PALAEONTOLOGY

Late extinctions of amphibians

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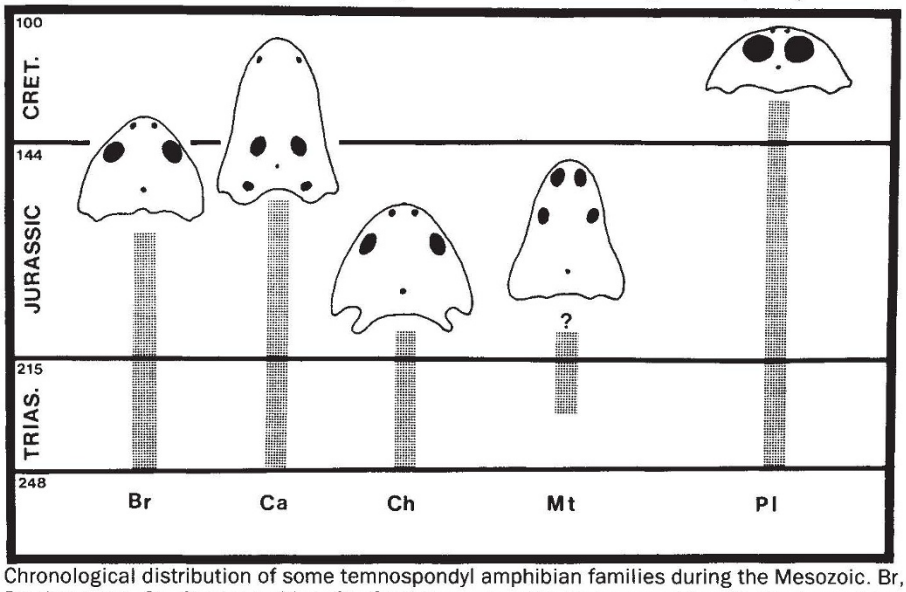
THE amphibian order Temnospondyli was the main group of early amphibians from the middle of the Carboniferous (315 million years ago) to the end of the Triassic (215 million years ago). During this time, these animals filled many of the niches now occupied by salamanders, crocodiles and even large freshwater fish. Until just over 10 years ago, no post-Triassic temnospondyls were known and it was reasonably assumed that all had become extinct at the end of the Triassic. Consequently, they have been incorporated as components of supposed Triassic extinction events[1–3]. But a series of new, little-publicized discoveries[4–7] extends the stratigraphical range of several temnospondyl lineages beyond the Triassic (see figure) and suggests that, as at the Cretaceous–Tertiary boundary event, amphibians passed unscathed through the events which made many reptiles extinct.

The first specimen to force a reconsideration of temnospondyl chronology was the huge complete skeleton from the Lower Jurassic (200 million years ago) of Queensland which Warren and Hutchinson[4] named *Siderops*. This specimen belongs to the Chigutisauridae, a family of neotenous temnospondyls (in which the larval body form is retained by the adult) previously known from the Triassic of South America and Australia. Before the significance of this single relict lineage could be determined, several more fossils were found in east and central Asia. One of these is a well-preserved skull from the Middle Jurassic (175-million-year-old) dinosaur assemblage found at Zigong, Sichuan, China[5] named *Sinobrachyops*, a member of the widespread family Brachyopidae. This specimen represents a different lineage of neotenous temnospondyls not previously recorded later than the Middle Triassic. Another is the series of temnospondyl bones from the later Middle Jurassic (165-million-year-old) estuarine beds of the Kirgiz region of Soviet central Asia just described by Nessov[6]. These bones seem to belong to the Capitosauridae, a family of crocodile-like forms. The associated fauna includes several fish more usually associated with the Triassic, together with typical Jurassic–Cretaceous reptiles. So at this locality, estuarine fish and amphibians seem to represent an entire relict ecosystem; Nessov suggests that it would have been difficult for other forms to replace families which had adapted to the osmotically demanding estuarine environment.

The most remarkable amphibian discovery is that of a temnospondyl jaw from the Lower Cretaceous (about 130-million-year-old) Strzelecki Formation of Victoria, Australia[7,8]. Because the fossil was found in an assemblage of dinosaur bones it was briefly identified in an exhibition catalogue[9] as the mandible of an ankylosaurid dinosaur! It has now been shown by Jupp and Warren[7] to belong to a large temnospondyl. These authors are uncertain as to its family position, but a comparison with Triassic specimens confirms that it belongs to the Plagiosauridae and that it has specific resemblances to *Plagiosternum* from the Middle Triassic of Germany. The plagiosaurs were wide-headed, neotenous forms superficially resembling large flattened axolotls (salamanders). Within the past decade, therefore, it has become clear that up to three temnospondyl families — the Chigutisauridae, Brachyopidae and Capitosauridae — survived into the Jurassic and one, the Plagiosauridae, into the Lower Cretaceous.

In global terms, none of these families contributed to Triassic extinctions. But all these discoveries have been made either in Australia, which was at the end of an Australasian–Antarctic peninsula by that time, or in central and east Asia, which was cut off from the other northern continents by the Turgai Straits in the Middle Jurassic. A conservative interpretation might be that temnospondyls did become extinct in the late Triassic in Europe, Africa and the Americas while persisting in partial or complete isolation in Asia and Australasia, implying a regional rather than a global extinction event. But although a few Lower and Middle Jurassic tetrapod assemblages in Europe and the Americas have now been discovered, there is plenty of potential for further reassessments.

An example of this is the Triassic–Jurassic boundary region in western North America which is still in a state of stratigraphic flux and may yet force further reconsideration of the timing of temnospondyl extinctions. Murry has recently noted[10] an assemblage of vertebrates from a Dockum Formation horizon in Apache Canyon, New Mexico, in which the metoposaurid temnospondyl *Anaschisma* (supposedly restricted to the Upper Triassic) is associated with scales of the fish *Redfieldius* (previously found only in the Jurassic). The Metoposauridae is one of the last remaining temnospondyl families still believed to have contributed to a late Triassic extinction event. It is not yet clear whether the fish represents an unprecedentedly early record or the amphibian a new late record. If the latter turns out to be the case, then there will be little remaining evidence that amphibians were involved in any Triassic global extinction event, at least at the family level. If, as seems likely, there are patterns of extinction and replacement among Triassic reptile families, it may be inadvisable to dilute them with amphibian data. □



Chronological distribution of some temnospondyl amphibian families during the Mesozoic. Br, Brachyopidae; Ca, Capitosauridae; Ch, Chigutisauridae; Mt, Metoposauridae; Pl, Plagiosauridae. Numbers on the left are in millions of years.

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