Silurian and Lower Devonian anaspids (Agnatha) from Severnaya Zemlya (Russia)

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ABSTRACT
In the Severnaya Zemlya Archipelago, Silurian anaspids are represented by scales of at least six different types of sculpture, and some subtypes, called Birkeniida sp. C, Birkeniida sp. C1, Birkeniida sp. C?, Birkeniida sp. D, Birkeniida sp. F, Birkeniida sp. F?, Birkeniida sp. G., Birkeniida sp. H and Birkeniida sp. J. In addition, *Birkenia*? sp. was recognized. A new taxon was erected on the basis of the material from the Severnaya Zemlya Formation, Lower Devonian. In the specimen, the trunk squamation is rather well preserved, but the head and the caudal fin are lacking. Characteristic are very big dorsal ridge scales. The stratigraphical range of anaspids on Severnaya Zemlya is from Wenlock to Lochkov.

KEY WORDS
Agnatha,
Anaspida,
Silurian,
Lower Devonian,
Severnaya Zemlya Archipelago,
Russia,
scale sculpture,
new genus,
new species.

RÉSUMÉ
Anaspides (Agnatha) du Silurien et du Dévonien inférieur de Severnaya Zemlya (Russie).
Dans l'archipel de Severnaya Zemlya, les anaspides siluriens sont représentés par des écailles appartenant à au moins six types (avec quelques sous-types) d'ornementation différents nommés Birkeniida sp. C, Birkeniida sp. C1, Birkeniida sp. C ?, Birkeniida sp. D, Birkeniida sp. F, Birkeniida sp. F ?, Birkeniida sp. G., Birkeniida sp. H et Birkeniida sp. J. De plus, *Birkenia* ? sp. a été identifié. Un nouveau taxon a été créé à partir du matériel de la Formation Severnaya Zemlya, Dévonien inférieur. Sur le spécimen, l'écaillure du tronc est assez bien conservée mais la tête et la nageoire caudale lui font défaut. De fortes écailles faîtières dorsales sont caractéristiques de ce taxon. Stratigraphiquement, les anaspides de Severnaya Zemlya ont une extension verticale du Wenlock au Lochkovien.

MOTS CLÉS
Agnatha,
Anaspida,
Silurien,
Dévonien inférieur,
archipel de Severnaya Zemlya,
Russie,
ornementation d'écailles,
nouveau genre,
nouvelle espèce.

INTRODUCTION

Samples with vertebrate remains were collected during the expeditions to Severnaya Zemlya by A. F. Khapilin and E. N. Lenkin in 1974, B. A. Klubov and E. I. Kachanov in 1976, V. V. Menner and V. N. Talimaa in 1978, and P. Männik and E. Kurik in 1978. The samples were dissolved by V. N. Talimaa, Vilnius, and P. Männik, Tallinn, and the scales as well as the well-preserved anaspid specimen were given to the author for description. Anaspids are rather rare in the Silurian and Lower Devonian of the Severnaya Zemlya Archipelago. Their scale fragments have been found in the Samojlovich, Ust' Spokojnaya and Krasnaya Bukhta formations, Silurian; in the Matusevich, Ushakov and Spokojnaya river sections of October Revolution Island, and in the coeval strata of Komsomolets and Pioneer islands where formations are not yet established.

Data on the geology of the region, as well as detailed descriptions of the sections, can be found in Klubov *et al.* (1980), and in Matukhin & Menner (1999). Thus, they are not repeated here.

The taxonomy of anaspids is based on characteristics of the overall body form, head and middorsal ridge scales, number of branchial openings, and lateral and anal fins of articulated specimens, mainly from Scotland and Norway. They have been studied for over a century by Traquair (1898, 1899, 1905), Kiaer (1911, 1924), Stetson (1928), Berg (1940, 1955), Smith (1956, 1957), Stensiö (1958, 1964), Obruchev (1964), Ritchie (1964, 1980), and others. Besides articulated specimens, the fragments of Silurian anaspid scales have gained some attention. Their sculpture and/or microstructure, the only features preserved in the material from the acetic acid preparation residues, have been described from Baltic bedrock and boulders of the North German Lowland (Gross 1938, 1958, 1968; Märss 1986; Fredholm 1988, 1990). Only one taxon, *Saarolepis oeselensis* (Robertson, 1941), has been identified by Gross (1958). Still, Pander (1856), writing a pioneer work, described the fragments of vertebrates that can be clearly identified as anaspid ones under the names *Coccopeltus asmusi* Pander, 1856 (taf. 5, fig. 1), *Rytidolepis queenstedtii* Pander, 1856 (taf. 5, fig. 2) and *Schidiosteus mustelensis* Pander, 1856 (taf. 5, fig. 13). Later, Rohon (1893: 11-13) believed they represent invertebrate groups like worms or crustaceans, and he did not include above-cited species in his work as vertebrates. Later on, Pander's taxa have not been used by subsequent authors.

The sculpture, its variability and microstructure of scales of completely preserved Norwegian anaspids should be described, since no Silurian (Wenlock, Ludlow) taxon can be erected on the species, genus, or even the family level without knowing these characteristics. Only after that can the comparison and identification of fragmentary material, collected during more than half a century from different parts of the northern hemisphere (Severnaya Zemlya, Canadian Arctic, Britain, Baltic), be realized. For such research the articulated exoskeleton of a specimen must be dissolved to reveal the sculpture which nearly always remains in the rock, and latex-casts made from the sculpture moulds. The sculpture of fragmentary material can be compared with that of latex-casts, and proper generic and species names given. Until then, following Märss (1986) and Fredholm (1988, 1990), it seems reasonable to establish on Severnaya Zemlya new forms in open nomenclature: Birkeniida sp. C1, Birkeniida sp. F, Birkeniida sp. G, Birkeniida sp. H, and Birkeniida sp. J. Three forms, Birkeniida sp. C, Birkeniida sp. C? and Birkeniida sp. D, are known from two regions – Severnaya Zemlya and the Baltic (see Märss 1986). Birkeniida sp. A, Birkeniida sp. B and Birkeniida sp. E, described from the Baltic (Märss 1986), were not found on Severnaya Zemlya. *Birkenia*? sp. and *Vilkitskilepis valentinae* n. gen., n. sp. are identified and described in the present paper.

BIOSTRATIGRAPHICAL REMARKS

About 20 samples from the upper Wenlock to Přidoli interval contained fragments of anaspid

SYSTEM	SERIES	FORMATION	SAMPLES	*Birkenia*? sp.	Birkeniida sp. C	Birkeniida sp. F	Birkeniida sp. F?	Birkeniida sp. G	Birkeniida sp. C1	Birkeniida sp. C?	Birkeniida sp. D	Birkeniida sp. H	Birkeniida sp. J	*Vikitskilepis valentinae* n. gen., n. sp.
DEV.	Loch.	Severnaya Zemlya	67-12											+
SILURIAN	Př.	Krasnaya Bukhta	MF 157-2										+	
	Ludlow	Ust' Spokojnaya u.	MF 157-3 2055zh										+	
		m.	2-3 2803; 20568										+	
			2-12; 2-14	+		+	+				+			
		l.	30; 30-1; 47-14	+	+	+	+		+	+	+	+		
			2-21; MF 157-4 5m											
	W.	Samojlovich	31-208 8g-1; 8g	+	+		+	+						
	Ll.		MF 46-23 5d	+	+	+	+							

FIG. 1. — Distribution of the anaspids in the sections of the Severnaya Zemlya Archipelago. Sample numbers from October Revolution Island on the left side, sample numbers from Pioneer and Komsomolets islands on the right. Abbreviations: **Dev.**, Devonian; **Ll.**, Llandovery; **Loch.**, Lochkov; **Př.**, Přidoli; **W.**, Wenlock.

scales, and a limestone nodule from the lower Lochkov, Lower Devonian, yielded a trunk squamation. Three main anaspid assemblages can be recognized in the Silurian sequence (Fig. 1). The first assemblage characterizes the Samojlovich Formation, Wenlock, on October Revolution Island (samples 31-208 and MF 46-23) and its equivalents on Pioneer Island (samples 5d, 8g-1 and 8g). The assemblage comprises *Birkenia*? sp., Birkeniida sp. C, Birkeniida sp. F, Birkeniida sp. F? and Birkeniida sp. G. The second assemblage was established in the lower part of the Ust' Spokojnaya Formation (samples 30, 30-1, 47-14, 2-21 and MF 157-4), Ludlow, and coeval strata on Pioneer Island (sample 5m). On that level the abundance of scales and the variability of the sculpture are largest. In addition to the Wenlock forms, Birkeniida sp. C1, Birkeniida sp. C?, Birkeniida sp. D and Birkeniida sp. H appear, but Birkeniida sp. G disappears. In the middle part of the Ust' Spokojnaya Formation, middle part of Ludlow, the diversity of forms decreases markedly (samples 2-12, 2-14). In the upper part of the Ust' Spokojnaya Formation, upper Ludlow (samples 2-3 and MF 157-3 on October Revolution Island, 2055 zh and 2803 on Pioneer Island, and 20568 on Komsomolets Island) the third assemblage was identified. It does not contain any forms from the lower assemblages; a new form, Birkeniida sp. J, appears and ranges into the lower part of Přidoli (sample MF 157-2). In the Severnaya Zemlya Formation, lower Lochkov, Lower Devonian, a new anaspid, *Vilkitskilepis valentinae* n. gen., n. sp., occurs (sample 67-12).

Birkeniida sp. C, Birkeniida sp. C? and Birkeniida sp. D from the Samojlovich and Ust' Spokojnaya formations, Wenlock and Ludlow, are identical to the Baltic forms and the beds can be correlated with the Rootsiküla and Paadla stages of the East Baltic, and the Halla and Hemse beds of Gotland, Sweden (Märss 1986; Fredholm 1988, 1990). Anaspid forms from the Krasnaya Bukhta Formation, Přidoli, and higher have no similarities with the Baltic ones, and no anaspid-based correlation can be made at the present stage of study.

SYSTEMATICS

Scales with collection numbers prefixed by Pi are deposited in the palaeontological collection of the Institute of Geology, Tallinn Technical University; those prefixed by LIG 35 are kept in the Institute of Geology, Vilnius.

Subclass ANASPIDA Traquair, 1899

Order BIRKENIIDA Berg, 1940

DIAGNOSIS. — Dermal skeleton very well developed: trunk covered with 4-5 rows of high and narrow scales, head with small platelets; both scales and platelets sculptured externally; viscerally scales carry one to two powerful ribs along the longer axis; dermal skeleton from compact lamellar or spongy aspidin; dentine tubules and osteocyte-spaces absent; pores can be present in the basal aspidin; 8-15 small branchial openings arranged in slanting rows; post-branchial and pectoral plate present; dorsally a row of median dorsal ridge scales or spines; paired ventrolateral fins; well-developed anal fin; hypocercal caudal fin (emended after Kiaer 1924; Berg 1955; Gross 1958; Obruchev 1964; Ritchie 1964, 1980).

Family BIRKENIIDAE Traquair, 1899

DIAGNOSIS. — Eight branchial openings; dorsal ridge scales anteriorly large and flat, and posteriorly spiny; posterior dorsolateral scales directed from above downwards and posteriorwards and not anteriorwards; anal fin short without anteriorly bordering spine (emended after Stetson 1928; Obruchev 1964).

Genus *Birkenia* Traquair, 1898

DIAGNOSIS. — Small birkeniid up to 10 cm long; scales and platelets covered with rounded tubercles.

Birkenia? sp.
(Figs 2A-D; 4A-C)

MATERIAL AND OCCURRENCE. — About 70 broken scales; sample 31-208, Ushakov River, October Revolution Island, Samojlovich Formation; sample 5d, Pioneer Island, Wenlock; sample 47-14, Spokojnaya River; samples 30, 30-1, Ushakov River, lower part of Ust' Spokojnaya Formation, lower Ludlow, Upper Silurian.

REMARKS

Scales have rounded or just slightly elongated, triangular keel-like tubercles (Fig. 2A-C). The anterior margin of the scales is smooth or covered with low, rounded tubercles. In the basal part of broken tubercles (Fig. 2D), microscopic holes, vascular canals (= *Gefässkanal* by Gross 1958) can be seen. A longitudinal rib rises on the under side of the scales, but not on small platelets. The width of the scales is 0.7 to 0.9 mm.

Family *incertae sedis*

Birkeniida sp. C
(Figs 2E; 4D)

MATERIAL AND OCCURRENCE. — 13 fragmentary scales; samples 5d and 8g-1, Pioneer Island, Wenlock, Lower Silurian; sample MF 157-4, Spokojnaya River, October Revolution Island, lower part of Ust' Spokojnaya Formation, lower Ludlow, Upper Silurian.

REMARKS

Diagnostic of the form are long rows of flat, heart-like tubercles, tightly packed together; the anteriormost tubercles are elongated and keel-like. The posterior end of each tubercle lies on the anterior part of posterior one. The rows can fade out or appear at different distances posteriorly.

Birkeniida sp. C1
(Figs 2F, G, J; 4E, G)

MATERIAL AND OCCURRENCE. — Two fragmentary scales; sample 5m, Pioneer Island, Ludlow, Upper Silurian.

REMARKS

Characteristic are long, tightly packed rows of keel-like, spiny, flat tubercles. Anteriorly on the scales the tubercles are rounded to triangular, then becoming strongly elongated; posteriorly they are again shorter and smaller. The width of the well-preserved scales is 0.7 mm. Birkeniida

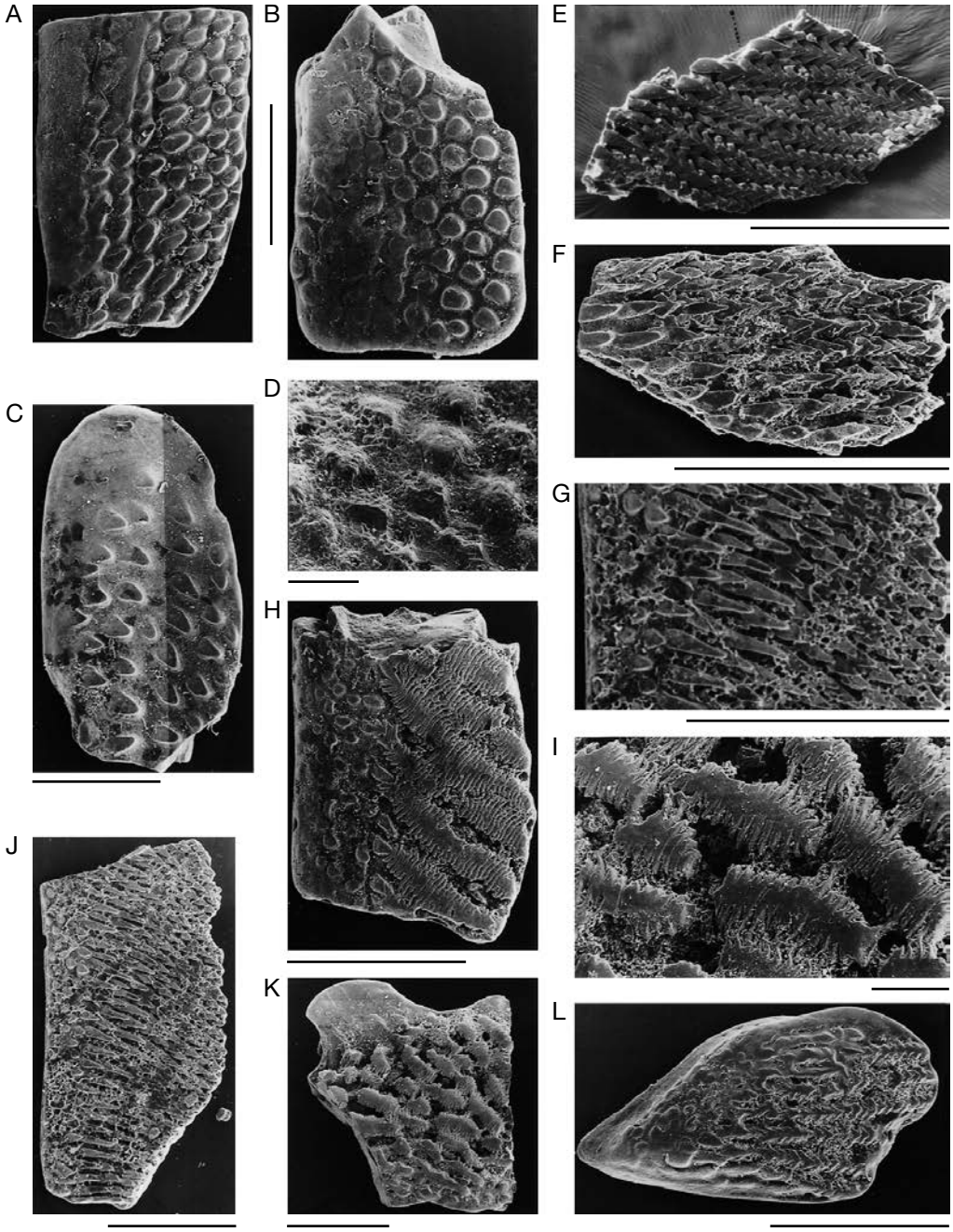

FIG. 2. — SEM photos of scales of Birkeniida spp. from the Severnaya Zemlya Archipelago; **A**-**D**, *Birkenia*? sp.; **E**, Birkeniida sp. C; **F**, **G** = **J**; Birkeniida sp. C1; **H**, **I** = **K**, Birkeniida sp. C?; **L**, Birkeniida sp. F; **A**, LIG 35-922; **B**, LIG 35-918; **C**, LIG 35-921; **D**, LIG 35-920; **E**, Pi 7570; **F**, LIG 35-916; **G**, **J**, LIG 35-925; **H**, LIG 35-929; **I**, **K**, LIG 35-928; **L**, LIG 35-919. **A**, **C**, **D**, **G**, **J**, **L**, sample 30-1; **B**, sample 30, Ushakov River; **E**, sample MF 157-4, Spokojnaya River, October Revolution Island, lower part of Ust' Spokojnaya Formation, lower Ludlow, Upper Silurian; **F**, sample 5d, Pioneer Island, Ludlow, Upper Silurian; **H**, **I**, **K**, sample 47-14, Spokojnaya River, October Revolution Island, lower part of Ust' Spokojnaya Formation, lower Ludlow, Upper Silurian. Scale bars: A-C, E-H, J-L, 0.5 mm; D, I, 0.1 mm.

sp. C1 differs from Birkeniida sp. C in having much more elongated tubercles; their antero-lateral corners are sharper and the rows are more continuous, with fewer fade-outs.

Birkeniida sp. C?
(Figs 2H, I, K; 3A, B; 4F, I)

MATERIAL AND OCCURRENCE. — Seven fragmentary scales; samples 30, 30-1, Ushakov River; sample 47-14, Spokojnaya River, lower part of Ust' Spokojnaya Formation, lower Ludlow, Upper Silurian.

REMARKS

The sculpture of this form is different from those of Birkeniida sp. C and Birkeniida sp. C1. Anteriorly on the scale surface, rounded tubercles are situated as usual. They are followed by elongated, wide and high tubercles (or short ridges) with deeply serrated margins. The ridges can be fused (Figs 2H; 4F). The width of the scales is 0.6 to 1.0 mm. A saddle-like median dorsal ridge scale (Fig. 2K) has rather short, serrated tubercles.

Märss (1986) suggested that Birkeniida sp. C? may be an adult form of Birkeniida sp. C. Finds of the scales with certain sculpture both in the Baltic and Severnaya Zemlya can indicate that these are different taxa, probably on the species level, Birkeniida sp. C having long ridges and Birkeniida sp. C? short ones.

Birkeniida sp. D
(Figs 3D; 4H)

MATERIAL AND OCCURRENCE. — Four broken scales; sample 30, Ushakov River; sample 2-21, Matusevich River, lower part of Ust' Spokojnaya Formation, lower Ludlow, Upper Silurian.

REMARKS

A few scales can be ascribed to this form. They are characterized by sinuous ridges of variable width and length. The width of the scale is 1.4 mm. Gross (1958: taf. 3, fig. 5) described fragments of an anaspid from the Baltic with similar sculpture that he identified as *Saarolepis oeselensis* (species was re-named by Ritchie 1980 as *Rhyncholepis oeselensis* [Robertson, 1945]). Gross had not seen the holotype to be sure about the species, and Ritchie did not describe the sculpture of the scales; therefore we cannot give this name to our form. In the Rootsiküla and Paadla stages of the Baltic, Birkeniida sp. D is a common form with a regular type of sculpture. Despite limited material, the same form can be identified on Severnaya Zemlya.

Birkeniida sp. F
(Figs 2L; 3F; 4N, O)

MATERIAL AND OCCURRENCE. — Eight broken scales; sample 5d, Pioneer Island, Wenlock, Lower Silurian; samples 30, 30-1, Ushakov River; sample MF 157-4, Spokojnaya River, lower part of Ust' Spokojnaya Formation, lower Ludlow, Upper Silurian.

REMARKS

A relatively common form on October Revolution Island. Long, separate ridges are composed of horizontal "piles of bowls": flat, bowl-like tubercles, each stem intruding into the next posterior bowl-like tubercle. The width of the scales is 0.9 to 1.1 mm. In Birkeniida sp. F, the scale sculpture resembles that of *Pterygolepis* Cossmann, 1920, which are present as moulds in samples from Ringerike housed in the Oslo Museum (Märss pers. obs.). However, more thorough study of these species is needed before making any decision about taxonomy.

Birkeniida sp. F?
(Figs 3E, K; 4J)

MATERIAL AND OCCURRENCE. — 23 broken scales; sample 5d, Pioneer Island, Wenlock, Lower Silurian; samples 30, 30-1, Ushakov River; sample 47-14, Spokojnaya River, lower part of Ust' Spokojnaya Formation, lower Ludlow; samples 2-12, 2-14, 2-21, Matusevich River, middle part of Ust' Spokojnaya Formation, middle Ludlow, Upper Silurian.

REMARKS

Scales have relatively high sinuous long ridges that are smooth above; sculpture is nearly the

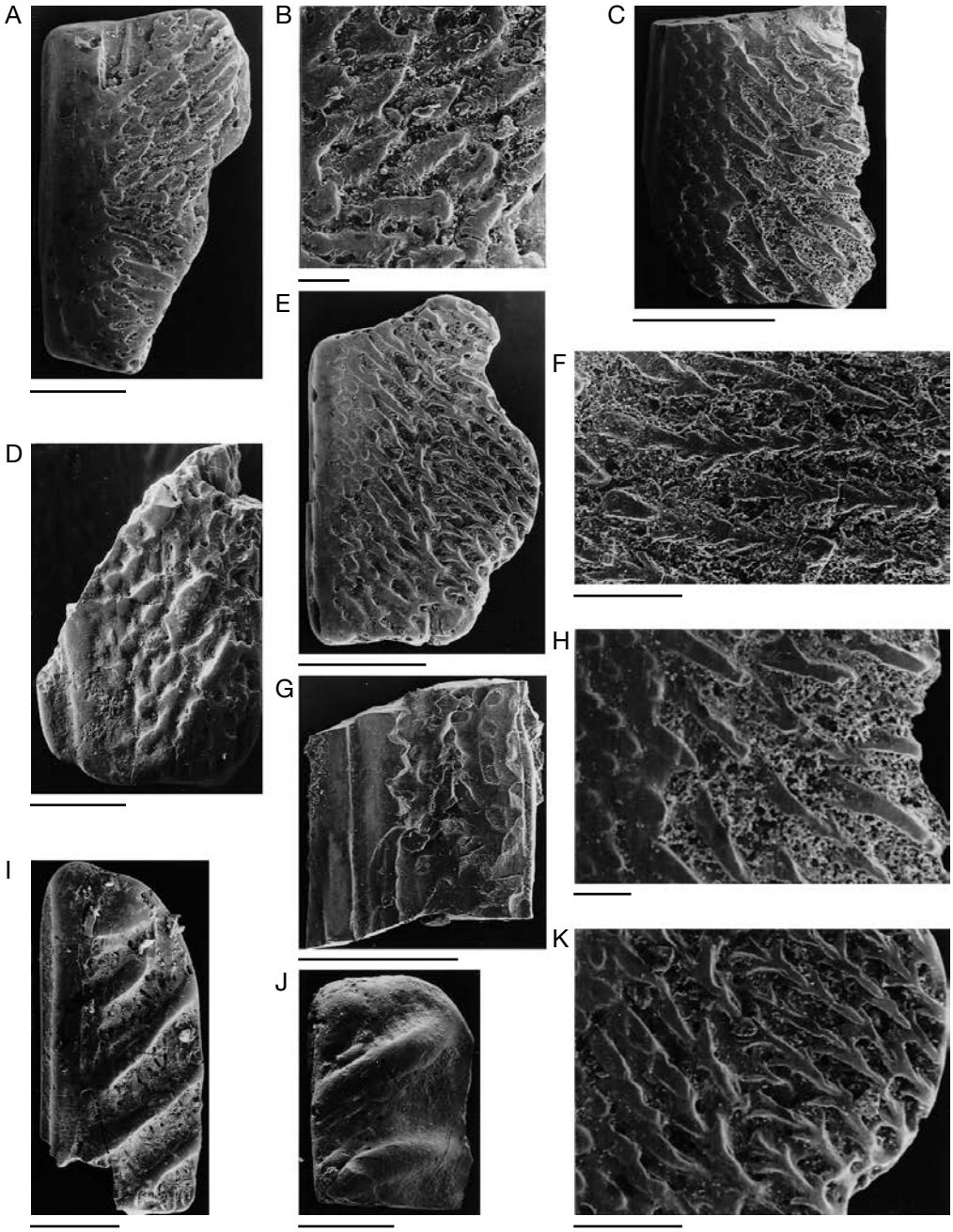

FIG. 3. — SEM photos of scales, **A**-**H**, **J**, **K**, Birkeniida spp. from the Severnaya Zemlya Archipelago; **I**, Cephalaspidida gen. et sp. ind.; **A** = **B**, Birkeniida sp. C?; **C** = **H**, Birkeniida sp. H; **D**, Birkeniida sp. D; **E** = **K**, Birkeniida sp. F?; **F**, Birkeniida sp. F; **G**, *Vilkitskilepis valentinae* n. gen., n. sp.; **J**, Birkeniida sp. J. **A**, **B**, LIG 35-923; **C**, **H**, LIG 35-926; **D**, Pi 7583; **E**, **K**, LIG 35-924; **F**, LIG 35-914; **G**, LIG 35-930; **I**, Pi 7578; **J**, Pi 7573. **A**-**C**, **E**, **H**, **K**, sample 30-1, Ushakov River; **D**, sample 2803, Pioneer Island, Ludlow, Upper Silurian; **F**, sample MF 157-4, Spokojnaya River, October Revolution Island, lower part of Ust' Spokojnaya Formation, lower Ludlow; **I**, sample 2-1, Matusevich River; **J**, sample 157-3, Spokojnaya River, upper part of Ust' Spokojnaya Formation, upper Ludlow; **G**, sample 67-12, Pod''emnaya River, October Revolution Island, Severnaya Zemlya Formation, Lochkov, Lower Devonian. Scale bars: A, C-E, G, I, J, 0.5 mm; B, F, H, K, 0.1 mm.

same as in Birkeniida sp. F. The reason for differentiating them was a peculiar scale sculpture illustrated in Figures 3E, K and 4J. The anterior narrow smooth margin is followed by an area covered with rounded or slightly elongated tubercles which become longer and sinuous posteriorly. A scale with repaired area posteriorly is well displayed in Figure 3E, K. On this area, the size, shape and orientation of the ridges differ from the normal scale surface. The bowl-like tubercles occurring on the scar area are clear and very similar to those of Birkeniida sp. F. Sculpture of the normal part (formed earlier) does not have very distinct bowl-like ridges, and they resemble to some extent those of Birkeniida sp. D. The pores between sculpture elements are distinct. The width of the scales is 0.9 mm. A relatively long pectoral? spine of the same age as Birkeniida sp. F? was found in sample 2-21 of the Matusevich River section.

Birkeniida sp. G
(Fig. 4K)

OCCURRENCE. — Sample 8g-1, 8g, Pioneer Island, Wenlock, Lower Silurian.

REMARKS

About six to seven scale fragments with long straight shiny ridges, separated by relatively deep grooves, were found. The anterior scale surface is smooth. Anterior to the long ridges there occur a few rounded tubercles. The width of the scale in Figure 4K is 0.7 mm.

Birkeniida sp. H
(Figs 3C, H; 4L)

MATERIAL AND OCCURRENCE. — 3 scales in sample 30-1, Ushakov River, lower part of Ust' Spokojnaya Formation, lower Ludlow, Upper Silurian.

REMARKS

This form is characterized by backwardly arising and sharpening ridgelets, placed in irregular rows. Longer ridgelets are bent down toward posterior ends. Anteriorly the scales have rounded tubercles, arranged indistinct lines. The width of the scale in Figures 3C, H and 4L is 0.8 mm.

Birkeniida sp. J
(Figs 3J; 4M)

MATERIAL AND OCCURRENCE. — 5 broken scales in samples 2-3, Matusevich River, and MF 157-3, Spokojnaya River, upper part of Ust' Spokojnaya Formation, upper Ludlow and MF 157-2, Spokojnaya River, Krasnaya Bukhta Formation, Přidoli, Upper Silurian.

REMARKS

Scales have a very coarse sculpture, consisting of wide, elongated ridges with small, rounded or elongated tubercles on the sides. On the visceral surface there occurs a longitudinal ridge. Microstructure is rather compact, made up by aspidine lamellae.

DISCUSSION

In several samples were found scales with the sculpture constituting a system of short and long, relatively straight ridges; the latter have fine ridgelets on their sides (Fig. 3I). The space between the ridges is equal to the width of the ridges. The basal plate is externally pierced by numerous and relatively large, elongated pores. Viscerally on the plates, there occurs one wide, or sometimes two narrower longitudinal ridges which are characteristic of anaspid scales. At first glance, especially because of the ridge on the lower surface, these forms resemble the anaspids. The microstructure, exposed in the base, contains osteocyte lacunae, aligned in rows. Thus, the scales belong to a cephalaspid osteostracan, and it is shown here to call once again attention to the transitional forms between Anaspida and Osteostraci (see also Arsenault & Janvier 1991: 32, point 14).

Genus *Vilkitskilepis* n. gen.

TYPE SPECIES. — *Vilkitskilepis valentinae* n. gen., n. sp.

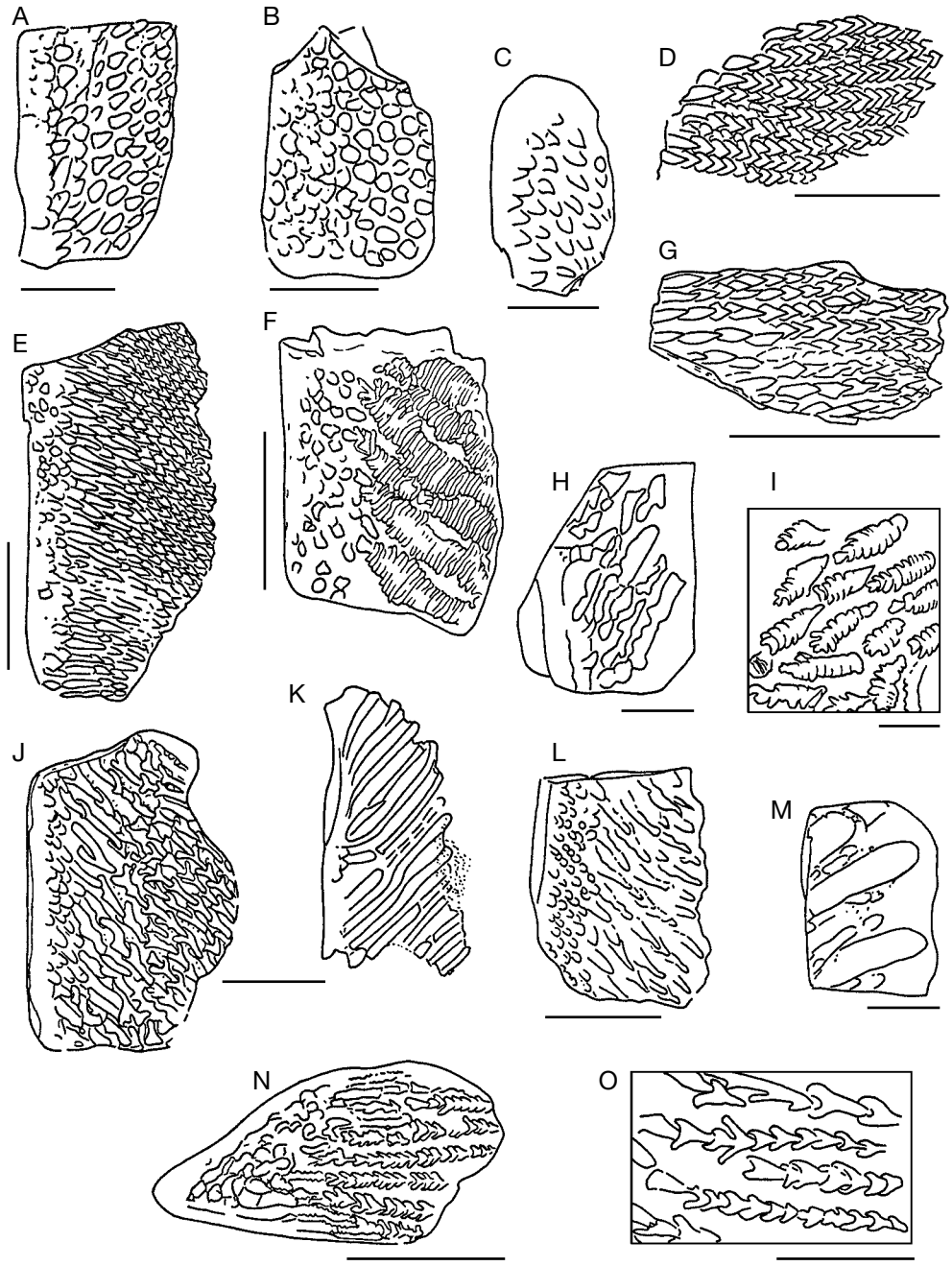

FIG. 4. — Drawings made after SEM photos from Figures 2 and 3 to illustrate different sculptures of birkeniids of the region; **A**-**C**, *Birkenia*? sp.; **D**, Birkeniida sp. C; **E**, **G**, Birkeniida sp. C1; **F**, **I**, Birkeniida sp. C?; **H**, Birkeniida sp. D; **J**, Birkeniida sp. F?; **K**, Birkeniida sp. G; **L**, Birkeniida sp. H; **M**, Birkeniida sp. J; **N**, **O**, Birkeniida sp. F; **A**, LIG 35-922; **B**, LIG 35-918; **C**, LIG 35-921; **D**, Pi 7570; **E**, LIG 35-925; **F**, LIG 35-929; **G**, LIG 35-916; **H**, Pi 7583; **I**, LIG 35-923; **J**, LIG 35-924; **K**, LIG 35-931; **L**, LIG 35-926; **M**, Pi 7573; **N**, LIG 35-919; **O**, LIG 35-914. **A**, **C**, **E**, **I**, **J**, **L**, **N**, sample 30-1; **B**, sample 30, Ushakov River; **D**, **O**, sample 157-4; **F**, sample 47-14, Spokojnaya River, October Revolution Island, lower part of Ust' Spokojnaya Formation, lower Ludlow; **G**, sample 5d; **H**, sample 2803; **K**, sample 8g-1, Pioneer Island, Ludlow; **M**, sample 157-3, upper part of Ust' Spokojnaya Formation, upper Ludlow, Upper Silurian. Scale bars: A-H, J-N, 0.5 mm; I, O, 0.1 mm.

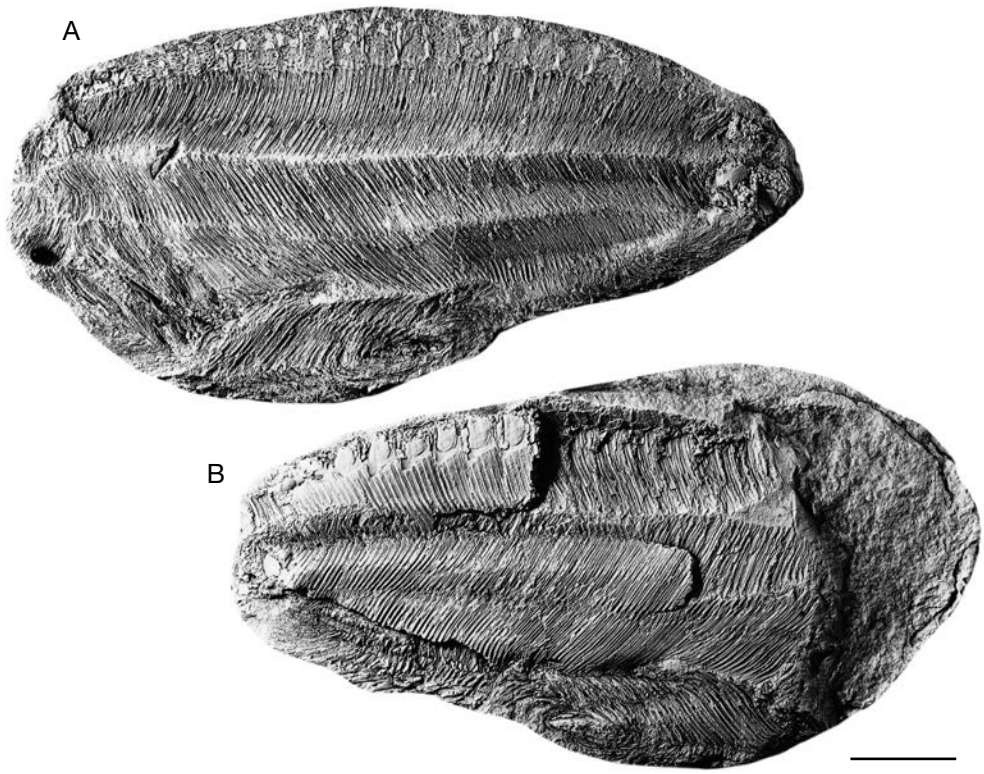

FIG. 5. — *Vilkitskilepis valentinae* n. gen., n. sp.; trunk squamation, holotype LIG 35-909, part (**A**) and counterpart (**B**); sample 67-12, Pod''emnaya River, October Revolution Island, Severnaya Zemlya Formation, Lochkov, Lower Devonian. Scale bar: 1 cm.

ETYMOLOGY. — Named after B. Vilkitski who discovered the Severnaya Zemlya islands, originally named as Land of Nikolai the Second, in 1913, and from *lepis*: scale.

DIAGNOSIS. — As for type and only species (see below).

Vilkitskilepis valentinae n. sp.
(Figs 3G; 5; 6)

HOLOTYPE. — Trunk squamation, LIG 35-909 A and B, part and counterpart.

TYPE LOCALITY AND HORIZON. — Sample 67-12, Pod''emnaya River, October Revolution Island, Severnaya Zemlya Archipelago, Severnaya Zemlya Formation, Lochkov, Lower Devonian.

ETYMOLOGY. — Named in honour of Dr Valentina Talimaa, a colleague of mine and a researcher who has studied lower vertebrate palaeontology for many years.

DIAGNOSIS. — Branchial area ends with postbranchial and pectoral(?) plates. The 25 (26?) dorsal ridge scales preserved are large. Each ridge scale straddles four to five trunk scales in the middle of the row. Dorso-lateral, ventro-lateral and ventral scales, and dorsal ridge scales form the trunk squamation. Anal fin is comparatively short, covered with narrow, straight, tiny posteriorly directed scales. Head and caudal skeleton unknown. Scales tuberculated anteriorly, and ridged in the middle of the scales. Dorsal ridge scales covered with elongated tubercles. Microstructure from lamellar aspidine.

DESCRIPTION

In the description, the terminology of Kiaer (1924) and Ritchie (1964) is used. A large portion of the holotype is preserved in part and counterpart (LIG 35-909 A and B; Figs 5; 6). It exposes trunk squamation, partly seen in visceral view; the scale covering is partly displayed as a

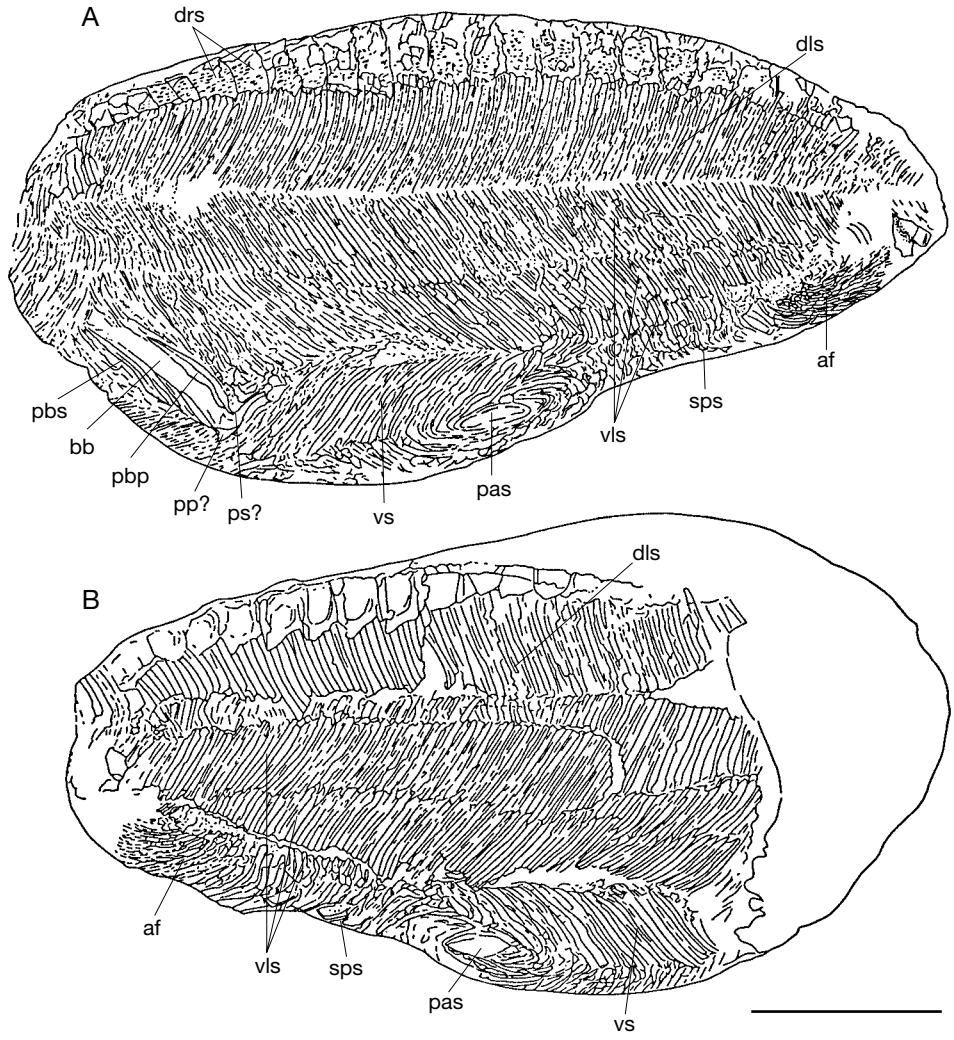

FIG. 6. — *Vilkitskilepis valentinae* n. gen., n. sp., drawing of the specimen in Fig. 5; **A**, holotype, LIG 35-909 A, part; **B**, holotype, LIG 35-909 B, counterpart. Abbreviations: **af**, anal fin; **bb**, branchial band; **drs**, dorsal ridge scales; **dls**, dorso-lateral scales; **pas**, pre-anal spine; **pbp**, post-branchial plate; **pbs**, pre-branchial scales; **pp?**, pectoral plate(?); **ps?**, pectoral spine?; **sps**, spiny scales along the ventral mid-line between the pre-anal spine and anal fin; **vs**, ventral scales; **vls**, ventro-lateral scales. Scale bar: 1 cm.

natural mould, the sculptured surface lacking. The scales are smooth, with a longitudinal rib internally, and sculptured external surface. Anteriorly the part of the holotype exhibits the area of the branchial band, and posteriorly, behind the anal fin, a fragment of the caudal peduncle. Its counterpart is shorter and broken off at a short distance behind the branchial band. The specimen is laterally compressed. The maximum preserved length is 78 mm; the length between the anterior end of the base of the post-branchial plate and the anterior limit of the anal fin is 40 mm. The maximum (compressed) height is 40 mm; the minimum height, 17 mm, is located behind the anal fin on the caudal peduncle. The height from the base of the post-branchial plate up to above the dorsal ridge scales is 32 mm.

TABLE 1. — Comparison of some measurements of *Vilkitskilepis valentinae* n. gen., n. sp. and Scottish and Norwegian birkeniids (after Kiaer 1924).

	Birkenia elegans **Traquair, 1898**	***Rhyncholepis parvulus*** **Kiaer, 1911**	***Pterygolepis nitidus*** **(Kiaer, 1911)**	***Pharyngolepis oblongus*** **Kiaer, 1911**	***Vilkitskilepis valentinae*** **n. gen., n. sp.**
Body length (cm)	8-10	6-7	11-12	19-20	*c.* 12
Number of dorsal ridge scales	11	18	17 (15-22)	40	25-26
Number of dorso-lateral scales covered by a dorsal ridge scale	3-4	3-4	5 (3-7)	2-3	4-5

Head

A few rows of head scales are preserved in front of the branchial band (bb, Figs 5; 6), but they are strongly compressed. The latter is a narrow, barren, band-like area, where no finer details can be seen. It forms an oblique area, about 1.5 mm wide and 15 mm high, at an angle of 35°, similar to the branchial band of *Pterygolepis* Cossmann, 1920 (see Kiaer 1924: 59). Anteriorly to the branchial band, the prebranchial scales (pbs, Figs 5; 6) are compressed and shorter, but have the same direction as the trunk scales. Above the branchial band, the scales are directed more anteriorly. In internal view the postbranchial plate and pectoral plate(?) (pbp and pp(?), Figs 5; 6) are situated at the posterior end of the branchial band.

Trunk

The arrangement and shape of trunk scales are similar to those in the Norwegian Birkeniida. According to Kiaer (1924: 61) and as seen in our material, on the side of the body there is a slightly bent, longitudinal line on the midline of the side of the body. On both sides of this line the scales proceed obliquely backward. On the ventral side, at some distance from the anal fin, the scales run obliquely forward toward the ventral midline (Fig. 6). Kiaer (1924) divides the trunk skeleton into 1) the median dorsal spines; 2) the upper lateral trunk scales (above the mid-line); 3) the lower lateral scales (below the midline); and 4) the ventral scales.

The median dorsal ridge scales (= median dorsal spines by Kiaer): in *Vilkitskilepis valentinae* n. gen., n. sp. the moulds of the external surface and internal impression of the scales are preserved (drs, Figs 5; 6) along the whole length of our specimen. There are 25 (26?) dorsal ridge scales; the 5th to 7th ridge scales have preserved their natural shape. Each scale arises slightly posteriorly and recedes then, the next scale starting at the lower level. Their height is two thirds of the height of the dorso-lateral scales. They are higher and longer in the middle part of the row, 3 mm long and 6 mm high as a maximum, where each median dorsal ridge scale covers four to five dorso-lateral scales.

The dorso-lateral scales (dls, Figs 5; 6) are arranged in regular rows that run forward and downward. The scale rows are higher in the middle of the body. There are 17 scales per 10 mm, meaning that the width of each scale is about 0.6 mm.

The ventro-lateral scales (vls, Fig. 6) occur in three rows situated below the body midline, running downward and backward. Their total height is larger than for the dorso-lateral scales. The trunk scales, which cover the whole area, become gradually lower and just slightly shorter posteriorly, towards the caudal peduncle.

The ventral scales (vs, Fig. 6), one row on either side, run forward and downward towards the ventral midline of the body. They are situated between the pectoral plate(?) and at some distance from the anal fin. The ventral scale row ends posteriorly with a structure showing scales arranged in concentric oval rows. A spine occurs in the centre of this structure (pas, Fig. 6), which Kiaer (1924: fig. 30) called the preanal spine. In our specimen the trunk with ventral scales and

the preanal spine is turned to the same plane as are the dorso- and ventrolateral scales. A very narrow area of ventral scales of the other side is visible. The anal fin (af, Figs 5; 6) is rather well preserved. The minute elongated scales covering it are directed obliquely backward. The base of this fin is 7 to 8 mm long. Between the preanal spine and anal fin, there occur two rows of special scales. In some respects they resemble the scales of *Rhyncholepis* (see Kiaer 1924: fig. 34b). The upper row comprises low, narrow scales, 15 to 20 in number. Below it, a row of spiny scales (sps) extends to the anal fin.

The scale sculpture of the type specimen is not as well preserved as in other Birkeniida from Severnaya Zemlya. It is broken in the plane of the smooth visceral side and the sculptured side was left in the rock. It was not possible to take scales out without destroying the only specimen. Still, a couple of scales show tuberculated ornamentation anteriorly (Fig. 3G), and ridged sculpture in the middle of the scales. Microsculpture is not studied. The dorsal ridge scales bear elongated tubercles, each ridge being higher anteriorly and lower towards the posterior end of the ridge. They have fine, short ridgelets on the sides. The ridges are coarser anteriorly and in the middle part of the row. Fragments studied in anise oil show typical lamellar aspidine.

Remarks

The body of *Vilkitskilepis valentinae* n. gen., n. sp. was approximately 12 cm long. In length, the new species is close to *Pterygolepis nitidus (*Kiaer, 1911) (for comparison see Table 1 where measurements after Kiaer 1924 are used). The preserved median dorsal ridge scales number 25 or 26 in our specimen, the total number lying, perhaps, between those of *Pterygolepis nitidus* and *Pharyngolepis oblongus* Kiaer, 1911. In relative size, the median dorsal ridge scales of *Vilkitskilepis valentinae* n. gen., n. sp., covering four to five dorso-lateral scales, are most similar to those of *Pterygolepis nitidus*. By the size and direction of the branchial band (at an angle of 35°, being 1.5 mm wide and 15 mm high) the new species is close to *Pterygolepis nitidus*. The flexible anal fin in our species makes it similar to *Pharyngolepis* Kiaer, 1911, while the scales between the pre-anal spine and anal fin resemble those of *Rhyncholepis* Kiaer, 1911.

This comparison reveals possible relationships between *Vilkitskilepis valentinae* n. gen., n. sp. and *Pterygolepis nitidus.* Still, considering the differences in morphology, we have enough reason to establish a new genus and a new species. There is not enough data to decide to which family it should be referred; thus this question is left open at the present stage of study.

NB: The Norwegian taxa have been revised and the names of *Rhyncholepis parvulus*, *Pterygolepis nitidus* and *Pharyngolepis oblongus* corrected by Blom *et al.* (in press).

CONCLUSION

Fragmentary scale material from the Silurian of the Matusevich, Spokojnaya and Ushakov river sections of October Revolution Island, and sections on Pioneer and Komsomolets islands, are described. Six main types with three subtypes of different scale sculptures were distinguished, each being referred to open nomenclature taxon: Birkeniida sp. C, Birkeniida sp. C1, Birkeniida sp. C?, Birkeniida sp. D, Birkeniida sp. F, Birkeniida sp. F?, Birkeniida sp. G, Birkeniida sp. H, and Birkeniida sp. J. The genus *Birkenia,* known from the Llandovery and Wenlock of Scotland, is represented here by *Birkenia*? sp. in the Samojlovich Formation (Wenlock), of the Ushakov River section, and coeval strata on Pioneer Island, and in the Ust' Spokojnaya Formation (Ludlow), of the Ushakov and Spokojnaya river sections of October Revolution Island.

A well-preserved trunk skeleton of a new birkeniid anaspid *Vilkitskilepis valentinae* n. gen., n. sp., from the Lochkov, Lower Devonian of the Pod''emnaya River section of October Revolution Island, was described. Its systematic position in the order Birkeniida is not clear.

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