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VERTEBRATE FAUNA FROM THE SAN CASSIANO FORMATION (EARLY CARNIAN) OF THE DOLOMITES REGION

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With 3 Figures and 1 Table

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1. Introduction

The basinal San Cassiano Formation (early Carnian) mainly consist of marls, micrites and oolitic-bioclastic calciturbidites. These sediments are heteropic with the prograding Cassian platforms and derive from the erosion of volcanic rocks and from the precipitation of carbonates exported from the platforms (Keim & Neri, 2005 and references therein).

Where the Formation is well represented, as in the area of Prati di Stuores (Stuores Wiesen), Sett Sass, Forcella Giau it has yielded an extraordinary invertebrate fossil fauna which has been studied since the XIX century (e.g., Münster, 1834). Being extremely diverse, and excellently preserved (aragonite is often still preserved in the thin shells) the San Cassiano invertebrate fauna is one of the best known of the whole Mesozoic (Fürsich & Wendt, 1977). This heavily contrasts with the paucity of vertebrate findings which is also highlighted by the almost complete absence of published papers on the topic (but see Boni, 1941, Bizzarini et al., 2001). Here we provide an updated check-list of historical and new vertebrate findings focusing on their bearing on the palaeoecology of San Cassiano Formation Biota.

Note that we are not considering the vertebrate remains that were found in the overlying Heiligkreuz Formation (mid-late Carnian) (e.g., Sirna et al., 1994; Bizzarini & Rottonara, 1997; Dalla Vecchia & Avanzini, 2002) among which is, most notably, the famous *Metoposaurus sanctecrucis* (Koken, 1913) despite the not always clear distinction between San Cassiano and Heiligkreuz formations in historical collections.

2. Vertebrate palaeontology

2.1 New findings

The new specimens described here have been collected near the Sief Pass (Badia Valley, Bolzano Province), just below and slightly East to the famous Richthofen Riff. The Carnian platforms are there clearly documented by the two main prograding carbonate systems: the Lower Cassian Dolomite, to which correspond the Richthofen Reef ridge, and the Upper Cassian Dolomite, which constitutes the Sett Sass. In the area of the Pass, above the Wengen (La Valle) volcanoclastic Formation, the San Cassiano Formation crops out. Although the specimens were not found in situ, the lithology of the matrix clearly suggests that the fossil bearing level is part of the San Cassiano Formation. In the outcrop, several bi-

oclastic calciruditic levels, bounded by finer-grained levels (possibly documenting turbiditic events) near the base of the Formation were identified as possible correspectives.

Systematic palaeontology

Class Chondrichthyes Huxley, 1880
Cohort Euselachii Hay, 1902
Superfamily Hybodontoidea Owen, 1846
Family Acrodontidae Casier, 1959
Genus *Acrodus* Agassiz, 1838

Acrodus sp. **(Fig. 1)**

The specimens are two domed, finely ornamented tooth crowns. Teeth are strongly arched in labial and lingual views. At least one lateral cusplet was clearly present although only half is preserved. A single, well marked longitudinal ridge runs across the crown. The crown is projected lingually. The ornamentation is finely reticulate. Crown is separated from the root by a band of vertical ridges. No expanded lingual torus is

Fig. 1: The two *Acrodus* sp. teeth found at the base of the Richthofen Riff, near the Sieff camp (BZ). *Acrodus* represent a new taxon for the San Cassiano association.

visible on the root. The root is high and perforate by numerous, randomly placed, foramina.

Studied teeth are very similar to those of other sharks such as *Acrononemus* Rieppel, 1982 or even *Asteracanthus* Agassiz 1837 and most of the characters that enable a clear distinction of these genera are found on the finspine and cranium. Nevertheless listed characters allow to confidently attribute the specimens to the genus *Acrodus* Agassiz, 1838. Given the fragmentary nature of the studied material we prefer to leave the determination in open nomenclature.

Fig. 2: Simplified location map of the fossiliferous outcrops (red dots) where vertebrate remains have been documented to date, Dolomites region, NE Italy.

2.2 Previous findings

The few studies listing vertebrate findings from the San Cassiano Formation have reported of fragmentary remains only (Figure 2). The here reported check-list (Table 1) is mainly based on the studies published by Wissmann and Münster (1841), Klipstein (1843-1845), Boni (1941), Broglio Loriga (1967), Sirna et al. (1994), Bizzarrini et al. (2001), and integrated with personal observations and new findings. Notably, specialists of invertebrates have sometimes found rare vertebrate remains both in their surface and bulk samples (e.g., fish otolithes and shark teeth, comm. pers. Alexander Nützel and Hans Hagdorn, 2011), but no further study has ever been conducted.

The determination of some of the listed specimens, especially those described in the past centuries, should be considered cautiously because of the fragmentary nature of the specimens, mainly represented by isolated teeth and body fragments with scales, and because a full revision of the material has not yet been completed.

3. The San Cassiano biota

The autoecology of the listed taxa deduced both from present-day equivalents and from previously described biotas, enables to reconstruct the broad scale characteristics of the San Cassiano ecosystem. The shelled invertebrate fauna could have sustained the diet of the classical Triassic shallow water durophagous reptiles, the placodonts, as well as neopetigian *Colobodus*. The strong and rounded teeth of this perleidiform were placed on the mandibles and

Reptilia	Archosauriformes	Archosauria indet.	Stuores Wald/Bosco di Stuores (Bizzarini et al., 2001)
	Sauropterygia		
	Nothosauria	Nothosauridae indet.	Stuores Wald/Bosco di Stuores (Bizzarini et al., 2001)
		Nothosaurus sp.	Wissmann and Münster (1841)
	Placodontia	Placodontia indet.	?Pralongià and Stuores Wald/Bosco di Stuores (Boni, 1941; Bizzarini et al., 2001)
		Placochelys sp.	San Cassiano and Forcella Settsass (Broglio Loriga 1967; Bizzarini et al., 2001)
		Cyamodontoidea indet.	Stuores Wald/Bosco di Stuores (Bizzarini et al. 2001)
Chondrichthyes			
	Elasmobranchii	Paleobatidae indet.	Forcella Giau, Milieres-Cian Zoppè
		Paleobates sp.	Stuores Wald/Bosco di Stuores (Bizzarini et al., 2001)
		Hybodontidae indet. *Hybodus* sp.	Forcella Giau, Milieres-Cian Zoppè Stuores Wald/Bosco di Stuores (Bizzarini et al., 2001)
		Hybodus hexagonus *Acrodus* sp.	San Cassiano (Broglio Loriga, 1967) Richthofen Riff, this work
Osteichthyes			
	Perleidiformes		
	Colobodontidae	*Colobodus bronni*	Pralongià, San Cassiano and Stuores Wald/Bosco di Stuores, Forcella Giau (Boni, 1941; Broglio Loriga, 1967; Bizzarini et al., 2001; Bizzarini M., 1979)

Table 1: Check-list of the vertebrates remains form the San Cassiano Formation with their finding localities. Note that the taxonomic status of the genus *Colobodus* is very confused (see Gardiner & Schaeffer, 1989; Mutter, 2004, and references therein).

on the palatine molariformes suggesting that *Colobodus* was a durofagous fish which could easily crush even thickly shelled invertebrates. The well represented shark population was dominated by euryhaline bottom-dwelling selachians as *Palaeobates* sp. which fed mainly on benthos. *Acrodus* sp. was itself a bottom-dwelling shark that probably had a mixed diet constituted of fish, hard-shelled molluscs and crustacea (Cappetta, 1987; Rees & Underwood, 2008). *Hybodus* sp. possesses a heterodont dentition with the predominantly 'clutchingtype' teeth of a piscivorous animal (Cappetta, 1987). The shallow water nothosaurs were fish and squid eaters; Bizzarini et al. (2001) estimated that the *Nothosaur* sp. found in the Stuores Wald/Bosco di Stuores locality could have been up to four meters in length. This would have possibly given the sauropterygian *Nothosaur* the position of top-predator in the San Cassiano biota, possibly together with the indetermined archosaur (here figured as a phytosaur based on similar findings in the Heiligkreuz Formation described by Dalla Vecchia and Avanzini, 2002).

Despite quantitatively and qualitatively scarce the here listed findings document the high trophic (feeding) levels of a well developed shallow water ecosystem. Most if not all the remains are thus interpreted as allochthonous. The complexity of the reconstructed food web is shown in Figure 3. Lower parts of the food chains are dominated by the well known bivalves, gastropods and cephalopods, besides there are durophagous fish and reptiles, followed by the top predators, animals that fed on fishes and small predatory reptiles.

Faunal composition is in particular similar to those documented in age-equivalent deposits from other regions of Europe. The most notable difference with other Middle-Late Triassic vertebrate marine associations from Europe is the absence of the classical Triassic top predators as *Saurichthys* or *Mixosaurus.* This latter has however been reported from the overlying mid-late Carnian Heiligkreuz Formation by Koken (1913). The paucity of the collected material leaves the question open for future findings and analysis.

This brief review of the vertebrate fauna of the San Cassian Formation aims to contribute to a better understanding of the ecology of a World-wide reference palaeoecosystem.

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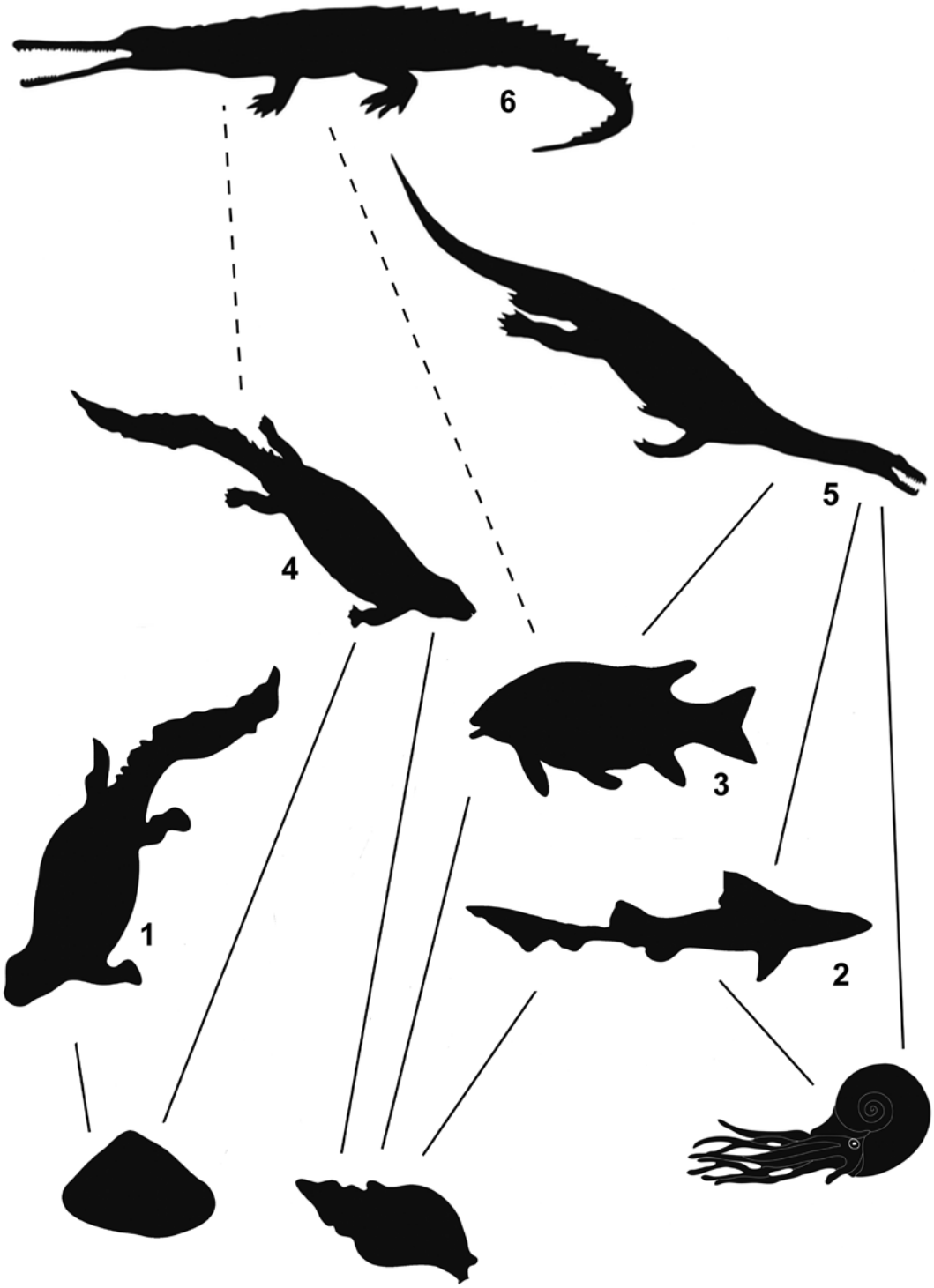

Fig. 3: Food web of the San Cassiano biota, showing assumed interactions among the key components of the marine fauna. 1 *Placochelys*, 2 *Paleobates*, 3 *Colobodus*, 4 Cyamodontidea, 5 *Nothosaur*, 6 *Archosaur* (?phytosaur).

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