Taxonomy and stratigraphic significance of *Trachyceras silberlingi* n. sp., from the Lower Carnian of South Canyon (New Pass Range, central Nevada, USA)

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**KEY WORDS** - Upper Triassic, Carnian Stage, Desatoyense Zone, Ammonoids, Taxonomy, Nevada.

**ABSTRACT** - New intensive bed-by-bed ammonoid collecting efforts conducted in 2010 and 2011 at South Canyon, the type locality of the lowest Carnian Desatoyense Zone of the North American chronostratigraphic scale, have lead to the recognition of a new species of *Trachyceras* that is herein described. The new species is dedicated to Norman J. Silberling (1928-2011), who was widely recognized as the leading authority on marine Triassic stratigraphy in western US for over 50 years. *T. silberlingi* n. sp. is characterized by a peculiar ornamentation consisting of two spiral rows of bullae on the flank (first row on umbilical shoulder and second row at about 70% of whorl height) and by ribs frequently looped in pairs at the lateral margin. The new species, from South Canyon site F, the stratigraphically highest level of the fossiliferous succession of the middle member of the Augusta Mountain Formation, represents the first definite occurrence of the genus *Trachyceras Laube, 1869* in this succession. For this reason, *T. silberlingi* n. sp. is of great importance for the revision of the Desatoyense Zone, a unit defined on the basis of a large collection of ammonoids described in 1941 from the lower part of the middle member of the Augusta Mountain Formation, without regard for the number and position of fossil bearing levels. We herein propose the subdivision and replacement of the former Desatoyense Zone with two biostratigraphic units: the lower unit referred to as the Daxatina beds, is an informal biozone characterized by the occurrence of *Daxatina* and Frankites sutherlandi, and the overlying *Trachyceras silberlingi* biozone is a range zone characterized by the occurrence of *Trachyceras*, based on the new species. The chronostratigraphic potential of this proposed subdivision is briefly outlined, but it will be more accurately defined upon completion of the taxonomic revision of the South Canyon ammonoid faunas.

**RIASSUNTO** - [Tassonomia e significato stratigrafico di *Trachyceras silberlingi* n. sp., del Carnico Inferiore di South Canyon (New Pass Range, Nevada centrale, Stati Uniti d’America)] - South Canyon, località tipo della Zona a Desatoyense, la prima zona del Carnico nella scala cronostatigrafica nordamericana, nel 2010 e 2011 è stata oggetto di campionamenti strato-per-strato che hanno permesso di individuare una specie nuova di *Trachyceras*, che viene descritta in questo lavoro. La specie è dedicata a Norman J. Silberling (1928-2011) che per 50 anni è stato l’autorità indiscussa per la stratigrafia del Triassico marino nella parte occidentale degli Stati Uniti. *Trachyceras silberlingi* n. sp. è caratterizzato da un’ornamentazione molto particolare, che consiste in due serie spiralali di bullae sul fianco, una in posizione vicina al margine umbellicale e una a circa il 70% di altezza del fianco, e da coste che spesso si congiungono a coppia alla bulla laterale. La nuova specie è stata raccolta dal sito F, il sito stratigraficamente più alto del membro medio della Augusta Mountain Formation of South Canyon, ove rappresenta la prima sicura presenza del genere *Trachyceras Laube, 1869*. Per questo motivo la nuova specie *T. silberlingi* è estremamente utile per una prima revisione della Zona a Desatoyense, basata originariamente su raccolte di ammonoidi effettuate nella parte inferiore del membro medio della Augusta Mountain Formation, senza distinzione sui livelli di raccolta. Si propone quindi la sostituzione della Zona a Desatoyense con due unità biostratigrafiche. I Daxatina beds sono una biozone informale caratterizzata dalla presenza di *Daxatina* e Frankites sutherlandi, e sono seguiti dalla biozone a *Trachyceras silberlingi*. Quest’ultima è una zona di distribuzione formalmente istituita in questo lavoro, caratterizzata dalla presenza di *Trachyceras*. Viene delineato il significato cronostatigrafico delle due biozona, ma il completamento della revisione del Carnico Inferiore della scala nordamericana sarà possibile solo dopo il completamento della revisione tassonomica di tutte le faune raccolte.

**INTRODUCTION**

Efforts to define the GSSP of the Carnian Stage (Upper Triassic Series) during the past fourteen years have involved considerable research by numerous biochronostratigraphers on Upper Triassic ammonoids, conodonts and pelagic bivalves, as well as specialists on palynology and physical stratigraphy. This search for the optimal section and events to mark the base of the Carnian has lead these specialists to reconsider and re-examine a few promising Tethyan and North American Upper Ladinian-Lower Carnian fossil-rich successions that have not been studied for many tens of years. The Working Group of the Subcommission on Triassic Stratigraphy (STS) eventually selected Prati di Stuores/Stuores Wiesen in Italy, Spiti in India and South Canyon in Nevada (USA) for further scrutiny. Following a thorough discussion of the strengths and weaknesses of these possible candidates during the 2007 “Global Triassic” conference in Albuquerque, NM, the FO (First Occurrence) of the ammonoid *Daxatina canadensis* at level SW4 of Prati di Stuores was ultimately selected as the GSSP, and eventually ratified by the STS and IUGS in 2008. Since the formal definition of this GSSP, many of these specialists have become involved with the Carnian/Norian boundary Working Group, and consequently, the completion of the taxonomic and bio-chronostratigraphic revision of the three above designated successions has been delayed. The presentation of the GSSP is now ready (Mietto et al., 2012) and the bio-chronostratigraphy of the
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Basically, the ammonoid succession at South Canyon has not been studied since the works of Johnston and Silberling, and for all practical purposes, the Desatoyense Zone may as well be an Oppel zone, sensu Hedberg (1976). Because of its importance to the definition of the North American bio-chronostratigraphic scale, this locality attracted the interest of the Ladinian/Carnian boundary Working Group of the STS about ten years ago and new extensive collections were made following a strict bed-by-bed approach from 2003 to 2007, mostly by MB and JJ, but also by M. Orchard for conodonts and C. McRoberts for pelagic bivalves. This investigation, which focused on the lowermost part of the middle member of the Augusta Mountain Formation (Fig. 3) at six sites (A, B, D1, D2, E and F), has lead to the following summarized results, some of which were unexpected:

1. As reported by Silberling & Tozer (1968), ammonoids replicating the “fauna” described by Johnston (1941) were collected from several levels (Balini et al., 2007) over some tens of meters of the lowermost part of the middle member of the Augusta Mountain Formation;  
2. These ammonoid bearing levels are mostly concentrated within two intervals (Fig. 3). The lowermost is about 25 m thick at sites A and B, and the uppermost occurs about 50 m above the base of the middle member at sites D2, E and F. Johnston’s fauna occurs in both intervals;  
3. Ammonoids, conodonts and bivalves typical of the Sutherlandi Zone of British Columbia were discovered within the lower interval (Balini et al., 2007; Balini, 2008). This fauna included Frankites sutherlandi, the index ammonoid of the Sutherlandi Zone (Fig. 2), which was not reported by Johnston;  
4. Trachyceras-like ammonoids from the lower interval were found to have ceratitic suture lines and were referred to Daxatina Strand, 1929 (Balini & Jenks, 2007). Daxatina Strand, 1929 can be separated from Trachyceras Laube, 1869 only by its suture line, the former being ceratitic and the latter characterized by an ammonitic suture. Daxatina is another component of the Frankites sutherlandi Zone (sensu Tozer, 1967; Silberling & Tozer, 1968; Tozer, 1981b, 1994) of British Columbia;  
5. The occurrence of Trachyceras Laube, 1869 at site F in the uppermost ammonoid bearing interval was
M. Balini et alii - Trachyceras silberlingi n. sp. from the Lower Carnian of Nevada

from part of the test during preparation, and thus show only incomplete suture lines and outer ornamentation. Second, and even more important, the internal molds of Trachyceratinae with exposed suture lines from South Canyon are very difficult to compare to the type specimens of T. desatoyense because the internal mold of this group of ammonoids very commonly exhibits a “weakening or dampening effect” with respect to the ornamentation on outer surface of the test (Balini & Jenks, 2007). This effect, first recognized in the early 1970s (Tozer, 1972, 1994; Howarth, 1975), is known to occur in some genera of the family Trachyceratidae Haug, 1894, and is supposedly caused by the development of a secondary inner test (“preseptal layer” of Guex, 1970 and Tozer, 1972, 1994) on the inside of the body chamber.

TOWARDS THE REVISION OF THE DESATOYENSE “FAUNA”

The occurrence of this “preseptal layer” in the South Canyon Trachyceratinae has not prevented the revision of Johnston’s taxonomy, but it certainly has hindered its progress, because relatively few new specimens can be prepared with the entire test still attached. Thus, it can be difficult to compare our material with Johnston’s type specimens. These specimens are generally quite rare with respect to the frequency of those found as internal molds; therefore, it became necessary to increase the overall collection in order to better understand the outer ornamentation of a population sample consisting mainly of inner molds. For this reason collecting efforts at South Canyon resumed in 2010 and were mainly focused on the upper ammonoid bearing interval at site F, where very few Trachyceras s.s. were collected in 2006.

Among the new specimens collected in 2010 and 2011, some are characterized by a well indented ammonitic suture line and the peculiar occurrence of two lateral rows of large sized bullae-like nodes. The first row is positioned on or just slightly above the umbilical shoulder, while the second row is located higher on the flank at 70% of whorl height. These ammonoids belong to a rare assemblage of Trachyceras that Mojsisovics (1893) described as the group of “Trachyceras acanthica”. This group, based on specimens from the classic Carnian Hallstatt Limestone localities at Feuerkogel and Raschberg (Northern Alps, Austria), has never been reported from anywhere else in the world. The differences between our South Canyon specimens and the Alpine species, while not great, do justify the erection of the new species, Trachyceras silberlingi. Since this new species is the first belonging to Trachyceras s.s., this identification is of great interest for its bio-chronostratigraphic implications. For this reason, we provide in the next chapters a detailed lithostratigraphic setting for the new specimens and a discussion of their bio-chronostratigraphic significance.

LITHOSTRATIGRAPHIC SETTING

At South Canyon, the Augusta Mountain Formation is divided into three members (Silberling, 1956). While the lower and upper members consist of medium to thick...
bedded shallow water carbonates, the middle member was deposited in a significantly deeper environment. The middle member, which yielded the rich ammonoid faunas described by Johnston (1941) and Silberling (1956), is about 280 m thick (Balini et al., 2007) and consists of a monotonous alternation of dark grey marl and marly limestone beds. The boundary between the lower and middle members is transitional, which documents the drowning of the carbonate platform of the lower member (Fig. 3). Its topmost part, consisting of medium bedded crinoidal packstones (Fig. 3, lithofacies 1), is overlain by medium to thin bedded brachiopod-packstones with a few very thin marly intercalations (lithofacies 2). The middle member consists of monotonous alternation of light grey to dark grey bioclastic marly mudstones and wackestones with grey marls (lithofacies 3). Included in the upper part is a ~5 m-thick interval dominated by grey mudstones up to 50 cm thick (lithofacies 4).

Structurally, the beds of the entire Augusta Mountain Formation at South Canyon dip to the south, and the middle member crops out only on the northern side of the canyon, where the beds dip with the slope. In general, outcrops of the ammonoid-rich middle member (lithofacies 3) are rather poor and scattered because of 1) the unfavorable dip/slope relationship of the bedding, 2) the soft weathering attitude of the grey marl-marly limestone alternations, and 3) the amount of covering debris produced by carbonates of the lower member, which are well exposed higher up on the northern slope of the canyon. Because of these unfavorable conditions, continuous exposures of the middle member are virtually non-existent. Extensive bed-by-bed sampling has been conducted at six sites (Balini et al., 2007; Balini & Jenks, 2007; Orchard & Balini, 2007; Balini, 2008), either on natural exposures on the side of small gullies cutting the slope of the canyon, or in hand-dug trenches. Two trenches were dug within the lowermost ammonoid bearing interval at sites A and B in the lower 20-30 m of the middle member, while the uppermost ammonoid bearing interval (from 50 to 80 m from the base) was sampled at sites D2, E and F. The successions at the different sites are correlated (Fig. 3) by using the top of lithofacies 2 and the well exposed lithofacies 4 as marker levels. Fossils occur in laterally continuous beds and to a lesser extent, in lenses that are more difficult to follow along strike.

Site F is a natural exposure on the eastern side of a small gully, where a ~28 m-thick section (Fig. 3) was sampled in 2006, 2010 and 2011. This exposure includes about 5 m of the normally well exposed marker level designated as lithofacies 4. Twelve fossil bearing levels were sampled along the section (Fig. 3), but unfortunately, the most fossiliferous level at site F is the large-sized lens F1 (~1.5 m diameter) that was exposed a few tens of meters east of the section (GPS WGS84 coordinates: 39° 36′ 48.0″ N, 117° 30′ 09.5″ W). Lateral tracing based on strike and dip of F1 (barring any covered faults) suggests a correlation with the lowermost part of the section (levels F10-F12).

The new species *Trachyceras silberlingi* is based on four specimens from levels F1 and F26. The best specimen of the type series, designated as holotype, is from F26.

**SYSTEMATIC PALAEOLOGY**

Family-group taxonomy follows that of Tozer (1981a and 1994).

Specimens described in this contribution are housed in the Museo di Paleontologia (MPUM), Dipartimento di Scienze della Terra “Ardito Desio”, Università degli Studi di Milano, Via Mangiagalli 34, 20133 Milano, Italy.

Each specimen is identified by both museum number (e.g., MPUM xxxxx) and collection number. The latter, in parentheses or dashes, indicates site, bed of collection and the individual number of the specimen (e.g., F26-1: site F, bed number 26, 1st specimen).

Order *Ceratitida* Hyatt, 1884
Superfamily *Clidoniaceae* Hyatt, 1877 (in Meek, 1877)
Family *Trachyceratidae* Haug, 1894
Subfamily *Trachyceratinae* Haug, 1894

Genus *Trachyceras* Laube, 1869
Type species *Ammonites (Ceratites) aon* Münster, 1834

*Trachyceras silberlingi* n. sp.
(Pl. 1, figs 1-4; Fig. 4)

*Etimologia* - The species is dedicated to the memory of Norman J. Silberling (1928-2011), who, for over 50 years, was the recognized authority on the Triassic of the western United States.

*Locus typicus and stratum typicum* - South Canyon (New Pass Range, central Nevada, USA), Augusta

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**EXPLANATION OF PLATE 1**

Type specimens of *Trachyceras silberlingi* n. sp.

Fig. 1 - Holotype MPUM 11061 (F26-14), a) lateral view; b) enlarged lateral view showing detail of the ornamentation.

Fig. 2 - Paratype MPUM 11062 (F26-2), lateral view.

Fig. 3 - Paratype MPUM 11064 (F1-144), phragmocone, lateral view.

Fig. 4 - Paratype MPUM 11063 (F1-91), phragmocone. a) lateral view; b) enlarged lateral view showing detail of the ornamentation; c) ventral view.

Asterisk marks the last suture line; white circle marks the ribs looped at the lateral bulla. All scale bars = 1 cm.
and much less obvious on the other type specimens. The ventral node is visible at the end of the preserved part of very weak, while the others are much stronger. A single nodes between the first and the second row of bullae are most visible on paratype MPUM 11062 (F26-2). The weakening more commonly affects the nodes rather than the ribs. The bullae, weakened by the "preseptal layer". This weakening more often accompanied by a further division of these paired bullae. Umbilical and lateral bullae are all paired on paratype MPUM 11062 (F26-2), whereas the ratio is four umbilical for five lateral per half whorl on paratype MPUM 11063 (F1-91). The umbilical bullae on paratype MPUM 11064 (F1-144) were damaged during preparation and cannot be counted.

Ribbing is visible only on the internal molds, and the few patches of test remaining on the surface of the specimens do not allow for the understanding of the cross section of the ribs on the outer surface of the test. On the internal mold, the ribs in cross section are top-rounded and symmetrical.

The organization of the ribs is very similar for all type specimens. Most ribs are primary and start at the umbilical shoulder, but some actually begin at the umbilical bullae, in groups of two or even three. Primary ribs independent of the umbilical bulla may bear a lateral bulla, and some of these may divide at this point. Intercalary ribs are rare (about one or two per half whorl) and appear only between the first and second row of bullae. A peculiar feature of this species is the looping of the ribs at the lateral bullae, which then is often accompanied by a further division of the looped ribs on their course to the venter (Pl. 1, figs 1a-b, 3, 4b). This feature is present on all type specimens except MPUM 11062 (F26-2).

A slight difference exists in the course of the ribs among the type specimens. The holotype and paratype from F26 exhibit an almost falcoïd-type of ribbing, while the ribbing style of specimens from F1 varies from more sinuous - MUPM 11064 (F1-144) - to almost concave - MPUM11063 (F1-91) -. However, this feature is considered of secondary importance since the two specimens from F1 are slightly deformed (elliptical), while the specimens from F26 are normal.

The ammonitic suture line is visible on all type specimens, with that of specimen MPUM 11063 (F1-91) (Fig. 4) being the most complete. The saddles are indented and rather spirally elongated.

None of the specimens attributed to Trachyceras by Johnston (1941) and Silberling (1956) can be attributed to the new species. This conclusion is based on information contained in both papers and the direct examination (by MB) of both collections at the National Museum of Natural History (Smithsonian Institution, Washington).

The combination of the lack of test and the occurrence of the "preseptal layer" does not allow for the understanding of the cross section of the ribs on the outer surface of the
test. This cross section is flat topped and symmetrical in the Trachyceras of the Aon Zone - group of T. brotheus (Münster, 1834), including also T. medusae (Mojsisovics, 1893), T. fontannesii (Mojsisovics, 1893) and T. jannuarius (Mojsisovics, 1893) - whereas it is asymmetrical in the Trachyceras of the Aonoides Zone (Krystyn, 1978 and personal communication 2012). The types of T. silberlingi consist of internal molds affected by “preseptal layer”, but show a symmetrical section, that suggest a connection of this species with the group of T. aon.

The spiral ornamentation, on the contrary, suggests a close similarity of Trachyceras silberlingi n. sp. to an assemblage of very rare Trachyceratinae, the group of “Trachycerata acanthica”, that thus far is known only from its original description by Mojsisovics (1893). This group, consisting of 15 species from the Hallstatt Limestone of Salzkammergut (Northern Alps, Austria), is characterized by frequent large sized nodes of varying intensity that accompany the typical small sized nodes of Trachyceras. Mojsisovics’ type specimens are beautifully preserved in a manner typical of the well-known Hallstatt style, and their illustration in hand drawn plates represents an amazingly high quality never again reached in the history of Triassic ammonoid taxonomy. Unfortunately the suture line of Mojsisovics’ species is not known (Mojsisovics, 1893) because all specimens retain the test. The 15 species of this group are all based on relatively few type specimens, and their stratigraphic position is difficult to determine because of their occurrence in the highly condensed Hallstatt Limestone facies at the type localities of Feuerkogel and Raschberg in the Salzkammergut, Northern Alps (Tozer, 1971; Krystyn, 1973, 1978, 1980; Balini et al., 2012, figs 10 and 12). Mojsisovics reported his 15 species from three marker levels with Lobites ellipticus, Trachyceras aonoides and Trachyceras austriacum, which at that time (Mojsisovics, 1893: p. 793; Mojsisovics et al., 1895) were included within the Trachyceras aonoides Zone.

Eight of the 15 species described by Mojsisovics in the “Trachycerata acanthica” group have two rows of bullae-like nodes in the same position as Trachyceras silberlingi n. sp. These are Trachyceras uraniae, T. ariae, T. thaliae, T. semiramis, T. stenonis, T. griselidis, T. supremum and T. scaphitoides. Several of these species also exhibit the alternation of paired and unpaired bullae that is equivalent to the organization of the bullae in T. silberlingi n. sp. However, none of Mojsisovics’ species have ribs looped at the lateral bulla. This feature is thus the most significant diagnostic characteristic of T. silberlingi n. sp.

With regard to the number of rows of small sized nodes, Trachyceras silberlingi with its 11 rows, falls within the range of the above mentioned eight species, which vary from nine rows (T. uraniae and T. ariae) to 13 rows (T. supremum). A rather common feature in Mojsisovics’ species is the occurrence of two rows of very closely spaced nodes that resemble a single row of double pointed nodes. This row of “double pointed” nodes, located in the next to last position, adjacent to the ventral shoulder, are best developed in T. uraniae, T. ariae, T. thaliae, T. semiramis, T. stenonis, T. griselidis and T. supremum. The type specimens of T. silberlingi do not exhibit these “double pointed” nodes. However, these specimens are preserved as internal molds and it is very unlikely that this feature of the outer surface of the test would be visible on the internal mold, especially on specimens with the “preseptal layer”.

**Age** - The species in known only from the Early Carnian of Nevada. See biostratigraphy for the discussion on its stratigraphic position.

**BIOSTRATIGRAPHY**

The original definition of the Desatoyense Zone by Silberling & Tozer (1968: p. 35), based on the investigation of Johnston (1941) and complemented by additional data by Silberling (1956), is no longer consistent with new data provided by recent studies at South Canyon, which adhered to a strict bed-by-bed approach. Taxa described by Johnston are documented in the lower 80 m of the middle member of the Augusta Mountain Formation, but the succession has also yielded some taxa that either were not found by Johnston, or were not correctly classified.

We here propose the subdivision of the Desatoyense Zone into two units (Fig. 5) that for now are considered as local biozones. The first unit is provisionally informal, while the second is formally described. Their chronostratigraphic potential will be more fully understood as soon as the ongoing taxonomic revision of South Canyon ammonoids is completed.

**Daxatina beds**

This biostratigraphic unit is documented at sites A and B, and its fauna is very close to the Frankites sutherlandi subzone 2 of Tozer (1994). The most typical taxon of this unit is Daxatina Strand, 1929, which probably also occurs in the lower part of the overlying Trachyceras silberlingi biozone (see below). For this reason we regard this unit as an interval zone based on the FO of Daxatina and FO of Trachyceras, rather than a biostratigraphic unit based on faunal content as was done by Tozer (1994). We choose not to formalize this unit because currently there is not a taxonomically well defined species to designate as the index ammonoid.

The ammonoid faunas of this biostratigraphic unit are dominated by the Trachyceratidae (Balini & Jenks, 2007, fig. 4) and in particular by Daxatina Strand, 1929, but the occurrence of Trachyceras Laube, 1869 (quoted in Balini, 2008, submitted long before Balini & Jenks, 2007) has not yet been confirmed by the discovery of specimens with an ammonitic suture line. In fact, it is highly probable that most of the species attributed by Johnston (1941) to Trachyceras, including T. desatoyense Johnston, 1941, actually belong to Daxatina. Frankites sutherlandi (McLern, 1947), a taxon not found by Johnston, is quite common in a certain part of the succession (site B, beds SCAN 14 and 15; Balini, 2008).

Besides Trachyceratidae, the taxa of the Daxatina beds includes several components of Johnston’s Desatoyense “fauna”, such as Clionitites Strand, 1929, Joannites Mojsisovics, 1879, Lobites Mojsisovics, 1875 and Neolycites Spath, 1951.

The co-occurrence of Frankites sutherlandi and Daxatina as well as the apparent lack of Trachyceras demonstrates the correlation of this part of the succession with the Frankites sutherlandi subzone 2 of British
Trachyceras silberlingi biozone (new)

INDEX AMMONOID OF THE BIOZONE - *Trachyceras silberlingi* n. sp.

**Type** - Range zone.

**Type locality and boundaries** - South Canyon (New Pass Range, central Nevada), site F. The lower boundary is recorded in level F1, correlated with F10-F12. The last bed assigned to the zone is F26.

**Faunal composition** - At the type locality *Trachyceras silberlingi* n. sp., *Trachyceras* div. sp. and *Perrinoceras novaditum* Johnston, 1941 occur throughout the entire zone. *Clionitites callazonensis* Tozer, 1994, *Silenticeras aff. schencki* (Johnston, 1941) and *Lobites* Mojisovics, 1875 are limited to the lower part of the zone. *Coroceras* Hyatt, 1887 is rather common in bed F26, the uppermost fossil bearing bed of the section. Thus far, *Daxatina* Strand, 1929 has not been identified at site F (Fig. 5), but representatives of this genus are common in level D10 of section D2, whose stratigraphic position most probably is above the FO of *T. silberlingi* n. sp. at site F (F10-F12; see correlation chart in Balini & Jenks, 2007, fig. 6).

**Remarks** - The occurrence of *Trachyceras* at South Canyon in the upper ammonoid bearing succession (site F) was previously reported by Balini & Jenks (2007), but at that time the taxonomic analysis of *Trachyceras* was in a very preliminary stage and no specific name was available to distinguish this part of the succession. The formal description of *Trachyceras silberlingi* n. sp., with its peculiar and easily recognizable spiral ornamentation provides a well defined reference for this biozone.

With regard to faunal composition we emphasize the occurrence of taxa already described by Johnston, such as *Lobites*, *Coroceras* and *Perrinoceras novaditum* together with taxa reported for the first time from South Canyon, such as *Silenticeras*, *Clionitites callazonensis* and *Trachyceras silberlingi* n. sp.

**Correlation** - The *Trachyceras silberlingi* n. sp. biozone is here regarded as a local biozone. Calibration of its chronostratigraphic position with respect to the Tethyan scale must await the completion of the taxonomic revision of South Canyon *Trachyceras*. The Tethyan scale is based mainly on species of *Trachyceras* that are quite well known due to the revisions of Krystyn (1978) and Urlichs (1994) and complemented by the recent description of the earliest Carnian species from the GSSP section at Prati di Stuores/Stuores Wiesen (Mietto et al., 2008). Aside from the systematics of *Trachyceras*, the occurrence of *Coroceras* in the uppermost part of the *Trachyceras silberlingi* biozone suggests the correlation of this portion of the biozone with the Aon Zone of the Tethyan scale (Fig. 5), as this genus is known from the Aon and Aonoides zones of the Tethys (cf. Krystyn, 1973, 1980; Urlichs, 1994; Bizzarini, 2000). The occurrence of *Coroceras* in British Columbia (localities GSC 45745 and 83824: Tozer, 1994) is not significant for calibration of the South Canyon biostratigraphy because Tozer (1994) dated this occurrence, based on the taxon’s occurrence in Columbia as implied by Tozer (1994), i.e., with the upper part of the Sutherlandi zone, characterized by the occurrence of *Daxatina*.  

![Fig. 5 - Revision of the Lower Carnian zonation at South Canyon, and its correlation with the Prati di Stuores/Stuores Wiesen GSSP (Tethys). Since bed F1 is actually located few tens of meters from the measured section, the position of the FO of *Trachyceras silberlingi* n. sp., documented from this bed is correlated to levels F10-F12 on the basis of strike and dip (see text). The LO of *Daxatina* is recorded in level D10 of section D2, but thus far, it has not been found at site F. Its projected position on the succession exposed at site F is marked with white circle.](image-url)
the Desatoyense Zone sensu Silberling & Tozer (1968), thus leading to a circular reasoning.

CONCLUSIONS

The study of recently collected Trachyceras from the type locality of the lowermost Carnian Desatoyense Zone of Silberling & Tozer, 1968 provides a number of known facts pointing in the direction of the revision of this zone that can be summarized as follows:

1. The new species Trachyceras silberlingi is described. This species is characterized by a peculiar and easy to distinguish feature, consisting of two rows of spiral lateral bullae, in addition to 11 rows of small sized spiral nodes, and by ribs looped at the lateral bulla.

2. None of the specimens collected by Johnston, presently housed in the National Museum of Natural History (Smithsonian Institution, Washington), are referable to the new species, and our new species is also quite rare in our new collections. Notwithstanding the present stage of the revision of the South Canyon fauna, T. silberlingi n. sp. represents a good, well defined marker for the subdivision of the former Desatoyense Zone into two parts.

3. These two units for the moment are considered as local biostratigraphic units. The Daxatina beds are characterized by Daxatina and Frankites, while the overlying T. silberlingi biozone is a range zone characterized by the occurrence of Trachyceras.

4. The chronostratigraphic significance and potential of the two biostratigraphic subdivisions will be demonstrated only after the completion of the taxonomic revision of the South Canyon ammonoid faunas. However, the subdivision of the former Desatoyense Zone into two parts appears to be worthwhile not only from a local perspective, but also on a broader scale. At South Canyon as in Spiti (Krystyn et al., 2004), the FO of Daxatina and the FO of Trachyceras are in stratigraphic sequence, but with a very limited overlap of the two genera. At the GSSP section of Prati di Stuores/Stuores Wiesen (Mietto et al., 2008, 2012) about 2/3 of the range of Daxatina actually overlaps the range of Trachyceras, and Mietto et al. (2008, 2012), have preferred to keep Daxatina and the first representative of Trachyceras together in the same subzone. This solution emphasizes the FO of Daxatina that is very useful for long distance correlations (Mietto et al., 2012), but on the other hand it diminishes the stratigraphic potential of the FO of Trachyceras, the genus that provides the markers for a major part of the Lower Carnian. This potential is also weakened by the attribution of the beds yielding Daxatina to the Trachyceras Zone (Mietto & Manfrin, 1995: p. 558; Mietto et al., 2008, 2012), even though they underlie the FO of Trachyceras.

5. The chronostratigraphic significance of Trachyceras silberlingi n. sp. has yet to be defined. This species shows a spiral ornamentation similar to the rare group of Trachycerata acanthica described by Mojsisovics in 1893 from the western Tethys of the Northern Alps (Austria), and at the same time it shows some similarity to the group of T. aon with respect to its ribbing cross section. Therefore this discovery from Nevada is of great interest in terms of its potential contribution to the reconstruction of the phylogeny of Trachyceras Laube, 1869.

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