Ancient fishes kept their young in a nursery

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Baby fish in a nursery. Credit: Flickr/« м Ħ ж », CC BY-NC-ND

Placoderms are armoured prehistoric fishes that are considered to be the first vertebrates to procreate by internal fertilisation. In other words, they had sex.

Once the sex was over no doubt many placoderms then discovered the joys of parenthood. But what did they do with their offspring?

By studying the fossils of ancient species we can learn much about how they lived and show how their behaviours compare with those of modern

species.

We can also take a closer look at fossils among themselves, a notion named assemblage. That's how we discovered that some placoderms chose the nursery solution for their offspring.

To Belgium

The Strud locality in southern Belgium is well known by palaeontologists and other geologists, notably because it yielded some of the earliest tetrapods - the first vertebrates with fingered limbs - and the earliest insects.

Palaeontologists also excavated numerous fossil fishes, especially placoderms, and large sarcopterygian (lobe-finned) fishes that were among the top predators during the Devonian time, roughly 360 million years ago.

Back then the locality was bathing under a tropical environment.

The palaeo environment of the Strud quarry corresponds to a meandering alluvial system, similar to today's existing Australian billabongs. The edges would have been covered with huge primitive trees such as *Rhacophyton*, whose long branches could fall down in the river.

The only animals crawling on hard ground were arthropods such as collembolans and centipedes, but not yet vertebrates.

Soils with microflora and microfauna were already there, where plants lived, that is close to the shore. The inside of continents was still a mineral desert, except for the exceptional oasis.

Tiny fossils

Under the water, placoderms were part of the pool party, alongside tiny crustaceans and ferocious sarcopterygians. But the placoderms found in this locality were very small.

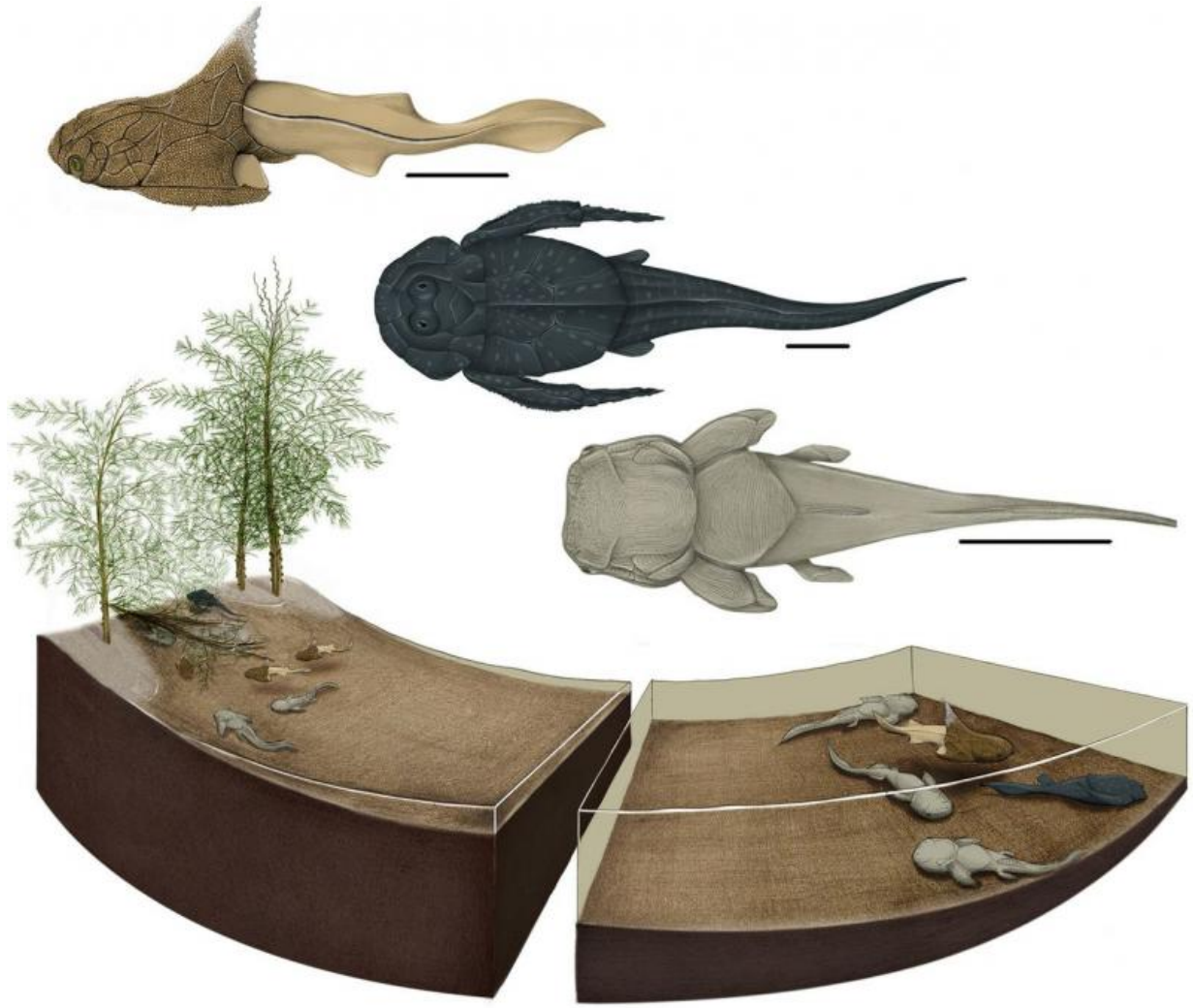
When we first studied the placoderms of Strud, we were really astonished by their tiny size, and wondered why they were so small.

Could they all be youngsters? In which case, where would the adults be?

Alternatively, could they be dwarf forms or just species with small adults?

Morphometric analyses (size or size ratios of multiple specimens or elements of the bony armour such as plates) and morphological observations (presence or absence of sensory lines) were used to assess the characteristics of the remains.

Comparisons with other localities such as the faunal and floral assemblage of the Catskill in Pennsylvania, USA, were made to reinforce initial suspicions.



A diagrammatic model of the Strud nursery displaying the habitat partitioning: on the left, shallow waters of the nursery with immature placoderms inside and Rhacophyton plant on the bank, and on the right, deeper area with the placoderm adults. Scale bars equal 2cm. Credit: Justine Jacquot Haméon (MNHN, Paris), CC BY

For a living thing to die and be transformed into a fossil is not always a quiet and peaceful process. Before any remains are buried, many events can occur.

Predators can disperse (and digest!) elements of the body, including bones. Streams and storms can disperse the body, and its parts can be transported over long distances.

Last but not least, once buried, not all elements can be epigenised (transformed into mineral). Mainly hard tissues such as teeth and bone are preserved, but soft tissues require very special biochemical conditions.

All these events occurring until burial are named taphonomy, and they really matter when you're a palaeontologist to understand the message yielded by the fossils.

The fragile nature of the placoderm elements at Strud was not consistent with any long post-mortem transportation, nor with a re-handling of the fossils.

Moreover, retrieving sarcopterygian remains such as huge fangs, together with tiny placoderm remains, shows an absence of any size sorting of the fossils after death or deposition.

Therefore, all Strud placoderm remains are considered as belonging to immature specimens that lived in the same place at the same time, rather than to small sized species or dwarf forms.

A nursery shared by several fish species

A nursery is characterised as an area nearly exclusively inhabited by immature individuals.

Fossil nurseries are not unknown. They have been identified for sharks in the 310 million year old Carboniferous locality of Mazon Creek in Illinois, USA, or for coelacanths in the 360 million year old Upper

Devonian rocks of South Africa.

This discovery at Strud sheds new light on the diversity of reproductive strategies of placoderms, especially in the handling of their offspring.

We already knew that some placoderms gave live-birth such as the ptyctodont *Materpiscis* from the Frasnian Gogo Formation in Western Australia. Some others are suspected to lay egg sacs, such as the phyllolepid Cowralepis, whose related forms are found in Strud.

The offspring were left in a hostile environment where giant lobe-finned fishes roamed in the vicinity, together with *Ichthyostega*-like tetrapods. But fallen tree branches provided shelter, hiding spots and nutrients at the same time for baby fishes. Interestingly, it is the first time we have a placoderm nursery with more than one species.

The placoderm nursery in Strud recalls strongly life histories of other groups with adults laying eggs or giving birth in shallow continental environments or near shore.

Strud may have been the ideal spot for this: a low velocity stream, plenty of fallen and rotten plants offering both protection and nutrients.

But where were the adults? That is another story.

These results are very interesting, because as technological human beings we tend to believe that only mammals and birds take care of their youngsters. So finding evidence for such behaviour in fish is always a surprise.

Some modern fishes such as several shark species have a common practice of nursery. The interest of this new study is that we can flag this behaviour in fossil species too, which are so remote in time but also at

the base of the jawed vertebrate tree, and that such environment was shared by several species.

So the discovery reveals that nursery behaviour in vertebrates is very ancient indeed.

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