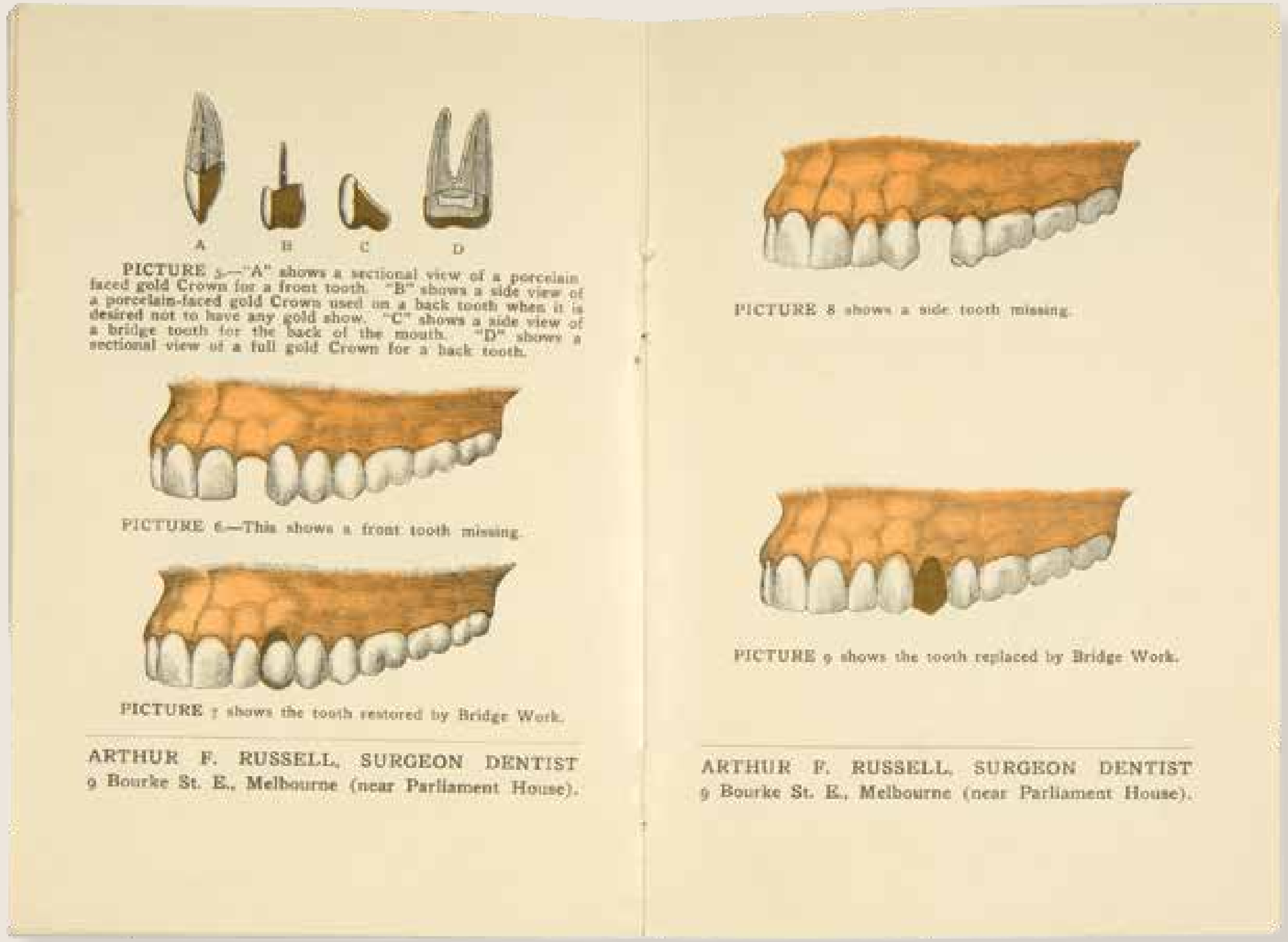

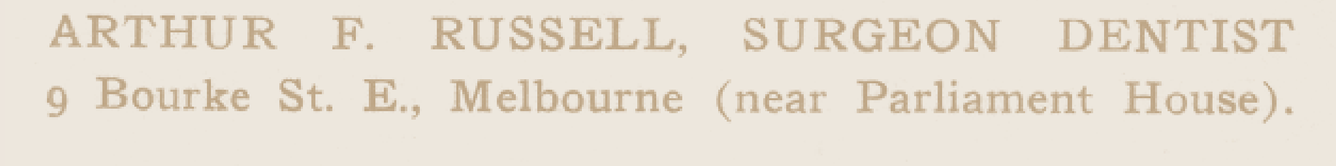

Teeth: Our record-keepers and story-tellers

Before the development of tools, implements and dental prostheses (however primitive the first of these were), human survival depended on a functioning dentition. Teeth meant life. This is still the case for many organisms today: if its teeth are lost, or cannot function—due to malocclusion, for example—the organism is unable to catch prey or break down other food sources and, as a consequence, dies. It might be this brutal fact that gives the image of teeth such power. Add to this the ability of teeth to seize, cut and cause trauma, and the symbolism of teeth is elevated further. Without teeth, all is lost—but the presence of teeth can mean danger!

Extracted teeth have long been used in stories and legends to represent trauma, disease and violence. Today, an image of an extracted tooth is often used in dental clinic logos, even though that is exactly what dentists are trying to help you prevent.

Odontologists and researchers in mineralised tissue spend a lot of time around teeth, either extracted or situated in the jaws of humans and animals now reduced to skeletons. They appreciate the importance of teeth to the human story, due to their understanding of how teeth develop and what they can tell us about human life and health. Because teeth are so important in this regard, they are under very strict genetic control. The number, size, shape, location, timing and sequence of development and emergence into the oral cavity are all subject to strict regulation. Knowledge of these regulatory pathways and patterns of growth can indicate when things don't exactly go to plan. Take for example the growth of enamel—the hard substance that makes up the external part of the tooth crown. Enamel is laid down by a group of cells, starting at the base of the future cusp or cusps of the teeth, at a rate of between two and four thousandths of a millimetre a day. Disruptions to this process are caused by changes in nutrition and disease. Even the process of being born causes a temporary cessation of nutrition necessary for enamel formation, and can produce a line visible by microscopy in a section of the tooth. This line is called the 'neonatal line'. Once enamel is formed, the cells that produce it cease working, and are no longer present once the tooth has emerged in the oral cavity. That means that whatever affects the formation of enamel can be seen in the tooth crown: repair and remodelling are not possible (as they are in bone, for example).

Cat. 93 Arthur F Russell (1864–1915), ***Dental bridge work to-day***, Melbourne: Renwick, Pride & Nuttall (printer), c. 1910s, paper, ink, 17.4 × 12.0 cm. HFADM 2781, gift of Mrs Newton, Henry Forman Atkinson Dental Museum, University of Melbourne.

In addition to this, the elements used in the formation of enamel originate in the environment. We can use isotopes of some elements to determine the environmental conditions under which a person lived while their tooth crown was forming. All this information is recorded in the enamel before the tooth is even visible in the oral cavity. Once the crown of the tooth emerges, variations in morphology and tooth tissue structure can be observed. Morphological variations of the teeth can indicate disease processes (for example, congenital syphilis), some population group ancestries, and the presence of syndromes that also affect other body systems and organs.

Throughout life, the tooth is subject to influences from the outside world, in the form of bacteria, chemicals and physical forces. All of these can and do affect the structure of the tooth, and can tell us about the diet, environmental conditions, activities and health of an individual. For example, people who habitually smoke pipes or hold bobby pins between their anterior teeth develop tell-tale grooves at the incisal edges.

When considering extracted or otherwise loose teeth, we can use a number of features to learn about an individual's population group, age, disease and diet history. In addition to morphology and variations thereof, the size of a tooth can indicate population group, as can variations in root morphology, which are most easily seen when the tooth is released from its socket.

In the context of individual identification, teeth can provide enough information to make a definitive decision about identity. Teeth are the only mineralised structures visible externally. Their distinctive morphology and arrangement in the oral cavity can enable superimposition of an image of the teeth in the skull over a living smiling photograph to support a match or exclude an individual. In addition to this, impeccable dental records and X-rays can be matched pre- and post-mortem. This is the domain of forensic odontology, which applies scientific techniques and odontological experience in a legal context, such as identification after mass-casualty disasters (catastrophic bushfires, for example).

The development of advanced techniques in the fields of imaging and genetic analysis is revealing new insights into the world of teeth and their attachments. We can now study the dental calculus microbiome, which tells us about bacteria in the mouths of ancient humans and their relatives. Calculus is mineralised dental plaque. It forms layer upon layer on the tooth surface, unless removed by cleaning. As it forms incrementally, calculus entombs micro-organisms, as well as food particles and other debris that enters the mouth. 'Digestion' (dissolution of the mineral) of calculus by chemicals can reveal fibres of plant material and starch granules—all evidence of an individual's diet. Determining the ancient calculus microbiome involves genetic sequencing of bacteria released from calculus samples. This is an extraordinarily delicate technique: samples are easily contaminated, and even though calculus is a wonderfully safe preserver of encased bacteria, disruption of the calculus structure and adverse environmental conditions to which post-mortem teeth are often subjected can destroy the bacteria, making genetic analysis impossible. Unfortunately, techniques for revealing calculus inclusions and the microbiome of the oral cavity through dental calculus are mutually exclusive. Both are destructive techniques, and can only be performed once on a given calculus sample. Improvements in the resolution and sensitivity of imaging techniques are letting us understand variations of the mineralisation in the tooth structure, helping us detect disturbances in mineralised tissue development, and the progression of carious lesions in teeth.

Rather than being a frightening, primal symbol of predation and the struggle to stay alive, teeth are the record-keepers and story-tellers of our existence. When we consider the investigative techniques we have available to us, we can help teeth to reveal more details about human life, health, habits and disease.

Dr Rita Hardiman