

VERTEBRATE MICROREMAINS IN THE SECTIONS OF THE ARUKÜLA REGIONAL STAGE OF ESTONIA AND COMPARISON WITH THE BURTNIEKI REGIONAL STAGE

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The biostratigraphical subdivision of the Estonian Devonian sequence is based mainly on early vertebrates (Gross, 1940, 1942; Mark & Tamme, 1964; Mark-Kurik, 2000). The Aruküla Regional Stage (for short, Stage) in Estonia corresponds to the Aruküla Formation, and is subdivided into three lithostratigraphical units: the Viljandi, Kureküla and Tarvastu beds (Kleesment, 1994). So far, these units are palaeontologically insufficiently characterized.

The main Middle Devonian biozones have been established on the basis of macroremains of psammosteids (Heterostraci) and placoderms collected from outcrops. Both the Viljandi and Kureküla beds of the Aruküla Stage contain *Pycnosteus palaeformis*, while the Kureküla Beds have yielded also *P. pauli*. *P. palaeformis* has not been found in the highest, Tarvastu Beds, and *Tartuosteus maximus* is present in the overlying Burtnieki Stage (Mark-Kurik, 2000). The remains of these taxa are rare in outcrops and very rare in drill cores.

Based on the study of vertebrate microremains, their species have been identified both in outcrops and drill cores, and biozonal schemes have been compiled. The acanthodian biozonal scheme is the most advanced (Valiukevičius, 1994, 1998), but reliable and detailed acanthodian biozones have been established only for the lower part of the Middle Devonian sequence. At higher levels, from the beginning of the Aruküla Stage, the acanthodian biozones are comparatively long-ranging, for example, the *Diplacanthus gravis* Biozone corresponds to both the Aruküla and Burtnieki stages. Microremains of other groups are as yet less studied.

Considering the micropalaeontological material from the outcrops of the Burtnieki Stage, the upper Abava Beds could be distinguished from the lower Härma Beds of the stage, as these beds have very similar lithology and mineralogy. Two new chondrichthyan taxa and one acanthodian taxon have been identified (Märss *et al.*, 2003; Kleesment *et al.*, 2003).

The examination of microremains in all three subdivisions of the Aruküla Stage has improved our knowledge on the distribution of Devonian vertebrates. The Viljandi Beds (Ar₁) were studied in the Tartu outcrop, Kureküla Beds (Ar₂) in the Kallaste and Tamme outcrops and Tarvastu Beds (Ar₃) in the Tarvastu outcrop (Table). Skeletal elements of *P. paleoformis* and *P. pauli* were common in the Aruküla Stage but not found higher in the Burtnieki Stage (Br₁, see Table). This has also been concluded from macrofossil data (Mark-Kurik, 2000). The distribution of psammosteid microremains shows some differences in comparison with their macroremains. The samples from the Aruküla Stage yielded small skeletal elements of *Pycnosteus tuberculatus* type and *Ganosteus stellatus* type. Macroremains of these forms have not been found in the Aruküla Stage (Mark-Kurik, 2000). It is possible that these taxa actually appeared earlier than shown by the macrofossil evidence. The acanthodian assemblages of the Aruküla and Burtnieki stages are similar. However, the scales of *Nostolepis gaujensis* type are very rare in the Aruküla Stage. A new taxon of Elasmobranchii (Niit *et al.* in prep.) appeared at the beginning of Burtnieki age (scales found in the Karksi locality) but was absent in all studied samples from the Aruküla Stage.

Microremains found in the Aruküla Stage need more thorough study to be used in the subdivision of the stage. At present we may state that the microremains of psammosteids as well as chondrichthyan scales are prospective in the correlation of the sections and elucidating the evolution of vertebrate fauna. to make clear

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Vertebrate taxa			Ar1 Tartu	Ar2 Kallaste	Ar2 Tamme	Ar3 Tarvastu	Br1 Karksi
	Heterostraci	✓ <i>Tartuosteus maximus</i>		+	+	+	+++
		✓ <i>Pycnosteus palaeoformis</i>	+	+	++		
		✓ <i>P. pauli</i>	+	+	+	+	
		<i>P. tuberculatus</i>	+	+		+	++++
		<i>Ganosteus stellatus</i>		++			+
		✓ <i>Psammosteus bergi</i>		+	+		+
		<i>Psammosteidae</i> gen. et sp.	+	+	++	+	++++
Placodermi			++	+++	++++	+	+++
Acanthodei		<i>Diplacanthus carinatus</i>	+	(+)	(+)	(+)	++
		<i>D. gravis</i>	+	(+)	(+)	(+)	
		<i>Diplacanthus</i> sp.					++
		<i>Ptychodictyon rimosum</i>	+	+	+	+	++
		<i>P. sulcatum</i>	+	+	+	+	+++
		<i>Cheiracanthus longicostatus</i>	+	+	+	(+)	+
		<i>Ch. brevicostatus</i>	+	+	+	(+)	++
		<i>Cheiracanthus</i> sp.					+
		<i>Cheiracanthus</i> sp. nov.					+
		<i>Nostolepis gaujensis</i> -type	(+)	+			++
		<i>Rhadinacanthus multisulcatus</i>	+		+	(+)	+
		<i>Rhadinacanthus</i> sp.	+			(+)	+
		<i>Markacanthus alius</i>	+				
		<i>Acanthoides</i> sp.	+				++
		<i>Acanthoides</i> sp. A	+		+	+	+
		<i>Acanthoides</i> sp. B	+		(+)	+	+
		<i>Acanthoides</i> sp. D	+		+	(+)	++
		<i>Acanthodei</i> gen. et sp.	++	++	++	+	++
Chondrichthyes	Elasmobranchii	<i>Elasmobranchii</i> gen. et sp. nov.					+
		<i>Elasmobranchii</i> gen. et spp.		+	+		+
Osteichthyes	Sarcopterygii	<i>Chondrichthyes?</i> gen. et sp.					++
	Actinopterygii		++		++	++	++++
		<i>Cheirolepis</i> sp.					+

Table 1. Distribution of vertebrate microremains in the Aruküla Regional Stage and basal Burtneiki Regional Stage of Estonia. The number of crosses indicates the quantity of remains. Identifications shown in brackets have been provided by J. Valiukevičius, Vilnius.

References

- Gross, W. 1940. Acanthodien und Placodermen aus *Heterostius*-Schichten Estlands und Lettlands. *Ann. Soc. Reb. Nat. Invest. Univ. Tartuensis Const.* **46**: 1-88.
- Gross, W. 1942. Die Fischfaunen des baltischen Devons und ihre biostratigraphische Bedeutung. *Korresp. Bl. Naturf. Ver. Rīga* **64**: 373-436.
- Kleesment, A. 1994. Subdivision of the Aruküla Stage on the basis of lithological and mineralogical criteria. *Eesti NSV Teaduste Akadeemia Toimetised. Keemia, Geoloogia* **43** (4): 221-233.
- Kleesment, A., Märss, T. & Niit, M. 2003. The Devonian of Estonia and the study of its vertebrate microfossils at the beginning of new century. In: Plado, J. & Puura, I. (eds.), *The Fourth World Meeting of Estonian Geologists "Estonian Geology in the Beginning of the New Century", Conference Materials and Excursion Guide*. The Geological Society of Estonia and Institute of Geology, University of Tartu. Tartu, 31-33. (In Estonian).
- Mark, E. J. & Tamme, A.-L. 1964. On the boundary of the Narva and Aruküla stages of the Estonian SSR. In: Karatajūtė-Talimaa, V. & Narbutas, V. *Voprosy Stratigrafii i Paleogeografii Devona Pribaltiki [Questions of Stratigraphy and Paleogeography of the Devonian Baltics]*. Mintis, Vilnius, 67-73. [In Russian].
- Mark-Kurik, E. 2000. The Middle Devonian fishes of the Baltic States (Estonia, Latvia) and Belarus. *Courier Forschungsinstitut Senckenberg* **223**: 309-324.
- Märss, T., Niit, M. & Kleesment, A. 2003. New findings of fish microremains in sections of the Burtneiki Regional Stage. *Ichthyolith Issues Special Publication* **7**: 42-43.

- Niit, M., Märss, T. & Kleesment, A. (in prep.). Fish microremains in the Karksi outcrop (Burtnieki Stage). To be submitted for the *Proc. Estonian Acad. Sci. Geology*.
- Valiukevičius, J. 1994. Acanthodian Zonal sequence of Early and Middle Devonian in the Baltic Basin. *Geologia* **17**: 115-125.
- Valiukevičius, J. 1998. Acanthodians and zonal stratigraphy of Lower and Middle Devonian in East Baltic and Byelorussia. *Palaeontographica A* **248**: 1-53.