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A Jurassic non-marine chondrichthyan in Australia and its palaeogeographic significance

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Abstract

After the demise of many fish taxa including xenacanth sharks before the Late Triassic, non-marine fish faunas reappeared in Australia the mid-Jurassic in the East Gondwana component of Pangaea with one new chondrichthyan occurring in the Late Jurassic freshwater Talbragar Lagerstätten near Gulgong, New South Wales. The Kimmeridgian Talbragar Fossil Fish Bed unit yields a Jehol-type fauna and flora, with a variety of bony fishes as well as this first-known Jurassic shark in Australasia. The new taxon is based on a partial skeleton lacking a head but with at least partial fins and scales. The latter might be from a hybodontiform or synechodontiform shark or even a crown group neoselachian. From the inferred palaeogeography, this was one of the most southerly living chondrichthyans of the time.

Keywords: Vertebrate palaeontology; Lacustrine sediments; 'Shark'; Kimmeridgian; Talbragar; New South Wales

1. Introduction

Strata of Jurassic age occur extensively across onshore Australia, but they are predominantly of non-marine origin; deposits with economic coals are distributed in the eastern states. Jurassic stage boundaries, in the main, are poorly constrained but on-going work on microfossils, plants, fish and zircon dating is providing a basis for improved correlation across Australian basins (e.g., Turner et al., 2009).

Australia witnessed increasing forest cover with intermittent lakes and volcanic activity prevalent throughout the Mesozoic with an equitable climate with glacier-free high latitudes (e.g., Kear and Hamilton-Bruce, 2011). Lake systems were common at least in the Sydney Basin and elsewhere in New South Wales (NSW), Queensland and South Australia, Western Australia and Tasmania (White, 1981a, 1981b). Non-marine fish faunas are known from the early to mid-Triassic and mid- and late Jurassic in the East Gondwana component of Pangaea. Relatively little is known of sharks in the far-eastern Australasian block of the disintegrating Pangaea (e.g., Turner et al., 2009). Faunas comprise xenacanth-dominated assemblages in the Lower to Middle Triassic of the Sydney Basin, NSW, and possibly in Queensland and Tasmania, with some evidence of hybodontiforms (Turner and Long, 2016); however, the Palaeozoic relict xenacanths did not survive the late Triassic crisis (Turner, 2012).

Abbreviations: AMF – Australian Museum Fossil collection; ANU – Australian National University; NSW – New South Wales; SA – Steve Avery.

1.1. Australian Jurassic vertebrates

Evidence of Jurassic fish in Australia is sparse and therefore often overlooked (Lopez-Arbarello, 2004, fig. 3). There are a few actinopterygian records in the Early to Middle Jurassic Clarence–Moreton Basin Walloon Coal Measures (Bathonian–Callovian) with fragmentary semionotiforms from the underlying Hutton Sandstone (Bajocian–Bathonian) near

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Monto in the Mulgildie Basin, Queensland (Turner et al., 2009, fig. 5). The Early to mid-Jurassic terrestrial fauna in Queensland also includes evidence of amphibians and dinosaurs (Turner et al., 2009).

Here we describe the first known Jurassic chondrichthyan ('shark') from Australia.

1.2. Talbragar fishes

The classic Talbragar Lagerstätten in the southern Surat Basin, originally thought to be Middle Triassic in age (Anderson, 1889), have yielded the best-preserved Jurassic fish in Australia (Figs. 1 and 3). The Talbragar Fossil Fish Bed Formation is approximately 14 km north-northwest of Ulan and 25 km northeast of Gulgong, central NSW, at grid reference 530 378 of the Uarbry 8833-1 and 1V 1:50 000 sheet area (Percival, 1979; Beattie and Avery, 2012; Figs. 1c and 2). Most of the Talbragar Fossil Fish Bed is within a reserve administered by the National Parks and Wildlife Office at Mudgee, NSW and a protected site under NSW legislation; permission must be obtained before collecting is allowed.

Bean (2006a, 2006b; in Turner et al., 2009) and Lopez-Arbarello et al. (2008) most recently reviewed the taxonomy and taphonomy of the bony fishes. Specimens were sent to the British Museum (Natural History), London where Smith Woodward's assessment based on the actinopterygians and a coelacanth was the first indication of rocks of this age in Australia and this was upheld by contemporary geological evidence (David and Pittman, 1895; Woodward, 1895a, 1895b; Zhen, 2012; Turner and Long, 2016). Later work showed that the beds were Jurassic in age but without much resolution (Turner et al., 2009). What is interesting now is that the fauna appeared to be much older than it is, with members from relatively primitive families.

The fish assemblage comprises actinopterygians — palaeoniscid *Coccolepis australis*; 'holostean' archaeomenids *Archaeomene tenuis*, *Aphnelepis australis* and *Aetheolepis mirabilis*, possibly *Madariscus*, which might be a mature form of *Archaeomene*; Macrosemiiformes family indet. *Uarbryichthys latus*; leptolepid *Cavenderichthys talbragarensis*; an amiiform fish similar to *Furo*, known elsewhere in the Late Jurassic (Ritchie, 1987; Bean, 2006a, 2006b; Turner et al., 2009; Lane and Ebert, 2012); and a sarcopterygian — a rare unidentified coelacanthid (Woodward, 1895a). Turner (in Turner et al., 2009; Turner, 2011) first noted the chondrichthyan.

The shark specimen was found (by SA) in the early 1990s while splitting Talbragar rock obtained from other fossil collectors. When the specimen was found its real identity was not known, and it was considered to be plant; sometime later it was given to the Australian Museum. The identity was realized later when SA discovered new Triassic xenacanth shark specimens in the Sydney Basin in 2004 (e.g., Turner, 2012); he immediately contacted Dr. Alex Ritchie (then curator AM) and advised him of his idea that the Talbragar specimen was also chondrichthyan. Ritchie confirmed this and also contacted the first author.

Jurassic shark fossils have not previously been found at Talbragar or in any site in Australasia. Here we provide a first description of the material. We offer a first interpretation of possible affinities.

2. Talbragar geology

The Talbragar Lagerstätten are actually several beds collectively 60–100 cm thick, which are divided into an upper package of very fine layers totaling 30–40 cm, and a lower rather more massive but still fine-grained bed, all of which are heavily fossiliferous; fish and plant fossils are notable from this site (e.g., White, 1981a, 1981b, 1986; Turner et al., 2009). The outcrop extends at least 200 m along strike and is thought to represent the erosional remnant of the margin of a short-lived freshwater lake-bed with a deposit not much more than 60 cm (Percival, 1979). The original source outcrop (see Fig. 1b) is now very poor because so much material has been removed and it is now in a paddock (large field) used for grazing (Bean et al., 2007).

Renewed collecting since 2006 has yielded new fossil discoveries, particularly of insects, spiders (Beattie, 2007; Beattie and Avery, 2012; Selden and Beattie, 2013). Plants include conifers, araucariaceans, a ?podocarpacean, pentoxylaleans, a ?cycadophyte, some enigmatic seedferns, and fern fragments (e.g., Turner et al., 2009, fig. 3; McLoughlin, 2015).

The Fish Bed is relatively thin, forming part of a non-marine sequence (Fig. 2). Unweathered samples are grey, fine grained, with angular fragments of detrital and igneous quartz, with no evidence of sedimentary flow structure (Beattie and Avery, 2012). Stratigraphically below this unit are quartz sandstones of the Purlawaugh Formation, which do show sedimentary structures such as cross-bedding, pebble layers and washouts. This sandstone unit is comparable to those of the Purlawaugh Formation that outcrop about 50 km away. The Fish Bed is probably the upper unit of the Purlawaugh Formation, but no equivalent outcrop to the Fish Beds is exposed elsewhere in NSW (Turner et al., 2009, see fig. 2 for correlation).

2.1. Dating of Talbragar Fossil Fish Bed

The precise age of the Talbragar Lagerstätten fish beds within the Jurassic was previously difficult to pin down because the relationship to surrounding rocks was unclear and there was little independent stratigraphic control. Twentieth-century dating had placed the Talbragar deposit in the Early to mid-Jurassic (Hind and Helby, 1969; Loughnan and Evans, 1978; White, 1981b; Drinnan and Chambers, 1985). No palynofloras had been recovered from the fish beds themselves because the rocks are highly oxidised. The later Jurassic floras, however, are essentially pan-Australasian, possibly reflecting the higher latitude and more insular setting of Australia–New Zealand (Turner et al., 2009; McLoughlin, 2015).

Recent excavations sourced zircons for SHRIMP (Sensitive High Resolution Ion Microprobe) radiometric dating, analysis of which indicated an age of 151.55 ± 4.27 Ma for the fossil fish bed samples from the youngest zircon population, i.e., during Late Jurassic (latest Oxfordian–Kimmeridgian–Tithonian) (Turner et al., 2009). Thus it is now apparent that the fish-bearing beds are somewhat younger than those parts of the Purlawaugh