ISSN 0031-0301, Paleontological Journal, 2006, Vol. 40, No. 3, pp. 286–289. © Pleiades Publishing, Inc., 2006.
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Margin Feeding Damage on the Leaves of Conifers and Ginkgoales from the Mesozoic of Transbaikalia

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Received May 11, 2005

Abstract—A new approach to the formal classification of arthropod margin feeding plant damage is proposed. Several types of margin feeding traces on the leaves of *Pityophyllum* sp. and *Ginkgoites* sp. from the Upper Jurassic–Lower Cretaceous Chernovskie Kopi locality, Transbaikalia, are described as five new species in the genus *Pinovulnus* gen. nov.

DOI: 10.1134/S0031030106030087

Key words: margin feeding damage, conifers leaves, Ginkgoales, Mesozoic, Transbaikalia.

INTRODUCTION

The earliest traces of arthropod feeding on plants are known from the Silurian and Lower Devonian (Labandeira, 1998, 2002; Scott et al., 2004). Reliable traces of feeding on live plant tissues appear in the fossil record since the Carboniferous, and are numerous though rather uniform until the Triassic. In the Upper Cretaceous, with the appearance of angiosperms in the fossil record, the number of damage types increased, reaching about forty well differentiated types by the beginning of the Cenozoic (Labandeira et al., 2002). Such diversity dynamics is characteristic of feeding traces in general, whereas the margin feeding traces remained rather uniform throughout their geological history, and their few morphotypes were determined, on the one hand, by differences in the host plant leaf structure (i.e., the composition of flora), and on the other hand, by aspects of herbivore behavior.

As for stratigraphic distribution of mechanically damaged (chewed) leaves, these feeding traces are exceptionally rare in the Mesozoic (prior to the advent of angiosperms), even compared to such specific formations as galls. For example, in the Chernovskie Kopi locality (Transbaikalia, Upper Jurassic–Lower Cretaceous) marginally chewed leaves constitute no more than one per cent of the leaves with other types of damage (galls, oviposition scars). In rare occasions the fossilized gut contents of Upper Jurassic insects from southern Kazakhstan yielded leaf fragments of morphological genera *Brachyphyllum* or *Pagiophyllum* (Krassilov, 1997; Rasnitsyn and Krassilov, 2000). The low herbivory level in the Mesozoic can probably be attributed to the xeromorphic structure of Mesozoic plants, with a large volume of skeletal and protective elements of low nutritional value (Ponomarenko, 1998).

CLASSIFICATION OF MARGIN FEEDING TRACES

During the history of fossil plant damage studies there were several attempts to classify them. Often, due to insufficient material, such efforts were restricted to giving a binomial name to a certain damage type and its description. The most successful and complete classification is the morphotopological one proposed for angiosperm leaf damage types: three basic categories (hole feeding, margin feeding, and skeletonization), subdivided according to their morphology into some

Explanation of Plate 8

Figs. 1–3. *Pinovulnus regularis* Vasilenko, sp. nov.: (1) holotype PIN, no. 4626/477, ×20, (2) specimen PIN, no. 4626/481, ×15, and (3) specimen PIN, no. 4626/482, ×20. Solitary marginal notches on leaves of *Pityophyllum* sp.

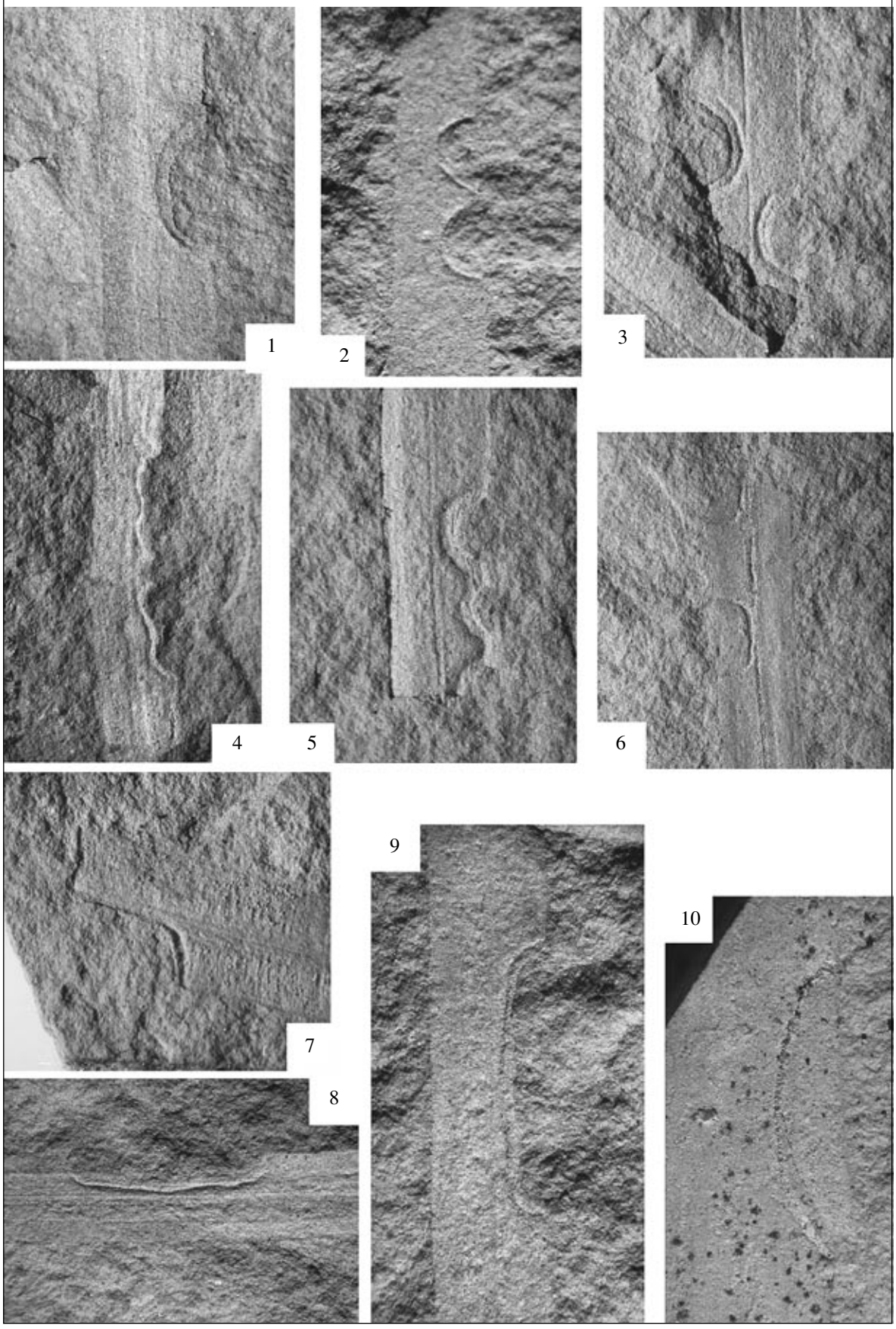
Figs. 4 and 5. *Pinovulnus serpentiformis* Vasilenko, sp. nov.: (4) holotype PIN, no. 4626/478, ×15, (5) specimen PIN, no. 4626/479, ×20. Sinusoidal notches on leaves of *Pityophyllum* sp.

Figs. 6 and 7. *Pinovulnus erectus* Vasilenko, sp. nov.: (6) holotype PIN, no. 4626/480, ×15, (7) specimen PIN, no. 4626/483, ×20. Subrectangular notches with rounded corners on leaves of *Pityophyllum* sp.

Figs. 8 and 9. *Pinovulnus procerus* Vasilenko, sp. nov.: (8) specimen PIN, no. 4626/484, ×15, (9) holotype PIN, no. 4626/486, ×20. Elongate notches on leaves of *Pityophyllum* sp.

Fig. 10. *Pinovulnus rotundus* Vasilenko, sp. nov., holotype PIN, no. 4626/485, ×15. Geometrically regular rounded notches on leaves of *Ginkgoites* sp.

Plate 8



40 numbered damage types (DT1, DT2, etc.; Labandeira, 2002; Labandeira et al., 2002).

The Latin binomial name was first applied to margin feeding traces by Fritch (1901; cit. after Vialov, 1975), who attributed semicircular incisions on the Cretaceous (Cenomanian) leaves to ants of the genus *Atta* and named these traces *Atta praecursor*. The first generic (and species) name for margin feeding traces, *Phagophytichnus ekowskii*, was created for chewing marks on Carboniferous ferns *Neuropteris* (Amerom, 1966). Later several kinds of angiosperm leaf damage from the Pliocene of Germany were ascribed to the same genus as other species (Straus, 1977; Givulescu, 1981).

These formal taxa proposed by Amerom and Straus are too few to reflect changes in the vegetation and the fauna of arthropod herbivores. Further usage of this oversimplified classification based exclusively on the shape, size, position and other superficial characters hinders the comprehensive study of margin feeding traces on various plants of different ages. Therefore, based on the general classification of plant damage types (Vialov, 1975; Zherikhin, 2003; Vasilenko, 2005) and taking into account classification used by Labandeira, we propose the following modification in the formal system of mechanical damage (chewing marks) on plant leaves.

Family Phagophytichnidae Vialov, 1975—herbivory traces on plant leaves (mechanical damage not causing neoplasms); currently two formal genera:

> Genus *Phagophytichnus* Amerom, 1966—margin feeding traces on fern leaves and pinnate leaves of Peltaspermales (pteridosperms).
>
> Genus *Pinovulnus* gen. nov.—margin feeding traces on leaves of Pinales (conifers) and Ginkgoales.

New formal species of margin feeding traces on the leaves of conifers and Ginkgoales are described below from the locality of Chernovskie Kopi, Transbaikalia (Chita Region, Chita district; Upper Jurassic–Lower Cretaceous, Doroninskoe Formation, Chernovskaya transitional sequence). Other leaf damage types from this locality (galls, oviposition traces) were described earlier (Vasilenko, 2005). The type material is housed in the collection of the Paleontological Institute (PIN), Russian Academy of Sciences.

SYSTEMATIC PALEONTOLOGY

Family Phagophytichnidae Vialov, 1975

Genus *Pinovulnus* Vasilenko, gen. nov.

Etymology. From Pinophyta and the Latin *vulnus* (wound).

Type species. *P. regularis* sp. nov.

Diagnosis. Margin feeding damage on leaves of Pinales and Ginkgoales. Damaged area bordered with thickened or more dense plant tissue.

Composition. Type species and four others from the Late Mesozoic of Transbaikalia.

Comparison. Distinct from the genus *Phagophytichnus* Amerom, 1966 in the type of damaged leaf blade (feeding traces *Phagophytichnus* are found on the fern and peltasperm leaves).

Pinovulnus regularis Vasilenko, sp. nov.

Plate 8, figs. 1–3

Etymology. From the Latin *regularis* (regular).

Holotype. PIN, no. 4626/477, margin feeding trace on leaf of *Pityophyllum* sp. (Pl. 8, fig. 1); locality of Chernovskie Kopi; Chernovskaya transitional sequence.

Description. Solitary semicircular notches on leaves. Reaction tissue well developed as broad flange. Sometimes several notches situated side by side, but not interconnected.

Comparison. Distinct from its congeners in the size and notch geometry.

Measurements, mm. Notch length, 1.5–2; depth, 0.5–0.8.

Remarks. On leaves of *Pityophyllum* sp. the notch radius is limited by the midrib.

Material. Besides the holotype, specimens PIN, nos. 4626/481 and 4626/482 from same locality.

Pinovulnus serpentiformis Vasilenko, sp. nov.

Plate 8, figs. 4 and 5

Etymology. Latin *serpentiformis* (snake-like).

Holotype. PIN, no. 4626/478, margin feeding trace on leaf of *Pityophyllum* sp. (Pl. 8, fig. 4); locality of Chernovskie Kopi; Chernovskaya transitional sequence.

Description. Wavy shaped, often nearly regular sinusoidal notches of inconstant amplitude.

Comparison. Distinct from its congeners in the wavy notch shape.

Measurements, mm. Total length of structure, up to 5; depth, up to 0.7–0.9.

Material. Besides the holotype, specimen PIN, no. 4626/479 from same locality.

Pinovulnus erectus Vasilenko, sp. nov.

Plate 8, figs. 6 and 7

Etymology. Latin *erectus* (straight).

Holotype. PIN, no. 4626/480, margin feeding trace on leaf of *Pityophyllum* sp. (Pl. 8, fig. 6); locality of Chernovskie Kopi; Chernovskaya transitional sequence.

Description. Subrectangular notches with rounded corners.

Comparison. Distinct from its congeners in the characteristic subrectangular notch shape.

Measurements, mm. Notch length, 1.5; depth, 0.8.

Remarks. On leaves of *Pityophyllum* sp. the notch depth is limited by the midrib. In some specimens, including the holotype, the cut portion is preserved in situ.

Material. Besides the holotype, specimen PIN, no. 4626/483 from same locality.

***Pinovulnus procerus* Vasilenko, sp. nov.**

Plate 8, figs. 8 and 9

Etymology. Latin *procerus* (long).

Holotype. PIN, no. 4626/486, margin feeding trace on leaf of *Pityophyllum* sp. (Pl. 8, fig. 9); locality of Chernovskie Kopi; Chernovskaya transitional sequence.

Description. Elongate notches of geometrically irregular shape, with entire to feebly waved margins.

Comparison. Distinct from its congeners in the geometrically irregular notch shape.

Measurements, mm. Notch length, up to 5; depth, 0.5–1.

Material. Besides the holotype, specimen PIN, no. 4626/484 from the same locality.

***Pinovulnus rotundus* Vasilenko, sp. nov.**

Plate 8, fig. 10

Etymology. Latin *rotundus* (round).

Holotype. PIN, no. 4626/485, margin feeding trace on leaf of *Ginkgoites* sp. (Pl. 8, fig. 10); locality of Chernovskie Kopi; Chernovskaya transitional sequence.

Description. The notches are rounded, geometrically regular in shape, with entire margins. The reaction of the tissue is indistinct.

Comparison. Distinct from *Pinovulnus regularis* sp. nov. in the larger size; from other congeners, in the notch shape.

Measurements, mm. Notch length, 5; maximal depth, 1.1.

Remarks. In the holotype the cut portion is slightly displaced.

Material. Holotype.

ACKNOWLEDGMENTS

The author is grateful to A.G. Ponomarenko, A.P. Rasnitsyn, D.E. Shcherbakov, and M.B. Mostovski (PIN) for valuable advice and consultations, and to the staff of the Laboratory of Arthropods (PIN) for providing technical support and favorable research atmosphere.

The study is supported by the Presidium of the Russian Academy of Sciences, program 25 "Biosphere: Origin and Evolution."

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