

## Abstracts

(Abstracts are sorted alphabetically according to the first author)

Poster

### **Varved lacustrine sediments in the South Velebit Channel, Croatia**

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#### **Introduction**

Pleistocene lacustrine sediments were found in the South Velebit Channel on both north and south coasts. These sediments are exposed on the north shore of the Velebit Channel near Seline in a 500 m long and 4-5 m high exposure, and on the opposite side of the channel at the Ždrilo locality in a 150 m long and 10 m high coastal exposure. Scattered outcrops of lacustrine sediments can also be found at the coasts of Novigrad and Karin Inland Seas, near Žegar and Ervenik settlements as well as in several karst poljes in Northern Dalmatia (Fig. 1). Pleistocene lacustrine sediments of the Novigrad and Karin Sea were briefly described by Marjanac et al. (1990) and Marjanac & Marjanac (2004), who interpreted the lake as formed in a proglacial setting due to common dropstones. The lacustrine sediments in Žegar, Ervenik and in Kninsko polje were studied by Malez & Sokač (1969) and Sokač (1975), who described a rich ostracod fauna indicative of cold climate. Glacigenic sediments were extensively studied in the coastal Dinaric Alps area (Marjanac et al. 1990, Marjanac & Marjanac 2004), and dating of secondary calcite from a moraine which overlies these lacustrine sediments yielded the minimal age of >350,000 years BP.

The lacustrine sediments of Seline and Ždrilo sections were studied from 2009-2011, and a well preserved fossil flora and gastropod moulds were collected. The collected flora comprises 10 specimens of fossil leaves at the Seline section, and more than 70 specimens at the Ždrilo section. The studied fossil flora belongs to 15 tree taxa of 9 families. In addition to fossil plants, mollusc moulds of Unionidae and Gastropoda were found at the Seline section, whilst Congeria-like bivalves and ostracods were found in the sediments from the Ždrilo section.

## Description of studied sediments

### Seline section

The lacustrine sediments of the Seline section are located in front of the Mala and Velika Paklenica Canyons (Fig. 1), where two stratigraphic intervals of lake sediments are divided by a conglomerate layer. Their close position with regard to the glacial valleys of the Paklenica and Velebit mountain range makes this section and the appropriate lake margin a proximal zone under moderate influence of the glacial debris input.

The older sediment package is well stratified, with common dropstones, whereas the younger is massive without evident stratification. The studied sediments in this profile are light brown, ochre to whitish coloured, are made of silt and sand grains, and do not comprise clayey laminae. The fossil plant debris is abundant but fossil leaves are rare. There also occur frequent moulds of fossil gastropods and bivalves, as well as cobble-size dropstones. The dropstones occur both in older and younger packages of lacustrine sediments and document the proglacial character of the lake.

The conglomerate interbed, which divides the two lacustrine intervals, is a distal part of deltaic fan bodies akin to those which underlie the oldest package of lacustrine fine-grained sediments and were interpreted as Gilbert-type deltas.

### Ždrilo section

Pleistocene proglacial lake sediments are also exposed on the southeast coast of the Velebit Channel, at the Ždrilo locality. The position of this section on the opposite side of the modern Velebit Channel and consequently on the opposite side of the paleolake, makes it distal in relation to the sediment sources on the Velebit mountain range and the feeding glaciers. The lacustrine sediments are moderately to highly disturbed due to glacial push, and partly submerged under the modern Adriatic Sea, which makes the study of the whole sediment succession difficult. However, the outcrops are good enough for the study of the younger package of lacustrine sediments, which are locally overridden and eroded by thick lodgement till.

The Ždrilo section lacustrine sediments are perfectly laminated, with well defined varves. The sediments comprise light to dark brown and rusty brown siltstone laminae in alternation with white to light grey clayey laminae. The boundaries between silt and clay laminae are sharp, sometimes with developed small-scale flame structures, sometimes marked by erosional surfaces and sometimes marked by bioturbation. The mid-part of the section was studied in detail, and the silt laminae vary from 1 to 111 mm in thickness. The thickest one is massive and undifferentiated. The clay laminae are considerably thinner with thicknesses between 1 and 30 mm. Traces of bioturbation were observed at the contact of silt and clay laminae, with burrows in underlying silt laminae infilled with clay from above. Silt and clay laminae are in most cases further differentiated which might imply the variation of sediment inflow during their deposition. In one part of the laminated lake sediment in Ždrilo, folding and reverse faults can be observed. This unique case of faulting and folding may indicate a synsedimentary deformation.

The moraine sediments were found on a lateral section in a distance of 300 m. Due to the glacier advance, overridden varved sediments were tilted, eroded and deformed, and a 13 m long slab of lacustrine sediment is incorporated into the moraine.

### Fossil flora and fauna from proglacial lake sediments

Lacustrine sediments of the Ždrilo section are rich in plant macrofossils. Most abundant are leaves of *Taxodium* sp. More than 30 specimens of *Taxodium* sp. fossil leaves, varying from poorly to excellently preserved were collected and photographed. The *Taxodium* leaves were found on silty laminae and were covered by a thin film of clay, which is common also for all other fossil leafs at the Ždrilo section. They occur throughout the section, and in most cases together with fossil leaves of *Zelkova* sp. and *Quercus* sp.

Aforementioned *Quercus* sp. and *Zelkova* sp. were second best represented by the number of specimens at the Ždrilo section; eight specimens of *Quercus* sp. and five specimens of *Zelkova* sp. were found. Two specimens of *Quercus* sp. were also found in lake sediments at the Seline section. Leaf fossils from Ždrilo are grey and well preserved, whereas those from the Seline section are rusty brown and poorly preserved. The leaf size of *Quercus* sp. varies from 30 to 100 mm. Five specimens of *Zelkova* sp. were found in the Ždrilo section, and one was found in the Seline section. The specimens were well preserved except for the few, with an invisible leaf nervature but the leaf edges were perfectly recognizable. The leaf size varies between 20 and 30 mm.

The plant macrofossils represented by two specimens were *Castanea* sp., *Acer* sp. and *Fagus* sp, found at the Ždrilo section. The leaves of *Fagus* sp. were found in sediment along with the *Zelkova* sp. and numerous *Taxodium* sp. fragments.

Other plant macrofossils found in varved lake sediments at the Ždrilo and Seline sections, are represented by a single specimen; such as *Liquidambar* cf. *europaea*, *Buxus* sp., *Pterocarya* sp., *Tilia* sp., and fruit of *Ulmus* sp. One specimen was recognized as a member of Moraceae family. The fossil leaf of *Tilia* sp. was also found in lake sediments of the Seline section.

Few specimens were poorly preserved and were hard to determine because of the lack of important diagnostic features such as leaf nervature, leaf base or leaf apex. Those are arbitrarily assigned to certain taxa: *Zelkova*, *Parrotiopsis*, *Pyrachanta* and *Buxus*-like specimens.

Poorly preserved specimens of fossil fauna were found in lacustrine sediments both in Seline and Ždrilo sections. Since the diagnostic features were missing, the specimens were determined only by their general characteristics. Seven specimens of fossil gastropods and bivalves were collected in lake sediments of the Seline section, whilst a large number of Congeria-like bivalves was found on a bedding plane of the Ždrilo section lacustrine sediment. Ostracods with unornamented shells and of different sizes were found in the Ždrilo section lacustrine sediments.

### Short discussion and conclusions

The fossil assemblage and the sediments of Pleistocene proglacial lakes have great importance in reconstruction of the paleoclimate in Northern Dalmatia and of the extent of glaciations in central Europe. In the south of Europe were the refugia for most of the plant species during the Pleistocene (e.g., Follieri et al. 1986, Magri 1998, Kuntzman et al. 2009). Findings from the localities on the eastern Adriatic coast, Ždrilo and Seline, can contribute to a better understanding of the response of plant communities to glaciations and cold climate.

Plant taphocoenoses found in lake sediments in Ždrilo and Seline correspond to mixed temperate forest vegetation, based on *modern* vegetation distribution pattern. It is generally perceived that the genus *Quercus*, *Fagus*, *Ulmus*, *Acer*, *Liquidambar*,

*Castanea*, *Tilia* and *Zelkova* represent typical temperate vegetation, whereas the genus *Taxodium* and *Pterocarya* being representatives of humid climate. Our findings are at odds with this model, the fossil leaves were found in sediments of a lake that was in direct contact with active (advancing) glaciers, as indicated by numerous dropstones and overlying ground moraines. Modern distribution patterns of certain taxa are, we believe, a consequence of several abiotic factors, such as the distribution of glacial ice. The modern plant distribution may neither represent their true distribution nor their climatic affinities in geological history.

The results presented in this paper are at the moment preliminary, and further, more detailed research is planned for the near future, in order to get better understanding of Pleistocene vegetation in the Dinaric Alps.

### Acknowledgments

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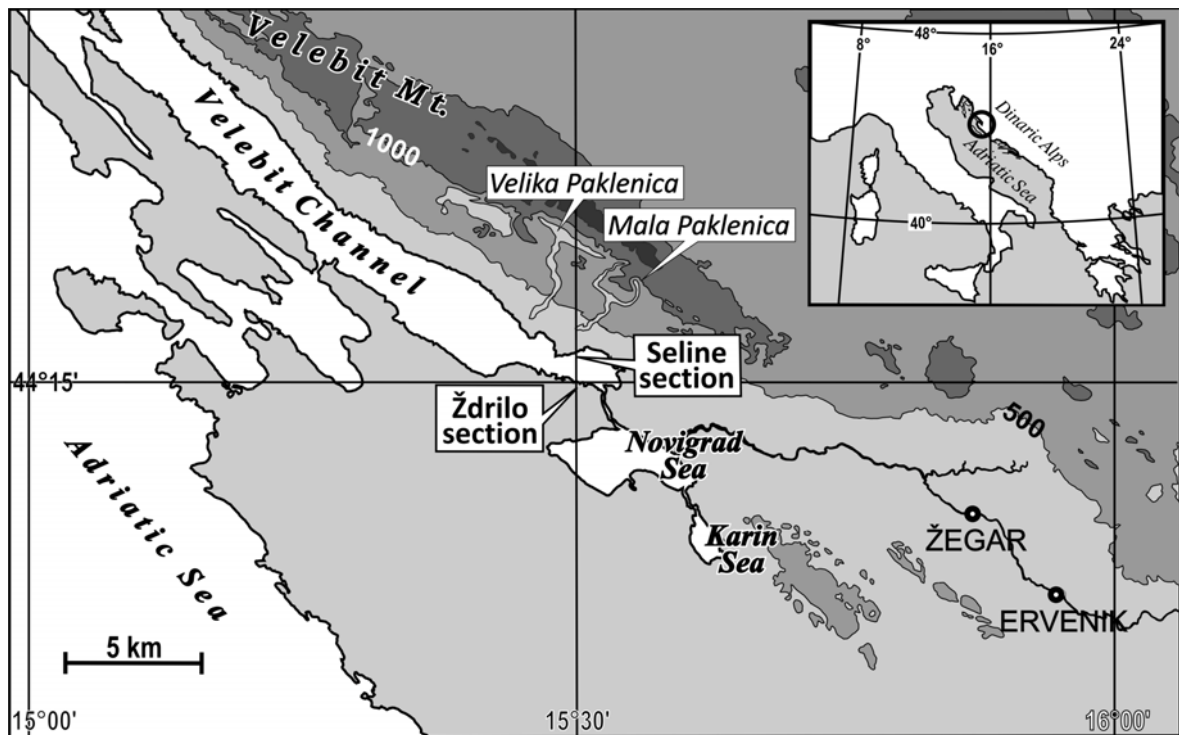


Fig. 1: Location of studied sections on the eastern Adriatic Sea coast.

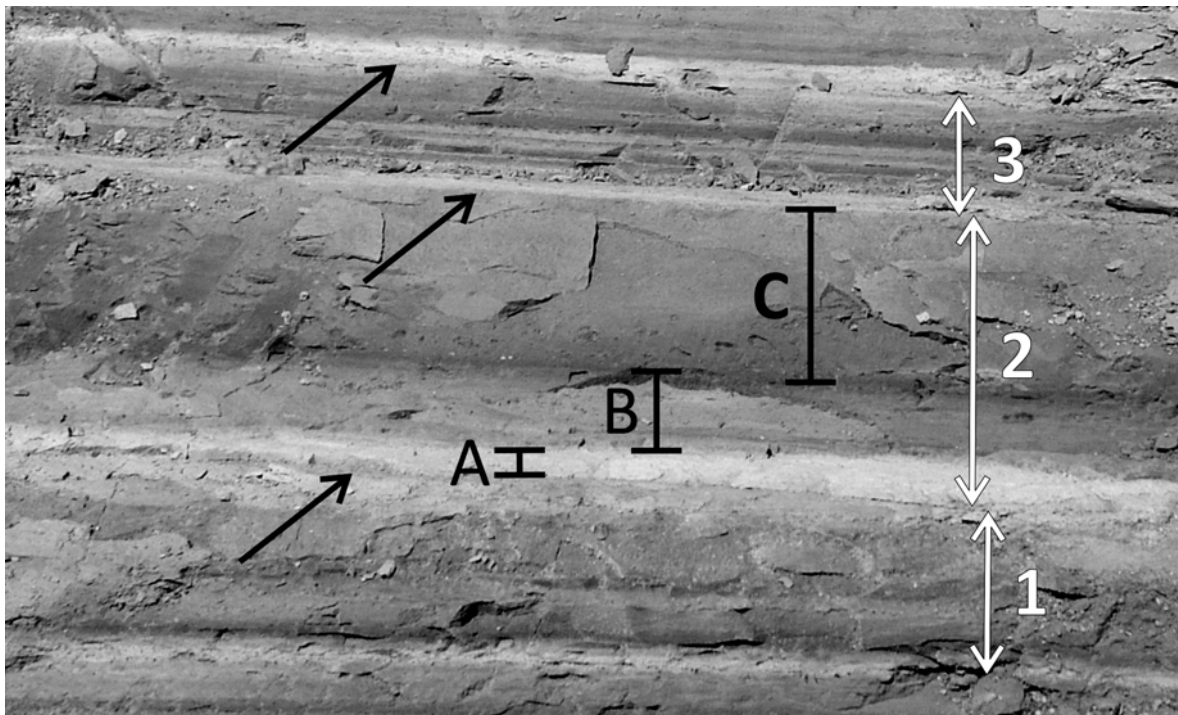


Fig. 2: Varved lacustrine sediment of the Ždrilo section. The section is 15 cm thick. White numbers (1-3) indicate annual layers (varves); a couplet consists of winter layer (white) and spring/summer layer (grey). Packet 3 is a complex varve, probably formed during a year with several freeze and thaw periods. A - winter layer; B - spring layer; C - summer/autumn layer. Arrows point to the autumn/winter boundary comprising fossil leaves.



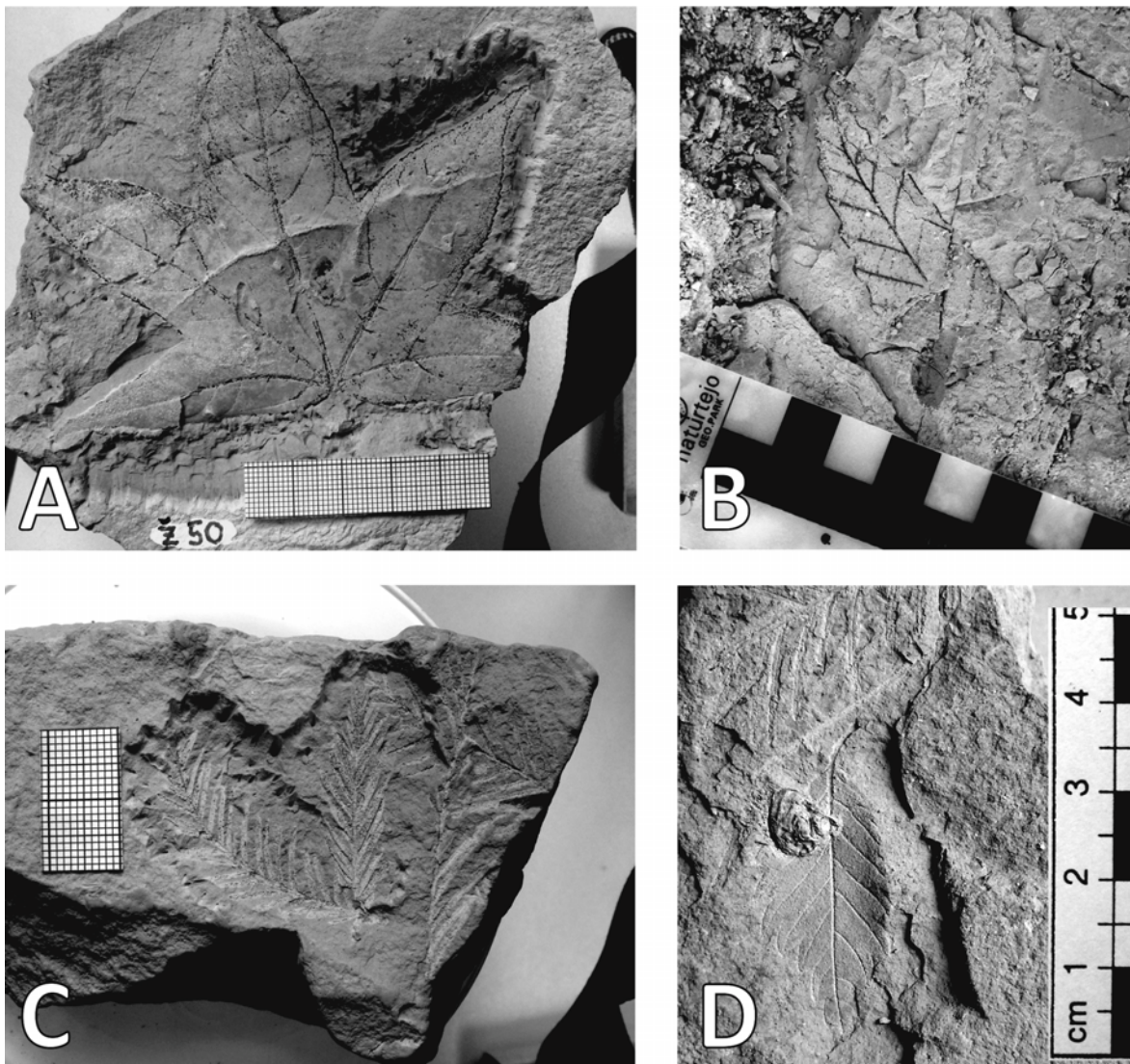


Fig. 3: Fossil flora from Ždrilo section varves. A) *Liquidambar* cf. *europaea*, B) *Quercus* cf. *trojana*, C) *Taxodium* sp., D) *Zelkova* sp.

Poster (presented by N. Roberts)

### **Reconstructing Holocene climate and environmental variability using ITRAX core scanning technology: preliminary results from Nar Crater Lake, Turkey**

**Samantha Lee Allcock and Neil Roberts**

A wide variety of climate information can be extracted from non-biological components of lake sediments. Physical and chemical properties of lake sediments can be related to climate signals either through varve thickness measurements or through geochemical analysis. Traditional methods for extracting these data often rely upon time consuming and destructive techniques. New approaches now utilise ITRAX core scanning to provide rapid high-resolution records. Annually laminated