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Amt für Geologie und Baustoffprüfung
Ufficio Geologia e Prove Materiali

Workshop on the Cassian beds (Upper Triassic)

ABSTRACT BOOK

Bolzano/Bozen (I), July 28–29, 2011

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Why the Cassian beds?

The Cassian beds are one of the most prominent basinal sediments of the Triassic successions of the Dolomites – since June 2009 inscribed on the UNESCO's World Natural Heritage List. The Cassian beds were deposited adjacent to the platforms of the Cassian Dolomite in water-depths between some hundreds and tens of meters and consist essentially of calcarenites, marly limestones and marlstones. Some intervals are quite fossil rich and bear well-preserved fauna such as gastropods, bivalves, echinoderms, crinoids, ammonites etc…Locally, even aragonite shells and corals are preserved. The age of the Cassian beds is Upper Ladinian to Lower Carnian. The Cassian beds bear also the GSSP for the base of the Carnian Stage at the Stuores Wiesen/Prati di Stuores section.

Despite a long history of research the Cassian beds pose still many questions, such as:

1. distribution of fossils and environmental changes in time and space
2. origin of the dwarfism of certain taxa
3. habitat studies
4. definition of the lithostratigraphic boundaries (lower, upper and lateral limits)
5. quantitative analyses of material provenience (carbonate platforms *vs* volcanic and crystalline hinterland) and sedimentation rates
6. response of the basinal sediments to changes of carbonate platform growth
7. terrigenous clastic input *vs* platform derived material: sea level changes, climatic control or environmental control on the carbonate factory?
8. paleoceanographic changes using high-resolution stable isotope studies (C, O)
9. magnetostratigraphy across the entire, composite succession
10. facies model

The aim of this workshop is to provide a forum for researchers interested in the Cassian beds. Participants will be invited to present: i) the state of the art in his field of research; ii) open questions in his field of research and iii) methods to solve these topics within a multidisciplinary research project.

The museum

Bozen/Bolzano city, at the western margin of the Dolomites, is the capital of the province of South Tyrol, one of the northernmost provinces of Italy. The small airport of the city permits only flights to Munich (D) and Rome (I), better served airports, however, are located in nearby localities, to the North (Munich, Innsbruck) and South (Verona). Bolzano is easily reached by train, from all of these cities.

The workshop is supported by the Museum of Nature South Tyrol and the Office of geology and material testing. The scientific sessions will be held at the Museum, in the city of Bozen/Bolzano (Bindergasse 1/Via Bottai, 1).

Organising and Scientific Committee

Evelyn Kustatscher (Museum of Nature South Tyrol)
Lorenz Keim (Office for Geology and Building Material Testing)
Rainer Brandner (University of Innsbruck)
Piero Gianolla (University of Ferrara)
Paolo Mietto (University of Padova)
Franco Russo (University of Calabria)
Max Urlichs (Staatliches Museum of Stuttgart)

Program

Arrival on Wednesday, July 27, 2011

From 5.00 p.m.	Arrival at the Museum with registration (posters and presentations may be handed in)
6.00 p.m.	Come-together-party with some appetizers

Workshop, Thursday, July 28, 2011

8.15 a.m.	Registration
8.45 a.m.	Opening ceremony
	Chairman: Piero Gianolla
9.00 a.m.	**Keim L**.: The stratigraphic framework of the “Cassian beds”
9.20 a.m.	**Preto N.**, Dal Corso J., Gattolin G., Roghi G., Birgel D., Pancost R., Peckmann J. & Westphal H.: Lipid biomarkers in shales and carbonates of the "upper Cassian beds" (Heiligkreuz Fm.) of the Dolomites: a preliminary report
9.40 a.m.	**Tosti F.**, Guido A., Demasi F., Mastandrea A., Naccarato A., Tagarelli A.2 & Russo F.: Microbialites as primary builders of the Ladinian-Carnian platforms in the Dolomites: biochemical characterization
10.00 a.m.	**Urlichs M.**: Stunting in invertebrates from the Cassian Formation (Early Carnian) of the Dolomites, Italy
10.20 a.m.	**Kroh A:**, Echinoids from the Triassic – A review
10.40 a.m.	Tea and Coffee break
11.00 a.m.	**Hagdorn H.:** Benthic crinoids from the Triassic Cassian Formation of the Dolomites
11.20 a.m.	**Nützel A.**: Paleobiodiversity of the Cassian Formation
11.40 a.m.	**Hausmann I.** & Nützel A.: Biodiversity of a Late Triassic Fauna from the Cassian Formation (North Italy, Dolomites)
12.00	**Kaim A.** & Nützel A.: Unusual low diversified fossil association from Settsass Scharte locality of the Cassian Formation
0.20 p.m.	**Kustatscher E.**, Bizzarrini F. & Roghi G.: Plant fossils in the Cassian beds and other Carnian formations of the Eastern Southern Alps (Italy)
0.40 p.m.	**Richoz S.:** Carbon Isotope variations at the Ladinian/Carnian Boundary in Northern Calcareous Alps (Austria)
1.00 p.m.	**Benjamini C.**, Bialik O. M., Kantorovitch A. & Korngreen D.: Controls on sedimentary cycles in the Ladinian-Carnian carbonate-evaporite succession of Makhtesh Ramon, Israel
2.30 p.m.	**Round Table discussion – chairman: Lorenz Keim**

Posters:

Bernardi M., Avanzini M. & Bizzarini F.: Vertebrate fauna from the San Cassiano Formation (early Carnian) of the Dolomites region

Alberto Riva: Internet resources for studying of the Cassian Beds in the Dolomites

Kroh A., Nichterl T. & Lukeneder A: Type specimens from the Cassian Beds in the collection of the NHM Vienna

Fieldtrip, Friday, July 29, 2011

8.00 a.m.	Start from the station with cars and small busses
9.30 a.m.	Arrival at Corvara – going up to Pralongià and to the Stuores section
5.00 p.m.	Back down to Corvara
c. 7.00 p.m.	Back to Bolzano, perhaps with stop at the Grödner Joch/Passo Gardena (if time)

List of Participants

Marco Avanzini
Museo Tridentino di Scienze Naturali
Via Calepina 14
38100 Trento
Italy
e-mail: Avanzini@mtsn.tn.it

Kathleen Bauer
Naturmuseum Südtirol
Bindergasse 1
39100 Bozen
Italy
e-mail: Kathleen.Bauer@naturmuseum.it

Chaim Benjamini
Ben Gurion Univ, Dept Geology
84105 Beer Sheva
POB 653
Israel
e-mail: chaim@bgu.ac.il

Massimo Bernardi
Museo Tridentino di Scienze Naturali
Via Calepina 14
38100 Trento
Italy
e-mail: massimo.bernardi@mtsn.tn.it

Fabrizio Bizzarini
Cannaregio 1269/a
Venezia
Italia
e-mail: fabrizio.bizzarini@alice.it

Rainer Brandner
Institute for Geology and Palaeontology
University of Innsbruck
Innrain 52f
6020 Innsbruck
Austria
e-mail: rainer.brandner@uibk.ac.at

David Bressan
Himmelreichstraße Nr.6
39031 Bruneck
Italy
e-mail: David.Bressan@uibk.ac.at

Giovanni Gattolin
Dipartimento di Geoscienze
Università degli Studi di Padova
Via Gradenigo, 6
35131 Padova
e-mail: giovanni.gattolin@studenti.unipd.it

Piero Gianolla
Dipartimento di Scienze della Terra
Università di Ferrara
Blocco "B"
Via G. Saragat 1
44100 Ferrara
Italy
email: glr@unife.it

Adriano Guido
Università della Calabria
Via Bucci, Cubo 14b
87100 Cosenza
Italy
e-mail: aguido@unical.it

Hans Hagdorn
Muschelkalkmseum
Schloss-str. 11
74653 Ingelfingen
Germany
e-mail: encrinus@hagdorn-ingelfingen.de

Ismelda Hausmann
Bayerische Staatssammlung für Paläontologie und Geologie
Richard Wagner Str. 10
80333 München
Germany
e-mail: Imelda.Hausmann@gmx.de

Robert Jenkins
Bayerische Staatssammlung für Paläontologie und Geologie
Richard Wagner Str. 10
80333 München
Germany
e-mail: r.jenkins@lrz.uni-muenchen.de

Andrzej Kaim
Bayerische Staatssammlung für Paläontologie und Geologie
Richard Wagner Str. 10
80333 München
Germany
e-mail: a.kaim@lrz.uni-muenchen.de

Lorenz Keim
Autonome Provinz Bozen-Südtirol
Amt für Geologie & Baustoffprüfung
Eggentalerstr. 48
39053 Kardaun /Cardano
Italy
e-mail: Lorenz.Keim@provinz.bz.it

Andreas Kroh
Naturhistorisches Museum in Wien
Geologisch-Paläontologische Abt.
Burgring 7
1010 Vienna
e-mail: andreas.kroh@NHM-WIEN.AC.AT

Evelyn Kustatscher
Naturmuseum Südtirol
Bindergasse 1
39100 Bozen/Bolzano
Italy
e-mail: Evelyn.Kustatscher@naturmuseum.it

Paolo Mietto
Dipartimento di Geoscienze
Università degli Studi di Padova
Via Gradenigo, 6
35131 Padova
Italy
e-mail: paolo.mietto@unipd.it

Giovanni Muttoni
Dipartimento di Scienze della Terra
via Mangiagalli 34
20133 Milano
Italy
e-mail: giovanni.muttoni1@unimi.it

Alexander Nützel
Bayerische Staatssammlung für Paläontologie und Geologie
Richard Wagner Str. 10
80333 München
Germany
Mail: a.nuetzel@lrz.uni-muenchen.de

Jordi Orso
Via Bertinoro, 9
20148 Milano
Italy
e-mail: jordi.orso@gmail.com

Nereo Preto
Università degli Studi di Padova
Via Gradenigo, 6
35131 Padova
Italy
e-mail: nereo.preto@unipd.it

Herwig Prinoth
Museum Ladin Ćiastel de Tor
Strada Tor 65
39030 San Martin de Tor
Italy
e-mail: herwig@museumladin.it

John J. G. Reijmer
VU University Amsterdam
Faculty of Earth and Life Sciences (FALW)
Dept. of Sedimentology and Marine Geology
De Boelelaan 1085
1081 HV Amsterdam
The Netherlands
e-mail: John.Reijmer@falw.vu.nl

Sylvain Richoz
Commission for the Palaeontological and Stratigraphical Research of Austria Austrian Academy of Sciences
c/o Institut of Earth Sciences (Geology and Palaeontology
Karl-Franzens-University Graz
Heinrichstraße 26
8010 Graz
Austria
e-mail: sylvain.richoz@uni-graz.at

Manuel Rigo
Dipartimento di Geoscienze
Università degli Studi di Padova
Via Gradenigo, 6
35131 Padova
e-mail: manuel.rigo@unipd.it

Alberto Riva
Via Cavour 28
32100 Belluno
Italy
e-mail: alberto.riva@geodolomiti.net

Guido Roghi
Institute of Geosciences and Georesources C.N.R.
Dipartimento di Geoscienze
Università degli Studi di Padova
Via Gradenigo, 6
35131 Padova
Italy
e-mail: guido.roghi@igg.cnr.it

Franco Russo
Dipartimento di Scienze della Terra
Università della Calabria
Ponte Bucci 15B
87036 Arcavacata di Rende (CS)
Italy
e-mail: f.russo@unical.it

Hans-Volker Thiel
Buntspechtweg 29
53123 Bonn
Steinmann-Institut

Abt. Paläontologie
Universität Bonn
Germany
e-mail: hv-thiel@gmx.de

Fabio Tosti
Dipartimento di Scienze della Terra
Università della Calabria
Via P. Bucci - Cubo 15b
87036 Arcavacata di Rende
Italy
e-mail: fabio.tosti@unical.it

Max Urlichs
Staatliches Museum für Naturkunde Stuttgart
Rosenstein 1
70181 Stuttgart
Germany
e-mail: max.urlichs@t-online.de

Controls on sedimentary cycles in the Ladinian-Carnian carbonate-evaporite succession of Makhtesh Ramon, Israel

Chaim Benjamini[1], Or M. Bialik[1], Antonina Kantorovitch[1] & Dorit Korngreen[2]

[1]Department of Geological and Environmental Sciences, Ben-Gurion University, Beer Sheva, 84105, Israel
[2]Geological Survey of Israel, 30 Malkhe Israel St., Jerusalem, 95501, Israel

The Triassic of the Levant region is known mostly from the subsurface, from a number of localized, relatively small evaporite basins. The Makhtesh Ramon outcrop is unique in that cyclic and spatial trends can be observed in detail in the field.

A high resolution bed-by-bed investigation of the Ladinian - Early Carnian Saharonim Fm at Ramon yielded a systematic framework of several orders of small cycles, composed of facies changes between evaporites, carbonates, stromatolites and other microbialites. The full Ladinian-Carnian section represents a single large scale upward- deepening and shallowing sequence.This large-scale cycle is composed of a higher order of deepening/ shallowing cyclic units.

In the Late Ladinian, an active barrier began to influence the depositional dynamics in the Ramon basin, limiting the connectivity to the open sea and contributing to periodic development of an evaporitic system, the products of which can be observed in lithological change as well as presence of ecologically-stressed biotas in the carbonates. Evaporites were particularly dominant during two intervals, in the Late Ladinian and in the Carnian.

We propose a dynamic model to explain how local sea level change due to structural activity, in tandem with eustatic change, govern periodicity. The basins are situated on the down-faulted side of tilted blocks belonging to a stepped half-graben system. The depressed part of the blocks provide accommodation space, while the uplifted parts form collectively part of the barrier system interfering with water exchange, both with the open sea and fresh water from land. Thus alternating carbonate and evaporite phases can be explained by climate change, with sea level change and tectonic movements responsible for short-term rapid, or longer-term graduated facies shifts, in this section.

The structural background for this scenario can be Neo-Tethyan rifting, more localized tensile tectonics, or transpressive movements related to shear. These structural styles have all been invoked for the Middle to Late Triassic of the northwestern Arabian plate.

Vertebrate fauna from the San Cassiano Formation (early Carnian) of the Dolomites region

Massimo Bernardi[1], Marco Avanzini[1] & Fabrizio Bizzarini[2]

[1]Museo delle Scienze, via Calepina 14, I-38122 Trento
[2]Museo Civico di Storia Naturale, S. Croce 1730, I-30125 Venezia

Although the San Cassiano Formation (early Carnian) is renowned for its highly diversified invertebrate fauna (e.g., Fürsich & Wendt, 1977), vertebrates from this unit are poorly known.

Few studies listing vertebrate findings from the San Cassiano Formation (Boni, 1941; Broglio Loriga, 1967; Bizzarini et al., 2001) report of isolated, fragmentary remains while several vertebrate remains were found in the overlaying Heiligkreuz Formation (mid-late Carnian) (e.g., Sirna et al., 1994; Bizzarini and Rottonara, 1997; Dalla Vecchia and Avanzini, 2002).

Despite quantitatively and qualitatively scarce, these findings provide evidence of the high *trophic levels of a* well developed food web, implementing the big picture of the San Cassiano ecosystem. To date, bony fish are represented by the perleidiform *Colobodus bronni* and chondrychthians by a diverse fauna comprising *Paleobates* sp., *Hybodus hexagonus* and *Hybodus* sp. The presence of marine reptiles is documented by *Nothosaurus* sp., *Placochelys* sp., and cyamodontid remains; Archosaurs are represented by a single tooth (Bizzarini et al., 2001).

Here we provide an updated check-list of the vertebrates from the San Cassiano Formation documenting the first record of the shark *Acrodus* sp. from near Passo Sief (Badia Valley, BZ), and propose a framework of their trophic interactions.

References

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Sirna, G., Dalla Vecchia, F.M., Muscio, G. & Piccoli, G., 1994. Catalogue of Paleozoic and Mesozoic Vertebrates and vertebrate localities of the Tre Venezie area (North Eastern Italy). - Mem. Sci. Geol., 46: 255-281.

Benthic crinoids from the Triassic Cassian Formation of the Dolomites

Hans Hagdorn

Muschelkalkmuseum, Schlossstr. 11, 74653 Ingelfingen, Germany

The crinoid fauna from the late Ladinian/early Carnian Cassian Formation is the most diverse Triassic fauna known from the western Tethys. However, unlike the obrutional conservation lagerstätten in the late Anisian/early Ladinian germanotype Muschelkalk, which has much less diverse crinoid faunas, articulated skeletons are extremely rare in the Cassian Formation. Hence, the variety of crinoid sclerites forms a puzzle with many parts still missing. Most of the taxa established during the last 170 years are based on fragmentary material, mostly columnals, many of which are of limited diagnostic value and cannot be unequivocally attributed to a genus or even a species. A revision of the fauna is still a desideratum, especially in respect of its worldwide importance for the post-Palaeozoic crinoid radiation and mid Carnian extinction (HAGDORN 2011).
This paper presents (1) a first step towards a revision of the Cassian benthic crinoids (the planktonic and benthic microcrinoids excluded), (2) evidence of their possible biostratigraphic value and (3) a first data set of their palaeogeographic distribution and relations to Eastern Tethyan faunas of this time interval. At present, the following taxa can be distinguished

Order Holocrinida	Family Tollmannicrinidae		
		Tollmannicrinus quinqueradiatus	rare columnals
Order Encrinida	Family Encrinidae		
		Encrinus n. sp. indet.	2 crowns, isolated sclerites
		Chelocrinus cassianus	a few crowns, many cups, isolated sclerites
		Cassianocrinus varians	a few crowns, many cups, isolated sclerites
		Zardinicrinus granulosus	1 crown, many cups, isolated sclerites
		Zardinicrinus tuberculatus	a few cups, isolated sclerites
	Family Traumatocrinidae		
		Traumatocrinus sp. indet.	a few columnals
	Family Ainigmacrinidae		
		Ainigmacrinus calyconodalis	a few cups, several calyconodals
Order Isocrinida	Family Isocrinidae		
		Tyrolecrinus tyrolensis	1 cup, 1 basal circle, columnals
		Balanocrinus subcrenatus	rare columnals
		Laevigatocrinus laevigatus	1 stem fragment, rare columnals
		"Isocrinus" propinquus	2 cups, columnals
		“Isocrinus” apetalus	columnals
		"Isocrinus" venustus	columnals
Order Millericrinida (?)	Family indet.		
		“Encrinus” cancellistriatus	columnals

A major cut in the phylogeny of the post-Palaeozoic crinoids marked by the extinction of order Encrinida between *aonoides* and *austriacum* biozone allows to establish a late Ladinian/Carnian crinoid biochronology for the Western Tethys on the base of abundant and easily determinable sclerites. However, more bed-by-bed collecting will be necessary.

References

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Biodiversity of a Late Triassic Fauna from the Cassian Formation (North Italy, Dolomites)

Imelda Hausmann & Alexander Nützel

Bayerische Staatssammlung für Paläontologie und Geologie, Department of Earth and Environmental Sciences, Palaeontology & Geobiology, Geobio-Center[LMU], Richard-Wagner-Str. 10, 80333 München, Germany.

A highly diverse fauna from a tropical marine shallow water environment from the Stuores Meadows is studied regarding diversity and composition. The fauna comes from marly sediments of the Cassian Formation which are of Late Triassic (Early Carnian) age. The material is well preserved although carbonate coating is common. Two different samples were analysed for palaeoecology: a bulk sample and one coming from surface sampling.

The bulk sample consisted of 16,5 kg sediment which was washed and sieved with a mesh size of 0.5 mm. Subsequently, the fossils were picked from the residue and were sorted and determined. The most common species were documented with photos and SEM images in order to facilitate identifications. The fossilized organisms from the surface sample were also sorted and determined. To assess the biodiversity, the two different samples were quantified.

The bulk sample comprises approximately 3000 identified specimens representing about 200 species with a large amount of coated grains; the surface sample yielded about 100 identified specimens representing c. 50 species. Most fossils are small, only a few millimetres in length. Size and composition of the bulk sample and the surface sample differ strongly from each other because small species and specimens are lacking in the surface sample. Additionally, some taxa like crinoids, ophiuroids, and ostracods can be found only in the bulk sample, but were not found in the surface sample, leading to the assumption that bulk sampling is a more accurate method for determining biodiversity of the Cassian Formation.

The fossil assemblage is allochthonous and comes from a shallow water environment on the carbonate platform. Both samples are mollusc-dominated, with gastropods as the most common organisms within the fossil assemblage. Molluscs form the most diverse group of the fauna with the highest number of species; this is due to the very high species richness of gastropods. Especially the bulk sample shows that the studied location from the Stuores Meadows is highly diverse with about 200 species found in a single sample.

Unusual low diversified fossil association from Settsass Scharte locality of the Cassian Formation

Andrzej Kaim[1,2] & Alexander Nützel[1]

[1]Bayerische Staatssammlung für Paläontologie und Geologie, Department of Earth and Environmental Sciences, Palaeontology & Geobiology, Geobio-Center[LMU], Richard-Wagner-Str. 10, 80333 München, Germany.
[2]Institute of Paleobiology, Polish Academy of Sciences, ul Twarda 51/55, 00-818 Warszawa, Poland

The Late Triassic Cassian Formation is renowned for its extremely diverse early Mesozoic marine invertebrate assemblages unrivalled worldwide. The association from Settsass Scharte, a small pass located between Mount Settsass and Small Settsass, is unusual in this respect because its diversity is rather low. A bulk sample of 6.5 kg of sediment provided 312 specimens, the surface collected material consists of 119 specimens. In the bulk sample gastropods are the most diverse group represented by 212 specimens and 11 species. The three most common species are the polygyrinid *Goniogyra armata*, a new mathildoid genus and species previously identified by Bandel (1995) as *Ampezzanilda aialensis*, and the coelostylinid *Gallensteinia* sp. These species are known also from other localities of the San Cassian Formation but they never constitute the majority in these associations; they are generally rare. The other gastropods belong to the following genera: *Cylindrobullina*, *Wortheniella*, *Ampezzalina*, *Bandellina*, *Sisenna* and *Spirostylus*. The surface collected material (88 shells of gastropods) differs significantly from that of the bulk sample, both qualitatively and quantitatively. The collection is heavily dominated by *Goniogyra* (nearly 75% of all specimens). The surface collection yielded several genera which are absent in the bulk sample: *Coelostylina*, *Anoptychia*, *Pseudoclanculus*, *Eucycloscala*, *Temnotropis* and *Schizogonium*. However, each of these genera is present with a single or a few specimens only. On the other hand the small-sized gastropod taxa are completely absent in the surface collected material (*Cylindrobullina*, *Bandellina*) or are clearly underrepresented ("*Ampezzanilda aialensis*" and *Gallensteinia*). The bivalves are dominated by nuculoids, both in bulk and surface samples but *Nucinella, Parallelodon* and *Prosolepsus* are also present in the bulk sample. Scaphopods (*Plagioglypta undulata*) are common both in the bulk sample and the surface collection.

The fauna collected at Settsass Scharte is strongly dominated by molluscs reaching up to 90% of species and specimens in the association. This dominance is particularly high even for San Cassian Formation standards. The recovered non mollusc fauna is represented by a very small number of individuals and consists of echinoderm spines and plates, cephalopod fragments and fish elements (otolithes, teeth and scales). The mollusc shells are relatively well preserved with no indication of extensive transportation. The majority of the bivalves were found with their valves articulated. We interpret the studied assemblage from Settsass Scharte as an autochthonous association representing the near platform soft-bottom environment.

Echinoids from the Triassic – A review

Andrea Kroh

Natural History Museum Vienna, Department of Geology & Palaeontology, Burgring 7, 1010 Vienna, Austria; andreas.kroh@nhm-wien.ac.at

The end-Permian mass extinction event severely affected most echinoderm groups and caused the loss of all but a few selected survivor clades (Twitchett& Oji, 2005), causing a severe evolutionary bottleneck. In echinoids, however,biodiversity was low during the Late Permian already and only one genus is known to have survived the end-Permian crisis (*Miocidaris* – Kier, 1965; Smith &Hollingworth, 1990). Data from lantern supports, however, indicates that at least two echinoid lineages passed from the Permian to the Triassic (Kier, 1984): one group with apophyses, which evolved into modern cidaroids and one lineage without apophyses, possibly being the ancestor of all euechinoids.

Recovery after the mass extinction occurred at different times in echinoderms (Twitchett& Oji, 2005). While crinoids and ophiuroids seem to have recovered relatively rapidly (Twitchett& Oji, 2005; Hagdorn, 2011), echinoids are exceedingly rare in the Early and Mid-Triassic. A significant evolutionary radiation did not occur before the Carnian in echinoids.From the Early Triassic just two echinoid species are known, both of which appear to be stem-group cidaroids related to the P/T-survivor *Miocidaris*. Unlike most modern forms they are construed from imbricating plates producing a flexible rather than a rigid corona. The mid-Triassic fossil record of echinoids is similarly poor. Only three species are known, all of stem stem-group cidaroids. In the Late Triassic echinoids become much more diverse and new clades appear (modern-type cidaroids, triadocidaroids and pedinoids in the Carnian, pseudodiadematoids in the Rhaetian). Ignoring the Cassian Beds echinoids five species are known from Carnian strata, eight from the Norian and four from the Rhaetian (Kier, 1977; Smith, 1994; Hagdorn, 1995).

The Cassian Beds contain the largest and most important echinoid fauna of Triassic age worldwide. More than 70 nominal taxa have been described from these deposits, 18 of which were considered valid upon critical revision by Kier (1977, 1984). The fauna contains both “old-fashioned” stem-group cidaroids, as well as modern type cidaroids and the short lived triadocidarid clade. The latter are cidaroid-like, but lack lantern supports and possibly are not part of the crown group (Kroh & Smith, 2010). Despite the considerable attention received in the past, the echinoid fauna of the Cassian Beds, however, is far from being fully investigated. Numerous additional taxa (10+) are known from small fragments only and were, in part, named in open nomenclature. Among these rare un-named specimens are some of the very first ancestors of non-cidaroid echinoids, including the oldest ambulacral lantern supports (auricles) and the first example of ambulacral compound plating (Kier, 1984). Both features are major innovations characterizing regular euechinoidsand the Cassian Bed examples might represent missing links between Early Jurassic modern-type euechinoids and their Triassic ancestors.

Additionally, the Cassian fauna contains the minute enigmatic echinoid *Tiarechinusprinceps*Neumayr, 1881. This species shows unique constructional features and can currently not be confidently placed anywhere in the echinoid tree. Known specimens possibly are juveniles (although their gonopores are already open) and future finds of larger specimens might help to resolve its taxonomic affinities.

It is envisioned that bulk-sampling might be a key to a better understanding and broader knowledge of the Cassian Beds echinoid fauna. Specimens available today largely were hand-picked from weathered surfaces and are usually not associated with detailed geographic and stratigraphic information. Consequently detached spines and lantern parts can usually not be referred to specific taxa known from test fragments. Such element associations, however, would likely considerable increase our knowledge on the Cassian echinoids and their phylogenetic significance. A further, as yet completely unexplored field in relation to the CassianBeds, is represented by echinoid pedicellariae. Recently published results (Mostler, 2009) have shown that pedicellariae of Middle to Late Triassic age may be preserved in excellent quality. Moreover, that they show a much higher morphological diversity than expected. Pending proper sampling techniques are employed, such high-quality preservation seems likely in the Cassian Beds too. Pedicellariae evolved in an arms race against pest and parasites (Coppard et al. 2010) and underwent a major radiation in the Early Mesozoic. Today these structures are important features for species-level taxonomy and an improved knowledge on their early diversification is much needed.

Type specimens from the Cassian Beds in the collection of the NHM Vienna

Andreas Kroh, Thomas Nichterl & Alexander Lukeneder

Natural History Museum Vienna, Department of Geology & Palaeontology, Burgring 7, 1010 Vienna, Austria; thomas.nichterl@nhm-wien.ac.at

The collection of the Natural History Museum Vienna contains abundant material from the Triassic deposits cropping out in the vicinity of St. Cassian, South Tyrol. Most of these specimens were collected during the first half of the 19th century. In the 1860ties Gustav Carl Laube(* 9.1.1839Teplitz, Bohemia; † 12.4.1923 Prag) was briefly employed at the Hof-Mineralienkabinett in Wien (today the Natural History Museum of Vienna) and at the k.&k. Polytechnisches Intitut, a precursor of the Vienna University of Technology. During this time he studied the material of the Cassian Beds housed at these institutions, as well as the material kept at the Geologische Reichsanstalt (today the Geological Survey of Austria). Comparing these specimens with Münster's type material housed in Munich (at the Bavarian State Collection on Palaeontology) he critically revised the complete invertebrate fauna of the Cassian Beds, synonymizing many of the species previously established by Münster and Klipstein. His results were published in a series of papers in the Denkschriften der k.&k. Akademie der Wissenschaften during the years 1865 to 1870.

Laube's material and additional Cassian specimens present in the NHM Vienna collection formed the basis for many subsequent studies. These focussed mainly on the gastropod fauna of the Cassian Beds, e.g. Kittl (1891, 1892, 1894), Bandel (1991, 1992, 1993a, b, 1994, 1995) and Schwardt (1992).

Currently the NHM Vienna collection contains 149 holotypes, 11 paratypes, 96 syntypes, 436 figured specimens and 9 lots of reference specimens from the Cassian Beds. Most of the types and reference specimens are gastropods (432 lots), followed by bivalves (170 lots), crinoids (35 lots), brachiopods (32 lots), sponges (16 lots) and other groups (16 lots). Additionally, abundant non-type material from the Cassian Beds is available for study at the NHM Vienna. Although some of the latter have been determined, the large majority remains unstudied so far.

Information on the type and reference specimens is available via the OeTyp-Website. The OeTyp-Project is a joint effort of the Austrian Academy of Sciences (Commission for the Palaeontological and Stratigraphical Research of Austria) and the Natural History Museum Vienna to provide data on palaeontological types, figured specimens and reference material in Austrian collections. Currently the database contains more than 70,000 animal and plant fossils. Regular updates are provided as further published fossil material is included.

Plant fossils in the Cassian beds and other Carnian formations of the Eastern Southern Alps (Italy)

Evelyn Kustatscher[1], Fabrizio Bizzarrini[2] & Guido Roghi[3]

[1] Naturmuseum Südtirol, Bindergasse 1, 39100 Bozen, Italy
[2] C/o Museo Civico di Rovereto, Borgo S. Caterina 41, I-38068 Rovereto
[3] Istituto di Geoscienze e Georisorse-CNR-Sezione di Padova, c/o Dipartimento di Geoscienze, Università degli Studi di Padova, Padova, Italy.

Plant fossils are well described from Middle Triassic sediments from the Eastern Southern Alps, but are almost completely missing from the Early and also from the Late Triassic. Historically, only Koken (1913) indicated badly preserved plant remains also from the Late Carnian of Heiligkreuz without describing nor figuring them. Outside the Dolomites Various authors described the Carnian flora of Raibl/Cave del Predil (e.g., Bronn, 1858; Schenk, 1866-7, Stur, 1868, 1885).

Lately, some plant remains were also collected and described from the Rio del Lago Formation (early Carnian) near Dogna in the Julian Alps (Roghi et al., 2006a). These remains belonged to the sphenophytes (*Equisetites*), the ferns (*Danaeopsis* sp.), the seed ferns (*Ptilozamites sandbergeri* (Schenk) Kustatscher & Van Konijnenburg-van Cittert, 2007) and to the conifers. Additional plant remains were found during an excavation of a partial *Nothosaurus* skeleton, together with mollusks and remains of other marine vertebrates (Bizzarini et al. 2003) and in the Heiligkreuz Formation near Heiligkreutz. Only few plant remains were so far found, two fragments of leaf sheets of *Equisetites* sp., a typical horsetail genus of the Triassic. Few fragments of conifer shoot fragments belonging probably to the genus *Voltzia*, were found as well. Charcoaled wood, seeds and small conifer shoots have been also collected also from Pralongia (com. pers., Helmut Buratti, 2011), Misurina (com. pers., Alexander Nützel, 2011).. Late Carnian plant remains are known from Lastoni di Formin and Dibona in the Dolomites (Heiligkreuz Formation) (Roghi et al., 2006a). Also in this case the plant remains belonged mostly to the conifers (also as isolated leaves) while some other fragments belong probably to the sphenophytes.

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Paleobiodiversity of the Cassian Formation

Alexander Nützel

Bayerische Staatssammlung für Paläontologie und Geologie, Department of Earth and Environmental Sciences, Palaeontology & Geobiology, Geobio-Center[LMU], Richard-Wagner-Str. 10, 80333 München, Germany.

The Late Triassic Cassian Formation has yielded the most diverse early Mesozoic marine invertebrate fauna world wide. The study of this famous tropical fauna may help to understand how diversity evolved during the Mesozoic. A screening of the literature suggests that more than 1.400 species have been described from the Cassin Formation although these data need confirmation by specialists of the various invertebrate groups. The fauna of the Cassian Formation comes from various locations representing different palaeo-environments and differ strongly in composition and diversity. The reasons for the high number of reported species are 1) a high primary diversity as is typical for tropical shallow water settings, 2) a low grade of lithification which facilitates disaggregation of the marly sediments and the finding of small sized species, 3) low grade diagenesis including aragonite preservation and a low tectonic deformation. A striking aspect of the Cassian fauna is the pronounced mollusc dominance. Molluscs and especially gastropods form by far the most diverse group of the Cassian Formation as whole but also on the community and sample level. Preliminary analyses of several large bulk samples from various settings of the Cassian Formation suggests that mollusc dominance is clearly reflected in species richness but commonly also in relative abundances. These samples were obtained according to a standardized protocol which facilitates comparability.

According to the current state of knowledge, mollusc dominance is a modern aspect of the Cassian Fauna. Accordingly, mollusks and especially gastropods and bivalves are less important in Palaeozoic faunas. A planned comparison of samples from the Cassian Formation with samples from modern similar tropical settings may reveal that their diversities are in the same magnitude. However, non-actualistic aspects of the Cassian fauna (e.g., calcareous sponges as main reef builders) and the high geological age must be considered when comparing such ancient and modern faunas.

Lipid biomarkers in shales and carbonates of the "upper Cassian beds" (Heiligkreuz Fm.) of the Dolomites: a preliminary report

Nereo Preto[1,2], Jacopo Dal Corso[1], Giovanni Gattolin[1], Guido Roghi[3], Daniel Birgel[4], Richard Pancost[5], Jörn Peckmann[4], Hildegard Westphal[2]

1) Department of Geosciences, University of Padova, 35131 Padova, Italy
2) Leibniz Center for Tropical Marine Ecology (ZMT), 28359 Bremen, Germany
3) Institute for Geoscience and Georesources - CNR, 35131 Padova, Italy
4) Department for Geodynamics and Sedimentology, University of Vienna, 1090 Vienna, Austria
5) School of Chemistry, The Cabot Institute, University of Bristol, Bristol BS8 1TS, UK

A major climatic event (Carnian Pluvial Event or CPE) is documented in the upper Cassian beds and Heiligkreuz Fm. of the Dolomites (Northern Italy). Unfortunately, this event is only poorly preserved in the Dolomites, since because the prevailing lithology are shales, the successions encompassing this interval are involved in landslides. We identified the onset of the CPE in the Milieres section near Rifugio Dibona, and analyzed the petrography and organic geochemistry of carbonate boundstones and shales immediately before and during the first phases of the CPE.

Decimeter to meter-scale microbial mounds or biostromes are present in the section before the event, intercalated within prevailing dark gray to blackish shales and subordinated oolitic, bioclastic and intraclastic rudstones, floatstones, grainstones and wackestones deposited in a prodelta or coastal offshore sedimentary environment. Microbial boundstones are characterized by clotted peloidal micrite (thrombolitic microfabric) and abundant Tubiphytes, and are nearly devoid of metazoans. Morphological studies at SEM show that clotted peloidal micrite is composed of a mosaic of pitted microspar crystals, appointing to an original aragonite mineralogy. After the onset of the CPE, boundstones become richer in metazoans.

The presence of in situ carbonates (microbial boundstones) within a high-sedimentation rate prodelta/offshore sequence has to be attributed to local temporary interruptions of terrigenous input. During stases of sedimentation, microbial mounds and biostromes could grow at relatively reduced rates without being buried by deltaic shales.

Molecular fossils were extracted from three carbonate boundstones and eight shales, and the hydrocarbon fraction was analyzed via coupled Gas Chromatography-Mass Spectrometry. Hydrocarbons preserved in shales and carbonates are different under several respects.

Long-chain n-alkanes are more abundant and have a clear predominance of odd over even carbon chains (average Carbon Preference Index CPI = 1.7) in shales, suggesting an increased contribution of terrigenous land-plant derived organic matter with respect to carbonates.

Lipid biomarker proxies recording maturity were calculated from hopanes (Ts/(Ts+Tm), 22S/(22S+22R), C30 βα/αβ) and show significant differences between shales and carbonates. These differences are most likely related to various sources of organic matter rather than differences in thermal maturity, as carbonates and shales are intercalated in the same stratigraphic section.

Apart from saturated hydrocarbons (n-alkanes and hopanoids), carbonates also contain polycyclic aromatic compounds (PAHs), including pyrenes, fluoranthenes and phenanthrenes, which are known as products of incomplete combustion of organic matter or hydrocarbons and thus, in geological samples, are usually attributed to wildfires. Surprisingly, PAHs were identified in carbonates only. We tentatively explain this with increased contents of wind-blown organic matter (e.g., soot) preserved in carbonates due to a decreased sedimentation rate compared to shales. Furthermore, shales are composed of fluvially transported matter, which possibly contained organic matter from a much larger basin than areas interested by wildfires, diluting PAH under detection limits.

Carbonates and shales of the Milieres section contain abundant and various organic compounds and underwent minimal thermal maturation, making them ideal for further environmental studies based on organic geochemistry.

Internet resources for studying of the Cassian Beds in the Dolomites

Alberto Riva
Via Cavour 28, Belluno, Italy

Internet gives a powerful opportunity for accessing a huge amount of different data and informations stores throughout the world. In particular, many institutions and Google decided to scan many historical royalty-free books and made them available on internet for free. Among these books, there are several pieces of palaeontology and stratigraphy of the XIX century, including various "classics". In particular, the early studies on the Cassian Beds are all available, with the exception of Hauer (1958). More recent literature is also available, but is very scattered depending on the journal or the author copyright agreements. Here, we are focusing only on free and royalty-free download.

The name "Kalkmergellager von St. Cassian" was introduced by Münster (1834, [1]), then changed in "Schichten von St. Cassian" by Wissmann (In Wissmann and Münster 1841, [2]).

The name "Cassianer Schichten" was introduced by Hauer (1858, unfortunately not present on the net), then used by Richthofen (1860, [3]) and by all of the subsequent authors. On the net is present also one of the major studies on the Dolomitic area, the monograph of Mojsisovics (1879, [5]), covering the stratigraphy of the area including the Cassian Beds.

The peculiarity of the Cassian Beds is the quantity and the quality of the fossils, often excellently preserved, that attracted palaeontologist since the XIX century. One of the first systematic studies was done by Laube in 1865 [4]. "Die Gastropoden der Schichten von St. Cassian der südalpinen Trias" (Kittl 1891) is certainly one of most important paleontological studies on the Cassian Beds and the three volumes are completely available on [6], with all the tables scanned at high resolution.

The unique gastropods were collected and studied by several authors including Zardini, still available only on paper format, but whose collections are preserved in the Museum of Cortina d'Ampezzo. The available papers are relatively few in the last years, while the St Cassian Fm is still producing a lot of new paleontological material with new species (e.g., Nützel 2002 [7], Nützel 2007 [8], Bandel 2009 [9]), sometimes with an outstanding preservation of mineralogy (Fryda et al. 2009 [10]).

Other common fossils of the Cassian Beds are the Echinoids (e.g., Kier 1984 [11]), Sponges (e.g., Reitner 1987 [12], Bandel 2007 [13]), Encrinids (e.g., Hagdorn 2004 [14]), Ammonoids (e.g., Urlichs, 2004 [15], Mietto et al. 2008 [16]) and Nautiloids (e.g., Urlichs 2000 [17]).

The first proposal about the Ladinian-Carnian GSSP in the Dolomites is also available on the net (Mietto et al., 2007 [18]), including the studies that contributed to develop such proposal (e.g. Broglio Loriga et al., 1998 [19]). The studies for the GSSP included detailed description of the ammonoids in the Stuores section (Mietto et al., 2008 [16]). Most of the material for the Ladinian- Carnian GSSP was published on the journal "Albertiana" which is freely available since number 26 in pdf format [20].

This list is obviously far away to be complete, but shows how powerful can be internet for collecting publications that are often are hard-to find on normal academic libraries.

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[3] http://books.google.com/books?id=Ejo_AAAAcAAJ
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Microbialites as primary builders of the Ladinian-Carnian platforms in the Dolomites: biochemical characterization

Tosti, F.[1], Guido, A.[1], Demasi, F.[1], Mastandrea, A.[1], Naccarato, A.[2], Tagarelli, A.[2], Russo, F.[1]

[1]Dipartimento di Scienze della Terra, Università della Calabria, Via Bucci Cubo 15b, 87036 Rende (CS), Italy.
[2]Dipartimento di Chimica, Università della Calabria, Via Bucci Cubo 12c, 87036 Rende (CS), Italy.

The sedimentological features and the microfacies of the Cassian platforms (Late Ladinian–Early Carnian) of the Dolomites can be studied only on the basis of the so called “Cipit boulders”, that are platform-derived olistoliths and clasts fed to the basin and escaped to the extensive dolomitization affecting the buildups.

The Punta Grohmann (SassoPiatto, Western Dolomites) is one of the most classical Late Ladinian– Early Carnian basin successions ((Wengen and S. Cassiano Formations) of Dolomites in which several levels containing gravity-displaced carbonate olistoliths occur. The carbonate platforms, from which the olistoliths derive, were made up mainly of carbonate mud, interpreted as microbialite, and therefore they can be regarded as “mud mounds” (Russo et al.1997, 1998).

Skeletal organisms (Tubiphytes, skeletal cyanobacteria, sphinctozoan sponges, etc.) represent a minor component of the rock (usually less than 10%). On the contrary the composition of Cipit boulders is dominated by the micritic fraction (about 60%), mainly represented by automicrite, with subordinate amounts of micrite interpreted as detrital (allomicrite).

The microbialites or automicrites, which may exhibit both dense microcrystalline (aphanitic) or peloidal microfabric, are sometimes organized in stromatoliti claminae or thrombolytic fabric. The organic-induced nature of microbialite was supposed on the base micromorphological evidence and epifluorescence observations(Russo et al., 1997).

To corroborate the microbialitic model of Russo et alii (1997) for the Late Ladinian – Carnian platforms buildups, biogeochemical analyses have been carried out on selected samples of carbonate boulders. Fourier Transformed Infra-Red (FT-IR) spectroscopy and Gas Chromatography Mass Spectrometry (GC-MS) analyses have been performed to confirm the presence of organic matter remains and identify the metabolic signature of bacteria/cyanobacteria.

The geochemical characterization of extracted organic matter shows a great prevalence of the aromatic fraction over the aliphatic and carboxylic ones.

The FT-IR spectra reveal the presence of stretching C=C vibrations attributable to alkene and/or unsaturated carboxylic acids, that may be synthesized by microbes. GC-MS investigations indicate the presence of extended hopane series, short chain methyl-steranes (C22, C23), straight chain saturated (C14, C16), monounsaturated (C17:1, C18:1), and diunsaturated Cl8-acids, diagnostic of microbial activity.

All data confirmed the presence of bacteria/cyanobacteria communities during platform deposition, indicating that microbes have played a prominent role in the genesis of these carbonates. These communities created the chemical conditions that triggered the induced

precipitation of great volumes of syndepositionally-cementedautomicrites, which stabilized the carbonate bodies controlling their depositional geometries.

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Stunting in invertebrates from the Cassian Formation (Early Carnian) of the Dolomites, Italy

Max Urlichs

Staatliches Museum für Naturkunde Stuttgart, Rosenstein 1, 70181 Stuttgart

The Cassian fauna is a well-known example of a stunted fauna. In general, this fauna is small-sized. Furthermore, bivalves, gastropods, ammonoids, and brachiopods are mostly represented by juvenile specimens. Unusually small adult and juvenile specimens occur in some horizons. However, detailed investigations in stunting have been made only in ammonoids and ostracods. In-situ collecting in the type area of the Cassian Formation provided the material for this study. The ammonoids (except *Lobites*) have a spacing of the septa, like in specimens from the time-equivalent Hallstatt Limestone. Therefore, they are considered to be of normal size, and they are mostly represented by juvenile specimens with body chamber, and rarely by small phragmocone specimens. In contrast, *Lobites nautilinus* and *L. pisum* are usually adult and often completely preserved with eccentric body chamber, hood and contracted aperture. From argillaceous marls, they have narrowed sutures, beginning at the protoconch, compared with those from marls which have normal-spaced septa. Therefore, the small-sized specimens are genuinely stunted. However, ostracods have equal sizes in stunted and normal-sized mollusc horizons.

The aim of the present study is to investigate the most common infaunal bivalves *Palaeonucula strigilata* and *Prosoleptus lineatus*, the herbivore gastropod *Rhaphistomella radians*, and the brachiopods *Koninckina leonhardi* and *Camerothyris subangusta* from the autochthonous sediments of the Cassian fauna whether or not stunting is present. Specimens of *Palaeonucula* which are derived from marls are normal-sized compared with Recent nuculids. Those from clays and argillaceous marls are small-sized, but of the same shape. Comparing the lengths of adult *Palaeonucula* and *Prosoleptus* specimens with narrowing of the growth rings respectively of the tiny concentric ribs, the small-sized specimens only reach about 45-70% of the normal-sized specimens; they are therefore genuinely stunted. In *Rhaphistomella radians*, differences in shape and size are also striking, but smaller than in bivalves. Stunted specimens have a 20-23% smaller mean diameter and an about 10° smaller apical angle. Comparing the widths of adult *Koninckina* and *Camerothyris* specimens with narrowing of the growth rings, the small sized specimens are about 20% smaller than the normal sized ones. They are also stunted.

The normal sized faunas occur in marls, and the stunted faunas occur in the dark clays and argillaceous marls which are rich in fromboid and fine dispersed pyrite. The high pyrite content indicates one plausible cause for the stunting. Growth and development are retarded in modern invertebrates by sulfoxide, an incompletely oxidized derivate of sulfhydryl. During dysaerobic intervals, the toxic sulfoxide was probably precipitated as pyrite in the Cassian Formation. These live conditions with a high pyrite content and stunted invertebrates occurred at the end of a Transgressive-Regressive System Tract, at the end of the prograding carbonate platforms, when stagnation took place within the St. Cassian Basin.