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The history of the dried *Mola mola* (Linnaeus, 1758) and *Mola tecta* (Nyegaard, *et al.*, 2017) specimens in the collection of Naturalis Biodiversity Center, Leiden.

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Abstract

This study provides an overview of the historical preparation techniques used on the *Mola mola* and *Mola tecta* specimens in the collection of the Naturalis Biodiversity Center, Leiden. The current state of the specimens is examined to ascertain these techniques, and observations are set against the contextual framework of a selection of 19th century taxidermy handbooks. The specimens came into the collection in three periods (1826-1836, 1889-1896 and 1940) and the techniques used to prepare them are compared to establish a standard for each period. Archival material and publications on these specimen have been used to gather background information on how these specimens were collected, in order to place them in their historical context. It can be concluded that the preparation techniques are very similar intra-period, and were certainly based on instructions from the museum and the experience of one (team of) preparator(s). The changing techniques from the early to the late 19th century can be attributed to changes in taxidermy practices as well as the fact that these specimens were larger since they were collected locally. This has opened up further possibilities for study, including a more thorough physical examination using modern technology and comparative studies between the techniques described here and other specimens in the Naturalis collection to gather more information about 19th century preparations in general.

Keywords: *Mola mola, Mola tecta,* Object Biography, Naturalis Biodiversity Center, Material History, Taxidermy, Preparation Techniques, 19th century, Museum Collection, Collection History.

Introduction

There are many specimens sitting in the collections museums around the world with almost no information attached to them. That is not to say there is no information on these specimens, but most of the time the information is not linked to the specimens, and there has been little time and/or money to place them in their proper context. Only on special occasions do most old specimens get researched. The restoration of a large dried *Mola mola* (Linnaeus, 1758) and *Mola tecta* (Nyegaard, Sawai, Gemmell, Gillum, Loneragan, Yamanoue & Steward, 2017) specimens at Naturalis Biodiversity Center, Leiden presented the opportunity to undertake additional research into their history, and how they were prepared over time.

This paper is the result of the following study, which aimed to give a historical context to these specimens as well as a detailed overview of the techniques that were used to prepare them.

The main goal of bringing all this information together was to be able to preserve these specimens more effectively, and to learn more about the history of the acquisition and preparation of specimens at Naturalis more broadly.

Naturalis currently has nine dried *M. mola* specimens and one dried *M. tecta* specimen in their collections. This study leaves out the two most recently acquired *M. mola* specimens, one of which was prepared in recent memory and one of which was prepared after this study was finished. Of all the specimens only the *M. tecta* is currently on display, in the Live Science hall of the museum. This study encompassed specimens RMNH.PISC.D.2676, RMNH.PISC.D.2677, RMNH.PISC.D.2678, RMNH.PISC.D.2679, RMNH.PISC.D.2059, RMNH.PISC.D.2757, RMNH.PISC.D.2758 and RMNH.PISC.D.2865 (Figure 1), identified within the figures and after their first mention by their final four digits.

Methods

This project into the history of the *Mola* collection had two sides, the collection history and the material history. For the collection history written sources were used, from archival material such as indexes and correspondence, to published accounts of the specimens and the labels attached to the them. The material history was established through a physical non-invasive study of the specimens as well as a literature study

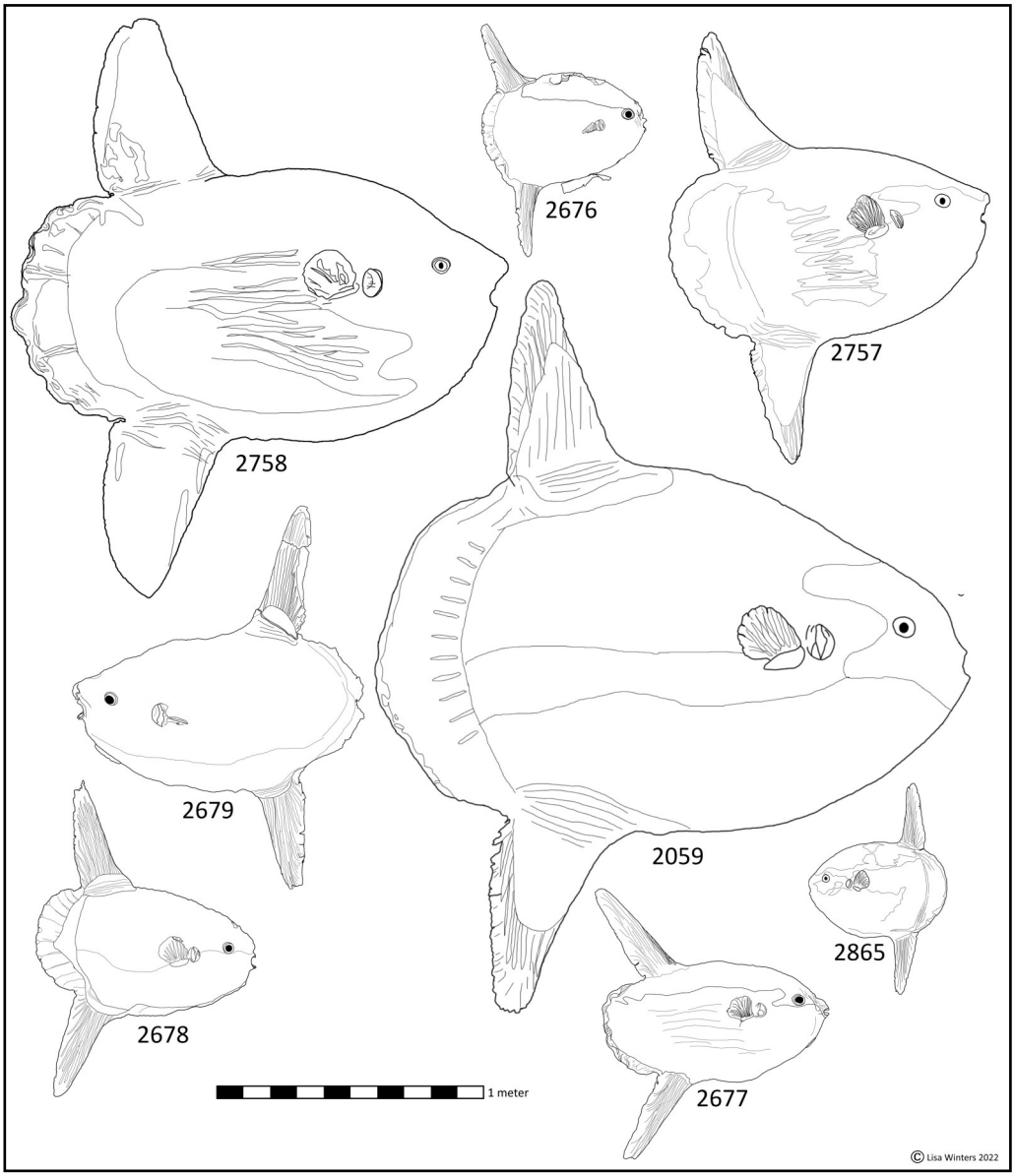

Figure 1. An overview of the dried Mola specimens in the Naturalis collections used in this study. Technical drawings by Lisa Winters, 2022.

of 19th century fish preparation techniques. All these sources were combined to reconstruct the most likely history of these specimens from the moment the fish died to the final preparation before being added to the shelves of Naturalis.

Naturalis Biodiversity Center, Leiden

Naturalis was founded as the 'Rijksmuseum voor Natuurlijke Historie' (National Museum for Natural History, shortened to RMNH), in 1820 by Coenraad Jacob Temminck (1778-1858). As chronicled in Gassó Miracle's scientific biography (2021), Temminck was a zoologist with a large collection of bird specimens on which he published many articles. He was also in good standing with Louis Napoléon Bonaparte (1778-1846), then the monarch of the Kingdom of Holland, for which he catalogued museum objects. In 1813 King William I (1772-1843) came to power, and Temminck made sure to establish good connections with the new government. He convinced William I to found the RMNH from the collections of the University of Leiden and the royal natural history cabinet as well as his own collections. In order to gain status for his new country of The Netherlands, William I sponsored Temminck in establishing even greater collections for the new national museum. In this context Temminck corresponded with many physicians and scholars in the Dutch colonies in order to collect specimens, as well as employing natural historians especially for this purpose. See also Borren and Drieënhuizen (2022) for a discussion on decolonizing natural history collections in the Netherlands.

The acquisition of the dried *Mola* specimens

For this study, seven dried *M. mola* and one dried *M. tecta* specimens from the collections at Naturalis were compared (Table 1). They can be divided into three groups based on their age; four specimens from approximately 1826-1836, three specimens from around 1890 and the most recent one from 1940. The oldest three specimens were collected abroad, all by men employed to collect as many different biological specimens as they could for the museum. It is not certain in what the order the first three sunfishes arrived at the museum. None of them have a date recorded on their labels, and while there are acquisition lists that record the work done by collectors these often simply list the animals in bulk. The dates can however be narrowed down to a range of a couple of years due to the combination of collector and country of origin. As the collectors were employed by the museum, their travels were well recorded as justification for their expenses (RMNH Jaarverslagen/Annual reports 1826-1835). One way to order them, which I will use in this article, is by specimen number. It is possible that the assigned numbers are also an indication for the order in which the specimens arrived at the museum, however these numbers have been reassigned over the years and cannot be taken as fact.

The first specimen, RMNH.PISC.D.2676, is from the Cape of Good Hope in South-Africa and was collected by Hubertus Benedictus van Horstok (1794-1838) between 1826 and 1834. He worked in Cape Town as a physician and surgeon and did his zoological and collection work on the side (S2A3 Biographical Database of Southern African Science, 2022). Horstok specifically collected ichthyological specimens for the RMNH, including our young *M. mola* of about one and a half years old (ages all based on Nakatsubo and Hirose, 2007).

The second specimen, RMNH.PISC.D.2677, was collected at Livorno, Italy, by François-Joseph Cantraine (1801-1868) between 1827 and 1833. Cantraine was a zoologist with a focus on molluscs and fish and studied preparation techniques at Leiden University (BESTOR, 2022). The RMNH sent him to Italy to observe birds, during which time he also collected a two-year-old *M. mola* specimen.

The third specimen, RMNH.PISC.D.2678, was collected in Japan by Heinrich Bürger (1804/6-1858) sometime between 1830 and 1835. During this time only people under the Dutch government were allowed to enter Japan for trade and study, and Bürger gained this access by working as an apothecary and assistant to Philipp Franz von Siebold (1796-1866) in employ of the RMNH. Siebold was a physician and studied Japanese flora and fauna, while Bürger collected copious amounts of specimens for the museum (Boeseman, 1947; Steenis-Kruseman, 1962). For a discussion of the relationship between the Netherlands and Japan at this time, and the importance of Siebold and scientific collecting abroad, see also Plutschow (2007). The *M. mola* specimen he collected and prepared for the RMNH was also approximately two years old.

The fourth specimen, RMNH.PISC.D.2679, arrived at Naturalis in 1836 and is both the first "Dutch" *M. mol*a in the collection and the first reliably recorded sunfish caught along the Dutch shore (Deinse and Verhey, 1964, p.66). It is also the biggest up till then, at approximately three years old. While the label simply reads "Hollande", it may possibly be from Katwijk aan Zee (Deinse and Verhey, 1964), however the exact location is undetermined.

The specimens from around the 1890's were all either caught or washed up along the Dutch shore and sent almost fresh to Naturalis. Due to the proximity to the museum, specimens of a much larger size could now be collected. *Notes from the Leyden Museum* (Lidth de Jeude 1890 and 1892; Reuvers 1897), presents examinations of all three specimens in the state they arrived at the museum, including extensive measurements as well as some notes on who donated them.

In December of 1889 an adult *M. tecta* was found stranded along the coast of the island of Ameland. The mayor of the island, D.W.J. baron van Heeckeren (1857-1904), sent the dead fish to the RMNH to be studied. This specimen, RMNH.PISC.D.2059, is an adult *M. tecta* of almost ten years old and is the largest specimen in the collection at 2.80 meters tall.

In December of 1891 another sunfish washed ashore at Callantsoog, close to the Zoological Station at Den Helder. It was brought to the attention of the Zoological Station and the director, P.P.C. Hoek (1851-1914), sent the specimen on to the RMNH. It is now labelled as RMNH.PISC.D.2757 and it's the smallest specimen of this period standing at 1.59 meters tall and being approximately four years old.

Another large specimen was caught by fishermen in the Den Helder area in November 1896, and Hoek also sent this specimen to the museum. It was still alive when it first arrived at the Zoological Station, so when it arrived at the RMNH it was fresh and in very good condition. After a photograph was taken and it was examined for a description (*Notes from the Leyden Museum,* Reuvers 1897) the specimen was prepared and is now part of the collection as RMNH.PISC.D.2758. The description states that the specimen was 2.18 meters tall, which would suggest it was around eight years old when it was caught.

The final specimen, RMNH.PISC.D.2865, is from 1940, which presents quite a gap in the dried *Mola* collection. This is the 33rd of the recorded sunfishes caught or washed ashore in the Netherlands, though it is only the fifth that was prepared as a dried specimen. While at least five of the other sunfishes that stranded between 1935 and 1941 were sent to Naturalis, they were dissected and either disposed of or (partially) preserved in alcohol (Van Roon and ter Pelkwijk, 1939; Van Roon, 1942). Other than the information on its label, that it was found at the Wieringen dike on the fourth of July in 1940 and sent to the museum through the interference of the Zoological Station, nothing else is known about the history of this specimen. It is the youngest and smallest specimen in the collection, standing 0.74 meters tall and estimated as being only one year old at the time of preparation.

Whether coming from overseas or sent immediately from the Dutch coast to the museum itself, all these specimens needed to be prepared for dry conservation. The ones from overseas must have at least been fully gutted and have had the skin treated with chemicals to keep from spoiling on the journey. The specimens that came to the museum "fresh" would have immediately been prepared and mounted as well. The museum had a team of preparators working full time on incoming specimens (Holthuis, 1995).

Preparation methods in the 19th Century

In 1825 C.J. Temminck, founder and director of the RMNH from 1820 to 1858, wrote a manual on the preparation and conservation of animal skins. The method he describes here for the preparation of large fish is not only a basis for the way the *Mola* specimens were prepared, but set the standard for fish preparation for decades (Gassó Miracle, 2021). He stated that the usual way of preparation, in which an incision was made along the ventral aspect, compromised part of the specimen for study. Instead, an incision should be made horizontally along one side of the specimen from head to tail. One side would be damaged, but the other side would still be intact for study and exhibition. The innards had to be removed through this incision and the skin cleaned and rubbed with a preservative. He describes laying the "fresh fish" on a plank of wood and pinning down the fins and tail on paper or cork (Temminck, 1825, p. 16). The specimen is then dried in 24 hours (in a European climate) after which it is easier to remove the skin from the muscles through scraping. Cartilage had to be cut away with sharp scissors, which means that some bones and cartilage were often left in the fins and head. The remaining skin has to be rubbed with arsenic soap mixed with plaster to keep the skin firm. The prepared skin was stuffed with wood wool, straw, bast fibres or similar materials. The preparator did not have to sew up the incision. Notes had to be taken on the colours of the living fish to paint the specimen after the preservation process. Temminck wrote these instructions specifically for use at the RMNH, as is stated clearly in his title "Instruction, how to handle objects of natural history with the goal of properly shipping and conserving them; for use of the National Museum of Natural History in Leiden" (my translation; Temminck, 1825).

In 1833 Thomas Brown (1785-1862) wrote a book on taxidermy in which he specifically addressed the stuffing and mounting of large fish. In accordance with the Temminck method he describes an incision along one side of the fish as well as the scraping of skin and the cutting away of cartilage. For the mounting of the skin he describes that tissue paper needs to be applied to the skin in order to retain the colours and the whole skin is to be rolled into a wet cloth. Large fish need a stick for a centre support, in addition to tow and cotton, and have to be sewn up. The prepared fish is set to dry in the open air without exposing it to direct sunlight. The orbits are then filled with cement and cotton, and glass eyes are added. The cartilage around the eyes is mimicked with a mixture of gum arabic and powdered starch. Finally, the skin is varnished and dried again.

As the century progressed, other methods of fish preparation became more popular, especially the modelling of skin around a frame. In 1885 it became common to whittle a solid wooden frame for smaller fish, around which the fish skins were wrapped while they were still wet. The skins then dried against this frame (Reed and Reed, 2012, Chapter 6: Mounting Fish). Due to this wooden frame the skin could easily be mounted by nailing a plank to the "ugly" side where the incision was made. The mounted fish was then hung on the wall. Manuals don't explain how this method of modelling the skin around a frame and mounting it can be used on large fish.

Until the late 20th century these existing preparation methods did not change much, except for the chemicals used in preservation (See also Dickinson, 2006). The techniques mentioned in the literature are very noticeable in the specimens, especially when you see them grouped into the periods they were created in. Apart from the techniques mentioned in the literature, each period also has its own particular style of preparation. These techniques are described here, grouped by time period, in order to find out their origins.

Specimens from 1826 to 1836

Of the four specimens that entered the collection between 1826 and 1836, three came from collectors abroad. This means that all the skins were prepared by different people with access to different materials and in different environments. The Fauna Japonica by Siebold *et. al.* (1850, p. 288) suggests that at least one specimen (2678, Japan) was stuffed before it arrived at the museum, but it is not certain in what state the other specimens arrived. The only exception is the Dutch specimen (2679) which arrived fresh to the museum, and was prepared by museum staff. Despite their different provenances the preparation methods are very similar (Figure 2). See also Tables 1 and 2 for an overview of all specimens.

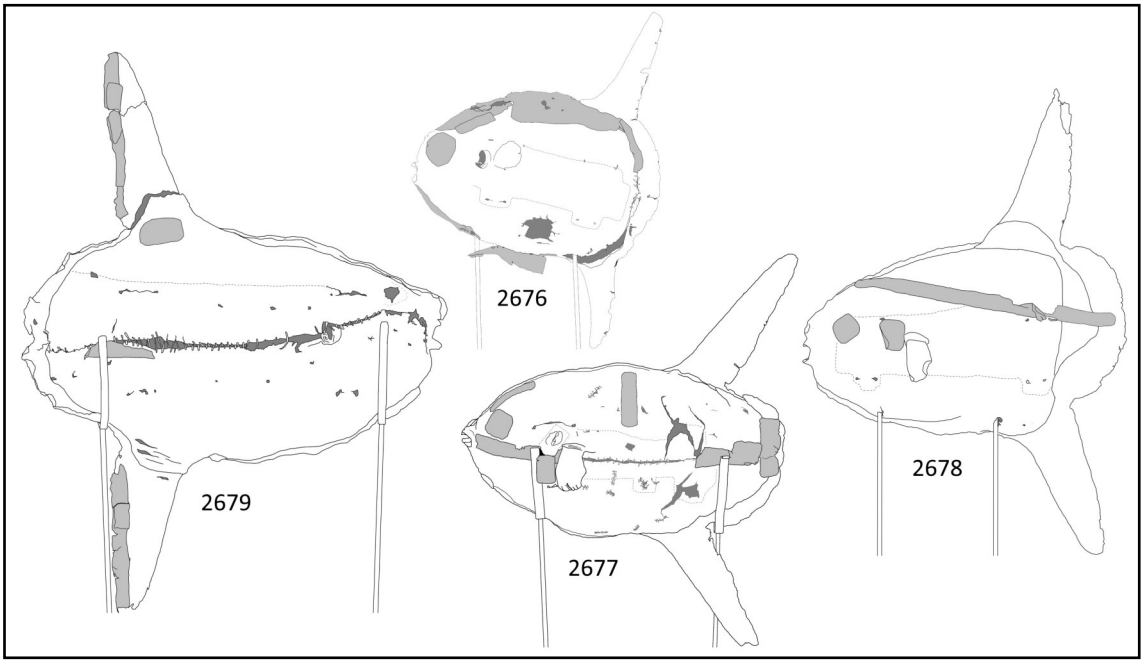

Figure 2. The preparation side of the early 19th century Mola specimens. Light grey shows paper patches and dark grey shows damage where the stuffing is visible. Technical drawing by Lisa Winters, 2022.

Table 1. Overview of the acquisition circumstances of the Mola specimens.

	Date (d-m-y)	Location	Collector / donated by	Size (lxh, cm)	Age (y)	State of arrival
RMNH.PISC.D.2676	1826-1834	Cape of Good Hope, South-Africa	H. B. van Horstok (1794-1838)	65x86	1,5	Preserved skin
RMNH.PISC.D.2677	1827-1835	Livorno, Italy	F. J. Cantraine (1801-1868)	85x102	2	Preserved skin
RMNH.PISC.D.2678	1830-1835	Unknown, Japan	H. Bürger (1804/6-1858)	83x120	2	Stuffed skin
RMNH.PISC.D.2679	1836	Katwijk aan Zee, the Netherlands	Unknown	110x144	3	Fresh
RMNH.PISC.D.2059	13-12-1889	Ameland, the Netherlands	D.W.J. baron van Heeckeren	223x280	10	Fresh
RMNH.PISC.D.2757	05-12-1891	Callantsoog, the Netherlands	P.P.C. Hoek	122x159	4	Fresh
RMNH.PISC.D.2758	19-11-1896	Den Helder, the Netherlands	P.P.C. Hoek	179x211	8	Fresh
RMNH.PISC.D.2865	04-07-1940	Wieringen dyke, the Netherlands	Unknown	52x74	1	Fresh

Table 2: Overview of the preparation techniques used on the Mola specimens.

	Incision side	Incision placement	Materials for stuffing	Holes for pinning
RMNH.PISC.D.2676	Left	Along the ventral, top of the head	Hay, bast fibres	No
RMNH.PISC.D.2677	Left	Beak to clavus	Hay, bast fibres	In the dorsal and anal fin
RMNH.PISC.D.2678	Left	Forehead to clavus	Hay, bast fibres	In all fins and along the edge
RMNH.PISC.D.2679	Right	Beak to clavus	Hay, bast fibres, plaster	No, pectoral fins missing
RMNH.PISC.D.2059	Left	Round and into fins and clavus, fin to fin	Unknown	Unknown
RMNH.PISC.D.2757	Both (R+L)	Round and into fins and clavus (R), fin to fin (L)	Wooden frame	In the pectoral fin
RMNH.PISC.D.2758	Right	Round and into fins and clavus	Steel frame, plaster	Unknown
RMNH.PISC.D.2865	Right	Round and into clavus	Metal rods, plaster	In the pectoral fin

The following description of the preparation methods is applicable to all specimens. An incision was made to remove all the flesh and most of the bone and cartilage. Part of the skull (the beak is visible, see Figure 5) and the bones in the fins are still in place. The skins have been stuffed with hay in the middle and tow in the more delicate parts and the main incision has been stitched closed with two twined threads. The stitch used looks like a single shoelace pattern, as seen on Figure 3. One side of the fish has been prepared to look "alive", including the pectoral fin positioned away from the body, a coloured varnish and an artificial eye. This eye consists of a gum arabic disk with uneven edges, painted to look like an eye. The eye is placed on top of the hole left in the skin and attached through an unknown method. The iris of the eye is a golden-brown, with a large pupil (Figure 5). This type of artificial eye is common in dried fish specimens in the Naturalis collection, from a broad range of species and sizes. The mouth has also been worked to look realistic, with the inside of the bone beak modelled smooth with gum arabic and painted red. Original damage to the skin has been patched up with paper strips, including a long strip covering the line of the incision and a diamond-shaped patch to cover the hole for the eye that has not been prepared. The original mounting method is not known, though the "bad" side of the fish shows a horizontal rectangular discolouration. The skin is lighter here, which suggests that something has protected it from dust, dirt, or other pollution. The specimens also all show holes within this discoloured section, at least four on the top and four on the bottom, spaced two-by-two (Figure 3).

There are also a couple of materials and methods present in some specimens that are not present in others. The only thing that is different in each

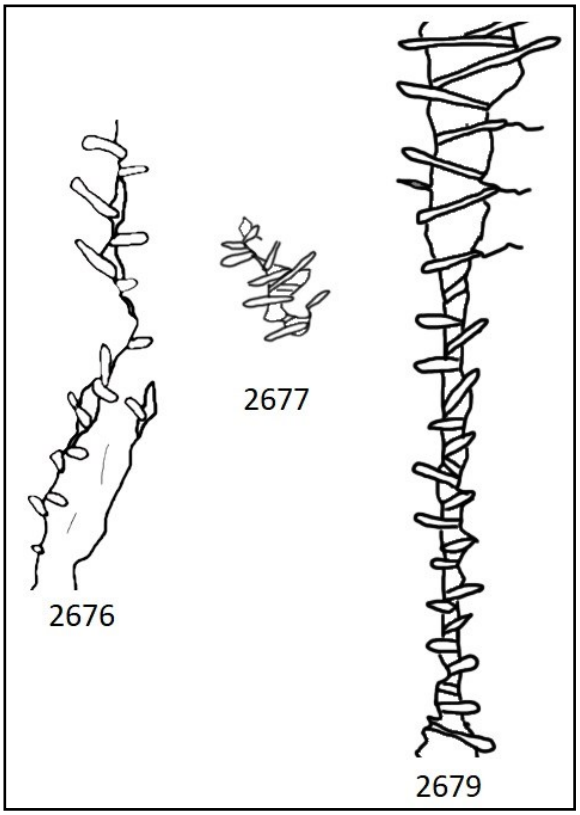

Figure 3: Examples of stitching on three Mola specimens. Technical drawing by Lisa Winters, 2022.

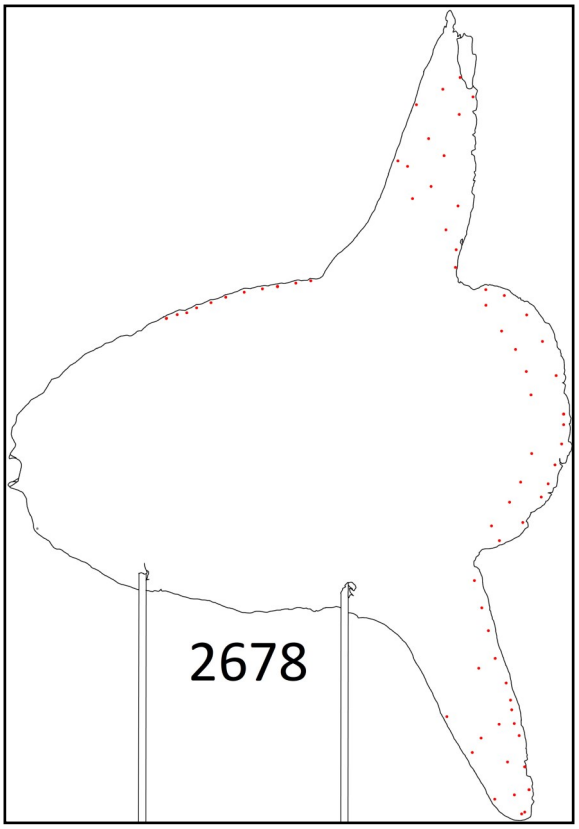

Figure 4: All holes visible in specimen RMNH.PISC.D.2678 from Japan. Technical drawing by Lisa Winters, 2022.

specimen is the placement of the incision. The specimen from the Cape of Good Hope (2676) has been cut along the ventral line from mouth to anal fin, contrary to Temminck's instructions. This is interesting as Horstok routinely collected fish specimens for the museum, and applied the recommended method for the incision in some of his other large fish specimens like an *Odontaspis taurus* (RMNH.PISC.D.2516) from the same place and period. His *Mola* specimen also has a large hole on top of the head, though whether this was damage to the skin or part of the original incision is not clear. The other three specimens follow Temminck's handbook more closely with an incision from the head to the clavus along one side of the body (Figure 2, in some cases (partially) covered up with paper strips).

The Dutch specimen (2679) is the only specimen from this period with the incision on the left side. It has also been reinforced with plaster on the inside of the right side. Both characteristics can be attributed to it having been caught in the Netherlands, enabling bigger size and thus requiring reinforcements as well as being the first *Mola* to be fully prepared by Naturalis' staff.

Temminck's instructions also mention pinning the fins down to let them dry in the correct position. This is especially visible in the specimen from Japan (2678) which shows holes along the fins as well as along the ventral and dorsal sides (Figure 4), which are still pinched and unstuffed. This unstuffed edge is also present in two other specimens (2679 and 2677), though there are no signs of holes here. This edge could suggest the difficulties of stuffing the skin fully without breaking it or loosing its shape. The only other specimen that shows holes for Temminck's pinning method is the one from Livorno (2677) so it was not consistently used during this time.

With regards to a possible mounting structure, the Dutch specimen (2679) has three more sets of holes in the discoloured section. It also has rust and even pieces of nail left in some of the holes, which are present in the specimens from the Cape of Good Hope (2676) and Japan (2678) as well. The presence of holes and nails suggests even stronger that the discolouration is linked to a mounting mechanism, traditionally where the fishskin would be hung on a plank on the wall. There is however no outside sign of an inside structure, leaving the question of what the mount would be attached to unanswered. It is also

possible the colouration is connected to the fish drying on one side, with the holes created as a result to keep the skin in place around the incision. However, this is not a practise described in any of the consulted literature.

The original mounting mechanism has been removed in all cases, and replaced by metal rods either sticking into the ventral side of the fish or supporting the specimen with Y-shaped prongs. All the specimens have a wooden base supporting the rods, though the base of the Dutch specimen (2679) has been treated to look like stone where the others are all painted a similar white.

The fact that all these specimens look so similar in their preparation techniques, with little details that are not specified in the prevalent handbooks (the gum-arabic eye and inside of the beak, the diamond shaped paper patch over the eye, the double thread and stitching pattern), suggests that a (team of) preparator(s) at the Naturalis museum patched up all the skins in a similar way before entering them into the collections. The skins from overseas might still have needed stuffing, and even a pre-stuffed skin (such as is suggested about the Japan specimen) would probably have needed some minor additions or alterations. This seems the most plausible option, since the collectors were not all trained at Naturalis and it is unlikely they would have such a specific shared way of preparing. If the overseas collectors did have such specific instructions, you would expect more similarities in things such as the incision pattern and holes for pinning.

Specimens from 1889, 1891, and 1896

These three specimens all arrived at Naturalis fresh, and were prepared by museum staff. There is a definite departure from the preparation techniques used in the first four specimens, which is likely a combination of the new popular method of stretching the skin over a frame and the much bigger size of these specimens. Both the Ameland (2059) and Den Helder (2758) specimens have been completely restored in recent years (2018 and 2021 respectively), which makes it difficult to ascertain the specifics of the original preparation techniques. The Ameland specimen (2059) especially has been difficult to study, as it is currently on display in an inaccessible place. The recent restorations also however gave more insight into the internal structure of the specimen, which helps to sketch out the broad lines of the preparation techniques.

The most obvious similarities between these specimens is that they have an internal frame around which the skin is fitted, as well as that both sides of the specimens have been prepared to look realistic. The internal structure allowed for the use of nails instead of or in addition to stitching. The specimen from Callantsoog (2757) comes closest to the examples in literature as it has a wooden frame, though this one is hollow and made of slats. The head has been modelled with plaster but on the main body the skin is immediately nailed to the wood. The specimen from Den Helder (2758) has a steel frame with plaster modelled around it. In all these specimens the plaster is not only used to provide a general frame but also to model details in the anatomy of the fishes. The heads for example have been modelled to show cheeks and other features, and particular attention has been given to the mouth which is painted pink and has a modelled tongue (Figure 5). During the restoration of the Den Helder specimen (2758) a piece of the beak was found under the plaster and removed, showing that even in the case of these larger and more recent preparations part of the bones were still kept in place, though covered. The Callantsoog (2757) has genitals modelled in plaster, and in the Den Helder specimen (2758) the skinfolds along the sides were found in the plaster in order to shape the dried skin.

Another similarity between these specimens and in contrast to the earlier specimens are the position of the incisions. A single incision was sufficient for the other preparations to remove the inside and stuff them back up with hay and tow, but in order to wrap the skin around a mount another type of incision was needed. These specimens have had a circle of skin removed on one side, with incisions going from this circle to the tops of the fins and clavus. The Callantoog specimen (2757) has an additional incision on the other side, going from the base of the dorsal fin to the ventral side of the anal fin (Figure 6 and Table 2).

The final difference between the first set of specimens and this one is the way the eyes are modelled. The socket has been shaped in plaster, into which a glass eye with a half-ball shape ‘D’ has been inserted. The back of this glass half-ball carries the image of the iris and pupil. The eye has been inserted into the plaster and the skin with the eye-holes has been pulled over these artificial eyes. The cartilage around the eye has been modelled with plaster as well. These methods are very similar to the techniques described by Brown in 1833, including the plaster, glass eyes and gum-arabic cartilage. Apart from the similar method, the eyes themselves do not look similar.

Figure 5. Comparison in preparation between RMNH.PISC.D.2677, Livorno, (left) and RMNH.PISC.D.2758, Den Helder. Photographs by Lisa Winters, 2022.

Specimen from 1940

The final specimen (2865), from 1940, is the smallest specimen in the collection with a size of 52x74cm. Due to its small size many preparation techniques would have been possible, but it seems that the preparator has taken the latest *Mola* preparations as examples. The specimen has a metal wire- and plaster frame around which the skin has been wrapped. The incision also mirrors this choice of preparation, with a round flap of skin cut off one side and incisions going into the clavus.

The frame would allow for the use of nails to secure the skin, however in this case a simple stitch with one thread has been used, and the seam has been covered up with a tar-like substance. Both sides of the specimen have been prepared, with the pectoral fins standing away from the body. Both pectorals also have a little hole from where it was pinned or hooked to stay in shape.

The eyes are also similar to the ones from the late

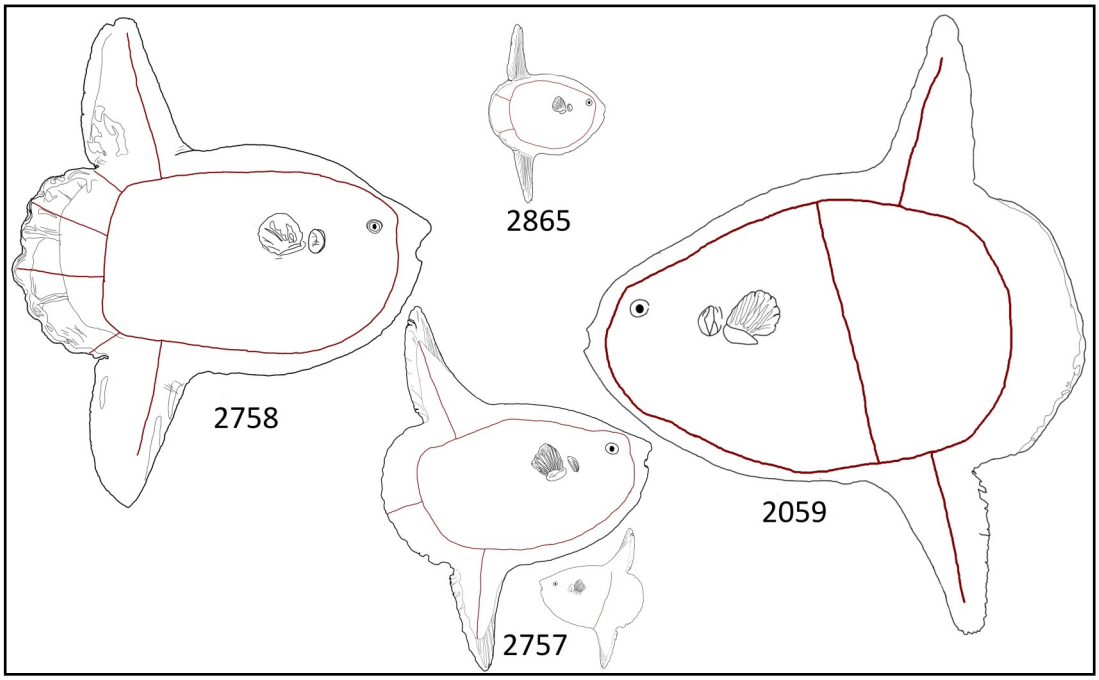

Figure 6: Incision patterns on the Mola specimens from the late 19th century and 1940. Technical drawing by Lisa Winters, 2022.

19th century, since it seems to be a plastic half-ball with a pupil painted or glued onto the back. Through the clear parts of the eye, the plaster into which it has been pressed is visible. Again, the eye seems to be inserted before the skin was pulled over the frame. The mouth has been modelled and does not show the original bone beak. It is pink in colour, again more in line with the late 19th century than with the red from the earlier ones. The skin seems to be heavily treated with conservation chemicals, but it has not been painted/varnished in the way all the other preparations have. Out of all the specimens, its skin looks the most like natural leather.

Due to the fact that there is only one specimen from this time period, it is difficult to say whether this technique was seen as a standard.

Conclusions and further research

This study has led to a description of the dry *M. mola* and *M. tecta* specimens in the collection of the Naturalis Biodiversity Center that can be used to properly conserve both the preparations themselves and the historical preparation techniques used on them in the past. From working with the restored specimens it is clear that a lot of the material history gets lost in this process in order to safeguard the specimen for future exhibition and conservation. A snapshot like this study could help in establishing a collection's historical value as well as their biological one.

The descriptions of the techniques used on these specimens can only hint at their value for the broader historical context of preparation techniques at the RMNH or in the 19th century more generally. We can conclude that their preparation was clearly following pre-existing guidelines. Even though fish skin preparations of this size were not very common, they were prepared in similar ways in their respective times. Many of the techniques used can be traced back to the literature on taxidermy at the time, especially the rules laid out for the RMNH staff and contractors by the founder and director himself, Temminck (1825).

While this first overview has documented many aspects of the preparation of these specimens, there are still a lot of questions left unanswered. Further research and more specialized techniques could help shine a light on some of these questions. For example, x-ray photography could be used to learn more about the internal structures of the specimens and their possible original mounting mechanisms. Another possibility is doing a chemical analysis of the skins, which could provide insights into the specific sources the preparators used for the preservation mixture they applied to the skins, as well as how the specimens can best be preserved today (for a related study, also see Allington-Jones and McKibbin, 2017).

This study can help understand 19th century taxidermy at Naturalis more broadly. If viewed from a technical standpoint, this can only really be done when comparing the techniques described here to other specimens in the collection. During my work in the collection depots I also came across two prepared shark skins that showed practices very similar to the earliest *M. mola* preparations, including the paper strips and sewing techniques. A comparative study of other fish- and animal preparations in the museum's collection from the periods around 1830 and 1890 could further shine a light on the RMNH's own preparation practices and the techniques that were specific to large fish.

From a sociological standpoint, this study suggests the importance that was attached to properly prepared specimens, not only for scientific use but also show to the public. This could be seen in the inference that RMNH preparators re-examined incoming specimen skins and patched them up, creating a "good" side to show off the fish's countenance in life. It could also be an answer to why a sunfish would have been chosen for a dry preparation in 1940, as it would have been easier to simply dissect it and/or preserve it in alcohol if it were only used for scientific study. This hypothesis is something that could again be explored through further study, especially in what would be the next step in a collection biography; how the collection was used.

During this study, the history of how these specimens were acquired was "re-attached" to these specimens. Even though the information was available in publications, in the archive and on the specimen labels, it was brought together here for the first time. Some of these specimens were collected from overseas by employees of the museum. Researching the circumstances in which specimens were collected could help us place specimens in a socio-historical context, and much more can be done on this front. This type of historical research does not only teach us how to care for our specimens, but could also be the first step in decolonizing our natural history collections.

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