Methodologies for Shark Illustration

Marta Ribeiro[1], Miguel Pessanha Pais[2] and Fernando J.S. Correia[3]
martapribeiro@ua.pt; fjorgescorreia@sapo.pt; mppais@fc.ul.pt
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Abstract

Sharks are animals that belong to the taxonomic class of Chondrichthyes or cartilanous fish and are known for having carilage instead of bones, placoid scales and numerous rows of teeth of continuous growth. Although they have been inhabiting oceans since several millions years ago, it is nowadays that they are facing their biggest threat — human activites, namely overfishing. Due to their reputation as predators, this group is not a priority in what concerns to conservation actions, mostly because these relly on people's perception of them. Even though the public's opinion is not the best, sharks play very important roles in the environment and in the ecosystems balance. For this reasons, it is fundamental to create awareness for the population decreases and for the consequences that might follow. Images are a great resource to capture people's attention and awareness when disseminating information. More precisely, scientific illustration is a type of strategically visual units used for scientific actions. It is characterized by its precision and accuracy, as well as versatility. It allows the dissemination of information for both specific audiences and the public in general, and it is also, many times, chosen over photography. To achieve a correct result, scientific illustration must follow specific criteria. Thus, the main aim of this work was to optimize zoological illustration process in order to design a protocol that should be used scientific illustrations of sharks. For that, we used the Carcharhinus plumbeus as a case study and model.

1. Introduction

Sharks are animals that belong to the Elasmobranchii subclass of the taxonomic class Chondrichthyes or cartilaginous fish. This group is mainly characterized for not having bones, but a flexible and tough cartilage skeleton instead, as well as tegument placoid scales and several rows of teeth that are constantly being replaced. Their body has a very functional and hydrodynamic shape and shows five to seven gill openings in the side of their head [1].

1 & 3 University of Aveiro, Department of Biology, Aveiro, Portugal
2 MARE – Marine and Environmental Sciences Centre / ARNET - Aquatic Research Network, Faculdade de Ciências, Universidade de Lisboa, 1649-004 Lisboa, Portugal
2 Departamento de Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, 1649-004 Lisboa, Portugal

Marta Ribeiro, Miguel Pessanha Pais and Fernando J.S. Correia ▪ martapribeiro@ua.pt; fjorgescorreia@sapo.pt; mppais@fc.ul.pt

Sharks have been on Earth for a very long time. They have suffered several evolutionary processes and survived multiple mass extinction events. However, nowadays, they are facing new challenges that are putting many species of this group at risk. All over the world, shark populations are suffering great depletions caused by human activities, with an estimate of 100 million sharks being killed every year. The facts that sharks have long life cycles, late maturity and low fecundity makes them a vulnerable animal group [2]. The previously mentioned human activities include habitat destruction and exploitation, but, most of all, overfishing practices with no significant regulations. Sharks have a great demand for culinary purposes, and more precisely for their fins, especially in the Asian continent [3].

Even though these consequences are known to the public, concerns about them are directly connected to peoples' opinion on these animals, and, through the years, sharks have gained a very negative reputation of being aggressive predators, which is proven not to be entirely correct. In fact, sharks are very relevant for the environment and for the ecosystems' balance, filling the top of food chains and regulating prey/predator balance.

With public opinion being one of the main factors on the environmental decisions and, in this case, the main impediment of conservation actions towards the shark population decreases [4], it is very important to not only properly inform people about this group of animals and try to change their perceptions of it (even though there has already been an improvement in the last few years) [5], but also increase awareness and consciousness. Moreover, sharing the species that are in danger is crucial, as well as their relevant roles in nature, so that the competent entities, such as fishery companies, can take practical measures to decrease their exploitation and other crucial decisions. In order to do this, dissemination actions should take place, not only diffusing information about them, but also showing what they look like or making visible the consequences that their disappearance has on the ecosystems.

When taking these actions into reality, it is, therefore, very relevant to use images (visual representations created manually or digitally, such as drawing, paintings and graphics) or photos. These allow the public to better envision what the subject of the campaign is, since images are often used as a "translation" tool for written text, showing what it means in a clearer and more immediate way [6][7][8]. Moreover, they better capture the public's attention in a world filled with all kinds of stimulus.

Among numerous kinds of visual representations, there is one, besides photography, that is specifically applied to science, named scientific illustration. Scientific illustration is a form of pictorial representation, being described as accurate drawing and painting. Its objective is to portray scientific supported explanations of reality events or phenomena, as well as entities, which include species, so that the viewer is completely informed about the object of study. For this reason, this type of visual communication is considered more disciplined and must be very precise. However, it should always be adapted to its purpose and the aesthetic part should never be compromised, always scientifically based [9][10].

Scientific illustration is many times chosen over photography. Amidst several reasons, it happens because photography can only capture one layer of an individual (external anatomy and morphology), which is often damaged, dirty or even showing phenotypical bias from the model recognized as the specie itself. Also, it is almost never possible to depict an organism's inner anatomy resorting only to photography without intrusive techniques that may leads to the specimen death. On the other hand, illustration allows the author to include complementary information gathered from different sources or different individuals studies in only one picture or, on the contrary, to choose a focus selecting and showing just a few small details (reducing visual noise or pollution) that is always caught by the camera in natural environment [9][11]. In fact, scientific illustrations has come to be the first meta-image, since its arising.

Images also have the capacity to be more vastly understood, no matter if the receiver is an expert on the topic of study or not. By using this method, science dissemination can achieve a much larger scale than only between scientists and investigators, being able to reach organizational levels or even social mass communication levels, for the public in general [10].

Given the significant role of illustration in the dissemination of information obtained in reliable scientific sources, it is crucial that these images are constructed rigorously and thoroughly, and they must follow certain criteria, according to the correspondent field of study, in order to assure the most universality possible.

Although these rules must be followed for an accurate, useful illustration making protocols are inexistent or incomplete, and technical information (scientific and/or pictorial) is dispersed. There is a big gap on which steps to follow to achieve a certain result for many groups of beings, namely the cartilaginous fish, and, more precisely, Selachii or sharks.

Thus, the aim of this study is to apply the scientific illustration process to shark illustration in order to achieve a functional protocol which is easy to follow step-by-step. The final work is going to be used in an action of conservation awareness by the creation of a poster, along with other species of sharks and rays that cross the Portuguese oceans. The sandbar shark (*Carcharhinus plumbeus*) was the anatomical model chosen as it resembles most of the sharks known and it occurs in Portuguese waters.

2. Materials, Methods and Procedures

The creation of a scientific illustration is, most of the times, a process done by an practical and functional association between an illustrator and a scientist. While the illustrator is mostly responsible for the pictorial function, the researcher is responsible for guiding the illustrator in the technical features that must be translated to the drawings (scientific validation), also making sure that the established conventions for that determined scientific area or publisher are being followed.

These conventions regulate factors, such as the number of drawings and whether they should be drawn in a single plate or more than one and assembled together later, the illustration's sizes and presentation techniques.

Marta Ribeiro, Miguel Pessanha Pais and Fernando J.S. Correia ▪ martapribeiro@ua.pt; fjorgescorreia@sapo.pt; mppais@fc.ul.pt

2.1. Aim of the Illustration

The first step in starting an illustration is to know what its main goal is — to depict as a taxonomic or behavioral picture for scientific purposes, or to use a more natural visual approach for dissemination to a non-expert public-target. More precisely, it's strongly advised to prior establish where it will be published and the target audience . Each dissemination media and/or audience requires different drawing specifications, such as the final dimensions of the artworks and wether it should be simple or more detailed, monochromatic (continuous tone or black and white) or full color, [13], depicted solely, in an ecological relationship action (predation, or others) or in an habitat or ecosystem, using a diorama strategy or an infographic style instead. This information should be prioritized as it will allow the illustrator to choose the correct techniques.

In the case of this project, the final goal would be to make a poster showing sharks species for conservational purposes and the target audience is general public mainly non-experts. As it is very important to show diversity of threatened and/or endangered Portuguese species, correlating them, the final poster will present the whole body of the specimen, in a colored and detailed illustration, as well some complementary information (visual units — teeth — and succinct text blocks) in an overall infographic design.

2.2. Views and Identifying Traits

After having a clear idea of the objective of the illustration and the information that should be explicitly represented, the views in which the specimen is going to be depicted should be chosen. In general shark representations, the most usual view is the lateral view, with the head facing the left side and the posterior part of the body on the right. This view by itself summarizes almost all the most identifying traits that ensure a correct diagnose, and allows a positive specie identification — therefore it was chosen to be applied to all the 21 species presented in the Portuguese sharks and rays poster project. Some shark species require a second perspective on the body, and ventral view usually being the chosen one.

It is also possible to find dorsal view illustrations and some investigation works require illustrations of species in more natural positions, such as swimming or feeding.

In certain species, it is also relevant to show parts of the body that can be used as identifying traits. In the case of sharks, teeth may usually help to reach the correct species or, at least, the genus.

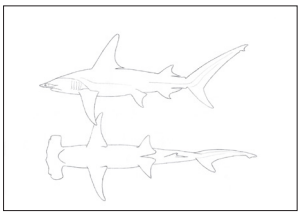

Fig. 1. Lateral and ventral views of the shark species *Sphyrna mokarran*.

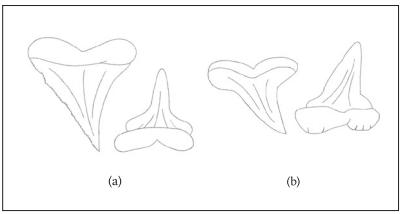

Fig. 2. Teeth outline. A- upper and lower teeth views of *Carcharhinus plumbeus*; B- upper and lower teeth views of *Sphyrna mokarran*.

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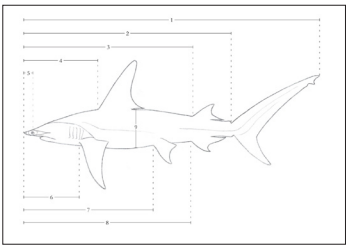

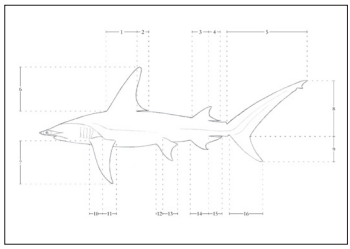

Fig. 3. Main longitudinal measurements: 1- total length of the body; 2- snout to caudal fin insertion; 3- snout to 2nd dorsal fin insertion; 4- snout to 1st dorsal fin insertion; 5- snout to eye; 6- snout to pectoral fin insertion; 7- snout to pelvic fin insertion; 8- snout to anal fin insertion; 9- abdomen height.

Fig. 4. Main fin measurements: 1- 1st dorsal fin insertion length; 2- 1st dorsal fin free rear tip length; 3- 2nd dorsal fin insertion length; 4- 2nd dorsal fin free rear tip length; 5- upper caudal fin lobe length; 6- 1st dorsal fin height; 7- pectoral fins height; 8- upper caudal fin lobe height; 9 – lower caudal fin lobe height; 10- pectoral fins insertions length; 11- pectoral fins free rear tip length; 12- pelvic fins insertion length; 13- pelvic fins free rear tip length; 14- anal fins insertion length; 15- anal fins free rear tip length; 16- lower caudal fin lobe length.

2.3. Measurements and Proportions

Before the pictorial process itself, drawing a specimen should start with the analysis of the subject or deep research about it and its anatomy — consulting reliable information on data bases (literature, web). Since it is very hard to find photography displaying the specimen in a straight lateral view without perspective distortions, it is important that, when one has access to a real individual, the investigator takes measures of the body features. The more measures taken, the more accurate the final illustration is going to be.

Besides the represented measurements, the number and placement of the gills is also important, as well as any other distinctive features that a particular specimen might present (snout, dorsal thorns, etc.).

When there is no access to a live or preserved specimen, which is normally the case with sharks, the illustrator should try to get as much information as possible from photographs and reliable sources. Hence, the first step in this process was to collect various images from the chosen specimen, *Carcharhinus plumbeus*, and to analyze the different distances, insertions points of the fins and their general shape.

In the case of this particular species, there were a lot of photos available, which made the following step easier. The different angles and positions found on the animals enabled the correct assessment of the correlated measures and proportions, as well as allowed to see its different details. However, there are some other species in which this isn't the case and where the photography is very scarce, making this step more difficult and requiring even more input from the scientist (literature descriptions, practical experience, etc.).

After having all the essential measurements, it's necessary to scale them down to the paper's size, making sure that all the sizes are on the right proportion. In the final artwork, it is also important to insert a scale, to give a dimensional idea of what the specimen's mean size in nature.

2.4. Drafting

After having all the anatomical details figured and properly scaled, drafting is the next step. Drafting is the process of graphically translating all information gathered in the previous steps. There are several techniques that may be used when making the sketches. In this case, tracing paper was used in a multi-layering superposition, in which each layer contains a specific visual information (body shape, fins, gill slits) drawn with HB graphite pencils. Each of them may be corrected individually, introducing editability,

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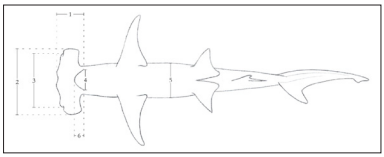

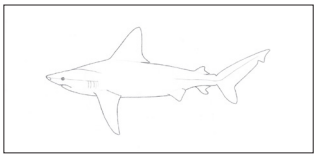

Fig. 5. Main ventral measurements: 1- snout to mouth; 2- snout width; 3- nostrils width; 4- mouth width; 5- abdomen width; 6- mouth length.

Fig. 6. Graphite line draft of a specimen of *Carcharhinus plumbeus* in lateral view.

This step may be one of the longest, since the drafts are constantly going back and forth between the illustrator and the scientist, ending up suffering several changes and corrections, until an anatomically right drawing is reached. In this particularly study case among the alterations pointed, the position of the gill slits had to be corrected and the fins' insertions and free rear tips needed more clarification.

After all corrections are done and finished, the final drawing was scientifically validated. Over it, preliminary volume essays were done using graphite shading in another layer of superimposed tracing paper.

2.5. Painting Techniques

To achieve the final color illustration from the validated preliminary drawing, many techniques may be used. These may be divided in two types: traditional and digital. Some traditional techniques examples are colored pencils, pastel, watercolor, acrylic and other kinds of painting or mixing techniques [12]. On the other hand, digital art is made using a computer and specific software, using a graphic drawing tablet and digital pen. There may also be a hybrid of these 2 techniques, which can resort mainly to traditional techniques finished in digital environment (background removal, saturation and color changes, shadow and brightness enhancement, etc.), but also blend them in a mainly digital artwork (using preliminary drawings to support color adding, for instance).

The techniques used in the final arts may be determined by printing methods and requirements requested by each publisher, but it's also a personal choice of the illustrator, usually one in which they feel comfortable. It is also very frequent that the researcher does not have a firm idea in which publication the illustration is going to be disseminated, which means that it's more favorable to select a versatile technique or set of techniques.

After some essays with traditional techniques, such as watercolor and colored pencils, and digital ones, and after evaluating aesthetical results and time required to achieve similar effects, it was decided that the shark illustrations will be done in digital techniques. A 2D editor (Procreate) was the election, as it simulates the use of traditional techniques, using different tools that allow the personalization of color and texture, amidst others.

No matter the final goal of the illustration, this process should result in a clean and clear artwork, without any distractions that could deviate the attention from the object of study. The background should be clean (neutral, as white or luminous pastel colors), unless it is an illustration with background context.

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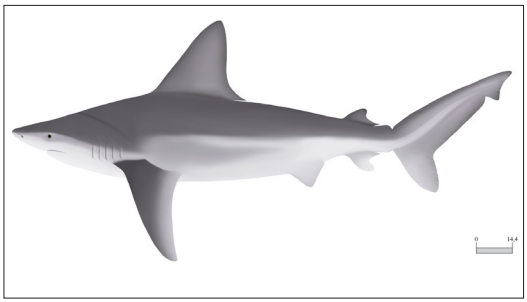

Fig. 7. Final illustration of a specimen of *Carcharhinus plumbeus*.

3. Results

Upon following all the steps, the illustrating process resulted in a final 2D illustration model — archetype — that truly represents the species *Carcharhinus plumbeus*.

4. Discussion and conclusion

As one of the most important tools for science dissemination, it is of extreme importance that the illustration process is clear and detailed. The aim of this study was to apply the zoological illustration process to shark illustration, more precisely to an individual from the species *Carcharhinus plumbeus*.

During the first phases of the illustration, especially in the drafting process, it was evident the relevance of a close contact between the artist and the scientist. The drafting process influences all the following steps, which is the reason why maintaining scientific accuracy is crucial, and the input from a specialist was fundamental. If the sketches are not correct and there are errors in these first stages of the illustration, all the following work is compromised and, in order to have an acceptable result, everything needs to be redone — which is a non-productive workflow.

The last step of the process started with the use of watercolor to achieve the final artwork. However, this technique has proven to be extremely time consuming, which led to the experimentation with digital techniques. This method ended up having several advantages when comparing with traditional techniques. For instance, the possibility of using layers allows a greater flexibility when working with different details of the illustration, as well as facilitates the correction of mistakes, since it is possible to delete or edit one layer without consequences on the others. Besides, digital editors have tools that mimic the use of conventional techniques, such as watercolor, airbrush and colored pencils, among others, and allow working with different brushes and blending options, textures, color options and opacities.

This set of characteristics makes this method very versatile and beneficial for scientific illustration in general. The zoom in and zoom out options makes possible to work and reach a level of detailing that could be harder to achieve in physical paper, even using magnifiers. Moreover, the stabilization options that are offered allow steadier, smoother and more uniform lines. Lastly, once in digital format, it is easier to resize the artworks without big impacts on their quality, and images may be saved in numerous file formats, which is the ideal option, since different publishers, whether it's for printing or digital presentation, might require it.

In conclusion, the study was a great opportunity to systematize the illustration process in a protocol approach that may enable others illustrators to achieve very similar final results in shark illustration.

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