

A NUMBER OF ADDITIONAL AND REVISED TAXA
FROM THE LADINIAN FLORA OF THE DOLOMITES, NORTHERN ITALY

Evelyn Kustatscher¹, Michael Wachtler² & Johanna H.A. van Konijnenburg-van Cittert³

With 1 figure, 2 plates and 1 table

¹ Dipartimento di Scienze della Terra, Università di Ferrara, C.so Ercole I d'Este 32, 44100 Ferrara, Italy,
e-mail: e.kustatscher@gmx.net

² Rainerstrasse 11, 39038 Innichen, Italy; e-mail: michael.wachtler@etv.it

³ Laboratory of Palaeobotany and Palynology, Budapestlaan 4, 3584CD Utrecht, Netherlands,
e-mail: j.h.a.vankonijnenburg@bio.uu.nl

Abstract

After the description of the flora from the La Valle (Wengen) Formation (Ladinian) in the Dolomites (Wachtler & van Konijnenburg – van Cittert, 2000a, b), some new material was found and an extensive search of the old collections in various museums and universities in Europe also unearthed many additional specimens. Moreover, there appeared to be nomenclatorial problems with some taxa as well. For these reasons we are describing a few taxa that have not been described from the La Valle Formation before, and are revising some of the taxa that were described previously, resulting in a description and discussion of the following taxa: the lycopsid *Annalepis zeilleri* Fliche, the fern *Neuropteridium elegans* (Brongniart) Schimper together with a fragment of its fertile frond *Scolopendrites* sp., a fern indet. (formerly *Anomopteris mougeotii*), the cycadophyte taxa *Dioonitocarpidium moroderi* (Leonardi) nov. comb. and *Sphenozamites* sp. cf. *S. brononii*, and the conifer *Pelourdea vogesiaca* (Schimper et Mougeot) Seward.

A short general discussion of the flora is presented as well.

Zusammenfassung

Nach einer Beschreibung der Flora der La Valle (Wengener) Formation (Ladin) in den Dolomiten, (Wachtler & van Konijnenburg – van Cittert, 2000a, b), wurden in den folgenden Jahren weitere Funde getätigt. Auch fanden sich nach genauerer Durchsicht alter Sammlungen in den verschiedensten europäischen Museen und Universitätssammlungen ergänzende Belegstücke. Darüber hinaus wurden bei einigen Arten Schwierigkeiten in der Nomenklatur aufgedeckt. Deswegen scheint es angebracht, einzelne Arten der La Valle Formation neu zu beschreiben und andere einer Revision zu unterziehen. Es sind dies folgende Arten: das Bärlappgewächs *Annalepis zeilleri* Fliche, der Farn *Neuropteridium elegans* (Brongniart) Schimper zusammen mit seinem fertilen Wedelteil *Scolopendrites* sp., ein nicht näher bestimmbarer Farn (vorher als *Anomopteris mougeotii* klassifiziert), die Cycadophyten *Dioonitocarpidium moroderi* (Leonardi) nov. comb. und *Sphenozamites* sp. cf. *S. brononii*, und die Konifere *Pelourdea vogesiaca* (Schimper et Mougeot) Seward.

Eine kurze Beschreibung der Flora erfolgt ebenfalls.

Riassunto

Dopo la descrizione della flora della Formazione di La Valle (Ladinico) delle Dolomiti (Wachtler & van Konijnenburg – van Cittert, 2000a, b), è stato trovato ulteriore materiale di studio, tra cui alcuni esemplari presenti in antiche collezioni di vari musei ed università europei. In questo articolo vengono quindi presentati alcuni nuovi taxa mai descritti precedentemente dalla Formazione di La Valle ed altri vengono revisionati. Sono descritti e discussi i seguenti taxa: la licofita *Annalepis zeilleri* Fliche, la felce *Neuropteridium elegans* (Brongniart) Schimper insieme

al suo frammento di foglia fertile *Scolopendrites* sp., una felce indeterminata (precedentemente descritta come *Anomopteris mougeotii*), i taxa di cicadee *Dioonitocarpidium moroderi* (Leonardi) nov. comb., e *Sphenozamites* sp. cf. *S. brononii*, e la conifera *Pelourdea vogesiaca* (Schimper et Mougeot) Seward. Segue inoltre una breve descrizione della flora.

1 Introduction

Fossil plants from the La Valle Formation have been known for over 120 years (Mojsisovics, 1879, although already Wissmann, 1841 mentioned and figured a fern frond). For a historical overview, see Wachtler & van Konijnenburg – van Cittert (2000a, b). In the latter two papers, new material was described, several new species were created and material from museums in Northern Italy and Innsbruck was included in the review of the flora. However, since then additional specimens have been found, and the first author visited several old collections in museums and universities throughout Europe where material from the Ladinian of the Dolomites is stored. This enables us to publish a short addition to the flora described in 2000, with three taxa that have not been described before from the area, i.e. *Annalepis zeilleri* Fliche, *Neuropteridium elegans* Brongniart together with a fragment of its fertile frond *Scolopendrites* sp., and *Sphenozamites* sp. cf. *S. brononii*. Several taxa could be revised because additional data have become available, or had to be renamed because of nomenclatorial problems with the names in general use, i.e. *Dioonitocarpidium moroderi* (Leonardi) nov. comb. and *Pelourdea vogesiaca* (Schimper et Mougeot) Seward.

2 Material and methods

The geology of the area and localities from which plants fossil had been recovered, was already described in Wachtler & van Konijnenburg–van Cittert (2000a, b) and will not be repeated here. All new specimens came from the same areas (Alpe di Siusi/Seiser Alm, Val Gardena/Grödentel, Val Badia/Gadertal, Braies/Prags, Cortina and Valle Zoldana/Zoldo Valley), except for the material from Livinallongo that has never been described before. See Fig. 1 for a map of the localities. Material from the following museums has been included in the revision: Museum of Natural History,

Bolzano; Museum de Gherdëina, Ortisei (St. Ulrich); Palaeontological Museum "R. Zardini", Cortina; "Museo Ladino Fodom", Livinallongo; Museum of Palaeontology and Prehistory "P. Leonardi", Ferrara; Museum of Geology and Palaeontology, University of Padova; Collection of the Institute of Geology and Paleontology, University of Innsbruck; Natural History Museum, Vienna; Palaeontological Museum, Munich.

3 Systematic descriptions

3.1 Lycophyta

Genus *Annalepis* Fliche 1910

Annalepis zeilleri Fliche 1910

Pl. 1 fig. 1

Synonymy:

- 1910 *Annalepis zeilleri* Fliche – Fliche, p. 272, pl. XXVII, figs. 3–5.
- 1983 *Annalepis zeilleri* Fliche – Grauvogel–Stamm & Düringer, p. 38.
- 1995 *Annalepis zeilleri* Fliche – Kelber & Hansch, p. 95, figs. 199–200.

Description:

Annalepis zeilleri is usually found as dispersed sporophylls. These sporophylls are more or less wedge-shaped, usually 2.5–4.5 cm long and 1–2 cm wide but smaller specimens have been recorded as well. The distal part is short and triangular, the proximal part is trapezium-shaped with a long, central, tongue-shaped sporangium. The sporangia contain either small monolet microspores, or large trilete megaspores (see Grauvogel–Stamm & Düringer, 1983). The only specimen found so far in the La Valle Formation of the Dolomites contains two almost complete sporophylls; one is 10 mm long, 7 mm wide, with a central 2 mm wide sporangium; the other is 12 x 7 mm (Pl. 1 fig. 1), again with a 2 mm wide sporangium. The preservation is not so good that spores could be obtained from the sporangia, so

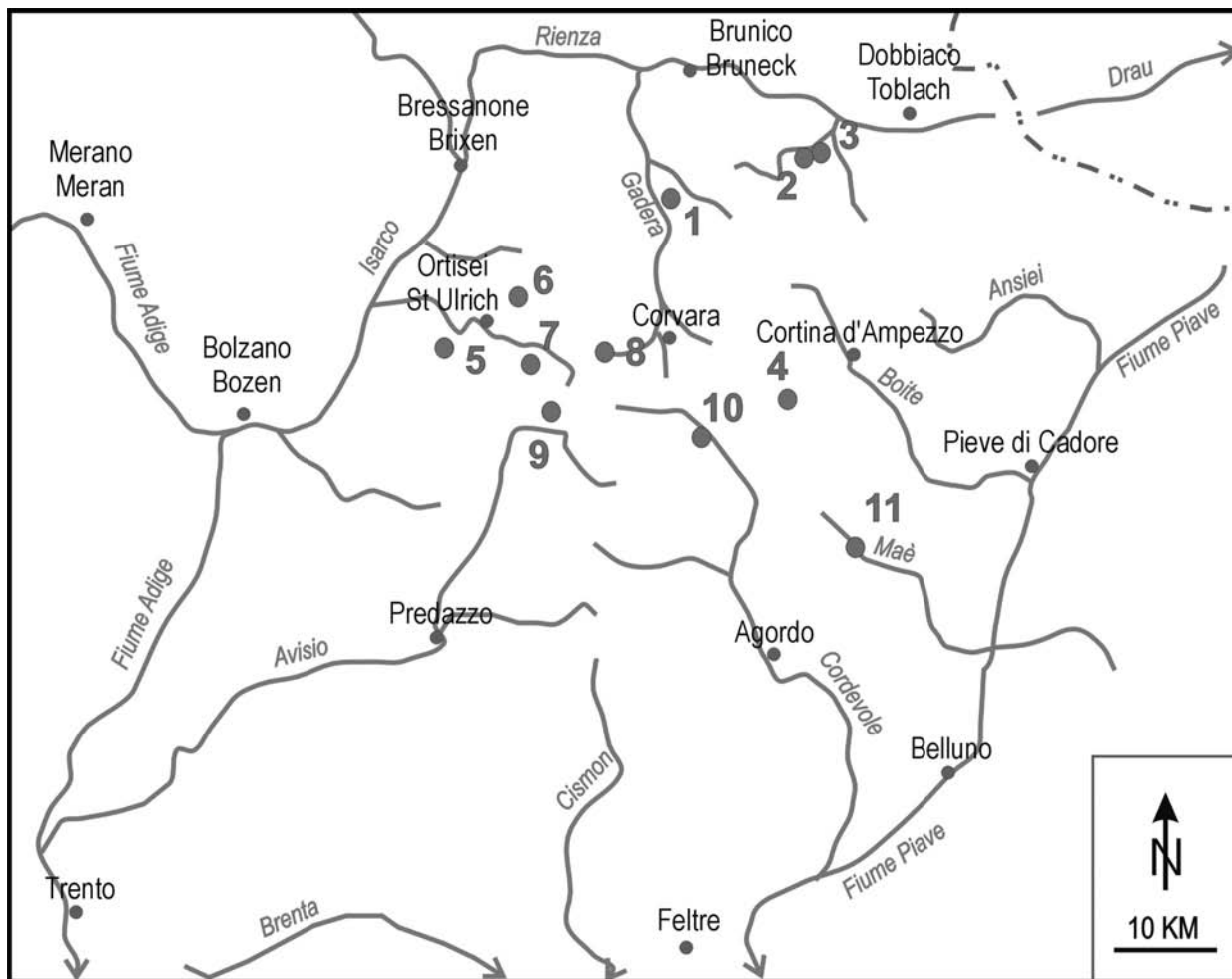


Fig. 1: map of the fossil plant localities of the Dolomites: 1. Ciablun, Ritberg (La Valle/Wengen); 2. Innerkohlbach; 3. Seewald (Braies/Prags); 4. Forcella Giaù, Corvo Alto, Mondeval; 5. Schwantschalpe, Bullaccia, Bulla (Alpe di Siusi/Seiser Alm); 6. Alpe di Cises, Alpe Mastlè, Pitzbach (Val Gardena); 7. Ciamp da Pinoi; 8. Passo Gardena/Grödner Pass, Col Alto (Corvara), Gardenaccia; 9. Passo Sella; 10. Livinallongo; 11. Fusine, Cercenà (Val Zoldano).

we do not know if they were macro- or microsporangiate.

Locality: Wengen (La Valle).

Storage: Natural History Museum, Vienna (no number).

3.2 Pteridophyta

Genus *Neuropteridium* Schimper 1879
Neuropteridium elegans (Brongniart 1828)
 Schimper 1879
 Pl. 1 fig. 2

Synonymy:

1828 *Nevropteris elegans* Brongniart, p. 247, pl. 74 figs. 1, 2.

1844 *Neuropteris elegans* Brongniart subgenus *Neuropteridium* Schimper; Schimper and Mougeot, p. 80, pl. 39.

1879, 1890 *Neuropteridium elegans* (Brongniart) Schimper; Schimper and Schenk, p. 117.

2000a *Neuropteridium grandifolium* (Schimper et Mougeot) Schimper; Wachtler & van Konijnenburg-van Cittert, p. 108, pl. 2 fig.1.

2000b *Neuropteridium grandifolium* (Schimper et Mougeot) Schimper; Wachtler & van Konijnenburg-van Cittert, p. 117, pl. 2 fig. 1.

Description:

Wachtler & van Konijnenburg-van Cittert (2000a, b) described and figured the specimen as *Neuropteridium grandifolium*. However, this was a mis-

identification, as the pinnules of *N. grandifolium* are much larger than those of *N. elegans*. Careful study of original *N. elegans* material and study of similar material from the Anisian flora of the Dolomites (see Loriga Broglio et al., 2002) proved that this specimen (pl. 1 fig. 2) should be assigned to *N. elegans*.

Locality: Forcella Giau.

Storage: Palaeontological Museum "R. Zardini", Cortina (nr. 2662).

Genus *Scolopendrites* Goeppert 1836

Scolopendrites sp.

Pl. 1 fig. 3

Description:

So far, only one fragment of *Scolopendrites* has been found in the La Valle Formation (Pl. 1 fig. 3) and it has never been described or figured before. It might well be the fertile foliage of *N. elegans* but as the fragment is only small and did not yield any sporangia or spores, we cannot assign it with certainty to a *Scolopendrites* species. The fragment is 4.6 cm long, and 0.9 cm wide. The rachis is 2 mm wide, and pinnules arise oppositely and at almost rectangular angles. The pinnules are 3–4 mm long and 1.5–2 mm wide, and their whole lower surface is covered with sporangia.

Discussion:

Fertile material belonging to *N. elegans* has often been classified as *Crematopteris typica* Schimper et Mougeot 1844. However, Brongniart (1828) already attributed this material from the Vosges to the fern genus *Filicites* Schlotheim 1820 under the name *Filicites scolopendrioides*. According to the ICBN (Art. 13.1) (Greuter et al., 2000) the names published by Schlotheim (1820) are not validly published. *Filicites* was validated by Brongniart (1822, p. 209), however, this name is not longer in current use because it is very broadly defined and refers to fossil ferns in general. Goeppert (1836, p. 276) created the generic name *Scolopendrites* for this material. Schimper & Mougeot (1844, p. 73) introduced the generic name *Crematopteris* for the same material which is illegitimate, but this name is in general use. However, *Scolopendrites* is the valid and legitimate name for such fertile fern material.

Locality: St. Kassian (San Cassiano).

Storage: Collection of the Institute of Geology and Paleontology, University of Innsbruck (nr. P 8088b).

Fern *incertae sedis*

Pl. 1 fig. 4

Synonymy:

?1953 felce indeterminata; Leonardi, p. 13, pl. 1 fig. 9.

?1953 cf. *Pecopteris sulzensis* Schimper; Leonardi, p. 10, pl. 1 fig. 14.

?1986 *Pecopteris* sp.; Calligaris, p. 9, fig. A48.

2000a *Anomopteris mougeotii* Brongniart; Wachtler & van Konijnenburg – van Cittert, p. 108, pl. 1 figs. 4, 5.

2000b *Anomopteris mougeotii* Brongniart; Wachtler & van Konijnenburg – van Cittert, p. 116, pl. 1 figs. 4, 5.

Description:

Many small fragments of fern fronds have been recorded from the La Valle Formation, that may probably all be attributed to the same fern. The most complete specimen is the one figured in Wachtler & van Konijnenburg – van Cittert (2000a, b; pl. 1 fig. 5), a bipinnate fragment only 4 cm long and just over 2 cm wide with pinnules 2 x 2 mm. This specimen, however, does not show any venation. Most other specimens are pinna fragments showing sometimes clear pecopterid-neuropterid venation (see Wachtler & van Konijnenburg – van Cittert, 2000a, b, pl. 1 fig. 4 and our Pl. 1 fig. 4).

Discussion:

The fragments are so small that a definite attribution cannot easily be made. Wachtler & van Konijnenburg – van Cittert (2000a, b) described and figured some fragments as *Anomopteris mougeotii*, Leonardi (1953) as cf. *Pecopteris sulzensis* (which is the juvenile form of *Anomopteris mougeotii*; see Grauvogel-Stamm & Grauvogel, 1980). However, examination of *Anomopteris mougeotii* from the Vosges (the type-area of the species) revealed that the venation of this species is different; moreover, its pinnules are generally smaller (maximum 2 x 3 mm, usually smaller, while in some of our specimens pinnules are 3–3.5 x 3.5–4 mm) and aphlebiae are present at the base of the pinnae while they have not been encountered in our material. *Anomopteris mougeotii* is, therefore, not present in the Ladinian flora of the Dolomites, contrary to the Anisian flora from the northern Dolomites where good material has been found (Loriga Broglio et al., 2002).

Localities: Wengen-Ritjoch (La Valle), Prags Seewald (Braies), Corvo Alto, Mondeval, Cerenà.

Storage: Museum of Natural History, Bolzano (WRI-003-4); Palaeontological Museum "R. Zardini",

Cortina (2670, 2671, 3197); Museum of Geology and Palaeontology, University of Padova (28138, 28145); Museum of Palaeontology and Prehistory P. Leonardi, Ferrara (FPL 58, 59, 80).

3.3 Cycadophyta

Genus *Dioonitocarpidium* Rühle von Lilienstern 1928
Dioonitocarpidium moroderi (Leonardi) nov. comb.
Pl. 2 fig. 1

Synonymy:

- 1953 *Cycadeoidea* (?) *moroderi* Leonardi, p. 14, pl. 2 figs. 6-8.
1968 *Cycadeoidea* (?) *moroderi* Leonardi; Leonardi, p. 179, pl. 28 fig.5.
2000a *Dioonitocarpidium* sp.; Wachtler & van Konijnenburg-van Cittert, p. 112, pl. 6 fig. 2.
2000b *Dioonitocarpidium* sp.; Wachtler & van Konijnenburg-van Cittert, p. 123, pl. 6 fig. 2.

Description:

Apart from the specimen described and figured by Leonardi (1953: pl. 2 fig. 8; 1967: pl. 28, fig. 5) as *Cycadeoidea* (?) *moroderi* and by Wachtler & van Konijnenburg – van Cittert (2000a, b) as *Dioonitocarpidium* sp. which is kept at the Museum de Gherdëina, Ortisei (St. Ulrich, Val Gardena), the second specimen figured by Leonardi (1953: pl. 2 figs. 6-7) of this possible cycad macrosporophyll has been found in the collections of the Museum at Ferrara and its counterpart in the Museum at Ortisei. It is the counterpart of Leonardi's holotype (his pl. 2 fig. 8) but less complete and consists of a 6.5 cm long apical fragment with a 5 mm wide rachis with longitudinal grooves. Only the sterile part of the sporophyll has been preserved (Pl. 2 fig. 1), the basal fertile part is completely missing. The lamina segments (10 x 2 mm) of the sterile part arise at an angle of c. 70°. The width of the fragment is c. 2.5 cm at its base, and it tapers gradually towards the apex. The counterpart at Ortisei is more complete and, therefore, slightly longer (almost 9 cm), rachis 5-10 mm wide and the lamina segments can be up to 20 x 2 mm.

Discussion:

Leonardi (1953) originally thought that the material represented a bennettitalean bract and, therefore, attributed it provisionally to the genus *Cycadeoidea*. However, a careful study of the holotype revealed that seeds probably had been present in its basal part, although the specimen was too badly preserved

to be sure of this, see Wachtler & van Konijnenburg – van Cittert (2000a, b).

The material resembles that of the type specimen of *Dioonitocarpidium*, *D. pennaeformis* (Schenk) Rühle von Lilienstern known from Keuper floras in Mainfranken and Thüringen, Germany (see Kelber, 1990; Kelber & Hansch, 1995). *D. pennaeformis*, however, has only two seeds at its base (one on each side), while the presumed fertile part of the material described from the Dolomites has a basal fertile part which is c. 9 cm long and should probably have contained two rows of several seeds (Wachtler & van Konijnenburg – van Cittert, 2000a, b: pl. 6 fig. 2).

Kräusel (1953) described *D. liliensternii* Kräusel and *D. keuperianum* (Krasser) Kräusel from the Keuper flora of Lunz (Austria). Both species are smaller than the material from the Dolomites. *D. keuperianum* (known from several specimens) is c. 9 cm long when complete and demonstrates, according to Kräusel (1953), 5 seeds on one side of the macrosporophyll over a distance of only 8 mm. The sterile part of this sporophyll has a narrower rachis (maximum width c. 4 mm). *D. liliensternii* is only known from the holotype which is c. 10 cm long. Its apical sterile part is c. 6 cm long, the basal fertile part 4 cm. On one side of the fertile part at least 3 seeds have been preserved, which are c. 5 mm in diameter.

Kelber (1990: 52, text-fig. 91) and Kelber & Hansch (1995: 73, text-figs. 154, 156) described and figured material similar to *Dioonitocarpidium* as gen. et sp. indet. In this material the seeds are partially enclosed by a lamina, just as in the Permian macrosporophyll genus *Archaeocycas* (Mamay, 1976) which has an undivided apical sterile part. It is possible that this is also the case in the material from the Dolomites, just as in *D. liliensternii*, but as long as this is not proved, we prefer to attribute the material to *Dioonitocarpidium*.

The motherplant of *Dioonitocarpidium* is not yet known. The macrosporophyll seems to be of cycadalean nature as it is comparable in its gross morphology, although certainly not similar, to that of the living *Cycas*. Rühle von Lilienstern (1928, p. 104) believed that simple leaves of *Danaeopsis angustifolia* (= *Taeniopteris angustifolia*) belonged to the same plant as *Dioonitocarpidium pennaeformis*. Kelber & Hansch, 1995 (p. 70) stated that, although the two occur in the same localities, this does not imply that they undoubtedly belong to the same plant, and they rejected Rühle von Lilienstern's

reconstruction of the plant (1928, text-fig.1). Of course, it remains a possibility that the two species might have belonged to the same plant. Kräusel (1953) does not indicate motherplants for his two *Dioonitocarpidium* species.

In the Ladinian flora from the Dolomites several cycad-like leaf taxa are present; the most common one and definitely of cycadalean nature is *Bjuvia dolomitica*, furthermore a *Taeniopteris*-type of leaf is present and *Sphenozamites wengensis*, both of which might have belonged to the Cycadales or the Bennettitales. As no organic connection with any of these leaves is present, nor has *D. moroderi* indeed been found associated on the same slab with any of them, we cannot attribute the species to any of these leaves. But contrary to *Sphenozamites wengensis*, *Bjuvia dolomitica* occurs at Scagul, the locality from which *D. moroderi* is known, and *Taeniopteris* sp. is known from Val Gardena in general.

Locality: The specimens originate from Scagul (Val Gardena).

Storage: Museum de Gherdëina, Ortisei (St. Ulrich, Val Gardena; nr. M22); Museum of Palaeontology and Prehistory P. Leonardi, Ferrara (no number).

Genus *Sphenozamites* Brongniart 1849

Sphenozamites sp. cf. *S. brononii* (Schenk 1865)

Passoni et van Konijnenburg – van Cittert 2003

Pl. 2 figs. 2–6

Synonymy for the possible specific name:

1858 *Noeggerathia vogesiaca* Bronn, p. 44, pl. VI figs. 1–4.

1865 *Pterophyllum brononii* Schenk, p.18.

1907 *Pterophyllum brononii* Schenk; Arber, p. 120, pl. 18 fig. 1, pl. 19 fig.4.

2003 *Sphenozamites brononii* (Schenk) Passoni et van Konijnenburg–van Cittert, p. 331, pl. IV.

Description:

Two specimens have been found that can be attributed to the genus *Sphenozamites* without any doubt, but that are distinctly larger than *Sphenozamites wengensis* that had previously been described from the Ladinian of the Dolomites (Wachtler & van Konijnenburg – van Cittert, 2000a, b). They more resemble *S. brononii* that is known from the Carnian floras of Raibl and the Bergamasc Alps (Passoni & van Konijnenburg – van Cittert, 2003). The first is a specimen from Livinallongo (Pl 11, see Pl. 2 fig. 2) showing an apical leaf fragment with a rachis (2–3 mm

wide) and 3 pairs of attached, incomplete pinnae. The lowest pair of pinnae arises at an angle of 70°, the next one at 60° and the last pair of pinnae stands almost upright. The pinnae are c. 1.5 cm wide just above their base and attain a width of 3–3.5 cm more distally. None of the pinnae is complete, they are 9–10 cm long but the apex is not preserved. The shape of the pinnae is lanceolate-rhomboidal. The veins run parallel, up to c. 15/cm. This specimen yielded good cuticle fragments; leaves are hypostomatic. Upper cuticle (Pl. 2 fig. 6) with epidermal cells that are irregular, elongated, more or less arranged in rows. There is no indication of veins, and papillae are absent. In the lower cuticle (Pl. 2 figs. 3, 4), the veins are indicated by stomata-free zones with elongated epidermal cells. Stomata are arranged in irregular rows in intervenal zones, longitudinally oriented. Stomata (Pl. 2 fig. 6) consisting of two sunken guard cells surrounded by 5–7 papillate subsidiary cells. Papillae usually covering the stomatal pit.

The second specimen originates from San Leonardo in Val Badia, and consists of a leaf fragment with three detached pinna fragments only. These fragments have more or less the same size as those of the specimen from Livinallongo: 7–9.5 cm long (but incomplete as the bases are missing) and max. 3–3.5 cm wide. In two of the pinna fragments the apices are preserved; the apex is truncate with rounded angles and is more or less asymmetrical, so that the upper margin is longer than the lower margin of the pinna. The venation is indistinct and no cuticle could be obtained from this specimen.

Discussion:

Both specimens show more or less the same size and shape, and are distinctly larger than *S. wengensis* (pinnae there 5 x 1.5 cm on average; here incomplete pinnae are 9–10 x 3–3.5 cm. Although they are somewhat smaller, these two Ladinian specimens resemble the Carnian species *S. brononii* (known from Raibl and the Bergamasc Alps) in shape (see Passoni & van Konijnenburg – van Cittert, 2003, p. 331). In *S. brononii* complete pinnae may obtain a length of 13–23 cm, the maximum width (near the apex) is 2.5–5.5 cm. The cuticle of the latter species is unknown, hence we assign our material only with a cf. attribution to this species.

The cuticle of this *Sphenozamites* material is definitely of the type found in the Cycadales, and does not show any affinity with bennettitalean cuticles. Therefore, we presume that at least these specimens are cycadalean in origin.

Localities: Livinallongo, San Leonardo (Val Badia).
Storage: "Museo Ladino Fodom", Livinallongo (nr. Pl 11); Museum of Natural History, Vienna (without number).

3.4 Coniferophyta

Genus *Pelourdea* Seward 1917

Pelourdea vogesiaca (Schimper et Mougeot 1844) Seward 1917

Pl. 1 fig. 5

Synonymy:

- 1844 *Yuccites vogesiacus* Schimper et Mougeot, p. 42, pl. XXI.
1917 *Pelourdea vogesiaca* (Schimper et Mougeot) Seward; p. 278, fig. 484.
1927 *Yuccites vogesiacus* Schimper et Mougeot; Schlüter & Schmidt, p. 20, pl. 3.
1953 *Yuccites vogesiacus* Schimper et Mougeot; Leonardi, p. 15, pl. II figs. 9, 11, pl. III figs. 3-4.
1978 *Yuccites vogesiacus* Schimper et Mougeot; Grauvogel-Stamm, p. 31, pl. 3 fig.1.
1986 *Yuccites* sp.; Calligaris, p. 15, figs. B21, 42.
2000a *Yuccites vogesiacus* Schimper et Mougeot; Wachtler & van Konijnenburg-van Cittert, p. 113, pl. 6 figs. 4, 5.
2000b *Yuccites vogesiacus* Schimper et Mougeot; Wachtler & van Konijnenburg-van Cittert, p. 121, pl. 6 figs. 4, 5.

Discussion:

The revision of this taxon (for illustration, see Pl. 1, fig. 5) is simply done for nomenclatorial reasons. Careful examination revealed that the genus *Yuccites* had been invalidly used for over 150 years for this taxon for the following reasons:

In 1822 Martius made the genus *Yuccites* with 3 species: *Yuccites microlepis*, *Y. sphaerolepis* and *Y. trigonolepis*. The genus has never been used afterwards in the sense of Martius. Only Goeppert (1848, in Bronn, Index, p. 1376) made some remarks, stating that *Y. microlepis* was according to him possibly *Lepidophloios laricinus* (Lycophyte) and *Y. sphaerolepis* was an *Ulodendron* species (also a Lycophyte), both Carboniferous in age. Nevertheless, the genus *Yuccites* was validly published by Martius in 1822.

In 1844 Schimper and Mougeot made the genus *Yuccites* from the Lower Anisian flora of the Vosges,

with the type species *Y. vogesiacus*, for long, lanceolate leaves with parallel venation, tapering both towards apex and base. They also described an axis as well which they believed to belong to *Yuccites*, which later proved to be not the case (Fliche, 1910). In their opinion the genus belonged to the monocots, affinity with *Yucca*, hence the name *Yuccites*. Later authors attributed the genus to cordaites or conifers, and i.e. Schlüter & Schmidt (1927) described female cones associated with shoots and leaves, which are definitely coniferalean. Nowadays a coniferalean affinity is generally accepted. Circa 25 species have been described in the genus from all over the world. However, the generic name *Yuccites* Schimper et Mougeot 1844 is illegitimate, according to the International Code of Botanical Nomenclature (Greuter et al., 2000), as *Yuccites* Martius 1822 has priority.

Seward (1917) created the genus *Pelourdea* to replace *Yuccites* because "it is undesirable to retain a designation suggesting false ideas with regard to affinity". He was convinced at that time that the genus belonged to the cordaites or conifers. The genus *Pelourdea* was proposed for "leaves of the *Yuccites*-type which in form, venation, and spiral phyllotaxis agree with those of *Cordaites* but cannot confidently be assigned to that genus or even to the Cordaitales". He designated *Pelourdea vogesiaca* (Schimper et Mougeot) Seward as the type species, and attributed material from various European localities to it. Although Seward (1917) made the genus *Pelourdea* for the wrong reason, it should be retained because as said above *Yuccites* Martius has priority over *Yuccites* Schimper et Mougeot.

Ash (1987) discussed the nomenclature and systematic position of the genus *Pelourdea* and gave an emendation of the its diagnosis, with special characters for the base of the leaves (base narrowing slightly to clasp stem) and the apex (acute to acuminate); this provided also the difference with most Cordaitalean leaves. The problem is that in the type species *Pelourdea vogesiaca* the leaves are basically more restricted and the apex is not always so acute or acuminate as in *P. poleoensis* which he described from the Late Triassic of the USA, so we prefer to retain Seward's generic diagnosis.

Localities: Wengen (La Valle), Prags (Braies), Scagul (Val Gardena).

Storage: Museum of Natural History, Bozen (Bolzano, various numbers); Museum de Gherdëina, Ortisei (St. Ulrich, Val Gardena; nr. M21).

4 General discussion

After the description of the fossil flora of the Wengen Formation (Ladinian) in the Dolomites in 2000 (Wachtler & van Konijnenburg – van Cittert, 2000a, b) a systematic search in old museum collections by one of us (E. Kustatscher) revealed many old specimens; some of them had already been described, and others not. Thus Ogilvie Gordon's material (1927) was traced in Munich but did not reveal any new data; Mutschlechner's material has been found at the Institute of Geology and Palaeontology (University of Innsbruck), but did not reveal new data as well, Mojsisovics material could not be found in the Geological Survey in Vienna and most of Leonardi's material published in 1953 had already been taken into account in 2000. However, some of that material and all of the material published in 1968 proved to be in the Museum of Palaeontology and Prehistory P. Leonardi, Ferrara and revealed some new data leading to a revision of *Dioonitocarpidium moroderi* (Leonardi) nov. comb. Moreover, examination of the Triassic material present in the Natural History Museum, Vienna revealed the first specimen of *Annalepis zeilleri* Fliche from the Ladinian flora of the Dolomites. And in the collections of the Institute of Geology and Palaeontology at Innsbruck the first specimen of *Scolopendrites* sp. was recovered (the fertile frond of *Neuropteridium*). In the collection of the Natural History Museum, Vienna a not too well preserved specimen of *Sphenozamites* sp. cf. *S. brononii* was encountered; a better specimen of the same taxon was found in the "Museo Ladino Fodom" at Livinalongo.

Thus, the Ladinian macroflora of the Dolomites now consists of the following taxa; *Annalepis zeilleri* (Lycophyta), *Equisetites arenaceus* (Sphenophyta), *Cladophlebis leuthardtii*, *C. ruetimeyeri*, *Neuropteridium elegans*, *Scolopendrites* sp., fern incertae sedis (formerly *Anomopteris mougeotii*) (Pteridophyta), *Ptilozamites heeri* (Pteridospermae), *Bjuvia dolomitica*, *Dioonitocarpidium moroderi*, *Pterophyllum jaegeri*, *P. sp.*, *Sphenozamites wengensis*, *S. sp. cf. S. brononii*, *Taeniopteris* sp. (Cycadophyta), *Voltzia dolomitica*, *V. ladinica*, *V. pragsensis*, *V. zoldana*, *Voltzia* sp., *Pelourdea vogesiaca*, *Elatocladus* sp. (Coniferophyta).

Of these taxa, *Pelourdea vogesiaca* and especially *Voltzia dolomitica* dominate the flora; *Ptilozamites heeri*, *Bjuvia dolomitica*, *Voltzia ladinica* and *Voltzia* sp. (small fragments that cannot be attributed to one

of the *Voltzia* species) occur in smaller numbers; *Equisetites arenaceus*, *Voltzia pragsensis*, *Cladophlebis leuthardtii* and fern incertae sedis are rarer but still occur in numbers between 5–10 specimens. The other taxa are either single or double finds, and are thus rare species.

Two facies are distinguished in the Triassic deposits of Europe: the German facies (mainly France, Switzerland and Germany) and the Alpine facies (mainly Italy, Austria and the Balkan). The only other Ladinian flora is the 'Lettenkeuper flora' in Germany (Kelber & Hansch, 1995). Anisian floras are mainly known from the Vosges (Grauvogel-Stamm, 1978), Italy (Recoaro, see Schenk, 1868) and recently also from the Dolomites (Loriga Broglio et al., 2002). Carnian floras are known from Austria (Lunz, see Dobruskina, 1998), Germany (Kelber & Hansch, 1995), Switzerland (Basel, see Dobruskina, 1994) and Italy (Raibl, see Schenk, 1865; Mount Pora in the Bergamasc Alps, see Passoni & van Konijnenburg – van Cittert, 2003). None of these floras is closely comparable to the present Ladinian flora from the Dolomites. A number of taxa occur in some of the other floras as well; *Annalepis zeilleri* is well-known from the Anisian flora of the Vosges and Keuper floras from Germany, *Equisetites arenaceus* is the only taxon that occurs in all the floras, *Cladophlebis ruetimeyeri* has been found in the Basel flora, *Neuropteridium elegans* and *Scolopendrites* sp. are known from the Anisian floras of the Vosges, the Dolomites and some small Anisian floras in Germany, *Ptilozamites heeri* has been recorded from the Rhaetian-Liassic flora of Sweden (see Wachtler, M. & van Konijnenburg – van Cittert, 2000a, b), *Pterophyllum jaegeri* is well-known from the Carnian of Lunz, Basel, the Bergamasc Alps and German Keuper floras, *Sphenozamites brononii* has been recorded from the Carnian of Raibl and the Bergamasc Alps, *Taeniopteris* sp.-like fossils occur in Lunz, Basel, Bergamasc Alps, the Anisian flora in the Dolomites and several Keuper floras in Germany, and *Pelourdea vogesiaca* was found in the Vosges, Raibl and the Bergamasc Alps. Quite a number of taxa has so far only been found in the Ladinian flora of the Dolomites: *Cladophlebis leuthardtii*, *Bjuvia dolomitica*, *Dioonitocarpidium moroderi*, *Sphenozamites wengensis*, *Voltzia dolomitica*, *V. ladinica*, *V. pragsensis*, *V. zoldana* and *Elatocladus* sp.

Concluding it can be said that, although the Ladinian flora from the Dolomites has several taxa in common with other Triassic floras in Europe, it

| taxon | Vosges Anisian | Recoaro Anisian | Dolom. Anisian | Germ. Anisian | Lunz Carnian | Basel Carnian | Raibl Carnian | Berga. Carnian | Germ. Keuper |
|-----------------------------------|----------------|-----------------|----------------|---------------|--------------|---------------|---------------|----------------|--------------|
| <i>Annalepis zeilleri</i> | + | | | | | | | | + |
| <i>Equisetites arenaceus</i> | + | + | + | | + | + | + | + | + |
| <i>Cladophlebis leuthardtii</i> | | | | | | | | | |
| <i>C. ruetimeyeri</i> | | | | | | + | | | |
| <i>Neuropteridium elegans</i> | + | | + | + | | | | | |
| <i>Scolopendrites</i> sp. | + | | + | + | | | | | |
| fern incertae sedis | | | ? | | | | | | |
| <i>Ptilozamites heeri</i> | | | | | | | | | |
| <i>Bjuvia dolomitica</i> | | | ? | | | | | | |
| <i>Dioonitocarpidium moroderi</i> | | | | | | | | | |
| <i>Pterophyllum jaegeri</i> | | | | | + | + | + | | + |
| <i>Pterophyllum</i> sp. | | | ? | | | | | | |
| <i>Sphenozamites wengensis</i> | | | | | | | | | |
| <i>S. sp. cf. S.bronnii</i> | | | | | | | + | + | |
| <i>Taeniopteris</i> sp. | | | + | | + | + | + | + | + |
| <i>Voltzia dolomitica</i> | | | | | | | | | |
| <i>V. ladinica</i> | | | | | | | | | |
| <i>V. pragsensis</i> | | | | | | | | | |
| <i>V. zoldana</i> | | | | | | | | | |
| <i>Voltzia</i> sp. | | | ? | | | | | | |
| <i>Pelourdea vogesiaca</i> | + | | | | | | + | + | |
| <i>Elatocladus</i> sp. | | | | | | | | | |

Table comparing the Ladinian flora from the Dolomites with other Triassic European floras. The data have been derived from Dobruskina, 1994, 1998; Grauvogel-Stamm, 1978; Kelber, Et Hansch, 1995; Loriga Broglio et al., 2002; Passoni, Et van Konijnenburg – van Cittert, 2003; Schenk, 1865, 1886; Wachtler Et van Konijnenburg – van Cittert, 2000a, b.

resembles no other flora closely and almost half of the taxa described have so far only been recorded from this flora.

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Plate 1

- Fig. 1 *Annalepis zeilleri* Fliche, scale fragment (no number, Natural History Museum, Vienna)
- Fig. 2 *Neuropteridium elegans* (Brongniart) Schimper, sterile frond fragment (2669, Palaeontological Museum "R. Zardini", Cortina).
- Fig. 3 *Scolopendrites* sp., fertile frond fragment (P 8088b, Collection of the Institute of Geology and Palaeontology, University of Innsbruck).
- Fig. 4 Fern incertae sedis, leaf fragment (WRI-003, Museum of Natural History, Bolzano)
- Fig. 5 *Pelourdea vogesiaca* (Schimper et Mougeot) Seward, two leaves partially overlapping (WSW 10, Museum of Natural History, Bolzano).

Plate 2

- Fig. 1 *Dioonitocarpidium moroderi* (Leonardi) nov. comb., distal, sterile part of macrosporophyll (no number, Museum of Palaeontology and Prehistory P. Leonardi, Ferrara).
- Fig. 2 *Sphenozamites* sp. cf. *S. bron nii* (Schenk) Passoni et van Konijnenburg – van Cittert, apical part of leaf (PI 11, Museum of Natural History, Vienna)
- Fig. 3 *Sphenozamites* sp. cf. *S. bron nii* (Schenk) Passoni et van Konijnenburg – van Cittert, fragment of the lower cuticle showing veins and interveinal bands with stomata.
- Fig. 4 *Sphenozamites* sp. cf. *S. bron nii* (Schenk) Passoni et van Konijnenburg – van Cittert, detail of the lower cuticle, showing one bands without stomata and fragments of two interveinal bands with stomata
- Fig. 5 *Sphenozamites* sp. cf. *S. bron nii* (Schenk) Passoni et van Konijnenburg – van Cittert, one single stoma
- Fig. 6 *Sphenozamites* sp. cf. *S. bron nii* (Schenk) Passoni et van Konijnenburg – van Cittert, upper cuticle

Plate 1

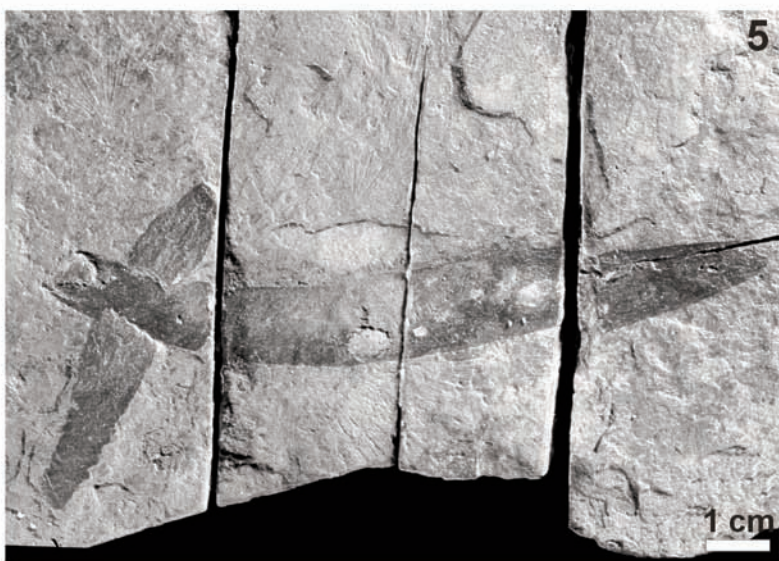
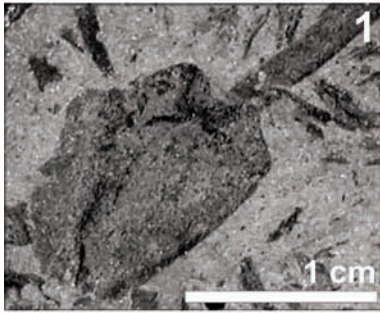


Plate 2

