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Conodonts from the Ladinian Buchenstein Formation (Southern Alps, Italy)

ELIAS SAMANKASSOU*)

4 Text-Figures, 1 Table and 1 Plate

Italy
Southern Alps
Triassic
Ladinian
Buchenstein Formation
Conodonts
Systematic
Biofacies

Contents

Conodonten aus den ladinischen Buchensteiner Schichten (Südalpen, Italien)

Zusammenfassung

Die Ladinischen Buchensteiner Schichten (Livinallongo Formation) wurden in der Umgebung von Vigo di Fassa, Dolomiten, Südalpen (Italien) untersucht. Die gut erhaltene Conodontenfauna besteht aus Vertretern der Familie Ellisonidae MÜLLER, 1956 mit *Ellisonia triassica* MÜLLER, 1956? und *Gladigondolella tethydis* (HUCKRIEDE, 1958), der Familie Gondolellidae LINDSTRÖM, 1970 mit *Neogondolella navicula* (HUCKRIEDE, 1958), und mit den problematischen *Enantiognathus petraeviridis* and *Enantiognatus ziegleri* (DIEBEL, 1956)?. Die quantitative Auswertung der Conodontenelemente zeigt eine eindeutige Vorherrschaft der Enantiognathiformen Elemente und Neogondolellaceen Formen im Verhältnis zu *Ellisonia* and *Gladidondolella*, was als Einfluß der Fazies gedeutet oder/und als eine Evolutionstendenz angesehen werden kann.

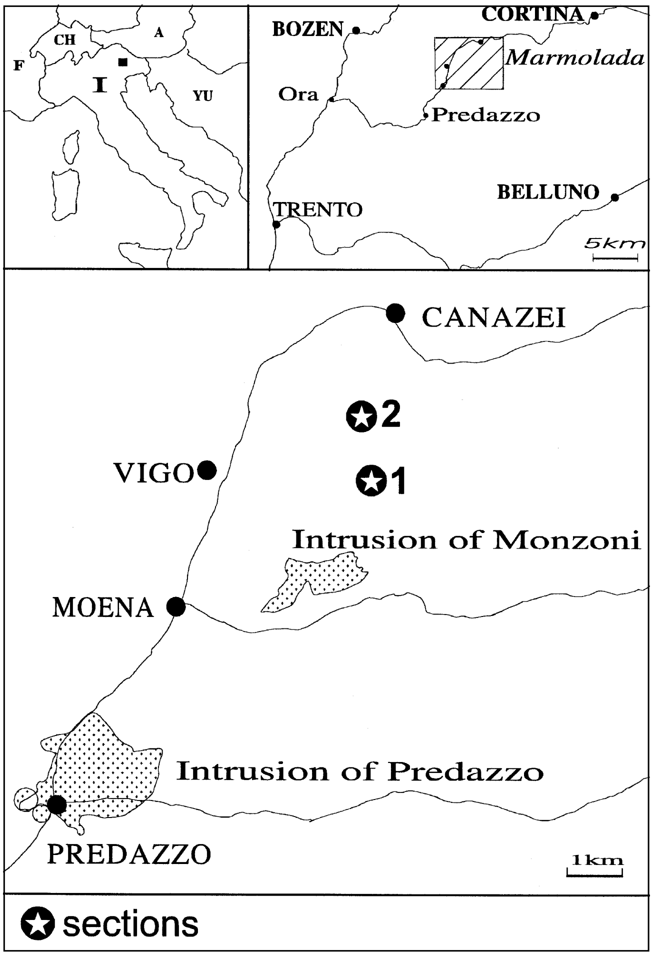
Abstract

The Ladinian Buchenstein (Livinallongo) Formation has been studied near Vigo di Fassa, Dolomites, Southern Alps (Italy). The well-preserved conodont fauna includes representatives of the family Ellisonidae MÜLLER, 1956 with *Ellisonia triassica* MÜLLER, 1956? and *Gladigondolella tethydis* (HUCKRIEDE, 1958), the family Gondolellidae LINDSTRÖM, 1970 with *Neogondolella navicula* (HUCKRIEDE, 1958), and the problematic *Enantiognathus petraeviridis* and *Enantiognatus ziegleri* (DIEBEL, 1956)?. The quantitative analysis of the conodont elements shows a clear predominance of Enantiognathiform elements and Neogondolellacean forms compared to *Ellisonia* and *Gladidondolella*, with a probable implication on biofacies or/and evolution.

1. Introduction

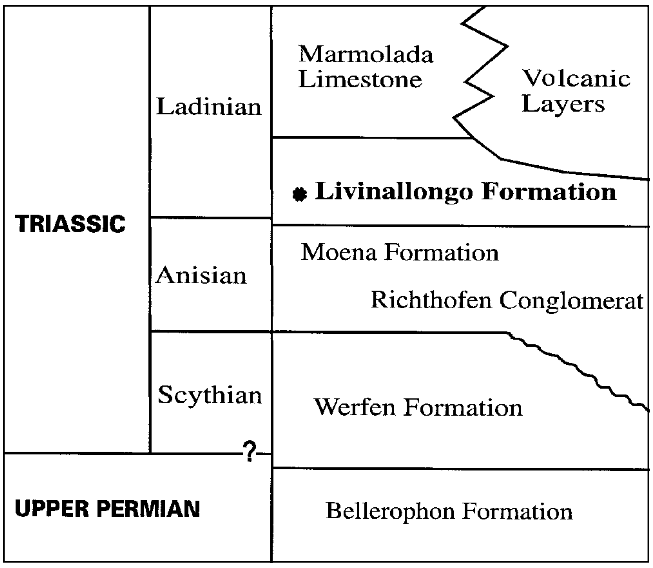
The study area is situated in Val di Fassa, in the western part of the Dolomites, northern Italy (Text-Fig. 1). The Triassic sequences in this area, overlying the uppermost Permian Bellerophon Formation, range from the Scythian Werfen Formation at the base to the thick and massive Ladinian buildups at the top (Text-Fig. 2). The described specimens are from the Ladinian Buchenstein Formation, which is subdivided into three members: The Plattenkalk,

*) Author's address: ELIAS SAMANKASSOU, Institut für Paläontologie, Universität Erlangen Nürnberg, Loewenichstraße 28, D-91054 Erlangen.



Text-Fig. 1.
Location of the study area.

the Knollenkalk and the Bänderkalk. The Plattenkalk is composed of bituminous mudstones, fine-grained dolostones and radiolarian-rich laminae. It has been interpreted as an anoxia deposit (BOSELLINI & STEFANI, 1991). The Knollenkalk is formed of cherty nodular limestones, with shaly interbeds. The nodules correspond to primary calcareous layers, the green matrix is diagenetic and corresponds to primary volcanogenic beds termed, according to their green color, “Piedra verde” (RICHTHOFEN, 1859, in OBENHOLZNER & PFEIFER, 1991). These sediments (Knollenkalk) correspond to slope to basin deposits. The Bänderkalk is composed of resedimented calcarenites, alternating with mudstone layers and partly nodular limestones. According to BOSELLINI & STEFANI (1991), the Bänderkalk was produced by the basinward progradation of a resedimented apron.



Text-Fig. 2.
Stratigraphical table of the Upper Permian–Triassic sequence of the study area.

The described outcrops belong to the Knollenkalk and to the Bänderkalk (Text-Fig. 3). Some samples came from blocks comprising the volcanic layers (Text-Fig. 3, section 2). The calcareous nodules yield excellently preserved conodonts. The conodont amount is high (about 20 elements/5 kg materials, s. Text-Fig. 3) in comparison with the lower Triassic sediments. The Conodont Alteration Index (CAI; EPSTEIN et al., 1977) ranges between 1–1.5 and differs from that of conodonts in the underlying formations (SAMANKASSOU, 1992).

2. Systematic Paleontology of the Conodont Fauna

The complete synonymy is not always given. In describing the conodont fauna, multielement taxonomy is applied by clearly identifiable elements. The described and figured specimens, part of the author’s Diploma Thesis (SAMANKASSOU, 1992), are deposited at the Geological Institute of the University of Erlangen (Germany).

Phylum: Conodonta PANDER, 1856
Class: Conodonti BRANSON, 1938
Order: Prioniodinida SWEET, 1988
Family: Ellisonidae CLARK, 1972
Genus: *Ellisonia* MÜLLER, 1956

Type species: *Ellisonia triassica* MÜLLER, 1956.

Ellisonia triassica MÜLLER, 1956?
(Pl. 1, Fig. 13)

1970 *Ellisonia triassica* MÜLLER – SWEET, p. 235, Pl. 5, Fig. 9, 13–15, 17, 18, 20–22.
1981 *Ellisonia triassica* MÜLLER – SWEET, p. W152, Fig. 3 a–f.
1987 *Ellisonia triassica* MÜLLER – PERRI & ANDRAGHETTI, p. 305–306.
1995 *Ellisonia triassica* MÜLLER – SAMANKASSOU, p. 252 and 254, Fig. 5 (5).

Remarks: *Ellisonia* MÜLLER, 1956 is seen in the present paper as synonym to *Neohindeodella* KOZUR, 1968.
The elements we found are very fragile. Two to three small denticles are interspersed between big ones. All denticles bend in the same direction. The cusp is missing. These elements are very similar to those described from the Salt Range by SWEET (1970).

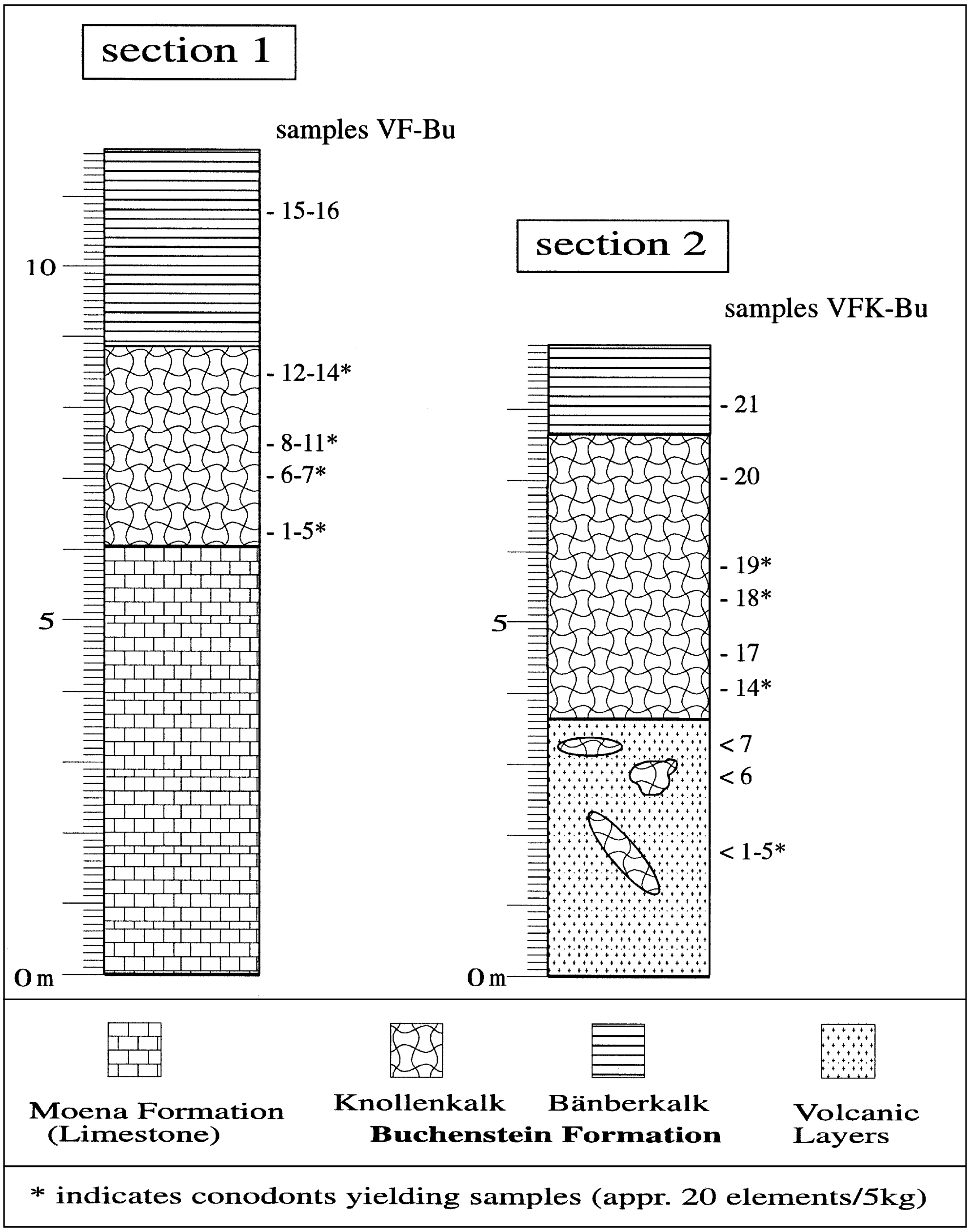
Genus: *Gladigondolella* **MÜLLER 1962**

Type species: *Polygnathus tethydis* HUCKRIEDE, 1958.

Gladigondolella tethydis (HUCKRIEDE, 1958)
(Pl. 1, Fig. 11, 12)

1958 *Polygnathus tethydis* HUCKRIEDE, p. 157, Pl. 11, Fig. 39, 40; Pl. 12, Fig. 38; Pl. 13, Fig. 2, 4, 5; ?Pl. 12, Fig. 1.

Text-Fig. 3.
Detailed sections of the two profiles represented in Text-Fig. 1.



1966 *Gladigondolella tethydis* (HUCKRIEDE) – ISHII & NOGAMI, Pl. 1, Fig.1, non Fig. 2.
1980 *Gladigondolella tethydis* (HUCKRIEDE) – KOVACS & KOZUR, Pl. 3, Fig. 5, 6.
1984 *Gladigondolella tethydis* (HUCKRIEDE) – VRIELYNCK, p. 184, Pl. 2, Fig. 4.
1986 *Gladigondolella tethydis* (HUCKRIEDE) – DURKOOP et al., Pl. 18, Fig. 5, 6, ?7–11, 12–15.
1986 *Gladigondolella tethydis* (HUCKRIEDE) – SUDAR, Pl. 8, Fig. 5, 6.
1988 *Gladigondolella tethydis* (HUCKRIEDE) – PFEIFER, Pl. 13, Fig. 1–4.
1991 *Gladigondolella tethydis* (HUCKRIEDE) – KOLAR-JURKOVSEK, p. 90, Pl. 16, Fig. 2, 5; Pl. 24, Fig. 1, 2.
1992 *Gladigondolella tethydis* (HUCKRIEDE) – CHHABRA & KUMAR, p. 18, Pl. 3, Fig. 7.
1995 *Gladigondolella tethydis* (HUCKRIEDE) – MASTANDREA, p. 498, Pl. 2, Fig. 1, 2.

Remarks: The form species illustrated represents M elements (Pb elements sensu KOZUR & MOSTLER, 1971).

The denticles are all broken in our specimens, so that a comparison between cusp and denticles is quite impossible. The cusp is sometimes bent and gives *Gladigondolella tethydis* the appearance of a bowl (Pl. 1, Fig. 12). The denticles vary extremely in their dimensions.

Some elements, seen as *Gladigondolella arcuata* BUDUROV, 1973 by DURKOOP et al. (1986, Pl. 18, Fig. 5–7, 12–15), are now placed to *Gladigondolella tethydis* (HUCKRIEDE, 1958). Whereas some elements seen by the same author (Pl. 18, Fig. 7–11) as *Gladigondolella tethydis* (HUCKRIEDE, 1958) are now placed to *Gladigondolella arcuata* BUDUROV, 1973 (s. MASTANDREA, 1995).

Family: Gondolellidae LINDSTRÖM, 1970

The taxonomic subdivision of Gondolelloid conodonts is subject of discussion. Some authors use *"Gondolella"* for all gondolelloid forms, another group of workers use *Gondolella* only in the Late Carboniferous, and *Neogondolella* for all other stocks from Late Carboniferous to the Late Triassic (see summary in CLARK et al., 1981 and discussion in SWEET, 1988 and KOVÁCS, 1994). The arguments for *Neogondolella* seem more logical to the author, and therefore this term is used in the present paper.

Genus: *Neogondolella* BENDER & STOPPEL, 1965

Type species: *Neogondolella mombergensis* (TATGE), 1956.

The apparatus of *Neogondolella* is problematic: " ... *Neogondolella* may have a relationship with *Cypridodella* and *Xaniognathus* like that between *Gladigondolella* and *Ellisonia*, or elements of *Neogondolella* and *Neospathodus* may represent dimorphs of *Cypridolella* and *Xaniognathus*" (SWEET, 1981).

***Neogondolella navicula* (HUCKRIEDE), 1958**

(Pl. 1, Figs. 8–10)

1958 *Gondolella navicula* – HUCKRIEDE, p.147–148, Pl. 11, Figs. 1–4, 13–19, 27, 35; Pl. 12, Figs. 2–8, 10, 15–22, 24–27.
1960 *Gondolella navicula* (HUCKRIEDE) – BUDUROV, p. 111, Pl. 1, Figs. 20–22a–c, 23, 25; Pl. 2, Figs. 24–27, 31.

1960 *Gondolella navicula* (HUCKRIEDE) – SPASOV & GATNEV, p. 79, Pl. 1, Figs. 11, 12, 14; Pl. 2, Figs. 19, 23, 24.
1960 *Gondolella navicula* (HUCKRIEDE) – BENDER et al., p. 207–210, Pl. 32, Figs. 13, 14. 1962 *Gondolella navicula* (HUCKRIEDE) – STEFANOV, p. 79, Pl. 1, Figs. 4a–c, 5.
1964 *Gondolella navicula* (HUCKRIEDE) – MÜLLER, p. 749–751, Pl. 1, Figs. 1–8.
1965 *Gondolella navicula* (HUCKRIEDE) – ZANKL, p. 299, Pl. 1, Figs. 6a–f.
1965 *Gondolella navicula* (HUCKRIEDE) – BUDUROV & STEFANOV, p. 117–118, Pl. 2, Figs. 1–4, 8, 10, 11; Pl. 3, Figs. 1, 2, 8–13.
1965 *Gondolella navicula* (HUCKRIEDE) – MOSHER & CLARK, p. 560–561, Pl. 66, Figs. 10, 14, 16–21.
1966 *Gondolella navicula* (HUCKRIEDE) – ISHII & NOGAMI, Pl. 1, Figs. 6–8.
1966 *Gondolella navicula* (HUCKRIEDE) – CLARK & MOSHER, p. 391, Pl. 47, Figs. 16–18, 20.
1968 *Paragondolella navicula* (HUCKRIEDE) – MOSHER, p. 939, Pl. 116, Figs. 20–27; Pl. 117, Figs. 1–5.
1972 *Paragondolella navicula* (HUCKRIEDE) – BUDUROV & STEFANOV, p. 844, Pl. 2, Figs. 10–14.

Remarks: The platformed elements of *Neogondolella navicula* (HUCKRIEDE), 1958 are tonguelike in form. The anterior part is sharp. The lateral furrow is deep. The posterior carina has distinct small denticles, the intermediate part of the carina (ridge like) is free and 2 laterally compressed denticles at the anterior end of the carina can be observed. The anterior end of the specimen is missing (Pl. 1, Fig. 9). The platform surface bears reticulate ornamentation (Pl. 1, Fig. 10).

The anterior end of the specimen is not preserved by our specimen, but the form of the posterior end differs strongly from *Paragondolella* sensu KOZUR (1989). Therefore, the identification as *Neogondolella navicula* (HUCKRIEDE), 1958 will be retained in the present work.

Genus *Enantiognathus* MOSHER & CLARK, 1965

The modern taxonomic position of *Enantiognathus* is unknown. Enantiognathiform elements are distinctive components of the apparatuses of species that belong in several conodont genera. They occur in the Pb position in apparatuses of *Ellisonia*, *Xaniognathus*, and *Cypridodella*, and probably in number of others (SWEET, pers. comm., 1994). Their position, either as Genera Incertae Sedis, or as elements of the group listed above, stay unclear and have to be clarified in the future. The specimens are described therefore as morphoelements. Similar morphoelements have recently been reported from the San Cassian Formation by MASTANDREA (1995).

Enantiognathus petraeviridis (HUCKRIEDE), 1958 morphoelements

(Pl. 1, Figs. 1–3)

1958 *Hindeodella petrae-viridis* – HUCKRIEDE, p. 149–150, Pl. 11, Fig. 46; Pl. 13, Figs. 7–11(?), 12, non (?)14.
1958 *Lonchodina spengleri* n.sp. – HUCKRIEDE, p. 152–153, Pl. 10, Figs. 55–56.
1966 *Hindeodella petrae-viridis* (HUCKRIEDE) – ISHII & NOGAMI, p. 98, Pl. 1, Fig. 14.
1968 *Parachirognathus petrae-viridis* (HUCKRIEDE) – BENDER, p. 524, Pl. 5, non Figs. 1–6.
1968 *Prioniodina petrae-viridis* (HUCKRIEDE) – MOSHER, p. 934–935, Pl. 116, Figs. 28–31.
1972 *Enantiognathus petraeviridis* (HUCKRIEDE) – KOZUR & MOSTLER 1972, p. 9, Pl. 10, Figs. 1–3; Pl. 12, Fig. 16; Pl. 14, Figs. 4, 5, 8, 12, 17, 18.
1995 *Enantiognathus petraeviridis* (HUCKRIEDE) morphoelement – MASTANDREA, Pl. 3, Fig. 1, 2.

Remarks: *petraeviridis* is derived from “pietra verde”, the green layers (s. introduction above) in the Knollenkalk (HUCKRIEDE, 1958).

Enantiognathus petraeviridis is the most frequent species in the Buchenstein Formation in our investigations. The cusp is small (ca. 1/3 smaller) compared to the denticles. The different bend denticles are round to oval in diameter; the oval forms with a sharp end dominate. The first denticle comes sometimes out from the cusp (Pl. 1, Fig. 3). The basal pit is below the first denticle to be observed.

Enantiognathus petraeviridis has been recently reported by MASTANDREA (1995) in the San Cassian Formation (Dolomites, Italy). The studied section in MASTANDREA (1995), late Julian (Carnian) in age, represents deep water deposits. This supports the assumption of a deep water occurence of *Enantiognathus petraeviridis*.

Enantiognathus ziegleri (DIEBEL), 1956 morphoelements

(Pl. 1, Figs. 4–7)

1956 *Apatognathus ziegleri* n.sp. – DIEBEL, p. 433, Pl. 5, Figs. 1–2.
1956 *Apatognathus longidentatus* n.sp. – TATGE, p. 130–131, Pl. 5, Figs. 18–19.
?1956 *Prioniodina insignis* n.sp. – TATGE, p. 141, Pl. 5, Figs. 20a, b.
1956 *Prioniodina decrescens* n.sp. – TATGE, p. 140, Pl. 5, Fig. 8.
1959 *Apatognathus insignis* (TATGE) – HIRSCHMANN, p. 42–43, Pl. 4, Fig. 1.
1959 *Apatognathus* cf. *ziegleri* (DIEBEL) – HIRSCHMANN, p. 43–44, Pl. 4, Fig. 2.
? 1962 *Prioniodella* n.sp. B. – BUDUROV, p. 121, Pl. 2, Fig. 1.
1962 *Apatognathus tribulosus* n.sp. – CLARK & ETHINGHTON, p. 107, Pl. 1, Figs. 3, 7, 13, 17.
1964 *Gnamptognathus tribulosus* (CLARK & ETHINGHTON) – LINDSTRÖM, p. 63, Fig. 22E.
1964 *Gnamptognathus ziegleri* (DIEBEL) – LINDSTRÖM, p. 63, Fig. 22J.
1965 *Enantiognathus tribulosus* (CLARK & ETHINGHTON) – MOSHER & CLARK, p. 560, Pl. 65, Fig. 6.
1965 *Enantiognathus ziegleri* (DIEBEL) – MOSHER & CLARK, p. 560, Pl. 66, Figs. 12, 15.
1966 *Gnamptognathus ziegleri* (DIEBEL) – VAN DEN BOOGARD, p. 4, Pl. 1, Fig. 4.
1970 *Ellisonia gradata* SWEET – SWEET, p. 229–231, Pl. 4, Fig. 1, non Figs. 2–8.
1972 *Enantiognathus ziegleri* (DIEBEL) – KOZUR & MOSTLER 1972, p. 9, Pl. 10, Figs. 1–3; Pl. 12, Fig. 16; Pl. 14, Figs. 4, 5, 8, 12, 17, 18.
1995 *Enantiognathus ziegleri* (DIEBEL) morphoelements – MASTANDREA, Pl. 4, Fig. 1–5.

Remarks: Represents of this species are also common in the Buchenstein Formation. Most of the denticles are round in cross section, in contrast to these of *Enantiognathus petraeviridis*, which are mostly oval with sharp margin. The first denticle is very long in some specimens (Pl. 1, Fig. 7).

3. Quantitative Analysis and Possible Implications

3.1. Methods

The statistical distribution of the conodonts has been analysed. The samples, previously taken at identical quantities of 5 kg, allow an approximate comparison of different samples. Only the samples containing more than 10 elements have been considered (VF-Bu 7, VF-Bu 11, VF-Bu 14 and VFK-Bu 18). The distribution of the different

Table 1.
Statistical distribution of conodont groups in the analysed samples. Only the identifiable elements have been considered, and only samples containing more than 10 elements/5 kg material are used.
Group 1: *Ellisonia* and *Gladigondolella*.
Group 2: *Neogondolella*.
Group 3: Enantiognathiform elements.

Samples	Weight of whole sample	Total of specimens	Group 1	Group 2	Group 3
VF-Bu 7	5 kg	23	3	5	15
VF-Bu 11	5 kg	30	4	7	19
VF-Bu 14	5 kg	36	2	10	24
VFK-Bu 18	5 kg	18	0	7	11

groups is shown in table 1, comprising the Group 1, composed of *Ellisonia* and *Gladigondolella*; the group 2, composed of *Neogondolella*; and the group 3, composed of Enantiognathiform elements.

3.2. Interpretation

The robust Ellisonidean forms with coarsely denticulate elements (*Hadrodontina* and *Pachycladina*), frequent in the Scythian Werfen Formation (SAMANKASSOU, 1995), are rare or missing in the Buchenstein Formation (Table 1 and Text-Fig. 4). They are represented by *Ellisonia triassica* and *Gladigondolella tethydis* and represent 0–13.3 %. The small and fragile Gondolellacean forms (*Neogondolella mombergensis* and *Neogondolella navicula*) are more frequent and represent 21.7–38.9 % (Text-Fig. 4). The Enantiognathiform elements represent the most frequent elements with more than 60 %.

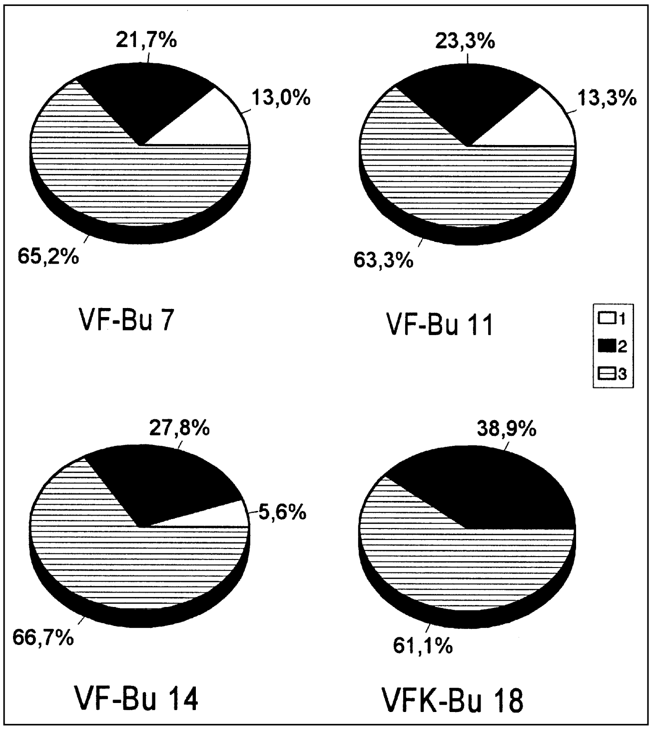
A high amount of Gondolellacean forms has been also recorded by KOVÁCS (1994). KOVÁCS (1994) investigated lithologies similar in age and similar in facies in Hungary, and also named Buchenstein Formation. Our results seem not limited to the studied areas in the western Dolomites.

The Werfen Formation are shallow subtidal to supratidal deposits (BROGLIO LORIGA et al., 1983), the Buchenstein Formation represents slope to basin deposits (BOSELLINI & STEFANI, 1991). The difference in depositional environments are therefore reflected in the conodont association.

Enantiognathiform elements are the most frequent conodont representatives in the studied Buchenstein Formation. Their presence in deeper water deposits, in association with Gondolellacean elements, could imply their systematic position near the *Xaniognathus-Cypridodella* stock (SWEET, 1988: 78) or/and their occurrence in deeper water or more offshore environments, as proposed by SWEET & BERGSTRÖM (1981: W101).

4. Conclusions

Ellisonia triassica, *Gladigondolella tethydis* (HUCKRIEDE, 1958), *Neogondolella navicula* (HUCKRIEDE, 1958), and morphoelements of *Enantiognathus petraeviridis* (HUCKRIEDE, 1958) and *Enantiognathus ziegleri* (DIEBEL, 1956) have been described. The collected elements show strong affinities with Triassic Formations from other regions. They are therefore usefull for stratigraphic correlations in the South Alps and, probably, also with other regions of the world. Although the systematic position of *Enantiognathus* remains unclear, the study of this "group" is, because of the high content in the Buchenstein Formation, of central interest for future works. The clear predominance of Enantiognathiform elements and Neogondolellacean forms compared to *Ellisonia* and *Gladidondolella* implies the systematic position of the first one near the *Xaniognathus-Cypridodella* stock or/and their occurrence in deeper water or more offshore environments.



Text-Fig. 4.
Composition of the conodont elements showing a predominance of Enatiognathiform elements and Neogondolellacean forms over *Ellisonia* and *Gladigondolella* (VF-Bu 7 = 23; VF-Bu 11 = 30; VF-Bu 14 = 36; VFK-Bu 18 = 18 elements).
1 = *Ellisonia triassica* and *Gladigondolella tethydis*; 2 = Neogondolellacean elements; 3 = Enantiognathiform elements.

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Plate 1

Figs. 1– 3: ***Enantiognathus petraeviridis* (Huckriede, 1958).**
Fig. 1: 130 ×, VF-Bu 14.
Fig. 2: 100 ×, VF-Bu 4.
Fig. 3: 230 ×, VF-Bu 4.

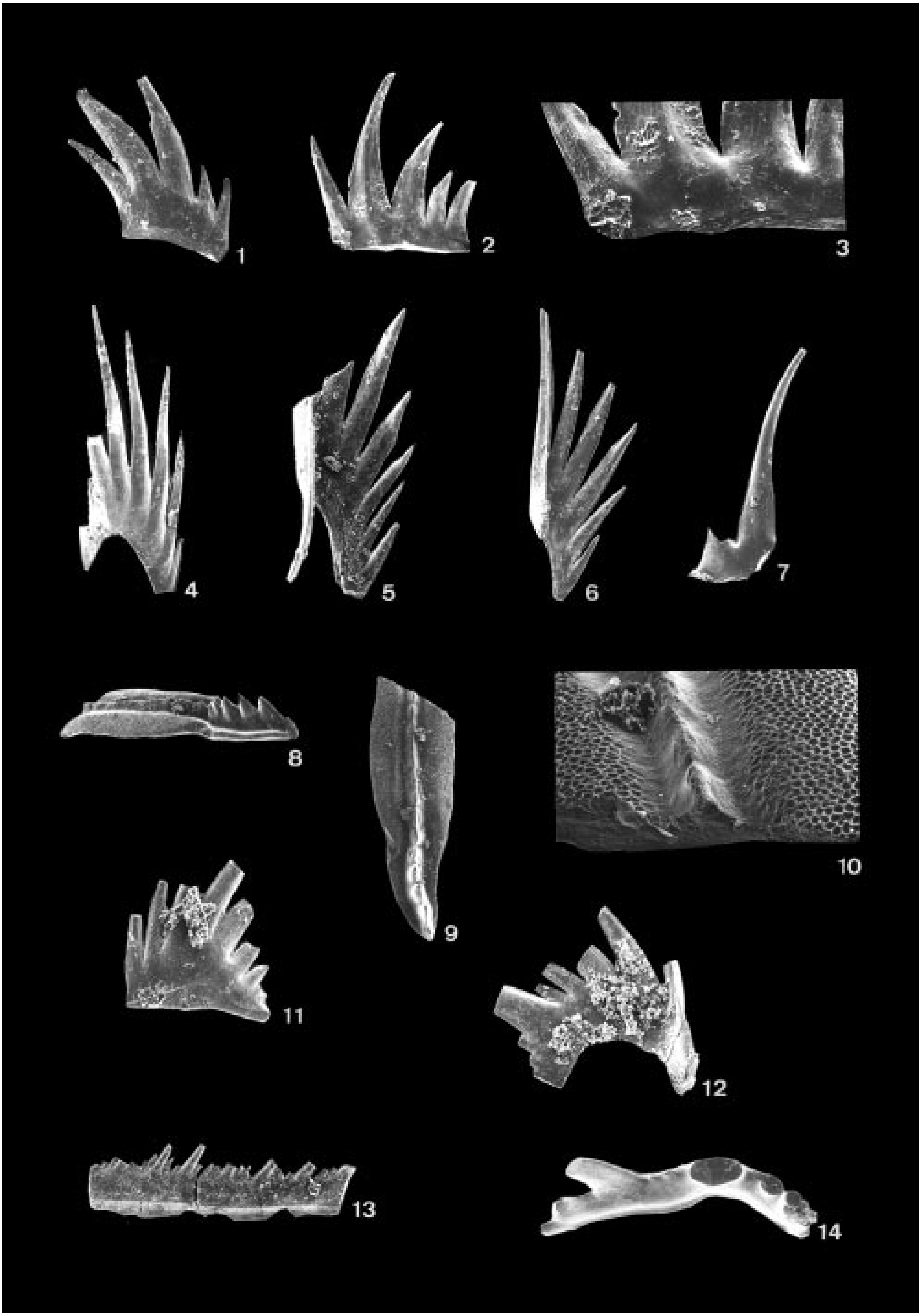
Figs. 4– 7: ***Enantiognathus ziegleri* (Diebel, 1956).**
Fig. 4: 160 ×, VF-Bu 10.
Fig. 5: 140 ×, VF-Bu 1.
Fig. 6: 110 ×, VF-Bu 16.
Fig. 7: 60 ×, VF-Bu 12.

Figs. 8–10: ***Neogondolella navicula* (Huckriede, 1958).**
Fig. 8: 55 ×, VF-Bu 7.
Fig. 9: 55 ×, VF-Bu 7.
Fig. 10: 260 ×, VF-Bu 17.

Figs. 11–12: ***Gladigondolella tethydis* (Huckriede, 1958).**
Fig. 11: 105 ×, VF-Bu 10.
Fig. 12: 130 × VFK-Bu 3.

Fig. 13: ***Ellisonia triassica* Müller, 1956.**
90 ×, VFK-Bu 18.

Fig. 14: ***Ligonodina triassica* Bassler, 1926 ?.**
55 ×, VFK-Bu 1.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