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What could eat dicynodonts (Dicynodontia, Therapsida) from Lipie Śląskie? (Upper Silesia, Poland) – preliminary results of research of the Late Triassic macroflora

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Abstract

Investigated plant remains came from Late Triassic clays explored by brickyard in Lipie Śląskie (south Poland) where also fossils of vertebrates and invertebrates were found. Dicynodonts and other plant-eaters could choose from few types of plants which were composing ecosystem of that time. Observations of *cuticulae dispersae* and shoots reveal presence of Pteridospermophyta, Cycadophyta and Coniferophyta.

Key words: Triassic, fossil macroflora, Lipie Śląskie

The Late Triassic ecosystem of Lipie Śląskie region was a habitat of a giant dicynodonts (Fig. 1). These were therapsids, as large as a rhino and feeding with plants.

Figure 1. Triassic dicynodonts were herbivorous synapsids and had a body length of up to 3 m, i.e. the size of a rhino(http://focus.pl, changed; scale bar 0.5m).

Animals of that size had needed appropriate kind and amount of food to survive. The dicynondont fossils at Lipie Ślaskie were recorderd together with remains of dinosaurs, pterosaurs amphibians and fishes, but also invertebrates like conchostracans, molluscan and insects (DZIK *et al*. 2008).

Lipie Śląskie is a hamlet of Lisowice village, about four kilometers in the South from Lubliniec, Silesia (Fig. 2).

Figure 2. Localization of Lipie Śląskie (http://googlemaps.com, changed).

In this area Late Triassic sediments lie discordantly on the Middle Triassic. Lipie Śląskie brickyard expose calcareous siltstones, interbedded with mudstones and sandstones. Siltstones dominate in this complex, they are brown, cherry-brown and grey. Generally laminated siltstones are often interbedded with mudstones rarely with sandstones (HAISIG *et al*. 1983). Cross – stratification apparently in mudstones and sandstones. At the top of few stratum current hieroglyphs could be seen (KOZYDRA & WYRWICKI 1977; FUGLEWICZ & ŚNIEŻEK 1980). Thickness of investigated complex is about 12 meters.

Lipie Śląskie brickyard was founded in 1928. In 1977 Kozydra and Wyrwicki described the lithological settings of the Lubliniec region. New stratygraphical data were submitted by FUGLEWICZ & ŚNIEŻEK (1980) who had made macrospore investigation. Microflora in Late Triassic sediments in Poland was inves-

tigated by Orłowska-Zwolińska, Dybova-Jachowicz, Fijałkowska, Laszko, Marcinkiewicz and lately by Staneczko (Staneczko 2007a,b). Since 2006 Institute of Paleobiology Polish Academy of Science in Lipe Śląskie brickyard conduct a research on Latest Triassic ecosystem (Niedźwiecki & Sulej 2008).

Materials

Lipie Śląskie sediments are rich in dispersed plant remains of small size. They are mostly fragments of leaves cuticles, but also seeds and shoots. A cuticle is a extracellular membrane covering epidermis of higher plants (Fig. 3). It protects plant from loosing water and solutes and from pathogens penetration (Taylor 1999). The cuticle consist of a wax fraction and cuticular matrix, in which could occur two biopolymers cutin and cutan. It makes cuticles very resistant during fossilization process (Tagelaar *et al.* 1991). The cuticles enable taxonomic recognition of plants, their reconstruction and furthermore ecological reconstruction because it forms a natural display of the underlying epidermis with characteristic cell pattern, stomata, hairs, papillae etc. Most plant species have they own cuticle pattern which is useful in taxonomy of fossil plants (Kerp & Krings 1999). Cuticles reveal morphological distinction that can divide them into few types. Observation of *cuticle dispersae* enable to distinguished Pteridospermophyta, Cycadophyta and Coniferophyta.

Siltstones, mudstones and sandstones also contains other plant macrofossil like charcoalified tree trunks, rarely branched shoots, single leaves (Fig. 4), cone-like specimens and seeds (Fig. 5). Cuticles were obtained from available shoots fragments and seeds shells. Preparation was realized with the same procedure as *cuticle dispersae.* Examination of shoots and cuticles allow to distinguished mostly plants from Coniferales.

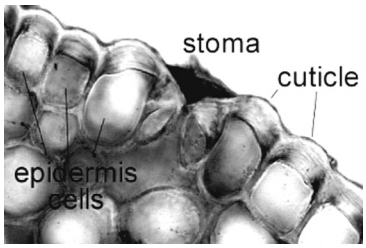

Figure 3. Scheme of cuticle covering epidermis (http://www.uni-muenster.de, changed).

Figure 4. Single leaf of Cheirolepidiaceae (scale bar 1 mm).

Figure 5. Seed shell (scale bar 5 mm).

Methods

Cuticles were obtained from the sediment (*cuticulae dispersae)* and from available shoots fragments.

Sediment samples were macerated with 65% HNO_3 and distilled water in proportion 1:1 with small portion of $KClO_3$ (method of Schulz). After 1 hour, when rock submitted dissolution specimen was rinsed with distilled water. Next into the sample was added diluted ammonia and after that specimen was again rinsed with distilled water. To dispose the rest of the sediment part of specimens were macerated with 40% HF and then rinsed with distilled water. Received plant remains have 0.1-5mm. Part of specimens were observed under light microscope, those which were macerating with HF were observed under scanning microscope.

Taxonomy

Pteridospermophyta – seed ferns

In the investigated material cuticles of cf. *Lepidopteris ottonis* (Goeppert) Schimper were recognized (Fig. 6). Very characteristic cuticles were also found in Lipie Śląskie by Staneczko (2007b). *Lepidopteris ottonis* (Goeppert) Schimper belongs to the order Peltaspermales described from the Late Triassic of Greenland, South Africa, North America, Europe and the Russian platform. Peltaspermales are known from Upper Carboniferous to Jurassic, and genus *Lepidopteris* from Triassic and Jurassic (Taylor *et al.* 2009). *Lepidopteris ottonis* (Goeppert) Schimper is an index species for Uppermost Triassic (Ociepa *et al*. 2008). It was a shrub – like or tree - like plant with pinnate and coriaceous leaves (Jachowicz & Dybova–Jachowicz 2003).

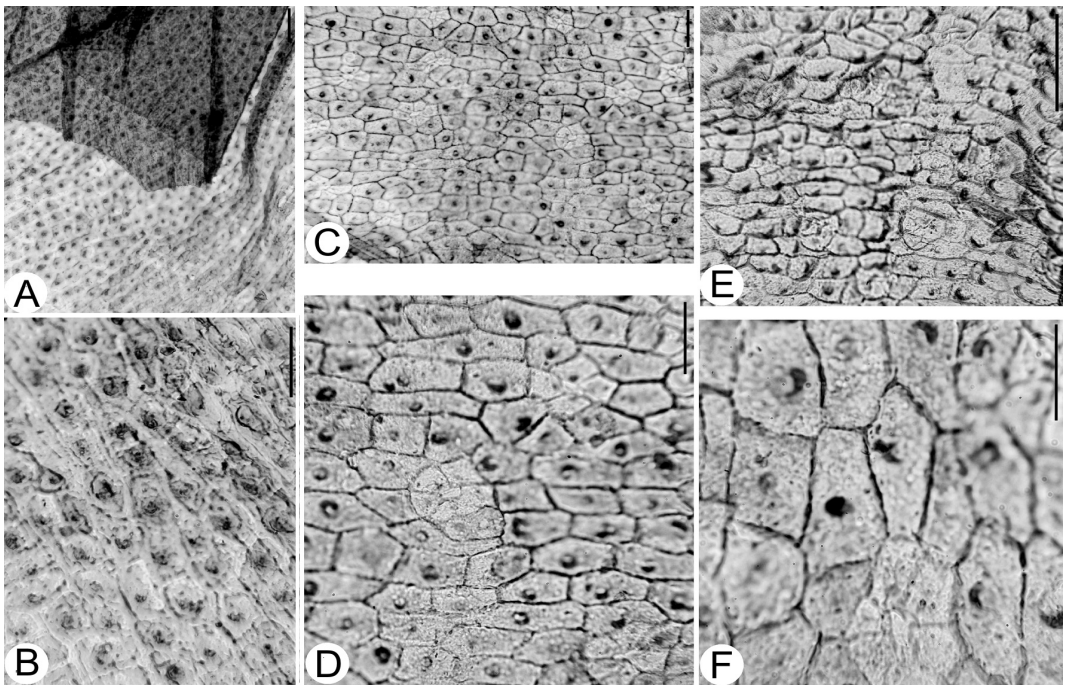

Figure 6. *Cuticulae dispersae* of *Lepidopteris ottonis* (Goeppert) Schimper (scale bar 50 µm).

Cycadophyta

Cycadophyta were recognized mostly from analyzing *cuticulae dispersae* (Fig.7) and fossilized male and female cones. Cuticles belong to genus *Nilssonia* Brongniart known from Triassic to Cretaceus. Leaves of *Nilssonia* Brongniart were long and compound with stomata on the adaxial side. It was also known from Late Triassic of Europe and North America and Jurassic of Europe, Iran, Japan and Greenland (Harris 1964, Ash 2001, Watson & Cusack 2005, Pott *et al*. 2007, Taylor *et al*. 2009).

Other representatives of cycadophyta in Lipie Śląskie sediments are *Androstrobus* sp. and *Beania* sp. Microstrobilus belong to genus *Andrsotrobus* Schimper. Male cone consist of microsporophylls set heliocentrically on the axis. Every microsporophyll have a microsporangium on the abaxial side (Taylor *et al.* 2009). *Androstrobus* Schimper was described also from Triassic sediments of Argentina, China, Greenland, Iran, South Africa and Jurassic sediments from France. The best known specimens came from Middle Jurassic of Yorkshire, England (Harris 1964, Taylor *et al*. 2009).

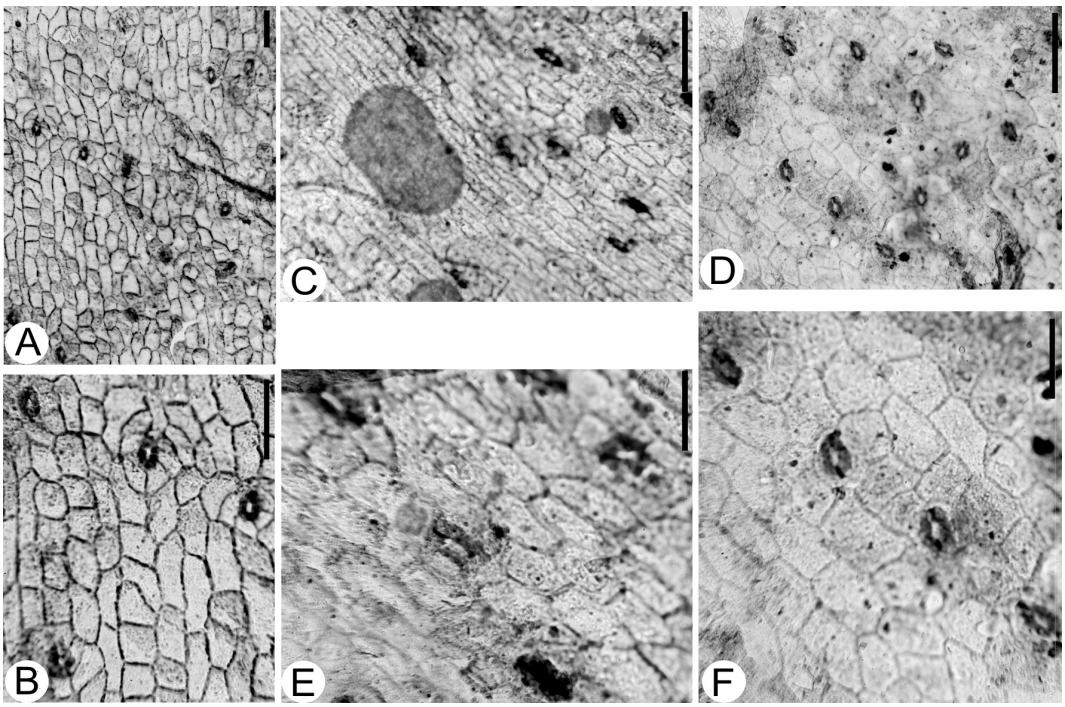

Figure 7. *Cuticulae dispersae* of *Nilssonia* sp. (scale bar 50 μm).

Genus *Beania* Carruthers include megastrobilus probably belong to the same plant which made microstrobilus from genus *Androstrobus* Schimper. Megastrobilus consist of axis with megasporophylls set in quite long distances. Megasporophylls have a thin pedicel and wide upper part with two orthotropous seeds. Specimens from Lipie Śląskie are similar to specimens of *Beania* Carruthers from Lower Jurassic of Iran and Middle Jurassic of Yorkshire, England (Harris 1964, Schweitzer *et al*. 2000).

Coniferales

The largest part of investigated plant assemblage consist of conifer remains. The fossil material includes fragments of rarely branched shoots (Fig. 8, 9), single leaves, cone-like speciments and cuticles. Some of them were identified as representatives of an extinct family Cheirolepidiaceae known from the latest Triassic to Cretaceus. These remeins probably belongs to *Pagiophyllum* sp. and *Brachyphyllum* sp. (Fig. 10). Some of the Cheirolepidiaceae some were evergreen trees several meters high or low-growing trees and others have been interpreted as shrubs or small herbs (Alvin 1982). Common for all genera of the group is the type of pollen grain—*Classopollis* (Taylor *et al.* 2009) identified in Lipie Śląskie sediments by Staneczko (2007b). The cuticle is very thick, stomata are sunken with protecting

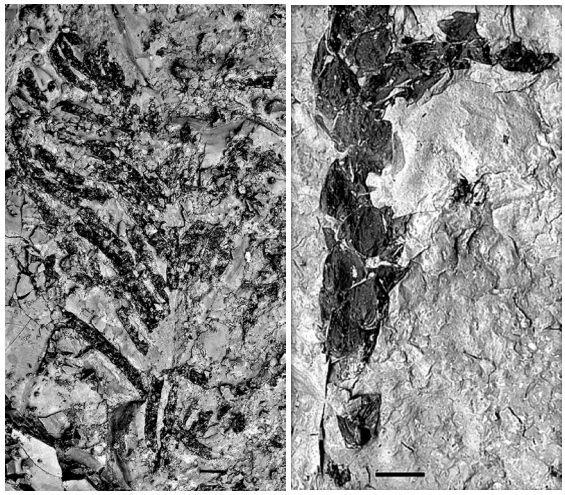

Figure 8 & 9. Shoots of Cheirolepidiaceae (scale bar 10 mm).

ring of papillae (Fig. 11, 12). These features could suggest that Cheirolepidiaceae were xenomorphic plants (Alvin 1982).

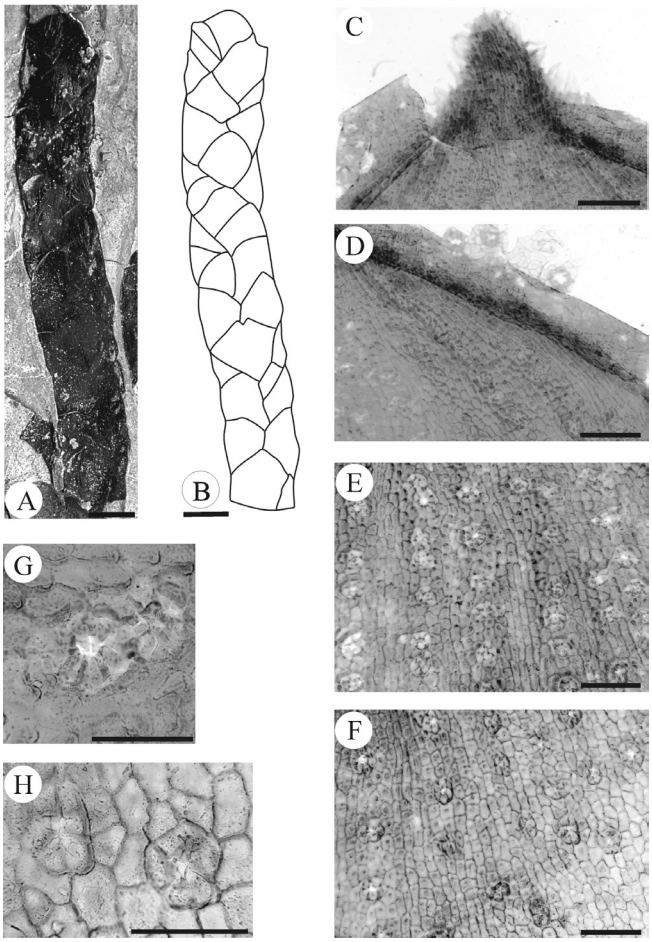

Figure 10. Cuticle macerated from *Brachyphyllum* sp. shoot (scale bar: cuticle 50 µm, shoot 0.5 cm).

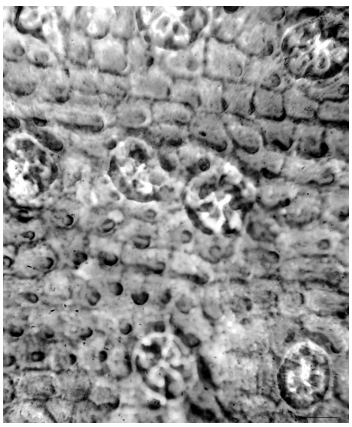

Figure 11. Cuticles of Cheirolepidiaceae (scale bar 50 µm).

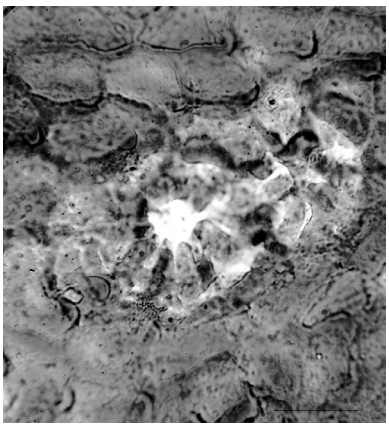

Figure 12. Cuticles of Cheirolepidiaceae (scale bar 50 µm).

Conclusion

Assuming the plants and animals represented by the fossil record of Lipie Śląskie belonged to the same biocoenosis dicynodonts and other plant-eaters could choose from forages from Pteridospermophyta, Ginkgoales and Coniferales (Cheirolepidiaceae). Although it is commonly believed that all non-angiosperm forages are of exceptionally low nutritional quality there are hypothesis that herbivorous dinosaurs preferred soft-tissued plants such as ferns, ginkgoes and the Cheirolepidiaceae (Hummel *et al*. 2008). It is possible that dicynodonts could also have similar preferations. An amount of remains indicate that on an investigated area lived more than one dicynodonts. According to this we can suppose that Lipie Śląskie in Late Triassic was a green area with productivity high enough to feed at least small herd of those large animals.

The material is still is under study, therefore the results presented above are preliminary. Further investigations should provide new data about the Late Triassic local flora of Lipie Śląskie and indirectly about environment and climate of that period.

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