S1. Calculation of relative elemental composition in shark skeletons and serum

S1.1 Estimate of the calcium and phosphate content in a shark skeleton

We used a range of data sources and some assumptions to estimate the calcium and phosphate concentrations in the serum and skeleton of a bull shark (*Carcharinus leucas*); the resultant data are presented in Figure 2. There are few data available on serum and skeletal composition for elasmobranchs; we converted all calculated values to percentages of body mass to provide generalizable values for serum, body and skeleton components per kg of shark wet body mass.

Body composition data are available from the analysis of a ~48 kg Lake Nicaragua shark (*Carcharinus nicaraguensis*), a similar species to *C. leucas* [1]. This species lives in freshwater, but data show that the sera compositions did not differ largely between this and three marine shark species [1]. The total body composition of *C. nicaraguensis* was reported to be 72% water (5.5% plasma water + 66.5% other water) and 28% solids by body weight [1].

The shark's 28% solid material was assumed to be comprised of skeletal mass (6%) and other solid mass (22%), such as skin, soft tissues, and teeth. Skeletal mass data come from direct measurements of two dry *C. leucas* skeletons (AMNH-218147: 73.5 cm TL, 149.9 g skeleton; AMNH-218184: 113.1 TL, 525.1 g skeleton; A. Summers, personal communication). Growth curves [2] were used to calculate what the wet body mass would have been for sharks of these total lengths. On average, the skeleton was calculated to be ~6% of wet body mass.

Dry skeletal weight was estimated to be 39% mineral and 61% other material, based on composition data for pelvic propterygia from several species of batoid fish (rays, skates and relatives) [3]. With these data, a value of 2.34×10^{-2} kg of mineral per kg of shark (i.e. 39% mineral x skeletal mass) was estimated.

Urist [4] reported a Ca/P ratio of 1.5 for elasmobranch skeletal mineral. Assuming that the mineral is only calcium and phosphate (as HPO_4^{2-}), this ratio, and the molecular weight of Ca^{2+} and HPO_4^{2-}, were used to estimate the Ca mass in elasmobranch skeletal mineral (0.385 g Ca/g mineral).

Given an estimate of 2.34×10^{-2} kg mineral per kg shark, this represents 9.01×10^{-3} kg calcium ($0.385 \times 2.34 \times 10^{-2}$), and 1.44×10^{-2} kg HPO_4^{2-} in skeletal mineral, per kg shark.

Applying these percentages composition data to a mature, 160 kg bull shark, we would expect 8.8 kg of plasma water, 106.4 kg of other water, 9.6 kg of dry skeletal mass, and 35.2 kg of other dry solid mass.

S1.2 Estimate of the calcium and phosphate content in shark serum

We assumed the shark's body water (72% of body mass) to be split between plasma (5.5%) and other tissue water (66.5 %) [1].

With these data, a value of $5.5x10^{-2}$ kg serum/kg shark was calculated. Assuming serum density of 1.026 g/mL [1], an estimate of $5.36x10^{-2}$ L serum per kg shark was calculated.

Values of the milliequivalents total calcium (7.5 meq) and free phosphate (2 meq) in elasmobranch serum were taken from Urist [4]. As there are both HPO_4^{2-} and H_2PO^{4-} phosphate species present in the neutral pH of serum, the average inorganic phosphate (P_i) charge was assumed to be 1.8 meq/mol P_i [4].

With the data from Urist, the total calcium concentration in serum was calculated to be 3.8 mM, and the free P_i concentration was calculated to be 1.1 mM. Given the serum density and atomic and molecular weights of calcium and P_i, these data gave serum values of $8.04x10^{-6}$ kg calcium per kg shark, and $5.72x10^{-6}$ kg P_i per kg shark.

Elasmobranch hematocrit data from Urist [4] were used to estimate the calcium and P_i content in the material that sedimented from elasmobranch blood. Hematocrit was estimated to be 20 percent of blood volume. Urist reported 3.4 meq total Ca^{2+}/L blood cells, and a surprisingly large 77.4 meq P/L blood cells. Assuming meq charges to calculate calcium and P_i content in serum, an estimate of 1.7 mM Ca^{2+} and 43 mM P was calculated for the blood cellular content. Assuming 20% of the serum volume, these cellular Ca and P values were calculated to be 13.6 mg total Ca^{2+}/L blood, and 826 mg P_i /L blood. Assuming $5.36x10^{-2}$ L blood per kg shark, estimates of calcium and P_i in the blood sediment are $7.3x10^{-07}$ kg Ca^{2+} and $4.4x10^{-5}$ kg P_i per kg shark.

References

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