Historicity of Sea Turtles Misidentified as Sea Monsters: A Case for the Early Entanglement of Marine Chelonians in Pre-plastic Fishing Nets and Maritime Debris

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Introduction

The world's oceans, even those regions far removed from human habitation[1,2], have become the receptacle for discarded human waste. Today, over six million tons are jettisoned into the oceans and redistributed around the globe by currents and convergences every year[3]. Plastic has become the predominant element of this litter flotsam[4-6] (Fig. 1), leading some to declare the problem "an ocean emergency".[7]

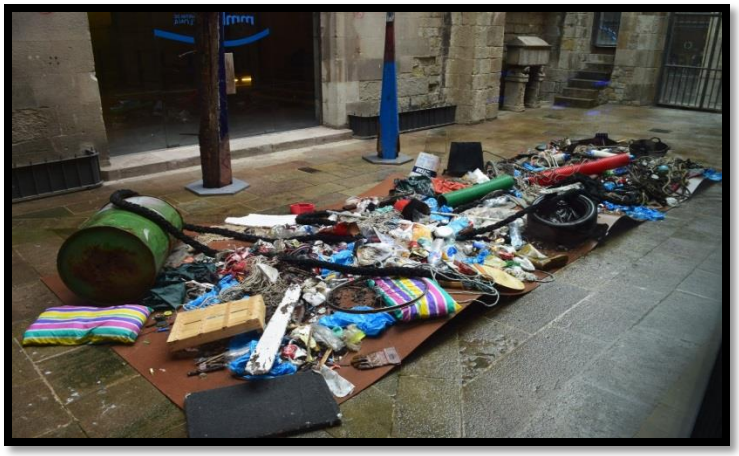

Figure 1 Fig. 1. Flotsam, a significant portion of it plastic, displayed in the foyer of the maritime museum in Barcelona.

Entanglement in maritime debris and both active and abandoned fishing gear is a serious environmental problem impacting the abundance and biodiversity of marine animals everywhere. More than two hundred species,[8,9] including six of the seven species of sea turtles,[10] can be caught in such material. Referred to by the ominous sobriquet of 'ghost nets', lost or purposely discarded fishing gear can continue their entrapment of animals for extended periods, and is an issue of particular concern.[11,12] Entanglement can result in immediate death from drowning or long-term disability due to impaired swimming and the consequent ability to feed or avoid predation. Many entangled animals display wounds from the abrasion and cutting action of the debris,[4] thereby increasing their risk of infection.

Due to their life cycle and swimming, feeding and migratory behavior, sea turtles (marine chelonians) are particularly susceptible to entanglement.[13] The statistics are alarming; for example, tens of thousands of turtles are caught annually in the Mediterranean as a result of fishing practices,[14] and 80% of all animals found in ghost nets in Australian coastal waters were

turtles, more than ten thousand such.[15,16] It is possible that the worldwide percentage of all marine chelonians that are entangled is 5%.[17]

Entanglement is widely believed to be a modern problem with little or no occurrence prior the advent of non-degradable plastic in the middle of the twentieth century. In a survey of the scientific literature, environmental management reports, and fishing records, Balazs[9] determined that 95% of all documented cases of entangled chelonians occurred after 1970, with none existing before 1950. From this, NOAA inferred, in their 2014 summary report,that "the absence of entanglement records prior to 1950 could be from the low use of synthetic materials in fishing practices and land-based products." Other conservation biologists echo such beliefs, as for example: "Prior to the 1950s, rope and cordage used in all marine activities, including fisheries, was made of natural fibres—typically Indian or Manila hemp and cotton, and it was often strengthened with a coating of tar or strips of worn canvas. These materials lose their resilience in usage and if lost or discarded at sea tend to disintegrate quickly."[18] It is only in the mid-1980s that scientists began to recognize the severity of the problem of marine litter and its implications for wildlife conservation. Literature reviews[6] were able to find only a single paper published in the 1950s about plastic pollution, and the earliest paper found pertaining thus to chelonians was published in 1985.[10]

The purpose of the present paper is to develop a case, based on illative reasoning, that entanglement of chelonians has probably been going on for far longer than what is commonly believed.

Scientists with an interest in environmental history have resorted to imaginative means in which to back-cast the temporal frame of reference from which to detect recent, anthropogenic changes. Some of these approaches are visual, such as the use of photographs to show declines in the size of trophy fishes[19] and changes in flowering phenology,[20] or the pre-photography, camera obscura paintings of Canaletto to gauge the subsidence of Venice.[21] Other approaches are textual based, such as using ancient Mesopotamian poetry to comment upon the destruction of Iraqi marshlands,[22] mining the journals of famous early naturalists such as Gilbert White and Henry David Thoreau to investigate climate change,[23] or examining fishery records to show alterations in the structure of marine food webs.[24-26] Here, I carefully parse the wording in historical accounts of eyewitnesses claiming to have seen sea monsters, highlighting those anecdotes

suggesting that the observed unidentified marine object (UMO) may have really been an entangled chelonian.

In the eighteenth and nineteenth centuries, during the great age of natural history, many of the leading scientists regarded the investigation of the possible existence of sea monsters as a legitimate and meritorious field of study.[27,28] Today, "no marine environmental historian worth his or her salt can afford to ignore early-nineteenth-century sea serpents".[29] The historical sources examined for the anecdotes included in the present paper include the authoritative texts of Oudemans[30] and Heuvlemans,[31] known for their comprehensive listing of the extant global sea monster sightings. Other works consulted included Lee[32] and Gould.[33] In addition to these classic references, encounters were sought in more recent compendia of global[34] and regional[35-37] sightings, as well as many cryptozoology on-line sources. As such, my survey of the corpus of literature can be considered to be complete, spanning the world's oceans over the period from the mid seventeenth to the early twenty-first centuries. A total of 24 anecdotes are presented below, of which 20 occurred before the advent and widespread use of plastic. Four other cases, which were some of the most famous sea monster sightings of their time, are examined in great detail in France.[38] A summary of their descriptive elements germane to the present thesis are included in the final synthesis about entanglement presented herein.

Confounding of Chelonians with Sea Monsters

There is a long history of conflating or misidentifying cetaceans as sea serpents,[39] including some of the most famous of all such sightings.[40,41] Sea turtles, however, as expected due to their more diminutive size relative to whales, are not as well represented in the anecdotal literature. Nevertheless, it is not difficult to imagine that seeing a large, rarely observed sea turtle swimming (Fig. 2), might lead some to cryptozoological flights of fancy (especially if the animal was pulling a long train of entangled fishing gear or maritime debris resembling a tail).

Two reports exist of what had at first been thought to be an UMO (unidentified marine object) but were almost immediately identified as being turtles of unusually large size. In 1883, off the coast of Newfoundland, the crew of a schooner encountered "an immense live trunk [i.e. leatherback] turtle, which was at first thought to be a vessel bottom up…The turtle was at least 40 feet long, 30 feet wide, and 30 feet from the apex of the back to the bottom of the under shell. The flippers were 20 feet long. It was not deemed advisable to attempt its capture."[37] In 1956, a "huge turtle about 45 feet long with an all-white shell" was seen south of Nova Scotia. In this case, the Canadian coastguard issued a warning to locals least they collide with "this gigantic reptile with flippers 15 feet long and capable of raising its head 8 feet out of the water".[31] Given that the largest sea turtle ever recorded, at 2.6 meters long (8.5 ft), was a leatherback found washed up on the Welsh coast (Fig. 3), whose death may have been due to ingestion of plastic,[42] and that the largest chelonian to have ever existed (Fig. 4), was never more than 5 meters (15 feet) in length, these truly gargantuan individuals spotted in Canadian waters have given rise, amongst hopeful cryptozoologists, to the idea that there is some "Father-of-all-the-turtles"[31] or giant "cryptid Chelonian"[34] out there waiting to be discovered. For did not Theseus thrown the bandit Sciron to a monstrous turtle in the Mediterranean. Perhaps such myths have a basis in fact. For example, Coleman and Huyghe[34] refer to a third century account of shells from monstrous turtles in the Indian Ocean being used for roofs, and that a medieval explorer to the same region reported to have seen sea turtles 10 meters long.

Figure 2 Surface swimming behavior of leatherback turtles.

Figure 3 The largest turtle ever recorded, a leatherback, was found washed up on a Welsh beach in 1988, whose death may have been due to ingestion of plastic42. (source: Wild Britain).

There are six cases documented in the sea monster literature where specific mention is made by eyewitnesses of the resemblance of a body part of the observed UMO to that of chelonians: "…head like a turtle's" and "the head was like that of a gigantic tortoise, or turtle"

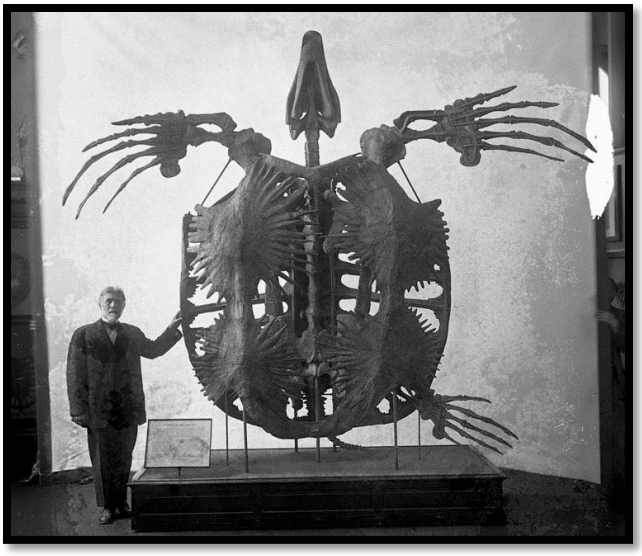

Figure 4 Fossil of Archelon, the largest turtle know to have existed. (source: American Museum of Natural History).

(from Sweden 1906 and India 1921, respectively[31]); "…its head resembled that of a turtle or a snake, black above and white beneath" (from Massachusetts 1875[35]); "…a monster of unclassified, but awe inspiring species…[with] huge tortoise eyes like saucers, glaring at me" (from England 1934[36]); "…a monster with a thick neck with flippers on either side, and a head like a turtle was seen through binoculars" (from Australia 1932[31]); and "We saw a large hump like the back of a rhinoceros emerge from the water. Ripples spread out to each side of it and then a head, something like a tortoise only many times bigger, broke the surface of the water, moved slowly around and swam forward a few yards. As it did so, the body was clearly revealed, circular and not less than ten or twelve feet in circumference. It was dark greyish in colour." (from Ireland 1963[36]).

There are four encounters with sea monsters, the first three from the British Isles, that are somewhat surprising given the failure of the eyewitnesses to even countenance sea turtles as being possible candidates for the observed UMOs, which they most probably were: "…with the aid of a glass it was observed that the eyes were of immense size, about nine inches across the ball, and the upper part of the back appeared covered with a furrowed shell-like substance" (from Ireland 1850[36]); "…a long neck as thick as an elephant's fore leg, all rough looking like an elephant's hide, was sticking up…The head was like that of a dog, coming sharp to the nose…Its body, as it was seen below the water, was dark brown, getting slightly lighter as it got the outer edge, then the edges appeared to be almost grey. It had two paddles or fins on its sides and two at its stern. My friends thought it would weight two or three tons, some thinking four to six." (from Scotland 1919[36]); and also from Scotland in 1931[36]:

> "…what I was certain must be an upturned boat lying on a rock in the water, a few yards from the beach…Immediately I came opposite to it, I dismounted and proceeded to make my investigation.

> I had not gone more than a few yards when, to my astonishment, a head turned and looked at me from what I thought to be the bow of the boat...The legs or flippers could not be observed, and I wanted to make sure of just what kind of extremities it had. I was disappointed, as the movement evidently frightened it, and it wobbled off the rock into the sea. It made off at a good pace, and left a considerable wake behind it.
>
> The head was parrot-shaped, that is to say it had a kind of beak. It was of a rather light grey colour. The body was longer than that of a large elephant, of a similar colour…
>
> I am of the opinion that although the head was small, and close to the body when I saw it, it is probable that the creature could be able to extend the head considerably. The head could be turned around so fully that there must have been rather a narrow neck between it and the huge body. I am familiar with seals, sharks, whales, etc. What I saw was unique.

But apparently this observer was unfamiliar with leatherback turtles, which are now known to regularly occur, albeit infrequently sighted, in British waters.

Finally, it is interesting to note the first compiler of sea monster sightings, the Norwegian Bishop Pontoppidan, reported the following encounter in the mid-eighteenth century, one that Heuvelmans[31] believes "all the commentators have overlooked, no doubt because it does not agree with the general notion of a sea-serpent." Displayed in the house of his captor, the beast is described as follows: "It's head was almost like the head of a cat; it had four paws, and about the body was a hard shell like a Lobster's; it purred like a cat, and when they put a stick to it, it would snap at it. The peasants looked upon it as a Trold, or ominous Fish, and were afraid to keep it; and consequently, a few hours later, they threw it into the sea again. According to the description, this might be called a Sea-Armadilla." And so we have here, in one of the earliest reports of an UMO in the modern age, an animal that resembles, ailurophilia ascribed traits notwithstanding, a sea turtle.

Possibility of Sea Monsters being Entangled Sea Turtles

In addition to the famous *Osborne*, 'Moha-moha', *Valhalla* and 'Soay beast' sightings,[37] twelve sea monster sightings exist of less renown, arranged in reverse chronological sequence below, in which the observed UMO, whose described features are either specifically mentioned or can be inferred to resemble those of a chelonian, which provide evidence for entanglement of the sea turtles in fishing gear or maritime debris.

In 2003 two Nova Scotia fishermen pulling lobster traps saw what they first thought to be a log but which "upon closer examination…turned out to be an 8 meter long sea serpent…The

head was reported to be like that of a sea turtle, with a body like a snake. The body was about as a big around as the diameter of a 5 gallon bucket."[38] [anecdote 1] Here is the first of several accounts in which the observers describe a fantastical, Doctor Moreau-esque, hybridization between a sea turtle and giant snake that I believe can be reasonably construed as representing a case of entanglement. And reference of the body to a "bucket" follows a common tradition of describing sea serpents in terms of various volumetric containers, which I believe also bespeaks of entanglement.[39,43]

In 1975, off the Welsh coast, a couple out for a recreational sail saw what at first they thought to be a seal playing with several tires but, upon closer inspection, realized it was not a pinniped:[36] "As we drew closer we thought it was a huge turtle, but it turned out to be unlike anything we'd ever seen. It had a free moving neck, fairly short, rather like a turtle's, and an egg shaped head about the size of a seal's. It's back had two spines, which were sharply ridged, and it was about eight feet across and eleven feet long, although the ripples on the water when it dived indicated that it was probably twice that length." [anecdote 2] Needless to say, any UMO observed "playing" with anthropogenic objects in the water, such as mentioned here, and numerous times in relation to the famous Gloucester sea serpent sightings of 1817,[44] is most certainly *not* having much fun in dealing with its entangled debris.[39,43] The "spines" might very well have been marlinspikes used to tie together pieces of rope and fishing gear, as were the "large horns" mentioned in several sightings of the famous Gloucester sea serpent.[43]

The following encounters predate the widespread adoption of synthetic materials such as plastic in maritime industries.

While fishing from their boat in 1934 off the Queensland coast of Australia several individuals observed four dark objects in the water which, upon close inspection, submerged "like a submarine" before reappearing five minutes later.[31] "After waiting half an hour and seeing no movements, excepting the head swaying from side to side, as if watching us, we decided to go back to town." Heading out onto the water a short while later they continued to watch the "monster": "The head rose about 8 feet out of the water, and resembled a huge turtle's head…The colour was greyish-green. The eye…was small in comparison to the rest of the monster. The other part in view was three curved humps about 20 feet apart, and each one rose from 6 feet in the front to a little less in the rear. They were covered with huge scales about the

size of saucers, and also covered in barnacles. We could not get a glimpse of the tail, as it was under the water." Additional information included mention of the presence of a "dark line along its spine", barnacles being the size of soup-plates, and the scales shining in the sun and being described as "butted and perpendicular" [anecdote 3] A week later, another, or possibly the same, UMO was observed nearby by another group of fishermen, who reported it to be about 30 feet long, with a turtle-like head, and a body shaped like "a huge armoured hose", before continuing: "Its head resembled a huge turtle more than anything else, and was slightly arched. Farther along three smaller dark objects were seen, giving the appearance of a Monster of the sea with a series of humps." [anecdote 4]

The presence of "a series of humps" and absence of a bi-lobed tail characteristic of whales, is suggestive of a marine animal pulling a string of fishing gear or maritime debris.[39,43] Likewise, a "tail" composed of large, "perpendicular" projecting "scales" that resembles "a huge armoured hose" is exactly what a chain of fishing floats looks like.[39,43] That they were mentioned as "shining" might indicate their composition to have been blown glass rather than cork. Heuvelmans,[31] drawing a parallel between this sighting and that of the famous "Moha-moha" creature, which was almost certainly a turtle[33] entangled in fishing material or debris,[38] correctly mentions the physical impossibility of horizontal rows of scales upon the humps of any animal that must bend, stating "If the monster was really humped and scaled as he [i.e. the observer] had depicted it, it is quite unlike any other sea-serpent, let alone any animal known to science." Encrusting barnacles commonly occur on slow-moving whales, sometimes on the shells of sea turtles, and frequently, of course, as I suggest to be the case here, on submerged pieces of anthropogenic material. But then the large size noted for the barnacles here indicate that they might have been floats. Furthermore, as has been observed elsewhere, which I suggest to be indicative of entanglement,[39,43] the "swaying" motion of what was mistaken for the head (due to the distance of the first sighting), may be nothing more than a piece of upright debris that is gently oscillating "side to side" in the waves. The behavior of an UMO lying motionless upon the surface of the water for extended periods is what occurs when entangled debris is floating while the marine animal to which it is attached is submerged and possibly engaged in feeding upon a dense patch of prey in a small area.[43]

In 1926, two fishermen were trawling off the coast of southern England when they "caught themselves a sea monster":[36] "It was twenty feet long, had an eight-foot tail and a beak, which they thought was 2 feet long and six inches wide. It also had four scaled legs, and a wide flat back, which was covered in a matted brown hair. The creature managed to escape by tearing the nets." [anecdote 5] This seems to have been a doubly unlucky UMO. The "beak", "wide flat back" and "four scaled legs" certainly indicate a normal sea turtle. Whereas, the presence of a very narrow "eight-foot tail" and "matted brown hair" suggests an entangled fishing net draped over and trailing behind the shell. And then, as reported, the unfortunate creature gets caught, once again, albeit briefly, in a second net.

Heuvelmans[31] recounts a 1925 sighting in the China Sea:

> I was surprised to see on the surface of the water, hardly immersed…an animal looking like a 10-foot snake, with a maximum diameter of 7 to 8 inches, decreasing towards the tail, the body annulated from one end to the other, alternatively light yellow and black, the length of each ring being about 4 ½ to 6 inches. The rather small head was immediately followed by a swelling about 12 to 14 inches in diameter, as thick as the body which followed it, and with four feet, two each side, recalling the shape of a turtle, but without the shell, striped in yellow and black and with an annulated tail about 10 feet long. I could not see whether this body was round like a snake's, or, as I supposed, slightly flattened. [anecdote 6]

He continues in mentioning that the animal moved slowly with no discernable appendages observed along the extended length of the body. The accompanying sketch, redrawn and commented upon by Heuvelmans (Fig. 5), "shows what seems to be a sea-snake swallowing a turtle." He likens this sighting to that of the 1876 *Nestor* encounter (see below), the difference being the more diminutive size in the present case, but believes such UMOs represent a large, unknown species of ray rather than what he refers to, somewhat dismissively, as "the turtle-bodied snake." This phrase, however, perfectly sums up my present thesis, as does the sketch suggesting itself as an appropriate schematic should a T-shirt emblem ever be designed about entangled chelonians.

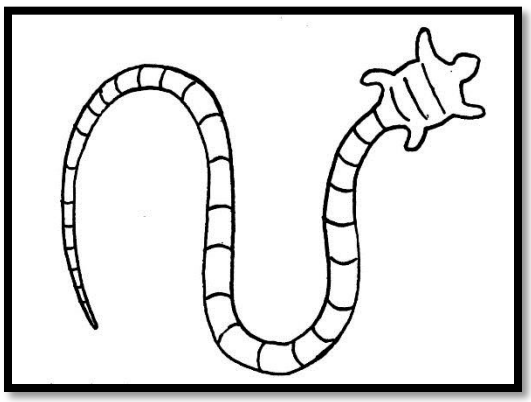

Figure 5 The "turtle-bodied snake" UMO observed in 1925 in the China Sea. Drawing by B. Heuvelmans based on original by eyewitness A. Jourdan. [Ref. 31]

In 1908, the steamer *Hanoi* was off the coast of Vietnam when its captain encountered a strange creature:[31]

> I saw, some way ahead, a black mass which at first I took for a capsized boat. On approaching and examining it with binoculars, I found it had a strange shape [Fig. 6]. This resembled a framework over which sail had been tightly stretched. The ribs were very marked. Seen from the side and from some way off it would certainly look indented, for the ridges were very sharp…The colour was black; the length about 16 feet and the width about 5 feet….It was very like the head of a turtle, but longer and certainly 2 feet wide by 3 feet long; it had two big very bright eyes and large nostrils. It was blackish like the rest….The head turned to look at the ship, blew noisily without spouting water and at once dived, the rest following and making a big wash…
>
> Given the dimensions of this animal it could not possibly be confused with a turtle. For one thing it certainly had no scales, of that I am sure. The skin was more like old tanned leather, and with my binoculars I could see it very well….What struck me most were the eyes. The turtle has only very small eyes, veiled by a membrane, and not big bright eyes like these. And so far as I know there are no turtles of this size.
>
> From the head to the end of the visible part was a good 30 feet; so it was indeed an extraordinary animal.
>
> From the disturbance of the water at the moment when it dived and from the part of the body that I saw, the shape of the body must be: a very long and flexible neck, indicated by the distance of the head from the visible part of the body, and by the head which turned without the middle part moving; then a much broader part in the middle, the part I saw; and finally a fairly long tail which did not show above the surface, but was clearly marked by the disturbance of the water. [anecdote 7]

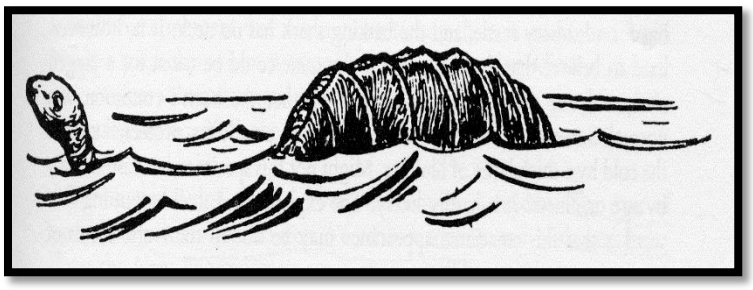

Figure 6. The UMO observed by the captain and crew of the Hanoi off the coast of Vietnam in 1908. [Ref. 31]

This is a puzzling description, particularly in relation as to whether the large boat-like body seen was that of a possible turtle or rather a large piece of entangled maritime debris. If the former, the absence of scales and presence of a ridged back resembling "old tanned leather" might suggest a leatherback turtle, as Heuvleman initially posits. However, the ridges that are shown in the illustration are more prominent in the transverse than longitudinal orientation. With reference to the turtle-like head, and contrary to the captain's statement, green and loggerhead turtles most certainly do have large, easily noticeable eyes. Ultimately, it is the large size of the UMO that causes Heuvelman to dismiss the idea that it could be a turtle. But what if the observed boat-like portion was a piece of entangled debris? It is easy to find disturbing on-line photographs of entangled marine animals, including turtles,[37]

pulling all manner of large bric-a-brac, and there are several sea monster sightings that I believe to have been whales dragging small canvas sails.[39] One wonders if the same might have occurred here as a way to explain the "flexible" neck and "long tail" of this UMO, given its noted 10-meter length which is of obvious dissimilarity in shape to correspondingly-sized whales, sharks, or giant squids.

In 1904, the commander of a gunboat, while in the same region of Vietnam, spotted an UMO:[31]

> I first saw the back of the animal at about 300 yard, on the port bow, in the shape of a rounded blackish mass, which I took first for a rock and then, seeing it move, for a huge turtle 12 to 16 feet in diameter.
>
> Shortly afterwards I saw this mass lengthen, and there emerged in succession, in a series of vertical undulations, all parts of the body of an animal having the appearance of a flattened snake, which I reckoned to be about a hundred feet long and the greatest diameter 12 to 16 feet….
>
> The head was the colour of the rocks in the bay (greyish, white mixed with yellow). It was like a turtle's; the skin seemed rough, and this roughness seemed due to scales rather than hair…
>
> The head blew out two jets of water vapour. The rest of the body appeared *à fleur d'eau*…When it was almost alongside, the head dived, and a series of vertical undulations were seen running along the body, just out of the water…
>
> The body moved forward in vertical undulations. In its whole length there were 5 or 6 marked undulations. This length is estimated by these two witnesses as more than 30 feet. They describe a head wider at the back then the front and longer than a seal's. [anecdote 8]

"A rock ahead!" shouted a crewman on a steamer off the same coast of Vietnam in late 1903 before the following encounter with a similar, and possibly the same, 20 meter-long UMO:[31]

> I stood up and stopped the engines, then I saw, not very far ahead, a grey mass shaped like a turtle's back, which we reckoned to be more than 12 feet across…We saw, almost touching the nearby shore…two huge coils which I supposed must belong to a monstrous eel at least 3 feet in diameter. I saw to my great surprise that the skin of this beast and the rocks on the shore were the same colour; dark grey with patches of yellow. From the distance that I was the skin seemed smooth and even. It appeared briefly, the two coils disappeared…I got the impression that the animal was just awash and moving by vertical undulations. [anecdote 9]

Once again, in these two anecdotes, we have a progression of described resemblances—rock→turtle→snake-like or coiled long extension believed to be a tail—suggestive of an entangled chelonian. The vertical undulations of the presumed tail, referred to in one case as being "à fleur d'eau", or lying upon the surface as if a water lily, and in the other as being

"awash", or alternatively covered and uncovered by lapping waves, suggests a train of entangled fishing net buoyed by small floats. The close proximity to the shoreline in the second encounter indicates that the UMO seen was indeed a sea turtle given that the other most likely candidate, pinnipeds, do not occur in south-east Asia. The presence of rough scales in the first encounter implies a loggerhead or green, rather than a leatherback, sea turtle.

In 1876, in the Malacca Strait between Malaysia and Indonesian Sumatra, the crew of the *Nestor* spotted at first what they thought to be an unrecorded shoal before realizing that it was a slowly swimming animal. The ship's captain and surgeon filed the following joint report before the British Supreme Court in Shanghai:[30]

> The shape of the creature I would compare to that of a giant frog [Heuvelmans thinks he meant a tadpole or newt]. The head, of a pale yellowish colour, was about twenty feet in length, and six feet of the crown were above the water….The head was immediately connected with the body, without any indication of a neck. The body was about forty-five or fifty feet long, and of an oval shape, perfectly smooth, but there may have been a slight ridge along the spine. The back rose some five feet above the surface. An immense tail, fully one hundred and fifty feet in length, rose a few inches above the water. This tail I saw distinctly from its junction with the body to its extremity; it seemed cylindrical, and with a very slight taper, and I estimate its diameter at four feet. The body and tail were marked with alternate bands of stripes, black and pale yellow in colour. [Fig. 7] The stripes were very distinct to the very extremity of the tail. I cannot say whether the tail terminated in a fin or not. The creature possessed no fins or paddles so far as we could perceive…It appeared to progress by means of an undulatory motion of the tail in a vertical plane (that is, up and down). [anecdote 10]

The surgeon added that the movements of the UMO seemed "lethargic", that "it did not blow or spout in the manner of a whale", and that the body was of "a gelatinous (that is, flabby) substance."

Figure 7. The rear portion, believed to be the tail, of the UMO observed by the captain and crew of the Nestor in 1876 in the Malacca Strait. Drawing by B. Heuvelmans based on original by eyewitness Captain Webster. [Ref. 31]

Oudemans[30] believed that the creature must have been propelled by "paddling with its flappers" that were "entirely hidden under water", and that the tail "which trailed inactively behind the trunk, must of course have been brought in motion by the action of the water, so that it is easy to understand the…undulatory motion." He then goes through what Heuvelmans[31] refers to as "mental gymnastics", or what I would call confirmation bias, in his attempt to explain the short neck and the banded colour patterns as being due, respectively, to the creature

swimming with its neck in a contracted state and to the differential wetting and drying of body segments. Oudemans dismisses the remarkable length as being a probable exaggeration on the part of the eyewitnesses. Heuvelmans recounts a letter published in a Shanghai newspaper in which the writer supposes that "the monster seen by the *Nestor*…was probably one of the Chelonidae, 'the father of all the turtles,' as he is fitly called by the natives of Sumatra, who fully believe in his existence, and to whom he occasionally appears." Heuvelmans, however, will have none of this, snidely commenting that "I have yet to meet a turtle with a long tail like the *Nestor* monster," though adding that the Father-of-all-the-turtles of Sumatra "is not irrelevant to the sea-serpent in general." He then goes on to hypothesize that the UMO might have been a large ray and its long tail merely the wake or even a recently birthed litter of young following their mother. This of course is a classic cryptozoological example of eschewing Occam's Razor in favor of positing theories that strain incredulity. Far simpler to hypothesize that the enormous, cylindrical 'tail' floating upon the surface to be a string of fishing gear, the coloured banding simply being sun-bleached cork or blown-glass floats interspersed by darkened gaps of the water in between than to invent a new genus. The oval, slightly ridged body situated immediately behind the short neck does suggest a chelonian, although its estimated length of 40 to 50 feet might imply a large cetacean, if not for the small head being observed. But for Heuvelmans, the "*Nestor* monster" remains a mystery in that there "may really have been an unknown animal stranger even than the sea-serpent."

An UMO was observed by the captain and crew of a ship in 1848 in the Gulf of California:[31]"Instead of legs the creature had four large flappers, somewhat like those of turtles, the anterior pair being larger than the posterior…its movements were somewhat serpentine, and an appearance of annulations, or ring-like divisions of the body, was distinctly perceptible." [anecdote 11] The mention of ring-like segments or "annulations" (as in annelid worms) is concordant with a string of floats on a fishing net.

In 1808, while rowing along the coast in the Scottish Hebrides, several observers spotted a "vast Sea-Snake, between 70 and 80 feet long":[30]

> At first it appeared like a small rock…Then I saw it elevated considerably above the level of the sea, and after a slow movement, distinctly perceived one of its eyes. Alarmed at the unusual appearance and magnitude of the animal, I steered so as to be at no great distance from the shore…Certain that he was in chase of us, we plied hard to get ashore. Just as we leaped out on a rock…we saw it coming rapidly under water towards the stem of our boat. When within a few yards of the boat, finding the water shallow, it raised its monstrous head above the water, and by a winding course get…clear of the creek, where

> our boat lay…It continued to move off, with its head above the water…before we lost sight of it. Its shoulders, if I can so term them, considerably broader, and thence it tapered towards the tail, which last it kept pretty low in the water, so that a view of it could not be taken so distinctly as I wished. It had no fin that I could perceive, and seemed to me to move progressively by undulation up and down. Its length I believed to be from 70 to 80 feet. [anecdote 12]

The only marine animal known to be in the size range given for this UMO is the Blue whale. That this particular UMO could come so close to the shore as the stern of a beached fishing dory, indicates that the girth of the animal must have been very small for its great length to enable it to so maneuver in such shallow water. The resemblance of the body to "a small rock" and presence of distinctive "shoulders" is similar to previously cited examples which have suggested chelonians. The only other potential candidate in north Scottish waters, some species of pinniped, would not be so described. The specific reference to a long "tail" lying just over the surface of the water, and displaying an undulating motion due, I would suggest, to being pulled by the turtle at the front end given the noted absence of a terminal fin to provide propulsion from the rear, is indicative of the imagined body being an inanimate string of trailing debris.

If this is indeed the case, then this represents the earliest record in the sea monster literature of a supposed chelonian being entangled in pre-plastic fishing gear or maritime debris. But then, what are we to make of the 1494 encounter of Columbus, off the coast of the Dominican Republic, with a whale-sized turtle that swam with its head out of the water and sported a long, snake-like tail sporting what were believed to be fin-like objects attached to either side?[45] Certainly this turtle-snake fusion once again bespeaks of entanglement, and there is plenty of evidence for the deleterious impacts of pre-Columbian fishing in the Caribbean.[46-48] Is this, then, the oldest record of entanglement of a chelonian in the New World?

Disentangling the giant Chelonian cryptid

The Gloucester sea serpent was seen by thousands of New Englanders around 1817 (Table 1), and is the most observed UMO in history.[35,44,49,50] As a result, it is worth comparing aspects of the present Chelonian-related sightings to that standard. Although Fama[51] believed that the "great New England sea serpent" seen at Gloucester was an entangled whale, I think it more likely to have been an entangled Bluefin tuna or some other large fish.[43]

When considered in aggregate, anecdotes of anomalous phenomena like UMO sightings, constitute data appropriate for legitimate scientific study.[52] The concordance between the observed physical and behavioral attributes from the 12 sightings described in the present paper, as well as the four sightings in France,[37] and those attributed to the purported Gloucester sea serpent,[43] are shown in Table 2. As was found for cetacean-related sightings,[39] there is a marked similarity between observed attributes.

With respect to anatomy, the composite UMO described in the present anecdotes has an elongated, snake-like body that is tapering in shape, of notable length, composed of irregular components which sometimes have sport large protuberances or be likened to scales or saucers, all with a noted flexibility. And in terms of behavior, the composite UMO, when not lying motionless, slowly moves through undulating movements of its body segments which can generate a wake, and in one instance seems to be oblivious to its surroundings, whereas in another, engages in throwing a portion of its extended body up into the air.

I believe that the interpretation of the sea monster sightings documented herein can be explained parsimoniously as evidence for entanglement in fishing gear or maritime debris. The other traits of body form and behavior noted by the eyewitnesses suggests the entangled animals to have been sea turtles. It is important to note, however, that due to inherent vagaries in the chain progressing from the actual presence of a UMO, to its immediate sighting, and then later to the recording of the encounter, all interpretations remain illative.[52,39]

Longevity of natural fiber hemp

Cordage has been used in maritime activities for six thousand years.[53] Throughout the nineteenth-century, ships carried miles of hemp and then later abaca or manila hemp.[54,55] At this time, fishing nets and ropes were primarily constructed of hemp and sometimes cotton.[29] Not until between the late 1950s and early 1970s did synthetic materials such as plastic became ubiquitous as the dominant material in ropes and fishing nets.[56,57]

Because of swelling from salt intrusion and degradation from sunlight due to the constant cycle of soaking and drying, in addition to ongoing microbial activity and the day-to-day physical stress and fatigue, natural fiber ropes and nets required regular repair.[53] However, it would be incorrect to believe that "these products broke down quickly in the marine

environment", thus rendering them incapable of entangling animals as the NOAA report[9] stated. In point of fact, owing to its hydroscopic nature, hemp fiber actually becomes "stronger when wet and does not rot easily in water".[53] Furthermore, when impregnated with pine tar or dye as a mordant, the rate of deterioration of hemp ropes is substantially reduced.[57,58]

Following treatment with artificial preservatives, the tensile strength of wetted hemp rope can increase by 20%, with longevity extending to about a year.[59] For manila hemp, it is specifically the presence of natural oils that provide resistance to deterioration, thereby eliminating the need for tarring,[53] that contributed to its progressive increase in maritime use throughout the nineteenth century. Additionally, sometimes hemp ropes would be reinforced with braided wire to further increase their longevity.[54]

Compared to modern ropes which are almost exclusively constructed of nylon or polyethylene and the like, earlier ropes made from treated natural fibers would have deteriorated more rapidly. Be that as it may, such material obviously lasted long enough to ensure its continual widespread use by mariners and fishermen. My contention is that any material of sufficient durability for maritime use will have also posed a threat for entangling sea turtles. Incidents of non-lethal entanglement in such material might have lasted for months, certainly enough time for a large chelonian, dragging a hemp line of buoys through the water, to have been observed and misidentified as a sea monster.

Evidence for widespread, pre-plastic entanglement

Eyewitness descriptions of the UMO seen in Gloucester in the nineteenth-century (Table 1), the most thoroughly investigated sea serpent in history, imply that it was almost certainly an example of early entanglement.[51,43] It is not a reach, I believe, to propose that a case can be made, based on the evidence contained within the anecdotes and drawings in present paper, as I have done similarly for cetaceans,[39,60] to suggest that nineteenth-, and early-to-mid-twentieth-century chelonians around the world could become entangled in anthropogenic material. In consequence, it would be incorrect to consider sea turtles entangled in fishing gear or maritime debris as being a recent phenomenon, as is the common perception.[9]

We now recognize that declines in the abundance of marine animals due to overexploitation, leading to extirpation, and in some cases, global extinction, is by no means a

recent phenomenon; instead it extends back centuries and possibly even millennia.[24-26,46-48] The present reinterpretation of sea monster sightings from historical documents is important in suggesting that rather than being restricted to only the recent advent and use of plastic, entanglement, just like exploitation, probably has a more lengthy environmental history. This work, together with that of France,[37] posits that an illative case can be made that chelonians have been susceptible to becoming entangled in hemp ropes used to fasten together fishing nets and associated maritime equipment, possibly ever since humans first placed such paraphernalia into the sea.

We can only guess at what the ultimate effect of centuries of entanglement might have been for the global abundance of marine chelonians. Due to the massive convergence of the Gulf Stream and the St. Lawrence River, the north-western Atlantic once contained a diversity and abundance of marine life almost unequalled elsewhere on the planet. Early explorers to the region frequently referred to the great abundance of large turtles compared to what they had been used to in their native, by then thoroughly exploited, European waters. As Mowat[61] recounts, Jacques Cartier commented on there being inestimable numbers of *grande tortures* or great turtles on an island in the St. Lawrence, and Sir Humphrey Gilbert listed 'tortoyses' as being the most dominant fauna after cod, salmon, seals, and mackerel, off the coast of Newfoundland. Today, a sighting of a large chelonian in the region merits mention in the local news, and is so rare that observations of a possibly entangled turtle can be misconstrued as being a sea monster (anecdote 1). In the absence of a targeted harvest of turtles for food in the North Atlantic, most of their dramatic decline in abundance is likely a result of being a by-catch of the extensive fishery for cod and bait fish, for which the region was famous.[29,61,63]

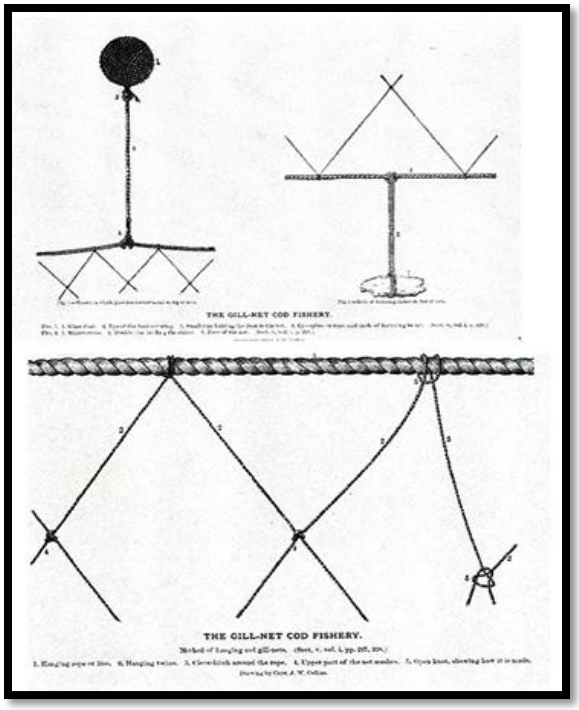

Figure 8. Details of nineteenth-century gill-net constructed entirely of hemp. [Ref. 55]

Because chelonians use floating objects for shelter and as foraging stations, they are very susceptible to becoming entangled in drifting ghost

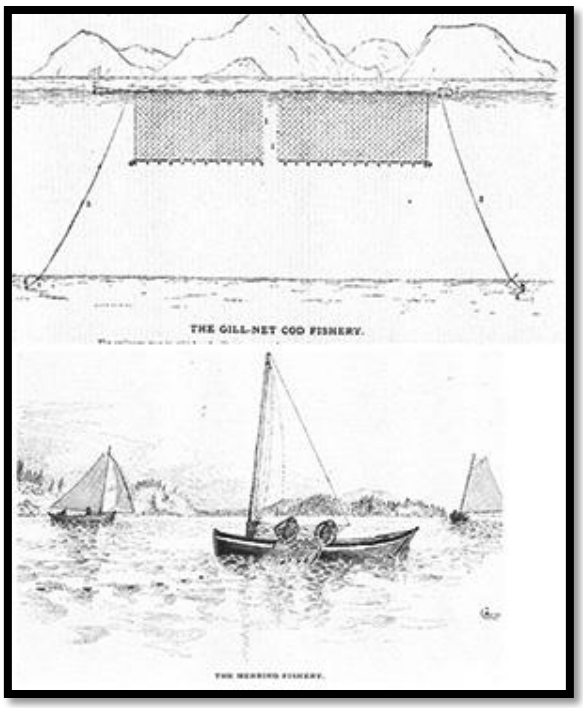

Figure 9. Deployment and retrieval of gill-nets in the nineteenth-century,55 whose surface positioning would make them susceptible to entangling marine chelonians. [Ref. 55]

nets.[16] For modern gill-nets, the entanglement of turtles increases in relation to mesh size.[64-66,16] Nineteenth-century nets made of hand-woven hemp were characterized by large mesh sizes (Fig. 8). So even though the thickness of the hemp would have made such nets more visible and thus less likely to ensnare turtles, as also occurs in relation to thickness for today's synthetic fiber nets,[16] this might have been offset by their large mesh sizes. For example, Josselyn[67] describes in-shore fishing for mackerel in New England in the middle of the seventeenth century using methods not dissimilar to those of two hundred years later (Fig. 9): "Our men…hoisted the Shallop out and took divers Turtles, there being an infinite number of them all over the sea as far as we could ken."

Finally, that so many eyewitnesses were unable to identify trailing gear or debris in their sightings may seem surprising. But it is possible to observe, in on-line photographs of entangled marine animals, examples of lengths of entwined rope and matted netting, some festooned with seaweed, that certainly do give the overt impression of solidity, thereby making it is easy to imagine how such a structure could give the illusion of being a tail.[37] It is also possible to view on-line photographs of chelonians pulling long lines of entangled gear, such as widely separated buoys or floats, which, were it not for being taken with telephoto lenses, could lead to misconstruing what was actually seen. Therefore, even though entanglement of chelonians has been documented by ecologists in specialized publications for the last three decades,[10] it is likely that many of the lay public today, as would also have been the case for the uninformed of the past, if prone toward an overt imagination, would be susceptible to being misled into believing that what they had seen was a sea monster. Even today, it is certainly much more interesting and uplifting to imagine being fortunate to glimpse a rare Doctor Moreau-esque turtle-snake than it is to perceive, recognize, and worry about yet another environmental threat to the precarious status of wildlife in the Anthropocene.

Table 1.

Descriptions of the imagined sea serpent observed between 1815 and 1824 in Gloucester harbor and nearby, as extracted from numerous sources[43] and clearly indicative of a marine animal entangled in fishing gear or other maritime debris.

"…his appearance in this situation was like a string of buoys. I saw perhaps thirty or forty of those protuberances and bunches, which were about the size of a barrel."

"…looked like the buoys of a seine"

"…with a good glass [I saw what] seemed like gallon kegs tied together"

"His body when out of the water looks like the buoys of a net, or a row of kegs, or a row of large casks"

"…of the size of a barrel about the body, which…are so prominent, that they resembled buoys attached to each other"

"[The body] appears in joints like wooden buoys on a net rope almost as large as a barrel, that the musket balls appear to have no effect on it, that it appears like a string of gallon kegs."

"…as he moved he looked like a row of casks following in a right line"

"He appears to be full of joints and resembles a string of buoys on a net rope, as is set in the water to catch herring. Others describe him as like a string of water casks…Two [musket] balls were thought to hit his head, but without effect."

"…resembled the link of a chain."

"…and his back appeared to be composed of bunches or humps, apparently as large as, or a little larger than a half barrel…The first view I had of him appeared like a string of empty barrels tied together, rising over what little swell of the sea there was."

"The back was composed of bunches about the size of a flour barrel, which were apparently about three feet apart…and looked like a string of casks or barrels tied together."

"The body, which is formed into parallel rings, which—when he is on the top of the water—are so prominent, that they resembled buoys attached to each other."

"…and to seem jointed, or like a number of buoys or casks following each other in a line."

"…the curvature and bunches on his back. To some he appeared jointed, or like a string of kegs or buoys connected on a rope"

Table 2.

Thirteen observed physical and behavioral attributes of the purported Gloucester sea serpent,[43] which was almost certainly a misidentified entangled marine animal (bracketed numbers indicate prevalence order), arranged herein from top to bottom in relation to diminishing incidence of occurrence from 27 sightings of different sea serpents thought to be entangled whales,[39] and identification of numbered anecdotes from the present paper (#s 1 – 12) and 4 others (O = *Osborne*, M = Moha-moha, V = *Valhalla*, S = Soay Beast) thought to be entangled chelonians,[37] which are in concordance.

Narrow, tapering, sinuous, snake/eel-like shape, often with absence of a tail or lateral appendages (11)	1, 3, 4, 6, 8, 9, 10, 12, O, M
Notable/unusual length (2)	4, 7, 8, 10, 12, O, M
Extended body pulled down into water, thrown up into air, or thrashed about on the surface (12)	M
Body composed of a series of irregular, jointed component parts (multiple humps, coils, or a ridge) (1)	3, 4, 6, 7, 9, O, M, S
Rapid speed of movement (3)	—
Presence of horn, spike, spine, mane or other protuberance (sometimes identified as a head) (13)	2, 5, 7, O, V, S
Vertical undulating movement of body segments (10)	8, 9, 10, 12
Notable flexibility of body (2)	7, 12, M, V
Body components likened to kegs or barrels, and sometimes scales or saucers (5)	1, 3, 8, M
Obvious trailing wake or water disturbance (7)	2, 7, V
Overall body likened to a string of kegs or buoys (6)	—
Oblivious of surroundings or impervious to disturbance (9)	S
Floating motionless, gently swaying in waves, or moving very slowly (8)	3, 8, 10, 12, M

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