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Swimming in Stone. The amazing Gogo fossils of the Kimberley, by John Long, 2006, Fremantle Arts Centre Press, Fremantle, Western Australia, 320 p., paperback, USD26.95; ISBN 1-921064-33-1.

At Gogo Station near Fitzroy Crossing, Western Australia, Upper Devonian rocks representing ancient reefs with shales with calcareous concretions are exposed. The calcareous concretions contain a diverse fish fauna preserved in spectacular three-dimensional detail. The author, John Long, has been collecting in this region for many years, mainly when he was curator at the Western Australian Museum in Perth. The author is a very productive writer of scientific publications and books, as well as popular books, including many for children. In this book he gives a lively account of his deep involvement with the Gogo locality, the Gogo fishes, the history of collecting at the site and his own experience in the study of fossil fishes. This book is dedicated to two other Australian colleagues, Ken Campbell and Richard Barwick, who contributed a lot to our knowledge of the fishes of Gogo.

An explanation of the geology of the region with reef, fore reef, and basin deposits (Gogo Formation) is followed by the history of its discovery (Chapter 1). Here Kurt Teichert's life history is given and put in connection with his discovery of the Gogo locality and fishes in 1940. It follows the life history of Richard Bedford (Chapter 2), an Australian from England, who alerted the British Museum of Natural History, London, to the existence of the Gogo fishes. That initiated the first English expedition to Gogo, led by Harry Toombs in 1963. Realizing the importance and excellent preservation of the fossils, the British Museum of Natural History, London, organized a large expedition together with the Hunterian Museum, Glasgow, and the Western Australian Museum, Perth, in 1967 (Chapter 3). All of the fossil material went to Great Britain, where it was prepared and described in many monographs over the years.

In Chapter 4, Long introduces a little bit of history of vertebrate paleontology, preparation methods, and his own encounter with the famous paleoichthyologist Erik Jarvik in Stockholm. He describes Sollas' grinding method, which Stensiö introduced to paleoichthyology in order to reconstruct braincases and brains of small fossil fishes in the first half of the last century. While the Stockholm researchers continued with the method, Toombs developed the acid-preparation technique. The whole story though is that Edwin Hills, an Australian paleontologist, had invented the method 10 years earlier. He described two Early Devonian fishes from Australia in 1936 and 1941, which were prepared with the acid-preparation method. Usually, Toombs (1948) or Toombs and Rixon (1959) are cited for the method, because they introduced plastics for stabilization.

In Chapter 5, Long deals with cladistics and shows the importance that some Gogo fishes have played in the establishment of the method, even though he cites Colin Patterson's statement that not fossils but extant forms are important to establish relationships. In the paper from the "Gang of Four" (Rosen et al., 1981) on the fish-tetrapod transition, a Gogo lungfish (*Griphognathus*) plays a key role. Nevertheless Rosen et al. (1981) argued that extant not fossil lungfish show that they are the closest relatives of tetrapods, not rhipidistian sarcopterygians as was argued earlier and today despite their view of the data. Again, Australian authors (Campbell and Barwick, 1984) were the first to show the mistakes in the argumentation (e.g., Schultze, 1981; or Holmes, 1985), and that the osteolepiform *Gogonasus* has placed the argumentation in the right line again.

In Chapter 6, Long himself steps into the picture. Doing his Ph.D. from 1981 to 1983 on compressed Devonian fishes of Victoria, he dreamed of the three-dimensional Gogo fishes. During his postdoc in Canberra with W. Campbell, Long began to work on the Gogo fishes. It followed a two-year fellowship in Perth, Western Australia, where he was able to raise the money to undertake a Gogo expedition (1986). One feels here directly all the difficulties, the excitement and the glorious feeling of a successful fossil hunt that resulted in the discovery of new fishes not known from earlier expeditions.

A fellowship in Tasmania followed, and in 1989, Long got a permanent position as curator at the Western Australian Museum in Perth. Now he could concentrate on exploring Gogo. Further field trips in 1989 and in the 1990s are described in Chapter 7.

Being established in Perth, he tried to bring attention to the importance of the collection for which he was responsible. He thus found the original agreement between the Western Australian Museum and the British Museum of Natural History concerning the fossils collected 1967 in Gogo. Chapter 8 deals with the Long's repatriation efforts: "By the end of 1992, all the then-known Gogo-fish holotypes were safely back in Australia . . . ." (p. 144).

In Chapter 9, Long describes the 2001 expedition with all circumstances. This is the last expedition described in this book

(since the publication of this book, Long, who is now head of Science in the Victoria Museum in Melbourne, has led more expeditions to Gogo); the following chapters deal with the scientific significance of the fossil fishes of Gogo.

Chapter 10 provides a short introduction into jawless fishes (agnathans) and jawed fishes starting with the formation of bone. Long argues that dermal bone occurred as the first hard tissue. In that connection he discusses the placement of conodonts with hard parts that are "pretty close to being a kind of bone," (p. 168): a wrong statement. There is no bone in conodonts (Schultze, 1996; Turner et al., in press). The first bone was found in the Upper Cambrian of Australia. In this chapter that we first encounter the idea that every human bone has its counterpart in the primitive bony fish skeleton (p. 169).

Arthrodire placoderms are the most common fishes in Gogo. The acid-prepared head and shoulder armor are impressive, even though the body is not preserved in most cases. In Chapter 11, Long refers to the work of Roger Miles and Kim Dennis Bryan from The British Museum of Natural History on the Gogo arthrodires after he criticizes the earlier work of the Stockholm School and the behavior of its representatives, especially Stensiö. The jaws and the size of such arthrodires as *Eastmanosteus* indicate that they were successful hunters and killers. The stomach contents suggest that such arthrodires as *Holonema* were browsers, whereas such arthrodires as *Incisoscutum* were crushers. Long wholly embraces the disputed discovery of true teeth in arthrodires (Smith and Johanson, 2003).

In Chapter 12, Long describes in detail the naming of a new arthrodire, *Mcnamaraspis kaprios*, and the campaign of a primary school in a suburb of Perth to make this fossil the state fossil of Western Australia. They were successful, and the arthrodire even appeared on a 1997 Australian 45c stamp.

Ptyctodonts are a special group of placoderms. They possess claspers for internal fertilization like chondrichthyans. This explains why Ørvig (1960) considered them to be ancestral to holocephalans. In Chapter 13, Long starts with his study of museum collections of Ørvig's *Ctenurella* and continues with the better-preserved Gogo ptyctodont. The title of the chapter "The secret sex life of ptyctodonts" points to more sensational discoveries in Gogo ptyctodonts: embryos in the body of a female (Long et al., 2008, 2009).

Within antiarch placoderms, *Bothriolepis* is the widest distributed and specious Devonian placoderm. It is so widely distributed it can even be used in biostratigraphy. Long describes his encounter with an aquarist and a dead armored catfish, which the author compares to an antiarch. In Chapter 14, the author describes his involvement with Australian antiarchs and continues to discuss earlier ideas that they possessed an internal buoyancy chamber, but not lungs or swim bladder as Denison (1941) described from *Bothriolepis* from the Upper Devonian of Miguasha, eastern Canada. Long misses the more likely interpretation of the internal infillings as valvular intestine (McAllister, 1987).

In the next four chapters, Long describes the less common bony fishes. In Chapter 15, he starts with the actinopterygians, of which Gardiner (1984) published the main description. Since Gardiner's description, Long discovered one new actinopterygian in Gogo, which is studied by the author's graduate students.

The sister group of actinopterygians are the sarcopterygians. At the time the book was written, three groups of Gogo sarcopterygians were known: onychodonts, lungfish, and rhipidistians. Mahala Andrews studied the Gogo onychodont, but her health deteriorated, and she was not able to finalize the manuscript even with the help of K.S.W. Campbell and R. Barwick. This paper became a multiple author paper (Andrews et al., 2006). In Chapter 16, Long describes these circumstances before he starts to deal enthusiastically with the fish, *Onychodus*, and its relationship to a primitive sarcopterygian, *Psarolepis*, from the Lower Devonian and Silurian of China, which Long considers as onychodont. He emphasizes the comparison of the internal structure of the pectoral fin of this fish with a human humerus.

The Gogo lungfishes were described in a monograph by Miles (1977), and Campbell and Barwick continued to publish on them continuously. In comparison to the number of species (eleven) and the amount of literature, Chapter 17 on the Gogo lungfish is short. Long emphasizes only one of the functional aspects, the possible adaptation of the gill arches for gulping air, upon which Campbell and Barwick elaborate in many papers.

Long was and is personally involved with the Gogo rhipidistian, *Gogonasus*. This is evident in Chapter 18 and throughout the book (Chapter 4: acid preparation of *Gogonasus*; Chapter 5: transition to tetrapods; Chapter 21: Gogonasus man). Acid preparation results in outstanding skulls of *Gogonasus* with all the details of the endo- and exocranium. Even more spectacular are the computer-generated X-ray tomographic images, which can show details like canals in bone (a beautiful picture is given of the canal system in a shark tooth from Gogo).

In Chapter 19, Long deals with the paleogeographic distribution of the Gogo fishes. Most fishes are endemic to Gogo in the view of Long. The exceptions are the three placoderms, *Bothriolepis, Eastmanosteus,* and *Holonema*.

In Chapter 20, Long vividly described the attempt of private collectors to smuggle Gogo fish out of the country, and his appearance in front of the court. Unfortunately, the prosecution of private collectors is an exception, and it is not possible to protect the national heritage as Long would like to enforce so strongly. He argues in favor of protection as an UNESCO World heritage site. He compares Gogo with two other Upper Devonian UNESCO World heritage sites, Miguasha in eastern Canada and Canowindra in New South Wales, Australia, and argues that Gogo is more important. He describes his efforts to develop the area as a possible tourist UNESCO World heritage site, and the efforts of a company to place the Gogo lungfish *Chirodipterus* on a record of the band Slub.

Chapters 19 to 21 are placed as Part 3 under the heading "The Bigger Picture." What could be bigger than the connection

to man, the *Gogonasus* man? Long shows connections between early (Paleozoic) vertebrates and advanced tetrapods, before he goes in detail to show the contributions of the Gogo ray-fins (palaeoniscoid actinopterygians), the Gogo dagger-toothed fish (onychodont), and the advanced lobe-finned fish *Gogonasus* to the anatomy of man. A recent publication (Long et al., 2007) placed *Gogonasus* close to early tetrapods, but later that had to be revoked (Holland and Long, 2009). In the book, he places a Gogonasus man beside a human skeleton. "We are all but highly advanced fishes (p. 277)." Here we are back a half a century to the arguments of the Stockholm School: "The osteolepiform *Eusthenopteron* has all the structures of man! No evolution after the Devonian!" Or as the author says (p. 285): "The rest of evolution, from amphibians to reptiles to mammals to man, involved no serious innovations of anatomy, only development or modification of the already locked-in body plan. All post-Devonian vertebrate evolution can, therefore, be seen as mere fine tuning from the advanced fish model [the osteolepiform *Gogonasus*]" (see also Long, 2005).

At the end of the book an exhaustive list of references and a complete faunal list of Gogo fishes are given. Placoderms (22 arthrodires, 2 ptyctodonts, 1 antiarch) form the majority of fishes with 25 species followed by 11 lungfish species. Actinopterygians (3 species), one onychodont, one osteolepiform, and one undescribed chondrichthyan species are rare in comparison to the placoderms.

Long covers a wide field from anatomy to protection and preservation of a prestigious locality for Australia. The book is really nice to read. Some imprecise data, which Long accepted as hearsay, concern other researchers or few historical events but these are only visible to the informed reader. For example, it was surprising to read that Long met Jarvik in 1982 as "Museum director at the time (p. 80)." In 1982 Jarvik was long retired (9 years) as head of the Paleozoologiska sektionen of the Naturhistoriska Riksmuseet, Stockholm, his successor Ørvig retired in 1982, and Ørvig's successor Jaanusson started in the same year (Schultze, 2009). Neither Jarvik nor Stensiö held the administrative position as the director of the museum.

Those who want to understand the enthusiasm of a born paleontologist will find that here. Personal involvement with colleagues all over the world and the importance for scientific progress are reported in detail. The importance of the Gogo fish fauna for many scientific questions is demonstrated with well-selected, excellent pictures.

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