovandi 1642)
42. Hendrik Hudson chronicled that two crew members sighted a mermaid on 15 June 1608 (Davidson 1993)
43. Captain Whitbourne observed a mermaid in the Harbour of St Johns (Davidson 1993)
44. Captain John Smith saw a mermaid swimming gracefully (Davidson 1993)
45. A merman seen off the coast (Davidson 1993)
46. A huge merman was taken in the Adriatic Sea (Pontoppidan 1755)
47. Reverend Debes recounts a mermaid was seen close to shore by inhabitants of Faroe Islands in 1670 (Davidson 1993)
48. Blackbeard slaughtered a pod of mermaids in 1717 (Sparrow 2011)
49. A "sea wife" is caught off the island of Borneo and put in a large vat, where it died after a few days
50. Several inhabitants of Alstahaug saw a merman lying dead on the shore
51. Merman sighting by three sailors off the coast of Denmark, near Landskrona, in 1723
52. Fishermen captured a mermaid in a net and killed it with sticks when it escaped (Davidson 1993)
53. Sailors of the ship Halifax caught and ate several mermaids
54. Sighted by black slaves in the 1740s (van Stipriaan 2005)
55. William Munro, a school teacher, observed a mermaid combing her hair (Anonymous 1809)
56. In 1810, two fisherman found one dead mer-child and another injured, which they nursed back to health
57. In a sworn testimony, farmer John McIsaac saw a mermaid on the shore in 29 October 1811 (Davidson 1993)
58. A farmer spotted a mermaid washing herself and combing her hair in 1811
59. Collection of Feejee Mermaid, which was displayed by PT Barnum in 1842 at his American Museum on Broadway
60. Twelve people watched a beautiful mermaid bathing in the water in July 1826
61. A farm woman spotted a mermaid frolicking in the water in 1830
62. A mermaid was killed by boys collecting seaweed and then buried by the sherrif in a coffin (Davidson 1993)
63. A family of mermaids regularly visited humans (Anderson 1837)
64. Fisherman saw a merman at 6 pm on Thursday June 4, 1857
65. Three fishermens saw a mermaid with yellow hair and brown skin surface close to their boat
66. Fishermen observed a mermaid in August 1886 (Anonymous 1886)
67. English fishing party, including Lord Devonshire, killed a mermaid in 1896 (Anonymous 1896)
68. The crew of the ship Leonidas, sailing from the US to France in 1917, witnessed mermaids swimming alongside the boat for 6 hrs
69. Several mermaids were spotted by Japanese soldiers in 1943 during World War II (Man 2012)
70. An 80-year-old man saw a mermaid sitting on a lobster trap and combing her hair in 1947
71. In 1967, ferry passengers saw a mermaid sitting on rocks eating a salmon (Anonymous 1967)
72. A mermaid corpse was washed ashore in Chennai after the tsunami in December 2004
73. Dozens of people reported seeing a mermaid leaping out of the water in August 2009 (Anonymous 2009)

## Methods

### Stranding

The five mermaids were first sighted on a remote beach on the island of Lesbos at 16:25 on 14 February 2018. All mermaids were alive but in distress when found, and repeated attempts to refloat them failed. All died by 18:30 that day. Sea conditions at the time were severe, with large waves ( $>5$  m) and blustery winds (up to 120 km.hr $^{-1}$ ).

### Dissection

We conducted a detailed autopsy of each mermaid. As mermaids have been reported both immersed in and emergent from water, we dissected their respiratory organs to ascertain whether they are air breathers dependent upon regular surfacing for breathing or are truly aquatic. To provide insights into their typical habitat, we estimated their diet using stomach contents analysis. Stomachs were removed by opening the body cavity and severing the gut at the oesophagus and at the posterior margin of the duodenum. Watery fluid was drained from the stomach and the solid parts of organisms were preserved in formalin. Prey items were identified microscopically using a variety of fish and crustacean guides. To compare the diet with other common pelagic and demersal species, we performed a multivariate analysis using multidimensional scaling (diet items as variables; individuals as objects), using the vegan package in R (Oksanen et al. 2013).

All stranded mermaids were female and pregnant. The gonads and uterus were dissected out and the reproductive system described. We were particularly interested in discovering the sex of fetuses, as few mermen have ever been seen and it is unknown whether this might reflect few males being born.

### Population estimate

We wanted to obtain an estimate of the possible population size of mermaids so we could assess its potential conservation status. As there are no direct data on the number of mermaids, we used an indirect approach. Google Books Ngram Viewer (<https://books.google.com/ngrams>) records the numbers of times different words are used in literature, both fiction and non-fiction. By 2011, 15 million books, comprising 5 billion pages, had been digitised, representing 11% of books ever published (Michel et al. 2011). Here we use the frequency of the word “mermaid/s” in the English Corpus from 1800-2000 to represent mermaid sightings, with the assumption that the

more mermaids are sighted, the more times “mermaid/s” will be mentioned in the literature. Because it is likely that the chance of observing mermaids has grown as the human population has increased and spent more time at sea, we have standardised the frequency of the words “mermaid/s” by the global human population through time. This provides a measure of observations per unit effort and thus abundance.

## Results

### Taxonomic description

#### *Taxonomic summary*

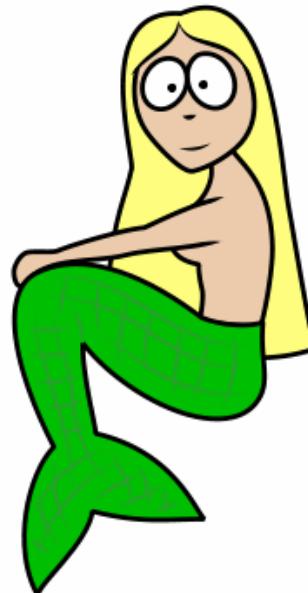
Phylum Chordata

Class Mammalia

Order Primates

Family Mermaidae

*Hydronymphus obscura* sp. nov. (Fig. 3)



**Fig. 3.** Image of one of the stranded mermaids on a secluded beach on the Island of Lesbos on the 14 February 2018.

#### *Description*

Only the female of the species was collected and described here. The upper body of the mermaid *Hydronymphus obscura* sp. nov. resembled that of modern humans *Homo sapiens*, but the lower body resembled that of a fish. Mermaids were shorter and lighter than humans, with a length of  $135.3 \pm 12.4$  cm (mean  $\pm$  SE, n = 5) and weight of  $40.8 \pm 3.0$  kg. All specimens had long hair, varying in colour among individuals from blonde to brown. The morphology of mermaids was similar to modern humans, with a rapidly rising forehead, a similar-size braincase relative to body size, similarly complex dentition, and opposable

thumbs. The lower body resembled that of a fish, being covered in leptoid scales, with a smooth outer margin, as in teleost fish. The scales overlap, presumably allowing a smooth flow of water and reducing drag. Mermaids have a muscular, forked, homocercal tail (caudal fin) at the end of the peduncle, apparently used for propulsion. There were no dorsal or pectoral fins (Fig. 3).

#### *Etymology*

The genus name *Hydronymphus* gen. nov., comprises *Hydro* from the Greek for water, and *nymphus* from the Greek *nymphe*, which were deities depicted as beautiful maidens inhabiting the natural environment. The specific epithet *obscura* is the feminine form in Latin for shadowy or unknown.

#### *Type locality*

Island of Lesbos, Greece (39.17°N, 26.33°E).

#### *Type material*

We have lodged the type specimen for *H. obscura* sp. nov. with the Museum of Bogologia (Island of Atlantis), preserved in formaldehyde (registry number 007/42). This will serve as reference material for future workers who might have improved morphological methods. We have also deposited a specimen in ethanol (registry number 007/43) for future genetic sequencing.

#### **Anatomy**

The autopsy revealed no obvious cause of the stranding; there was no infestation of major organs by parasites and no serious bacterial or viral infections. All five mermaids stranded were demonstrably adult, because all were pregnant. Their uterus is similar structurally to that of humans. Each mermaid carried a single fetus ( $1.182 \pm 0.245$  kg). The gestation period is unknown, but fetuses were well developed and presumably near-term. Of the five fetuses *in utero*, three were male and two were female.

Dissection of the respiratory system showed a well-developed gill system. Mermaids have a large surface area of well-developed, folded gills in their chest cavity. Water is taken in through the mouth and expelled through external slits, covered by an operculum under each armpit. Mermaids also have a single small lung (~1 l capacity) in the chest cavity, <20% that of a human lung. The alveolar structure of the lung is simple compared with that of *Homo sapiens*. Their larynx is situated in the throat.

Stomach contents analysis showed that mermaids ate several species of deep-water (>1,000 m) bottom-dwelling fish, crustacean and molluscs (Table 1). Of the items in the stomachs that could be identified, most were hard parts of fish (bones and otoliths), fragments of the exoskeleton of crustaceans (carapaces, claws, eyes) or beaks of molluscs. Bony fish (58.8% by mass of identifiable items) and large beaks of giant squid *Architeuthis dux* (27.3%) dominated the stomach contents. Other items included ambergris (from the feaces of sperm whales *Physeter macrocephalus*), the giant isopod *Bathynomus*, the deep-sea sponge *Chondrocladia*, Vestimentifera tube worms found near hydrothermal vents, and Pycnogonida sea spiders common on the sea floor.

The multidimensional scaling analysis showed that the diet of mermaids was similar to abyssal fish and benthos, but clearly distinct from pelagic fish and zooplankton (Fig. 4).

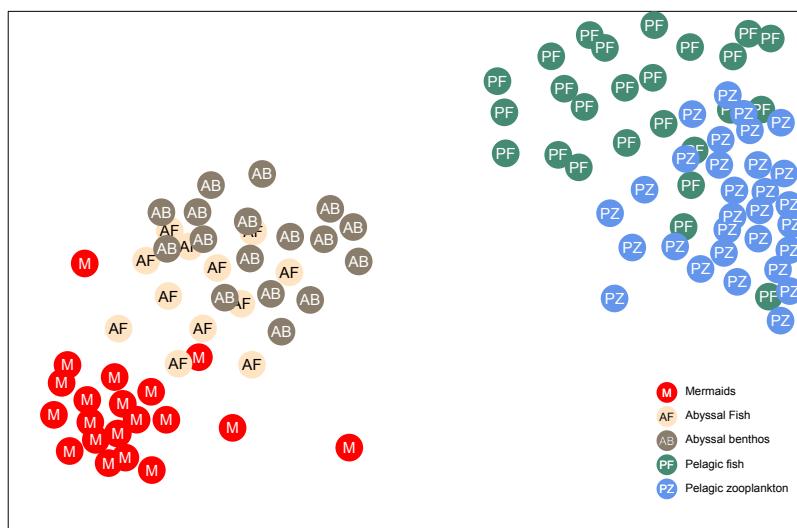
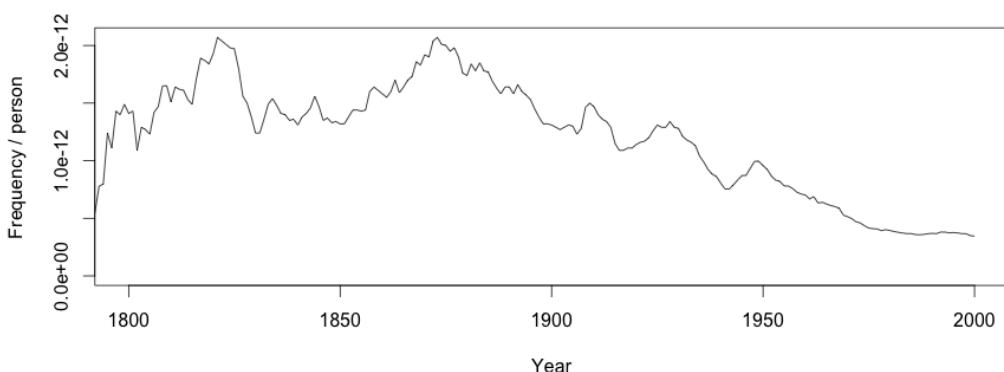
#### **Population size**

Using the number of times mermaids are referred to in English literature standardised by the global population size as an index of mermaid population size each year, their numbers showed longer-term changes. There was a slight increase in estimated numbers up until the 1870s, followed by a significant and marked decline to the beginning of the 21<sup>st</sup> century (Fig. 5;  $r = -0.84$ ,  $t = 17.26$ ,  $df = 129$ ,  $p = 1.2e-16$ ).

When standardised by the global population size (Fig. 5B), there has been a marked and significant decline in estimated numbers of mermaids since the 1870s.

Table 1. Mass (g) and number in brackets of bathypelagic items found in mermaid stomachs.

Item	Mermaids				
	#1	#2	#3	#4	#5
Ambergris	12.8 (2)	8.9 (1)	9.6 (1)	10.1 (3)	10.4 (5)
Giant isopod <i>Bathynomus</i> – antennae	4.5 (12)	5.9 (6)	3.9 (9)	4.34 (2)	6.0 (15)
Giant squid <i>Architeuthis dux</i> beaks	124.6 (1)	325.3 (2)	282.6 (2)	95.3 (1)	521.2 (3)
Sea spider Pycnogonida – assorted	2.8 (18)	2.7 (23)	2.9 (23)	3.1 (31)	3.4 (21)
Tube worm Vestimentifera – roots	2.8 (174)	2.4 (138)	2.6 (148)	3.3 (163)	3.1 (157)
Snake dragonfish – otoliths	1.9 (78)	1.9 (71)	2.2 (68)	1.7 (83)	1.9 (78)
Sponge <i>Chondrocladia</i> – spicules	3.0 (467)	5.6 (517)	3.4 (525)	4.1 (492)	3.7 (513)
Bony-fish muscle blocks	417.9 (44)	628.1 (33)	226.2 (49)	359.4 (55)	320.0 (51)
Unidentified	582.1 (56)	371.9 (67)	773.9 (51)	640.6 (45)	680.1 (49)

**Fig. 4.** Mermaids feed on deep-water animals. Multidimensional scaling analysis showing that the diet of mermaids is most similar to that of abyssal fish and benthos, but distinct from pelagic fish and zooplankton.**Fig. 5. A.** An index of mermaid population size each year, estimated from the frequency (%) of the words "mermaid/s" out of all words in English language books (from Google Books Ngram Viewer), standardised for human population size (Goldewijk & Drecht 2006).

## Discussion

**1. Summary: State the goal and major findings**  
 Although mermaids have surprisingly evaded formal scientific description for three millennia, we show conclusively they exist and have given them the scientific name *Hydronympus obscura* sp. nov. Their well-developed gills, rudimentary lungs, scales, muscular homocercal tail, and marine diet establish that they are primarily aquatic, spending only short periods out of water and living in the deep ocean. Their existence forces a re-evaluation of the evolutionary history of modern humans, providing evidence for the controversial aquatic ape hypothesis. As mermen are just as common as mermaids *in utero*, we suggest mermen rarely make excursions into surface waters and are thus less commonly seen than mermaids.

**2. Major findings: Explain each in detail, why it is important, and theoretical advances, in relation to similar studies**

### Why have mermaids evaded description?

Although there have been intermittent sightings of mermaids since antiquity (Fig. 2), they have remained elusive until now. There are several likely reasons. First, most species in the ocean have not yet been found; the ocean constitutes 90% of the habitable space on the planet, yet 95% of it remains unexplored, and only ~15% of species have been described (Bouchet et al. 2006). Second, as large marine mammals, their populations are likely to be small, making them difficult to find and observe. Third, their diet suggests mermaids live predominantly in deeper waters, with only occasional excursions to the surface. Deeper-dwelling species take longer to be discovered and described than those near the surface (Gibbons et al. 2005). Even the giant squid *Architeuthis dux*, up to 13 m long, was filmed for the first time only in 2004 (Kubodera & Mori 2005). Fourth, mermaids are partially cryptic, so it is possible that some mermaids sighted were dismissed as dugongs, manatees or seals, especially by inebriated sailors and fisherman (Glass 1894). Last, the scientific study of cryptids such as mermaids is hampered by the conservatism of scientists; even Linnaeus (1758) considered describing mermaids, but was afraid of the damage to his reputation (Banse 1990).

### Evolutionary history

The confirmation that mermaids exist lends support to the aquatic ape hypothesis (Westenhofer 1942). Hardy (1960, 1977) argues

that a branch of primitive apes, forced by competition with other arboreal species, moved to the seashore and led a semiaquatic existence, hunting for fish and shellfish. He suggests that this species, *Homo aquaticus*, evolved in tropical seas in the Miocene epoch (23.0 to 5.3 MYA). We suggest that *Homo aquaticus* might have been the common marine ancestor of both the mermaid *H. obscurus* sp. nov. and *Homo sapiens*. Mermaids and *Homo sapiens* share many features suited to an aquatic existence, presumably inherited from *Homo aquaticus* (Hardy 1960, Morgan 1982, 1997): little body hair; a subcutaneous fat layer for insulation; a streamlined body ideal for aquatic locomotion; a larynx situated in the trachea, which can be closed off while diving, rather than in the nasal cavity; and a preference for water births in many human mothers and presumably in mermaids. Humans retain social vestiges of their former aquatic existence as we still commonly live in coastal regions and bathe regularly for hygiene, which is not seen in other primates. Mermaids thus fill in an important gap in human evolutionary history and provide solid evidence of our aquatic ancestry.

### Where are mermen?

Despite most sightings being of beautiful mermaids, with only occasional sightings of ugly mermen (4.1% of the sightings in Fig. 2), the three male and two female fetuses observed suggest a sex ratio close to 50:50 at birth. Many marine animals have female-biased sex ratios, including some fish and zooplankton (Kouwenbourg 1993). However, skewed sex ratios in populations are not theoretically optimal and require modified behaviour or life history characteristics to ensure fertilisation (Fisher 1958). After birth, greater mortality of males is found in some species, but is rare. Assuming similar mortality for mermaids and mermen, begs the question: where are the mermen? They might remain at depth, whereas mermaids make excursions into surface waters, sometimes in maternal pods, where they are seen by maritime folk. There is therefore likely to be sexual segregation of mermaids and mermen for at least part of their lifecycle, as there is for some marine species such as sharks (Richardson et al. 2000).

### 3. Alternative explanations, caveats and limitations

#### Caveats

The primary caveat of this work stems from the small number of specimens sampled. We have

described the anatomy, diet, and sex ratio at birth from only five specimens, all of which were female. We thus do not know how mermen differ from mermaids in terms of their physical appearance, life history or ecology. Similarly, our interpretation that the sex ratio at birth is close to 50:50 is based on only five fetuses. It is also difficult to estimate the population trend of newly-discovered species. Although our approach of using the frequency of the words “mermaid/s” in the English language literature is indirect, we believe it is a first step toward identifying population sizes. There are also limitations in the stomach content analysis, as it reflects recent rather than long-term feeding, so mermaids might feed at other depths and could eat soft-bodied organisms such as jellyfish that are not identifiable after digestion. Future work on the diet of mermaids using biochemical techniques, including analysis of stable isotopes and fatty acids from their muscle tissue (e.g. Couturier et al. 2013), will elucidate the longer-term diet of mermaids.

#### 4. Relevance: State practical advances and relevance of findings and policy implications

##### Cryptozoology

The confirmation of the existence of mermaids is a major milestone in the emerging field of cryptozoology. The existence of mermaids can be added to several previously unknown or presumed-to-be mythical creatures that have now been proven to exist. These include the Loch Ness monster *Nessiteras rhombopteryx* that has been described (Scott & Rines 1975; Fairburn 1975), counted (Sheldon & Kerr, 1972; Schneider & Wallis 1973; Mortimer 1973) in the 1970s and recently observed in an Apple Maps image (Brown 2014); the montane unicorn *Monoceros montanus* that has been described (della Roba 1985) and was the focus of a detailed distribution study (Hurlbert 1990); the drop bear *Thylarctos plummetus* in Australia that was photographed and tracked (Janssen 2012); the dangerous bunyip *Bunyippee bunyippee* that was exhibited in the Australian Museum in 1847 (Anonymous 2001); and big foot (*Homo sapiens* x unknown hominid) in the US that was confirmed from molecular data in 2013 (Ketchum et al. 2013). Mermaids share common traits with these animals, including rarity, living in inaccessible habitats, and cryptic behavior. The current findings will bolster the maligned field of cryptozoology, reinvigorating searches for rabbits *Lagus cacao* on Easter Island (Bunny 2012), leprechauns in Ireland (McAnnally 2006), goat suckers (Chupacabra) from North and

South America (Radford 2011), and Queensland tigers from Australia (Smith 2012). If cryptozoology is to flourish, we will need to combat the staid conservatism and lack of imagination in modern science.

##### Population decline and threats

The proof of the existence of mermaids raises a critical question concerning their long-term population viability. A characteristic feature of mermaids is that they are rarely seen, a fact that suggests the population is small and thus vulnerable to extinction (IUCN 2008). As the species is long-lived (Anderson 1837), the inter-annual variability in their population is likely to reflect environmental fluctuations that influence observability. However, the estimated steep decline in population size after 1870 (Fig. 5) is concerning, as it coincides with increasing impacts of humans on marine systems. The annual biomass of fish removed from the oceans has increased by an order of magnitude during the 20<sup>th</sup> century (Pauly et al. 2003) and effort has moved to deeper water (Morato et al. 2006). Dragging nets along the sea bottom damages sea floor communities, leading to declines in the fish and crustaceans that mermaids depend upon for food. Noise in the marine environment has also increased over the past 50 years; the number of ships worldwide has increased 3-fold and the tonnage 6-fold, together with an increase in travel frequency (Southall 2005) and there has been more noise produced by the oil and gas industry during exploration, by the military, and for scientific research. Although the impact of acoustic pollution on mermaids is unknown, it can compromise marine mammal communication and predator-prey detection (National Research Council 2003). The fledgling deep-sea mining industry could pollute the environment of mermaids in the future.

#### 5. Future research: Suggestions for further research based on your study

##### Potential for multiple species

Key to protecting mermaids will be identifying whether there are multiple sibling species, as each will have different habitat requirements. Even the large and relatively common manta ray was only split into two species in 2010 based on subtle morphological differences, with each having unique lifestyles and population parameters (Marshall et al. 2010). As mermaids likely exist in relatively low numbers and are widely distributed, there could be multiple species. Banse (1990) suggested that there were three species of

mermaids based on sightings hotspots: the Mediterranean-Lusitanian species, the western Atlantic species, and the Red and Arabian Seas species. Circumstantial evidence also suggests that there might be sibling species that prefer different oceanographic conditions. Many mermaid sightings are made in calm conditions, and these mermaids are described as beautiful and are regarded by sailors as harbingers of good luck, love and prosperity (Lewis 1952). Other mermaids are seen prior to violent storms and are considered bad omens, with the creatures using their enchanting voices to lure sailors to their doom (Rowling 2000). Identifying the sibling species of *H. obscura* sp. nov. will allow a management plan bespoke for each species.

## Conservation

Now we know mermaids exist, we can plan effective conservation strategies. There are many issues that need to be addressed to underpin the long-term viability of mermaid populations. The first is to identify populations of mermaids globally. Because of the stranding event off the Island of Lesbos and the fact that Aristotle lived here for a while and wrote about mermaids, deep waters of the eastern Mediterranean Sea are a key area to begin a comprehensive search for mermaid populations. The many legends and sightings of mermaids around the UK and Ireland also suggest that this is a key area for exploration (Fig. 2). Deep-sea submersibles with imaging systems will be invaluable to find where mermaids live and their habitat. We can then gazette marine protected areas. The second issue is to investigate the ecology and life history of mermaids. We do not know their key life history parameters such as growth rate and age at maturity to assess how resilient populations are to human impacts. Knowledge of their movements will help to identify critical habitats for mermaids and where these overlap with human threats such as fishing, high levels of pollution and marine extraction. The third issue is solving the mystery of where mermen are found. We have speculated that they are found in the deep ocean, but this remains to be confirmed. Finding the location of mermen and protecting them is necessary for effective conservation of mermaid populations. Last, an integrated science and education program in the Mediterranean Sea will facilitate the conservation of mermaids. A model for such a science program is the R10 million (\$US1 million) South African Coelacanth Conservation and Genome Resource Programme launched in 2002 by the South African Government that studies the ecology, evolutionary biology and life history of the

coelacanth, and involves local populations through capacity building and education (<http://scienceinafrica.com/south-africa-announces-plans-coelacanth-programme>).

## 6. Conclusion: Give the “Take-Home Message” Conclusion

This study has proven that mermaids exist. We contend that mermaids and humans evolved from a common aquatic ancestor, supporting the aquatic ape hypothesis. Now that we have discovered this unique primate, we are responsible for its protection.

## Acknowledgements

This study was conducted with permits from the Mediterranean Marine Park Authority (MYOMY09/298.1) and approval from the University of Poseidon Animal Ethics Committee (RUMAD/206/11). Funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. We would like to thank Karl Banse, who wrote an article in 1990 about mermaids that one of us (AJR) read as an Honours student that planted the seed for the current contribution.

Written by Anthony J. Richardson (University of Queensland/CSIRO) and David Schoeman (University of the Sunshine Coast).

## References

- Aldrovandi U (1642) *Monstrorum historia cum Paralipomenis historiae omnium animalium*
- Anderson HC (1837) The Little Mermaid (Originally *Den lille havfrue*). Published by CA Reitzel
- Animal Planet (2012) *Mermaids: The Body Found*. Aired on 27 May 2012
- Animal Planet (2013) *Mermaids: The New Evidence*. Aired on 26 May 2013
- Anonymous (1809) The Times (of London), 8 September 1809
- Anonymous (1886) Cape Brooklyn Eagle newspaper, 22 August 1886
- Anonymous (1896) Cape Brooklyn Eagle newspaper, 3 November 1896
- Anonymous (1967) Report in Times Colonist Newspaper
- Anonymous (2001) National Library of Australia. Bunyips – Evidence
- Anonymous (2009) Haaretz Newspaper (12 Aug 2009). Is a mermaid living under the sea in northern Israel? <http://www.haaretz.com/news/is-a-mermaid-living-under-the-sea-in-northern-israel-1.281876>
- Banse K (1990) Mermaids – Their Biology, Culture, and Demise. *Limnology and Oceanography* 35: 148-153
- Benwell G & Waugh A (1965) *Sea enchantress: the tale of the mermaid and her kin*. Citadel Press. 287 pp
- Bottrell W (1873) Traditions and Hearthside Stories Of West Cornwall, 2nd Series
- Bouchet P (2006) The magnitude of marine biodiversity, in: Duarte C (Ed) *The exploration of marine biodiversity: scientific and technological challenges*. pp. 31-62
- Brown J (2014) Loch Ness Monster: Nessie's back, just in time for Scotland's big year. The Independent, Sunday 27 April 2014
- Bunny RUA (2012) Is Easter Island where the chocolate easter rabbit *Lagus cacao* lives? *Journal of Cryptozooids* 1: 1-13
- Canese S, Cardinali A, Fortuna CM, Giusti M, Lauriano G, et al (2006) The first identified winter feeding ground of fin whales

- (*Balaenoptera physalus*) in the Mediterranean Sea. *Journal of the Marine Biological Association UK* 86: 903–907
- Cary M & Warmington EH (1929) *The Ancient Explorers*. Methuen & Company. 270 pp
- Columbus C (1493) The log of Christopher Columbus of his first voyage to the New World, 1492-1493. Held in the Smithsonian Library, USA
- Couturier LIE, Rohner CA, Richardson AJ, Marshall AD, Jaine FRA, Bennett MB, Townsend KA, Weeks SJ, Nichols PD (2013) Stable isotope and signature fatty acid analyses show reef manta rays snack on surface zooplankton and feast on demersal zooplankton. *PLoS One* 8(10): e77152. 1-15
- Davidson A (1993) Adventures in Unhistory: Conjectures on the Factual Foundations of Several Ancient Legends, Owlswick Press
- Della Roba FV (1985) First capture, taming and systematic description of the montane unicorn. *Journal of Unicorn Systematic Ecology* 5: 10-55
- Disney WC (1989) *The Little Mermaid*. Walt Disney Pictures
- Donkin RA (1998) Beyond price: pearls and pearl-fishing, origins to the age of discoveries. Philadelphia: American Philosophical society
- Drewal HJ (2008) Introduction: Charting the Voyage. *Sacred Waters: Arts for Mami Wata and other divinities in Africa and the diaspora*. Bloomington: Indiana University Press
- English LJ (1986) Tagalog-English Dictionary, Manila: Congregation of the Most Holy Redeemer; National Book Store, ISBN 971-91055-0-X, 1583 pp
- Fairburn N (1975) The Times. London, 18 December 1975. A Scottish member of Parliament has discovered an anagram for *Nessiteras rhombopteryx*. Scottish politician Nicholas Fairbairn pointed out that the name was an anagram for "Monster hoax by Sir Peter S".
- Gibbons MJ, Richardson AJ, Angel MV, Buecher E, Esnal G, Fernandez Alamo MA, Gibson R, Itoh H, Pugh P, Boetger-Schnack R, Thuesen E (2005) What determines the likelihood of species discovery in marine holozooplankton: is size, range or depth important? *Oikos* 109: 567-576
- Glass C (1894) Drunken sailors. *Journal of Brewing* 13: 250-254
- Goldewijk KK & van Drecht G (2006) Data from History Database of the Global Environment. HYDE 3.0: Current and historical population and land cover. Netherlands Environmental Assessment Agency (MNP), Bilthoven, The Netherlands
- Grimm J (1888) *Teutonic Mythology Volumes 1-4*
- Hardy A (1960) Was man more aquatic in the past? *The New Scientist*, 17 March, 4 pp
- Hunt R (1865) Popular Romances of the West of England
- Hurlbert SH (1990) Spatial distribution of the montane unicorn. *OIKOS* 58: 257-271
- IUCN (2008) IUCN Red List categories and criteria. Version 3.1 Second edition. 33 pp
- Janssen V (2012) Indirect tracking of drop bears using GNSS technology. *Australian Geographer* 43: 445-452
- Ketchum MS, Wojtkiewicz PW, Watts AB, Spence DW, Holzenburg AK, Toler DG, Prychitko TM, Zhang F, Bollinger S, Shoulders R, Smith R (2012) Novel North American hominins, next generation sequencing of three whole genomes and associated studies. *DeNovo Journal* 1:1-41
- Kouwenberg JHM (1993) Sex ratio of calanoid copepods in relation to population composition in the northwestern Mediterranean. *Crustaceana* 64: 281-299
- Kubodera T & Mori K (2005) First-ever observations of a live giant squid in the wild. *Proceedings of the Royal Society B: Biological Sciences* 272: 2583–2586
- The Lego Movie (2014) Directed by Phil Lord and Christopher Miller. Warner Brothers Pictures. 100 minutes
- Lewis CS (1952) *The Chronicles of Narnia: The Voyage of the Dawn Trader*. Geoffrey Bles Publisher. 223 pp
- Linnaeus C (1758) *Systema naturae*. V. 1. *Regnum animale*, 10th ed. Salvius
- Lockhart JHS (1893) Pearls as tears of mermaids. 280 pp
- MacEwan G (1978) *Mermaids and Ikons: A Greek Summer*
- Man M (2012) The curious case of the Orang Ikan. <http://www.cryptomundo.com/cryptotourism/case-of-the-orang-ikan/>
- McAnally DR Jr (2006) *Irish Wonders*. (EBook # 19486). 218 pp
- Michel J-B, Shen YK, Aiden A, Veres A, Gray MK, The Google Books Team, Pickett JP, Hoiberg D, Clancy D, Norvig P, Orwant J, Pinker S, Nowak MA, Aiden EL (2011) Quantitative analysis of culture using millions of digitized books. *Science* 331: 176-182
- Morato T, Watson R, Pitcher TJ, Pauly D (2006) Fishing down the deep. *Fish and Fisheries* 7: 24-34
- Morgan E (1982) *The Aquatic Ape*. Stein & Day Publishers
- Morgan E (1997) *The Aquatic Ape Hypothesis*. Souvenir Press
- National Research Council (2003) *Ocean Noise and Marine Mammals*. National Academies Press. 192 pp
- Oksanen J, Blanchet FG, Kindt R, Legendre P, Minchin PR, O'Hara RB, Simpson GL, Solymos P, Stevens MHH, Wagner H (2013) Package 'vegan'. *Community Ecology Package*. 263 pp
- Pauly D, Alder J, Bennett E, Christensen V, Tyedmers P, Watson R (2003) The future for fisheries. *Science* 302: 1359-1361
- Pliny, The Elder (77-79 AD) *Naturalis Historia*
- Pontoppidan E (1755) *The Natural History of Norway*
- Radford B (2011) *Tracking the Chupacabra: the Vampire Beast in Fact, Fiction and Folklore*. University of New Mexico Press
- Rowling JK (2000) Harry Potter and the Goblet of Fire. Bloomsbury. 635 pp
- Satyavrat S (2006) *Discovery of Sanskrit Treasures: Epics and Puranas*. Yash Publications
- Scott P & Rines R (1975) Naming the Loch Ness monster. *Nature* 258: 466-468
- Schneider W & Wallis P (1973) An alternate method of calculating the population density of monsters in Loch Ness. *Limnology and Oceanography* 18: 343
- Sheldon RW & Kerr SR (1972) The population density of monsters in Loch Ness. *Limnology and Oceanography* 17: 796-798
- Short A, Kerlie G and Kerley W (2001) Mermaid sightings from Lake Eyre, Australia. *Journal of Cryptozooids* 1: 242-249
- Smith JLB (1938) Discovery of the coelacanth
- Smith M (2012) *The Queensland Tiger: Further Evidence on the 1871 Footprint*. *Journal of Cryptozoology* 1: 19-24
- Southall BL (2005) Final Report of the National Oceanic and Atmospheric Administration (NOAA) International Symposium: "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology". 18-19 May 2004, Arlington, Virginia, U.S.A.
- Teach, E (1717) Logbooks of Edward Teach
- Sparrow J (2011) Pirates of the Caribbean: On Stranger Tides. 137 minutes
- Thompson CJS (1930) *The Mystery and Lore of Monsters*
- van Stipriaan A (2005) Watramama/Mami Wata: Three centuries of creolization of a water spirit in West Africa, Suriname and Europe. *Matatu. Journal for African Culture and Society* 27/28: 323-37
- Westenhöfer Max (1942) *Der Eigenweg des Menschen. Dargestellt auf Grund von vergleichend morphologischen Untersuchungen über die Artbildung und Menschwerdung*. Verlag der Medizinischen Welt, W. Mannstaedt & Co., Berlin
- Wood R (2010) The Norman Chapel in Durham Castle. *Northern History*, XLVII: 1



Akhzivland, Israel – Independent Kingdom