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New chondrichthyan teeth from the Early Carboniferous of Britain and Russia

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ABSTRACT:

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Ginteria fungiforma gen. et sp. nov. is described on the basis of isolated teeth from the Viséan (Brigantian) of the Matlock Limestone Formation of Derbyshire, England and the Late Viséan (Msta Formation) of the Novgorod District, and the Early Serpukhovian (Steshev Formation) of the Moscow District in Russia. The teeth are very small (0.54 mm maximum tooth height) with a deeply incised, pedestal-like crown/base junction separating the orthodont, enameloid-covered, unornamented crown from a base of overall anachronistid design. A lingually-offset occlusal crest lacks cusps and divides the crown into a short lingual section and a triangular labial section with a slightly concave surface, expanded to form a pronounced labial flange.

Key words: Viséan-Serpukhovian, Carboniferous, Anachronistidae, *Ginteria* gen.nov., England, Russia.

INTRODUCTION

The record of Carboniferous chondrichthyans is known on the basis of some occasionally well preserved, articulated and whole-bodied material from localities such as Bearsden in Scotland, and Mazon Creek and Bear Gulch, both in the U.S.A. (ZANGERL 1981). Macroscopic isolated teeth and fin spines have a long publication history beginning with AGASSIZ (1833-1843). Whilst new material has occasionally come to light (e.g. NEWBERRY & WORTHEN 1866, 1870) more recent studies have tended to concentrate on the necessary task of taxonomic revision (e.g. DUFFIN & GINTER 2006). Sampling of Carboniferous rocks for vertebrate microfossils is in its infancy, but such techniques are being increasingly applied to the Mesozoic with encouraging results for biostratigraphy (JOHNS, BARNES & ORCHARD 1997) and palaeoecology (UNDERWOOD 2004). GINTER & IVANOV (1995) have already had some success in this area with Devonian phoebodonts.

The purpose of the present paper is to describe a new shark genus obtained from English and Russian Carboniferous samples.

MATERIAL AND METHODS

British material

The British material forms part of a series of samples originally made for conodont analysis by the Micropalaeontology Unit at Leicester University and taken from the succession at the western

Fig. 1. Location map for Cawdor Quarry (disused) at Matlock, Derbyshire, England

end of Cawdor quarry on the West bank of the River Derwent as it runs through Matlock, Derbyshire (Text-fig. 1). This quarry, circa SK 286604, is now disused and exposes the Matlock Limestone Formation (formerly called the Upper Lathkill Limestones (D2) and the succeeding highly fossiliferous Cawdor Limestone Formation (P2) (SHIRLEY 1959, 1967; FROST & SMART 1979). These rocks belong to the mid-Brigantian 'shelf' facies (*L. mononodosa* Biozone) of the Late Viséan of the Derbyshire Dome. The sample comes from a 1.5 m thick mid-grey micrite overlying a thin dark shale some 12 m above the base of the section. Additional microvertebrates in the sample include as yet unidentified palaeoniscid teeth and scales, together with placoid and ctenacanthoid chondrichthyan scales. Further samples from elsewhere in the succession have yielded the teeth of protacrodontids, *Thrinacodus*, xenacanthids, and ?helodontids together with acanthodian scales. A full description of the fauna is in preparation.

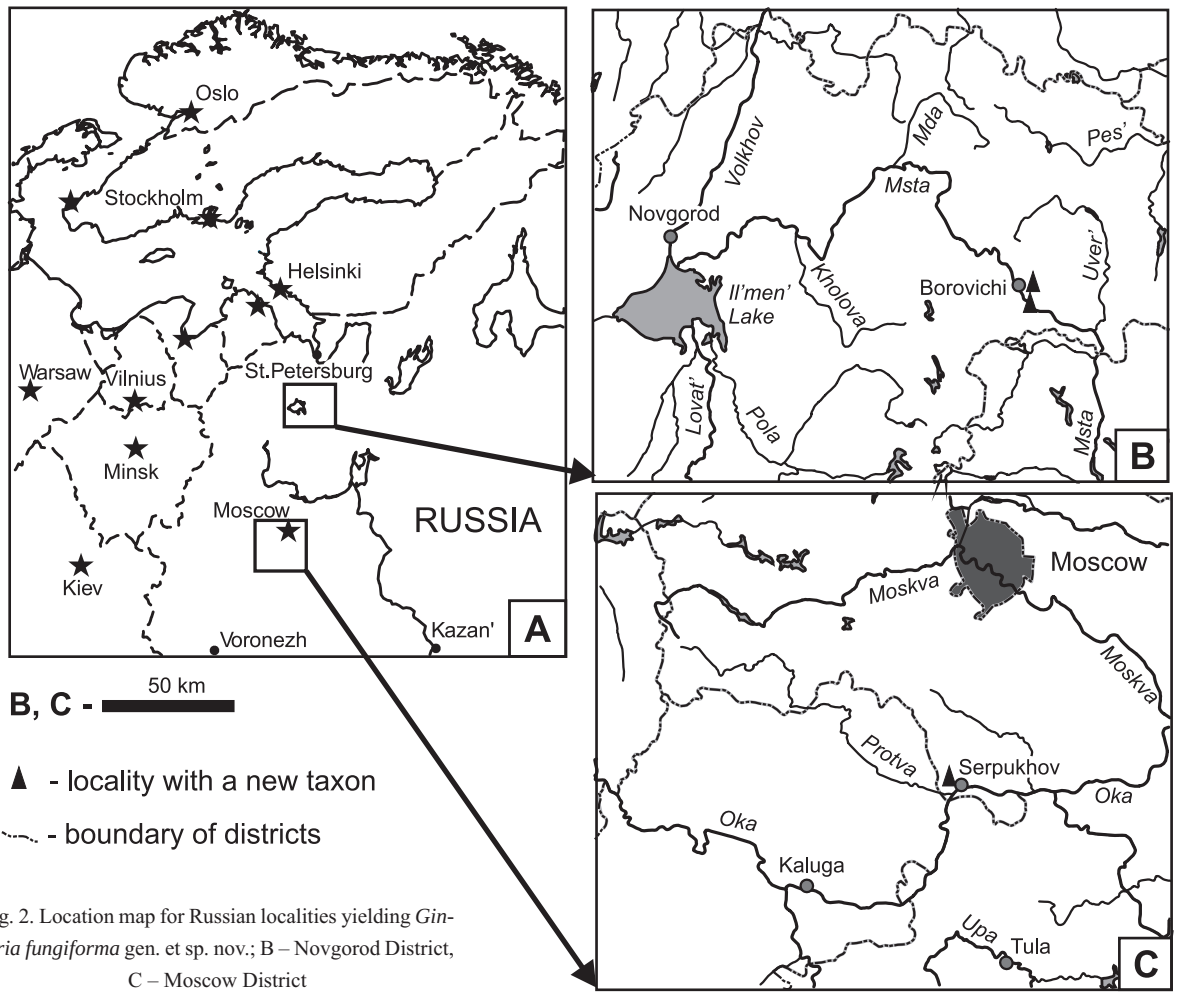


Fig. 2. Location map for Russian localities yielding *Ginteria fungiforma* gen. et sp. nov.; B – Novgorod District, C – Moscow District

Russian material

The material from Russia was obtained from acid-processed samples collected for microfossils (mainly conodonts and ostracods) from two regions in the European part of Russia (East European Platform; Text-fig. 2A). The localities of the first region comprise the outcrops on the right bank of the Msta River, between the villages of Putlino and Shibotovo, as well as its tributary (Kamenka River) in the Borovichi area of Novgorod District (Oblast), on the north-western slope of the Moscow Syneclise (Text-fig. 2B). Teeth of *Ginteria* have been found in the grey clay underlying an A_2 limestone in the upper part of Msta Formation. These sediments belong to the *Mestognathus bipluti* conodont zone of the Aleksino Regional Stage (Late Viséan), and contain the remains of various invertebrate and some vertebrate fossils such as teeth of the chondrichthyans *Thrinacodus, Denaea, Cooleyella, "Lissodus"*, orodontids, together with chondrichthyan and acanthodian scales, and palaeoniscid teeth and scales (SAVITSKIY & *al*. 2000).

The locality in the second region is Kalinovskie Vyselki quarry in the Serpukhov area of the Moscow District (Text-fig. 2C). An abundant and taxonomically diverse vertebrate fauna consisting of chondrichthyans (including the material described here), acanthodians and osteichthyans were recovered from the grey siltstones of the Steshev Formation (Early Serpukhovian, Steshov Regional Stage, *Lochriea ziegleri* conodont zone).

The specimens from Russia are housed in the Palaeontological Museum of St. Petersburg University (PM SPU), and the English specimen is housed in the Natural History Museum, London (NHM).

SYSTEMATIC PALAEONTOLOGY

Class Chondrichthyes HUXLEY, 1880
Subclass Elasmobranchii BONAPARTE, 1838
Cohort Neoselachii COMPAGNO, 1977
Order *incertae sedis*
Family Anachronistidae DUFFIN & WARD, 1983

Genus *Ginteria* gen. nov.

TYPE SPECIES: *Ginteria fungiforma* sp. nov.

ETYMOLOGY: named in honour of Professor MICHAŁ GINTER (Warsaw University, Poland) in recognition of his work on Palaeozoic chondrichthyans.

DIAGNOSIS: Chondrichthyans whose teeth possess a base of anachronistid design with a deeply incised, pedestal-like crown/base junction; up to four vascular canals open lingually on the base and unite inside the tooth, ascending to the crown; there is no labial foramen on the base; no central cusp or lateral cusplets present; occlusal crest is lingually offset with a central dip; labial face of the crown concave and unornamented; strong labial flange present; teeth orthodont.

Ginteria fungiforma sp. nov.
(Text-figs 4A-L, 5A-C, 6A-D)

2000. Neoselachii gen. nov.; SAVITSKIY, IVANOV & ORLOV, pl. 10, figs 3, 4.

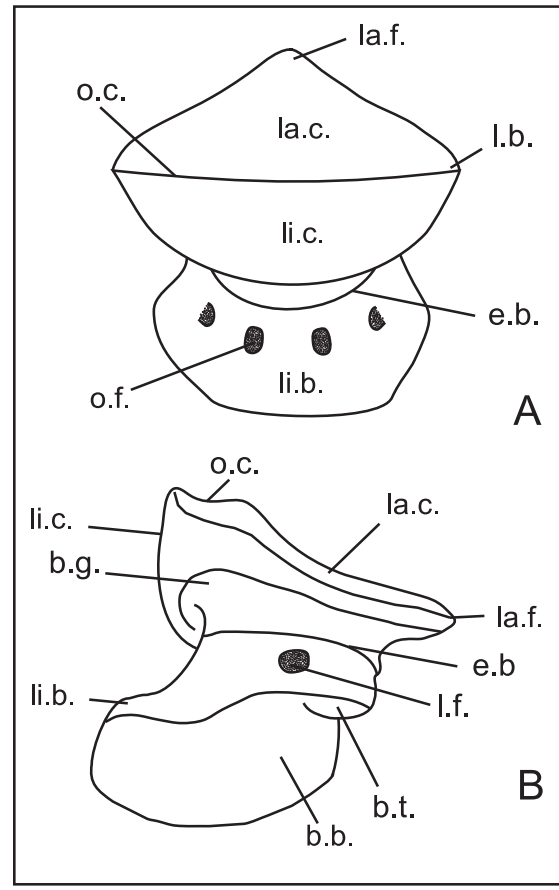


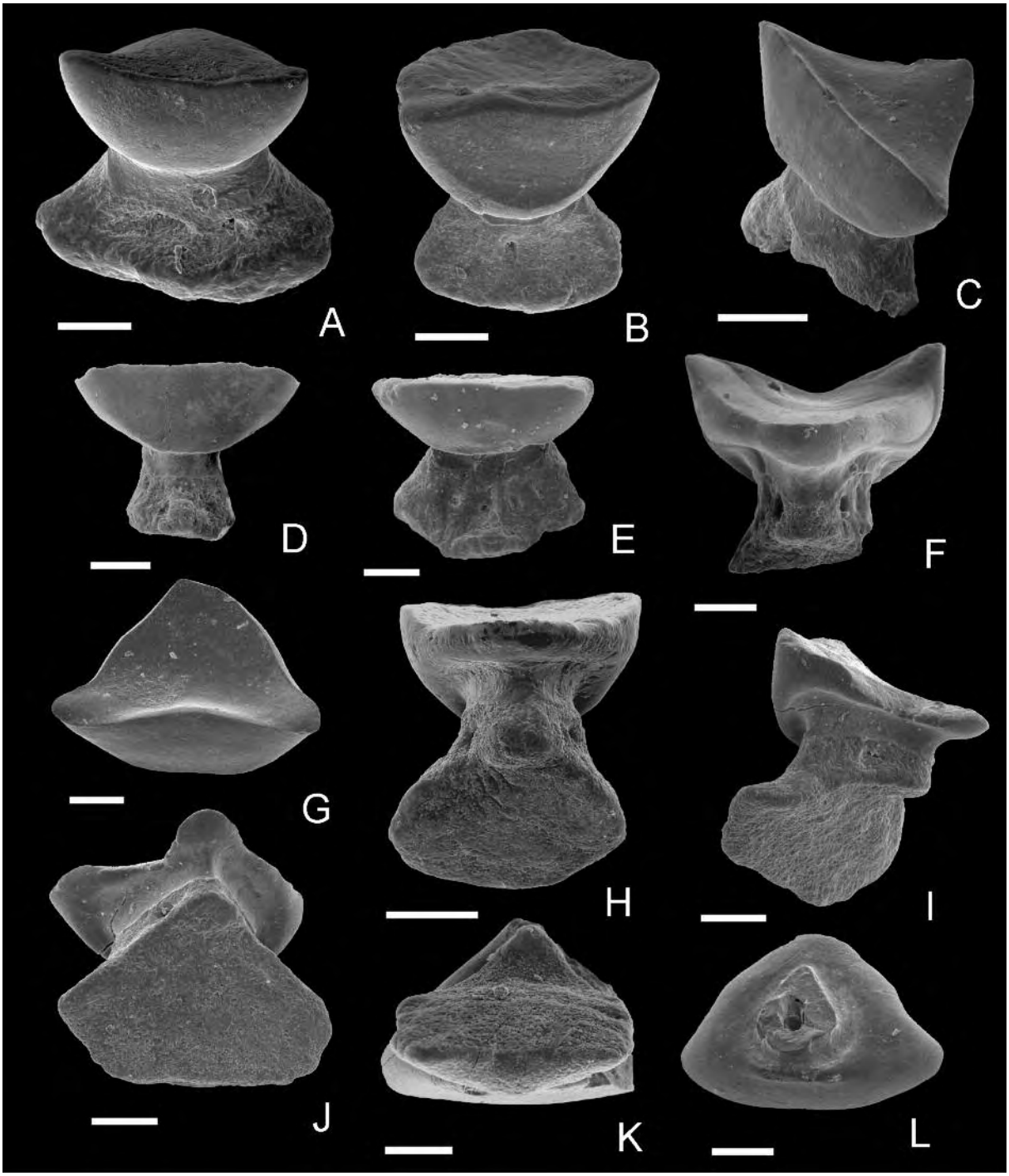
Fig. 3. Descriptive terminology of *Ginteria* teeth in A – lingual-occlusal and B – lateral views. Abbreviations: b.b. – basal face of the base; b.g. – basal groove of the crown; b.t. – basal tubercle; e.b. – enameloid border (crown/base border); l.b. – lateral blade of the crown; l.f. – lateral foramen; la.c. – labial face of the crown; la.f. – labial flange of the crown; li.b. – lingual face of the base; li.c. – lingual face of the crown; o.c. – occlusal crest; o.f. – occlusal foramen

ETYMOLOGY: Latin *fungiforma* = mushroom like.

HOLOTYPE: Isolated tooth, PM SPU 44-8 (Text-fig. 4H), from Kalinovskie Vyselki Quarry, Borovichi area, Moscow District, Russia; Early Carboniferous, Early Serpukhovian, Steshov Regional Stage, *Lochriea ziegleri* conodont zone, Steshev Formation.

DIAGNOSIS: As for genus.

MATERIAL: 1 isolated tooth from the Matlock Limestone Formation (D2), Brigantian, Late Viséan of Cawdor Quarry, Derbyshire, England (NHM P. 66676; Text-figs 5A-C) ; 16 teeth (PM SPU 44-1 – 44-16; Figs 4A-L) from the Steshev Formation, Early Serpukhovian of Kalinovskie Vyselki Quarry, Moscow District,



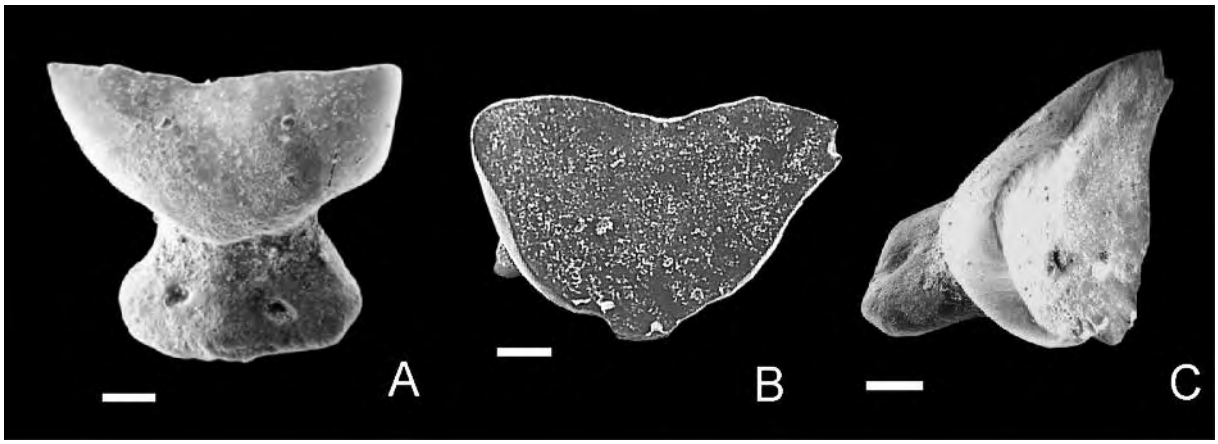


Fig. 5. Teeth of *Ginteria fungiforma* gen. et sp. nov. from the Matlock Limestone (D2, Brigantian, Late Viséan) of Cawdor Quarry, Matlock, Derbyshire, England; NHM P.66676 in A – lingual view, B – occlusal view, C – oblique lateral view. Scale bar equals 100 μm

Russia; four teeth (PM SPU 44-1 – 44-16) from the Msta Formation, Late Viséan of Msta and Kamenka rivers, Novgorod District, Russia.

DESCRIPTION: A guide to the descriptive terminology used here is given in Text-fig. 3. The teeth are very small, ranging from only 0.25 to 0.66 mm mesiodistally and from 0.32 to 0.54 mm high. The crown is strongly demarcated from the base by a very narrow, pedestal or neck-like, deeply incised crown/base junction, and forms 50% of the total tooth height. The occlusal crest (o.c. in Text-fig. 3) divides the crown into two sections – an almost vertical lingual face (li.c.) and a shallow-sloping, considerably extended labial face (la.c.). The labial face is triangular in outline (frequently an equilateral triangle), slightly concave and lacks any ornamentation. The lingual face is semicircular, convex and also lacks ornament. The occlusal crest is a lingually placed, transverse ridge formed at the junction of the labial and lingual faces of the crown, but lacks cusps. The cutting edge is straight or slightly sinuous with a shallow central dip giving way to two lateral blades (l.b.), before swinging laterally around the mesial and distal margins of the tooth. Then, rather reduced, it travels along the labial margin of the crown, and bears traces of ante-mortem abrasion in some teeth. The labial face extends well beyond the crown/base junction, forming a pronounced overhanging apron or flange (la.f.). The underside of the flange is convex. The basal face of the crown bears a groove (b.g.) surrounding the narrow lower part of the crown.

The crown/base junction is deeply incised around the whole tooth and somewhat pedestal-like. The basal limit of the enameloid layer (e.b.) accentuates the crown/base junction in the middle of the pedestal. The base forms half the total height of the tooth and is located directly beneath the crown, from which it is only very slightly angled lingually. The lingual part of the base (li.b.) is extended, oval, concave and perforated by between two and four prominent foraminae (o.f.). The labial part of the base is short, and possesses a compact basal tubercle (b.t.) located directly beneath the labial flange of the crown. Two lateral foramina (l.f.) open before the basal tubercle, near the crown/base junction. The undersurface of the base (b.b.) is convex, and is separated from the basal tubercle by a small depression. The mesiodistal size of the base varies and can be either greater or smaller than the width of the crown (compare Text-figs 4A and 4D, for example).

The crown is composed of orthodentine with branched dentine tubules (metadentine; Text-figs 6A-D), and is covered by a layer of enameloid. The vascular canals enter the base, joining to form a single large canal in the narrow part of the tooth (Text-fig. 6B).

The teeth of *Ginteria* show considerable variation in relative proportions of the crown and base, the

Fig. 4. Teeth of *Ginteria fungiforma* gen. et sp. nov. from Kalinovskie Vyselki Quarry, Moscow District, Russia; Early Serpukhovian, Steshev Formation. Scale bars equal 100 μm. A – PM SPU 44-1 in lingual-occlusal view. B – PM SPU 44-2 in lingual-occlusal view, C – PM SPU 44-3 in oblique occlusal view, D – PM SPU 44-4 in lingual view, E – PM SPU 44-5 in lingual view, F – PM SPU 44-6 in labial view, G – PM SPU 44-7 in occlusal view, H – PM SPU 44-8, the HOLOTYPE, in labial-basal view, I, J – PM SPU 44-9 in I – lateral and J – oblique basal views, K – PM SPU 44-10 in basal view, L – PM SPU 44-11 in basal view (with broken base)

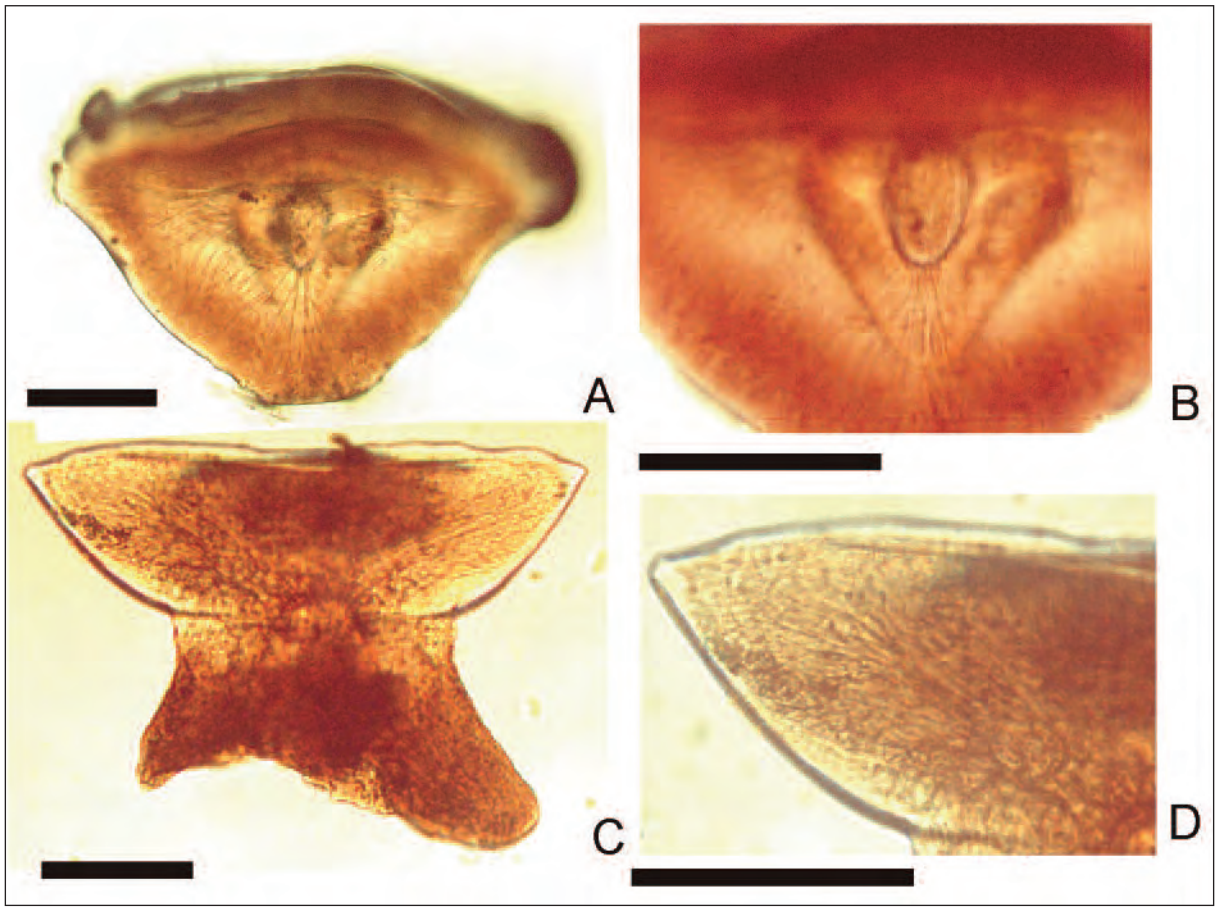


Fig. 6. Tooth histology in *Ginteria fungiforma* gen. et sp. nov. immersed in aniseed oil. A, B - PM SPU 44-12, "occlusal" view, focusing on the lower part of the crown. C, D - PM SPU 44-11, "lingual" view, focusing on the plane of the occlusal crest. Scale bars equal 100 μm

height of lingual surface of the crown, the size of the lingual part of the base, and in the trajectory of the occlusal crest (Text-figs 4A-L). These variations probably relate to the positions of the teeth in the jaw as well as tooth development during ontogeny, although too few teeth are currently known to adequately distinguish between these two types of heterodonty.

STRATIGRAPHIC RANGE: Late Viséan (Brigantian) of England; Late Viséan - Early Serpukhovian of Moscow Syneclise, Russia; as well Late Viséan of Belgium (IVANOV & DERYCKE 2005).

REMARKS: SAVITSKIY & *al*. (2000) illustrated teeth of *Ginteria* (but did not describe them) as Neoselachii gen. nov. IVANOV & DERYCKE (2005) also mentioned teeth of this genus from the Late Viséan of Royseux, Belgium and suggested it belongs to a new genus within the Anachronistidae. The architecture of the base in teeth of *Ginteria* conforms in several major features to that of *Cooleyella,* which is known from *C. fordi* (DUFFIN & WARD 1983) from the Viséan (Asbian to Brigantian) of Derbyshire, England, *C. amazonensis* DUFFIN, RICHTER & NEIS, 1996 from the Late Pennsylvanian of Brazil, *C. peculiaris* GUNNELL, 1933 (the type species of the genus) from the Pennsylvanian of Kansas, Missouri, USA, *C.* cf. *C. fordi* from the Late Viséan of the Moscow Syneclise, Russia (SAVITSKIY & *al*. 2000) and the Guadalupian (Wordian-Capitanian) of Texas, USA (IVANOV & *al*. 2007), *Cooleyella* spp. from the Late Viséan of the Nearpolar Urals, the Moscovian of the North Timan and the Artinskian of the South Urals, Russia (IVANOV 1999, 2000, 2005), the Late Viséan of Belgium (IVANOV & DERYCKE 2005) and the Leonardian of Nevada, USA (DUFFIN & WARD 1983).

The teeth of *Ginteria* differ from those of *Cooleyella* primarily on the basis of crown morphology and type of crown/base junction. *Ginteria* lacks the central cusp and lateral cusplets present in *Cooleyella*, and possesses no weak vertical ridge on the labial face of the crown or along its labial margin.

The occlusal crest in the two genera have completely different trajectories, and the labial face of the crown is much more concave in *Ginteria* than in *Cooleyella*. In the base, *Ginteria* possesses numerous foramina on the lingual face which unite to form a single canal rising through the base tissue to the crown. By contrast, *Cooleyella* has a single vascular canal in the base with openings both labially and lingually. The basal face of the base in *Cooleyella* has a strong depression in comparison with the flat basal face in *Ginteria*. The teeth of *Cooleyella* are much larger than those of *Ginteria*.

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