The Variation and Distribution of Placoid Scales in Chain Catsharks and its Significant to Taxonomy

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Abstract

Many taxonomists classify sharks based on distinctive characteristics such as number and/or shape of teeth or placoid scales. Historically, teeth and placoid scales have long proven to be great resources to categorize sharks when studied in full detail. However, when crucial information becomes vague, it becomes valueless and leads to confusion. The overall objective of this Honors Summer Research was to compare and analyze placoid scales from different areas of the shark’s body, to determine if predicted variation is present. I examined scales from one species, Scyliorhinus retifer, in three different size ranges from juveniles through adults, and both sexes. Skin samples were taken from at least thirteen body regions. The skin samples were air dried, metal coated, and examined for scale shape using a scanning electron microscope. A total of at least one hundred and fifty scale samples was closely examined to support my hypothesis that scale shape varies with age, location on body, and that female scales are different from those of male scales of the same age and/or body location. Throughout the eight weeks, the first week focused on intensive training on the scanning electron microscope. Over the next several weeks, I analyzed placoid scales and compared them to different body regions, sizes, and sexes to support the hypothesis that scales shape do change within body region and age. However, the scale shapes do not vary with both sexes. The last week I compiled material and made it into a presentable, arguable document in support of my hypothesis. This will in effort, show that when essential information is provided placoid scales can be very useful in taxonomy.

Introduction

Surprisingly, most recognized taxonomists provide a vague description of shark species and one image of placoid scales. Placoid scales are very important in distinguishing species and deserve a more conscientious treatment. Traditionally, taxonomists will identify species of sharks based on various characteristics such as placoid scale (i.e. their shape, texture, and size); however, they will typically just present one placoid scale and not specify where on the body it was extracted, size, or sex of the shark. This leaves readers with no choice but to assume this type of scale is found all over the shark’s body when it is not necessary the case. I intend to demonstrate that scale shape and size do change with shark’s age and body region. Therefore, this makes it extremely risky to identify a shark based on one placoid scale. When crucial information
is not provided, the placoid scales essential becomes valueless because of no usage since it only provides more confusion and frustrations. Therefore, when information is not provided in details, we are left with the assumption that this kind of scale shape and size is all over the shark’s body.

The purpose of this research, 1) is to show that placoid scale shape and size change with age and body region; therefore, it is extremely risky to identify species of sharks with just one scale, 2) to show that placoid scales can play a significant role in taxonomy if used correctly, and 3) to provide helpful suggestions for future scholars and taxonomists.

To complete the research requirements, I used Chain Catsharks for several reasons. First, it was convenient, because we have catsharks of every age and both sexes at Sweet Briar College. In addition, they are small (under 2 feet in length). They are easy to care for and are non-aggressive. Last, they are tough, and they can tolerate stress (e.g., allowing people to handle them, allow measurement, and receive injections).

General background information on the Chain Catsharks, *Scyliorhinus retifer*, belongs to family *Scyliorhinidae* and order *Carcharhiniformes*. They are respectively the largest and most diverse groups of shark (1). They are noteworthy for their emerald green eyes and beautiful black chain pattern covering their skin. They live in cold deep water and are fairly small (under 2 feet in length). These sharks are bottom dwellers, and their bodies are elongated and not designed for fast swimming. They tend to eat crabs, clams, snails, and small fishes by crushing the prey with their teeth. They are distributed from Nova Scotia to Nicaragua. Chain catsharks are commonly taken as by-catch (2).

Shark’s skin is covered with tooth-like dermal denticles structure teeth. The basal plate of the scale is implanted in the epidermis of the shark. The basal plate contains the pulp that supplies the troth with nerves and blood vessels. It has been noted by Wolf-Ernst Reif, that the basal plate is initiated by osteoblasts and consists of acellular bone
(4). The outer-most surface is hard enamel, which is why placoid scales seem to resemble teeth (5).

**Figure 1:** A detail image of a placoid scale and the various parts labeled (6).

Individual denticles are constantly being replaced instead of increasing in size unlike fish scales that do enlarge as the fish grows. Shark denticles are replaced and the replacements are larger than the previous ones (6). The placoid scales are aligned parallel to each other facing in one direction from front to the back.

Placoid scales provide a variety of different functions depending on body region. The four major functions are: protection from predators and ectoparasites, protection from abrasion, accommodation of sensory organs, and reduction of frictional drag (3). The most common purpose of placoid scales is protection. These scales must be tough enough to endure scrapes and scratches from coral, reefs, other sharp objects, but yet smooth enough to escape from predators and swim though water efficiently. Also, they must somehow shed efficiently to remove ectoparasites, in addition, to functioning in defense against abrasion from the substrate. W. Rashi and C. Tabit have noted that during breeding seasons, to avoid damage and to reduce cost of repair, females thicken the scales of their dorsal surface to minimize the wounds caused by males biting them during mating. The placoid scales accommodate sensory organs by altering ridge patterns, number of ridges, or scale shape to redirect and direct water flow into sensory organs more efficient. The last, but not least, function is reduction of frictional drag. Ridge pattern characteristics will change to provide drag-reduction and redirection of water
flow (3). W. Rashi and C. Tabit have observed that this anterior-posterior channeling of water flow and this reduces frictional drag (3).

**Methods and Materials**

The specimens were collected as by-catch of commercial fisheries trawling off New York and New Jersey. Five specimens were studied: two juveniles, one adolescent, and two adults. Three females, one of each age, 11.6 cm, 34.0 cm, 40.8 cm, and two males (one juvenile, and one adult) 10.6 cm and 46.9 cm were included. Due to the regiment time schedule, the male middle age set was not viewed under the SEM, but intend to do so in the future research. Each specimen was preserved in 70% Ethanol. The skin samples were cut from thirteen body regions in females and fourteen body regions in males, (See Figure 2). The body regions included the following: H1 (head/snout area), H2 (mouth/chin area), H3 (gill region), P1 (pectoral fin), P2 (pelvic fin), CLA (claspers, male sexual organ), A1 (anal fin), C1 (caudal fin), T1 (body region posterior to pectoral fin), T2 (body region anterior to 1st dorsal fin), T3 (body region posterior to 1st dorsal fin), T4 (body region anterior to 2nd dorsal fin), D1 (1st dorsal fin), and D2 (2nd dorsal fin).

![Figure 2](image-url)

**Figure 2:** This image shows a Chain Catshark and the regions where samples were taken. The head area is represented by the red color and its arrows point to its specific regions. The six fins area is represent by blue color and its arrows point to its specific regions. The trunk area is represented by the green color and its arrows point to its specific regions. The claspers area is represented by black color and its arrow point to its specific region.
Body regions included, H3, T1-T4, and all six fins area were sampled from dorsal, lateral, and ventral areas. All samples were viewed under the SEM to detect the changes in the scale shape and/or sizes. The skin samples were pinned down onto styrofoam to pervert curling up when drying. In addition, to limit dust accumulation, I placed a paper towel over the specimens, and placed them in a drawer to dry for about twenty-four hours. When the samples appear to be dry, they are tough feeling and are non-flexible. To prepare for viewing under the SEM, I placed 12-mm-diameter, carbon-conductive sticky tabs on each stub. Then, I placed a dab of Elmer’s glue onto the sticker and placed the sample onto the glue. I allowed the glue to dry an additional 24 hours. The stubs were placed in a sputter coater, (Desk II Denton Vacuum), and were coated with gold-palladium until the surface resembled a silvery color. Due to the rough surface, it required approximately 60 seconds at approximately 50 mTorr. This process takes about 10 minutes. Once coated the samples were ready to be viewed under a scanning electron microscope, (AMRAY 1810). Viewing the samples under the SEM will enable me to see the difference in the scale shapes and sizes according to body regions on different age sets and sexes.

**Results**

Size and shape of scales do change with age and body region. A general overview of this variation is provided below. The juveniles represent a size range of birth until 14.9 cm. The two juveniles examined was 10.6 cm and 11.6 cm total length. The scales were very spiky and non-overlapping. The scales protrude outward and are rough instead of smooth and flat. There are several different scale shapes on the bodies of juveniles, and some development of ridges and dimples are present on the scales. Scale sizes were 0.2-0.4 mm; there are some variations of sizes within the juveniles.

The adolescent represents a size range of 25.0-34.9 cm. The single adolescent shark examined was 34.0 cm total length. The scales were non-spiky and overlapping unlike the juveniles. The scales have 3-5 strong ridges and well developed dimples along the edges of the scales. The scales are parallel to the skin and do not protrude outward. There were some size variation among the scales; the overall length was 0.4-1.2 mm.
The adult represents a size range of 45.0 cm and up, but do note catsharks grow under two feet in length. The two adults examined were 40.8 cm and 46.9 cm total length. The scales of adults are not spiky but parallel to the skin and overlapping. The scales have distinctive bold ridges and well-developed dimples along the edges. The base is wider than the other size ranges. The adult scale ranges in size from 0.4-1.3 mm. I did not detect any differences in the scale shape or sizes between sexes.

Within body regions, the following observations were made. From dorsal to ventral, the ridges become less defined. The number of ridges decreases from 3-5 to none. In addition, the dimples become shallow and less numerous towards the ventral surface of the shark. Also, the scales are thick and appear rough on the dorsal surface, and become thinner and smoother towards the ventral surface.

**Discussion**

One can clearly see that scale shape and size both change with body regions and age. The scale tenure change, its design, the number of ridges, the boldness of ridges, the developed dimples or poor developed dimples, how wide bases and/or narrow bases, the thickness and/or thinness all are detected with various body regions and ages of sharks. No significant scale shapes or sizes change with both sexes. However, maybe there is a change in the scale thickness during breeding seasons. Maybe the females change their scale only in a certain time of the year such as breeding season, and the females’ scale thicken to tolerate males biting them to latch on. The only way to know is to capture catsharks in both sexes during breeding season, and do the same procedure again to analyze and compare scales (3).

It is surprising to see respected taxonomists provide only one image of placoid scales without valuable information given (e.g. where the scale was extracted, or the age of the specimen). The result of this practice causes readers to assume that sharks possess only one scale shape and size all over their body when that is not the case. This is a major mistake and causes nothing but confusion. Clearly, a uniform standard method of
nomenclature must be established. For example, extracted placoid scales from one body region only (e.g. the left side of the trunk below the 1st dorsal fin). In addition, the length of the specimen must be reported. This method will establish consistency and fewer frustrations when given all the proper information.

Everything must be named to distinguish those characteristics to limited confusion. If the species has a name, it can provide important information for management and conservation purposes. This can help keep track of the status of the species’ population (i.e., if it needs to be added to the endangered list, or banned from fishery). Another important factor about establishing a uniform classification is that it can provide hints and clues in other closely related species that are poorly studied. For example, there are approximately 400 known species of sharks worldwide, and Chain Catsharks are one of 225 species in their order and 160 species in their family (1). This means Chain Catsharks are close relatives of at least forty percent of all shark species. So, knowing something about this species can help give clues or hints to other poorly studied species.

In summary, placoid scales are very useful in taxonomy when given proper consideration. It has been proven that scale shape and size do change with body region and age. Therefore, it is extremely risky and nearly impossible to identify species of sharks with just one placoid scale. A standardized methodology must be established to avoid confusion and make species identification more trustworthy.
Literature Cited


