

# 1. Introduction

## 1.1. SUMMARY OF PREVIOUS RESEARCH

Permian acanthodians in the region of the Czech Republic were for the first time mentioned by BEYRICH (1848) at the end of his original description. Numerous finds of *Acanthodes gracilis* were referred from Rudník (Hermannseifen in the German transcription) in the Krkonoše Piedmont Basin (for the geographic position of the limnic basins see ZAJÍC 1998; for the stratigraphic correlations see Fig. 1). GEINITZ (1861, page 21) mentioned finds of *Acanthodes gracilis* from the same locality. The only Lower Permian representatives of the genus *Acanthodes* (isolated scales) from the Česká Kamenice Basin were described by ZAJÍC (1996; 1997) from the borehole Vf-1 (Volfartice). No acanthodian remains (unlike sharks and actinopterygians) have been found in Permian sediments of the Mnichovo Hradiště Basin up to the present (PROUZA, ŠIMŮNEK & ZAJÍC 1997). Numerous acanthodian specimens and fragments from Lowermost Permian of the Krkonoše Piedmont Basin are described or mentioned by AUGUSTA (1939), BLECHA et al. (1997), DANĚK (1902), FRIC (1912), FRITSCH (1893), GEINITZ (1861), HAVLENA & ŠPINAR (1954), ŠIMŮNEK, ZAJÍC & DRÁBKOVÁ (1990), ZAJÍC (1986; 1989; 1991; 1996), ZAJÍC, ŠIMŮNEK & DRÁBKOVÁ (1997) and others. The only known specimen (scaly body fragment) from the Blanice Basin is presently lost. I saw it in the collections of the National Museum at Prague about ten years ago. Acanthodian finds are mentioned by ZAJÍC in MARTINEK, DRÁBKOVÁ, MIKULÁŠ, ŠIMŮNEK & ZAJÍC (2001). Acanthodians of the Boskovice Basin are described or mentioned by AUGUSTA (1926a, 1926b, 1931, 1947), HAVLENA & ŠPINAR (1955, 1956a, 1956b), IVANOV (2003), JAROŠ (1959), RZEHAČ (1881), ZAJÍC (1996, 1997a, 1997b, 2002) and others. Important informations concerning Permian acanthodians are included in overall faunal lists and stratigraphic faunal inventories (FRITSCH 1895, PEŠEK et al. 2001, ZAJÍC 1988, 1998, 2000; ZAJÍC & ŠTAMBERG 1986).

Permian acanthodians of the Czech Republic were named as *Acanthodes gracilis* already by GEINITZ (1861). The subspecies *Acanthodes gracilis bendai* from the Boskovice Basin and the Krkonoše Piedmont Basin was erected by FRITSCH (1893) on the basis of characteristic sculpture of scale crowns. RZEHAČ (1881) mentioned another subspecific name – *Acanthodes gracilis micracanthus* from the Boskovice Basin. This name is, however, a nomen nudum. The stratigraphically youngest acanthodian find from the Czech Republic was mentioned by FRIC (1912) from the Olivětín Member of the Intra-Sudetic Basin. The specimen is, however, extremely doubtful because it was lost before the publication of Frič's paper and no other specimen was ever found at the same stratigraphic level. There is most probably a mistake (wrong locality or determination).

## 1.2. STRATIGRAPHY AND FOSSIL MATERIAL

The following two Permo-Carboniferous regions of the Czech Republic (see ZAJÍC 1998, Fig. 1 or ZAJÍC 2000, Fig. 1) yield Lower Permian acanthodians:

1. Sudetic area (the Česká Kamenice and Krkonoše Piedmont basins)

2. Southeastern (formerly Furrows) area (the Boskovice and Blanice basins).

The described and mentioned fossil material is deposited in the collections of the National Museum, Prague (M), the Institute of Geology and Paleontology of the Charles University, Prague (A, I, and PUK), Town Museum of Nová Paka (unnumbered sample), Moravian Museum, Brno (MZM), Czech Geological Survey, Prague (YA), and Regional Museum of Eastern Bohemia, Hradec Králové (MHK). The specimens that were collected by the author or his colleagues (S. Štamberg and Z. Šimůnek) are now deposited in the collections of the National Museum, Prague under the numbers M 4244 – M 4701, and M 4704 – M 4744.

The comparative material of *Acanthodes gracilis* comes from Poland (from the North Sudetic Basin, the Upper

Age	Biozones (ZAJÍC 2000)	Krkonoše Piedmont Basin & Česká Kamenice Basin			Boskovice Basin			Blanice Graben						
		Formation	Member	Taxon			Formation	Member	Taxon					
				1	2	3			1	2	3	1	2	3
Artinskian		Chotěvice												
Sakmarian	<i>Xenacanthus decheni</i>	Hiatus			Letovice	Upper								
		Prosečné	Upper				Middle							
Asselian	<i>Acanthodes gracilis</i>		Lower				Lower	•	•	•				
		Vrchlabí	Upper			Veverská Bítýška			Český Brod	Bulánka				
			Lower	•		•	Padochov	•		•	Chýnov		•	
									Kostelec n. Čer. lesy	Lhotice				

Fig. 1. Occurrence of Lower Permian acanthodian taxa in the Czech Republic; lithostratigraphy of all basins is based on PEŠEK et al. (2001); taxon 1 – *Acanthodes gracilis*, taxon 2 – *Acanthodes stambergi* n. sp., taxon 3 – *Acanthodes* sp.; scales of *Acanthodes* sp. were just found in the Česká Kamenice Basin.

Anthracosia Shales) and is deposited in the Institute of Zoology of the Wrocław University, Institute of Geology and Paleontology of the Charles University, Prague, National Museum, Prague, and Natural History Museum, London.

For the stratigraphic position of Permian acanthodians see Fig. 1. The possible correlation between the lithostratigraphic units of the Krkonoše Piedmont Basin and the Boskovice Basin is based on ZAJÍC (2002). The probable stratigraphic position of the Blanice Basin is original. Lithostratigraphy of the Česká Kamenice Basin (completely covered by the Upper Cretaceous marine sediments) is based on the lithostratigraphy of the Krkonoše Piedmont Basin particularly thanks to the borehole Vf-1 (Volfartice; see VEJLUPEK 1984, VEJLUPEK, NOVÁK & SCHOVÁNKOVÁ 1986, ZAJÍC 1996, 1997a). Lower Permian acanthodian find comes from the equivalent of the Rudník Horizon. All specimens which were found in the Krkonoše Piedmont Basin originate also from the Rudník Horizon (Lower Vrchlabí Formation). The complicated lithostratigraphic chart of the Boskovice Basin (PEŠEK et al. 2001; Supplement 19) is induced by tangled tectonic and facies situation. Numerous local (mostly fossiliferous) horizons and layers were erected (see Fig. 2) but their exact correlation is still not definite. For the detailed lithostratigraphic charts of the individual basins see PEŠEK et al. (2001) and ZAJÍC (2000).

The list of localities and boreholes with known finds of *Acanthodes* is arranged according to the basins. Correlation of the numerous fossiliferous horizons of the Boskovice Basin is complicated by an intricate tectonic arrangement. Most localities are therefore not assigned to a definite lithostratigraphic unit. Full names (in case of boreholes) or the possible old names, the number of relevant maps (1 : 25 000), potential references, known lithostratigraphic units (in case of Boskovice Basin), and numbers of specimens at my disposal are given in parentheses.

#### • Česká Kamenice Basin

*Vf-1 borehole* (Volfartice; 02-241; ZAJÍC 1996; ZAJÍC 1997a; equivalent of the Rudník Horizon)

#### • Krkonoše Piedmont Basin (all specimens come from the Rudník Horizon)

*Dolní Sytová* (03-413; one specimen in the collection of the Institute of Geology and Paleontology of the Charles University, Prague which is now missing; BLECHA et al. 1997, ZAJÍC 1988)

*F-1 borehole* (Fořt; 03-423; BLECHA et al. 1997)

*F-2 borehole* (Fořt; 03-423; BLECHA et al. 1997, ZAJÍC 1986)

*F-3 borehole* (Fořt; 03-423; BLECHA et al. 1997)

*HK-1 borehole* (Horní Kalná; 03-414; BLECHA et al. 1997, ZAJÍC 1989, ZAJÍC & ŠTAMBERG 1986)

*Janovice* (03-423; BLECHA et al. 1997)

*Jk-6 borehole* (Javorník; 03-423; BLECHA et al. 1997)

*Košťálov, diverse outcrops* (= former Czech name Košťálov; 03-413; BLECHA et al. 1997, DANĚK 1902, FRIČ 1912, FRITSCH 1893, FRITSCH 1895, HOLUB 1961, WERNEBURG & ZAJÍC 1990; ZAJÍC 1988, ZAJÍC & ŠTAMBERG 1986)

*Košťálov, Kovářův mlýn (Kovář's Mill)* (03-413; BLECHA et al. 1997)

*Košťálov, za hospodou (behind the tavern)* (03-413; BLECHA et al. 1997)

*Košťálov, za domovem mládeže (behind the hostel)* (03-413; BLECHA et al. 1997)

*Kundratice, Doly* (03-413; BLECHA et al. 1997)

*Prostřední Lánov, za továrnou (behind the factory)* (03-414; BLECHA et al. 1997)

*Příkrý, Honkův potok (Honkův creek)* (03-413; BLECHA et al. 1997)

*Rk-9a borehole* (Rudník; 03-423; BLECHA et al. 1997)

*Rudník, probably diverse outcrops* (= former German name Hermannseifen; = former Czech name Heřmanovy Sejfy; 03-423; BLECHA et al. 1997, FRIČ 1912, HAVLENA & ŠPINAR 1954, HOLUB 1961, ZAJÍC 1988, ZAJÍC & ŠTAMBERG 1986)

*Rybnice, Hrádecký potok (Hrádecký creek)* (03-413; BLECHA et al. 1997)

*Semily, probably diverse outcrops* (03-413; BLECHA et al. 1997)

*Vichová* (03-413; BLECHA et al. 1997)

*Vrchlabí, zářez silnice (road cut)* (03-414; BLECHA et al. 1997, ŠIMŮNEK, ZAJÍC & DRÁBKOVÁ 1990)

Notes: The Libštát locality (= the former Czech name Liebštát) is necessary to exclude from the list because the fossiliferous outcrops surely belong to the present Košťálov cadastre (no sediments of the Rudník Horizon are known from the present Libštát cadastre). Some specimens in diverse collections are still labelled with this locality name. The Libštát locality is also mentioned in some previous papers like AUGUSTA (1939), DANĚK (1902), FRIČ (1912), ZAJÍC (1988), and ZAJÍC & ŠTAMBERG (1986).

The Rybnice, Hrádecký creek locality is also known as Háje nad Jizerou (ŠTAMBERG 1993) or Roprachtice (RIEGER 1971) but is located in the Rybnice cadastre.

Acanthodians of the Rudník Horizon usually come from the black shales (blackish grey claystones and mudstones) and grey laminated mudstones. Slight deformation of some specimens (postmortem bends) allows correct measurements of the body proportions. Various growth stages were found in some localities. Colour of the fossil remains is black or blackish grey. Numerous acanthodian remains were found in the reddish brown laminated limestone of the Vrchlabí locality. All specimens are highly stricken by pressure. The result is both plastic and brittle deformation. No specimen of this rich locality is usable for the measurement of the body proportions. Fossil remains are carbonized and without visible details (e.g. surface of the scale crowns).

#### • Blanice Basin

*Český Brod, Na skalce* (13-134; collection of the National Museum, Prague, unnumbered specimen collected by Kopecký, now missing)

#### • Boskovice Basin (known lithostratigraphic units are mentioned in parenthesis)

*Černá Hora, zářez nedostavěné dálnice (uncompleted motorway cut)* (24-144; probably Zboněk-Svitávka Ho-

Fig. 2. Lithostratigraphic chart of the Boskovice Basin (according to PEŠEK et al. 2001 and JAROŠ, unpublished data); horizons of the Letovice Formation (derived from JAROŠ in PEŠEK et al. 2001) are of local nature and their superposition has not been proved.

Formation	Member	Horizon	Biozone (ZAJÍC 2000, in prep.)
Letovice	Upper = Sudice		?
	Middle	Bačov, Míchov, Kochov	<i>Xenacanthus decheni</i>
	Lower	Lubě	
Zboněk-Svitávka			
Zbraslavec			
Veverská Bítýška		Chudčice	
Padochov		Řičany	
		Zbýšov	
Rosice-Oslavany			<i>Sphaerolepis-Elonichthys</i>

rizon; 5 specimens in the collection of the Institute of Geology and Palaeontology of the Charles University, Prague which were collected by professor ŠPINAR in 1954; MARTINEK et al. 2002)

*Černá Hora, unknown outcrop* (24-144; FRITSCH 1893, ZAJÍC 1988)

*Hluboké Dvory* (= former Czech name Hluboký u Tišnova or in transcription to English as Hluboký near Tišnov; 24-144; Lubě Horizon; AUGUSTA 1926a, AUGUSTA 1931, AUGUSTA 1933, AUGUSTA 1946, AUGUSTA 1947, MAKOWSKY & RZEHAČ 1884, IVANOV 2003, ZAJÍC 1988, ZAJÍC & ŠTAMBERG 1986)

*Hluboké Dvory – Skalička, zářez nedostavěné dálnice (un-completed motorway cut)* (24-144; Lubě Horizon; IVANOV 2003, JAROŠ 1959)

*Kladoruby, Dolní pepřík* (= Trávník, Dolní pepřík in Ivanov 2003; 24-124; probably Lubě Horizon; about 70 specimens collected by S. ŠTAMBERG in 2002; MARTINEK et al. 2002)

*Lubě* (= former Czech name Lubie; 24-144; Lubě Horizon; AUGUSTA 1931, AUGUSTA 1946, AUGUSTA 1947, FRITSCH 1893, IVANOV 2003, ZAJÍC 1988, ZAJÍC & ŠTAMBERG 1986)

*Malá Lhota, Příčná zmola* (= former Czech name Lhotka; 24-144; probably Zboněk-Svitávka Horizon; AUGUSTA 1926a, AUGUSTA 1931, AUGUSTA 1946, AUGUSTA 1947, FRITSCH 1893, IVANOV 2003, MAKOWSKY 1876a, MAKOWSKY 1876b, RZEHAČ 1881, ZAJÍC 1988, ZAJÍC & ŠTAMBERG 1986)

*Malá Lhota, Podhájí* (= former Czech name Lhotka; 24-144; probably Lubě Horizon; the common list of quotations concerning both Malá Lhota localities see above)

*Moravský Krumlov, za lesním závodem (behind the wood company)* (24-334; Zbýšov Horizon; AUGUSTA 1951a, IVANOV 2003)

*Neslovice, údolí Neslovického potoka (valley of the Neslovice creek)* including *Rybičková skála* (24-341; Řičany Horizon; AUGUSTA 1931, AUGUSTA 1946, AUGUSTA 1947, AUGUSTA 1951b, MARTINEK et al. 2002, ZAJÍC 1988, ZAJÍC & ŠTAMBERG 1986)

*Oslavany, levý břeh Oslavy (left bank of the river Oslava)* (24-341; Zbýšov Horizon; IVANOV 2003, ZAJÍC 1995)

*Padochov, výkop pro plynovod (pipeline excavation)*

(24-341; Zbýšov Horizon; IVANOV 2003, ZAJÍC, MARTINEK, ŠIMŮNEK & DRÁBKOVÁ 1996)

*Polánka* (= former Czech name Polanka; 24-334; Zbýšov Horizon; AUGUSTA 1951c, AUGUSTA & ČEPEK 1948; IVANOV 2003)

*Svitávka, vrch Hradisko (Hradisko hill)* (24-142; Svitávka-Zboněk Horizon; AUGUSTA 1931, HAVLENA & ŠPINAR 1956b, IVANOV 2003, ZAJÍC 1988, ZAJÍC & ŠTAMBERG 1986)

*Zbraslavec* (24-142; Zbraslavec Horizon; AUGUSTA 1947, IVANOV 2003, MARTINEK et al. 2003, ZAJÍC 1988, ZAJÍC & ŠTAMBERG 1986)

*Zbýšov, za pilou dolu Antonín (behind the sawmill of the Antonín Mine)* (= Zbýšov, behind the sawmill of the Jindřich Mine; 24-341; Zbýšov Horizon; AUGUSTA 1947, HAVLENA & ŠPINAR 1956a, IVANOV 2003, ZAJÍC 1988, ZAJÍC & ŠTAMBERG 1986)

Notes: Current situation of fossiliferous localities is described by IVANOV (2003). Acanthodians were described also from the southern continuation of the Boskovice Basin near Zöbing in Austria (SCHINDLER & HAMPE 1996, VASICEK & STEININGER 1996).

Acanthodians of the Zbýšov Horizon are mostly fragmentary and affected by hair cracks. However, their preservation is often excellent. Delicate structures as gill arches or labyrinths are occasionally preserved.

Zbraslavec Horizon is represented by grey or yellowish grey organic rich limestone. The fossil remains are reddish brown coloured. Both the nearly complete bodies and the delicate structures of the head are preserved. Rather larger growth stages were collected on the Zbraslavec locality. This locality yielded three specimens of the below described new species as well.

The type of sediment and the way of preservation of fossil remains of the newest locality of Kladoruby, Dolní pepřík look similar to the situation of the Zbraslavec Horizon. The growth stages are, however, rather smaller.

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## 2. Description

### 2.1. INDEX OF ABBREVIATIONS

alb – axial lobe of the caudal fin  
 as – anal fin scales  
 asp – anal fin spine  
 asq – anterior border of squamation  
 cmo – circumorbital bone  
 cs – semicircular canal  
 dmt – dermatrichia  
 d<sub>O</sub> – outer diameter of circumorbital ring  
 dsp – dorsal fin spine  
 es – enlarged scales  
 gla – gill arch  
 glr – gill rakers  
 iosl – infraorbital sensory line  
 l<sub>A</sub> – anal spine length  
 l<sub>D</sub> – dorsal spine length  
 l<sub>M</sub> – mandibular bone length  
 l<sub>P</sub> – pectoral spine length  
 l<sub>PR</sub> – prepectoral distance

l<sub>T</sub> – total specimen length  
 l<sub>V</sub> – ventral spine length  
 lb – labyrinth infilling  
 m. add – surface for the dorsal adductor muscles  
 mca – anterior ossification of the meckelian cartilage (mentomandibular)  
 mcp – posterior ossification of the meckelian cartilage (articular)  
 mdo – mandibular bone (mandibular splint)  
 mll – main lateral line  
 orb – orbit  
 oto – otolith  
 pgl – pectoral girdle  
 pop – preopercular sensory line  
 pr – procoracoid  
 psp – pectoral fin spine  
 qjst – quadratojugal sensory line  
 qu – quadratum  
 rbr – branchiostegal ray(s)  
 rdl – radials  
 sc – scapular blade  
 scd – semicircular duct  
 scl – sacculus  
 sl – sensory line  
 sosl – supraorbital sensory line  
 ssc – suprascapula  
 ts – trunk scales  
 v – ventral sensory line (unpaired)  
 v<sub>A-D</sub> – anal-dorsal spine distance  
 v<sub>D-Z</sub> – distance from dorsal spine to caudal cleft  
 v<sub>P-V</sub> – pectoral-ventral spine distance  
 v<sub>V-A</sub> – ventral-anal spine distance  
 v<sub>Z-O</sub> – distance from caudal cleft to tip of axial lobe  
 vl – ventrolateral sensory line  
 vlb – ventral lobe of the caudal fin  
 vsp – ventral fin spine  
 vss – ventral scaly shield  
 Z1, Z2, Z2'', Z3, Z4 – Heyler's scale zones of the caudal fin

### 2.2. METHODS

Methods of measurements and subsequent definition, calculation, and valuation of the ratios were exactly described in ZAJIC (1998). There is highly important to assess grade of specimen deformation before a measurement. The post-mortem body bends are not the main obstacle (see ZAJIC 1998). Acanthodian trunk is frequently affected by a longitudinal deformation both compression and dilatation. The compression is accompanied by the skin wrinkles. The dilatation comes through the vertical skin gaps. Longitudinally deformed acanthodian bodies cannot be used for measurements of body proportions.

Digital photographs (large contrasting printouts) were successfully used as foundation of drawings. Cameras Nikon Coolpix 950 and Nikon Coolpix 4500 were used.

Specific types of sediment (marlstones, some limestones) allow chemical preparation and separation with help of acetic acid (for methods see ŠTAMBERG 2003, ZAJIC 1997a, 1997c).