Parrotfish tooth research may ring in new era of biomaterial development

By DTI

SINGAPORE/BERKELEY, USA: The achievements of science are evolving constantly. However, there are many natural wonders that humanity has not been able to mimic yet. Among these are parrotfish teeth, which are one of the strongest and most abrasion-resistant in the animal world. Investigating their structural make-up, a team of researchers has now determined the underlying properties that make the fish’s teeth strong enough to even bite stony corals.

“Parrotfish teeth are really good all-round biters of hard things, and few other teeth in nature are harder or stiffer,” said lead author Dr Matthew Marcus from the Lawrence Berkeley National Laboratory in California. To feed, the investigated steephead parrotfish Chlorurus microrhinos bite off corals and assimilate the organic material within it. To do so, these fish have two sets of teeth: one for biting corals and a pharyngeal set for grinding and chewing the bitten-off material.

Aiming to find out what makes the fish’s teeth so resistant, the researchers first measured their mechanical properties in nanoindentation experiments. Afterwards, they performed chemical analysis with a variety of techniques, including scanning electron microscopy with energy-dispersive X-ray analysis and electron probe micro-analysis.

As reported by nanotechweb.org, the results showed that it is not the material of parrotfish teeth that is special, but the arrangement of the crystals of the teeth. Studying the structure, the researchers found that the enameloid nanocrystals co-orient and assemble into bundles interspersed like the warp and weft threads in fabric. The fibres gradually decrease in size from 5 μm at the back to 2 μm at the tip, and according to Marcus, it is this size decrease that makes the tooth structure so hard.

“The results also show that in nature, complex structures have evolved to carry out specialised extraordinary functions, like biting coral, using simple, unsophisticated materials,” Marcus told nanotechweb.org. “Man-made materials, in contrast, usually do the opposite—that is, we use high-tech materials with a very basic structure.”

According to the researchers, the techniques used in the study could be employed to study human bone and teeth more thoroughly and help in the development of new biomimetic materials.

The study, titled “Parrotfish teeth: Stiff biomaterials whose microstructure makes them tough and abrasion-resistant to bite stony corals,” was published online ahead of print on 30 October in the ACS Nano journal.

Dental radiographs can reveal vitamin D deficiency

By DTI

HAMILTON, Canada: Human teeth hold vital information about vitamin D deficiency, and Canadian anthropologists have now found that this serious but often hidden condition can be detected on a simple dental radiograph. Identifying individuals who may have experienced vitamin D deficiency has significant potential for further understanding of the factors that may have compromised the health of people in the past.

McMaster University researchers Prof. Megan Brickley, Lori D’Ortenzio and their colleagues had previously discovered that human teeth hold a detailed and permanent record of serious vitamin D deficiency. This appears as microscopic deformities in dentine and can be extremely valuable for understanding precisely when people, even those who lived centuries ago, were deprived of sunlight, necessary for the body’s production of vitamin D.

The record is preserved by enamel, which protects teeth from breaking down, unlike bones, which are subject to decay. The problem with looking for such deformities is that a tooth must be cut open to observe the patterns that form a lifetime’s vitamin D record, and the supply of post-mortem teeth available for study is limited.

To avoid wasting precious specimens, the researchers looked for a way to isolate teeth for further investigation. By using radiographs to study the readily observable shapes of the pulp horns, the researchers found a consistent, recognisable pattern that could prove helpful both to their studies of archaeological teeth, as well as to people who may not realise they are suffering from vitamin D deficiency.

The pulp shape in a healthy person’s tooth resembles an arch topped by two cat ears, but in a person who has had a severe deficiency of vitamin D is asymmetrical and constricted, typically looking like the profile of a hardbacked chair.

D’Ortenzio and Brickley’s previous research had suggested such a recognisable pattern, and their examination of both historic and current teeth proved that radiographic images are consistent and reliable indicators of prior deficiency.

“It was a real eureka! It wasn’t just that it looked different. It was different,” remembered Brickley, who holds the Canada Research Chair in Bioarchaeology of Human Disease. “I think it’s really important. It was a piece of work that aimed to look more at past individuals, but it has the potential to contribute to modern healthcare as well.”

Since the consequences of vitamin D deficiency can be severe—especially in terms of bone health—knowing who has had a deficiency can help identify people who may have ongoing issues to prevent worse damage, the researchers said. If regular dental radiographs show a problem, blood tests can confirm whether there is a current deficiency.

Knowing more about ongoing vitamin D deficiency can also help to determine what is the best balance between protecting people from harmful UV rays and making sure they get enough sun to maintain a healthy level of the vital nutrient.

The study, titled “The rachitic tooth: The use of radiographs as a screening technique,” was published online on 7 November in the International Journal of Paleopathology.