

SABELLID AND SERPULID WORMS FROM THE BOHEMIAN CRETACEOUS BASIN (UPPER CENOMANIAN – MIDDLE CONIACIAN) ORIGINALLY IN THE COLLECTION OF PROFESSOR ANTONÍN FRIČ

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Abstract. Nine specimens of sabellid and serpulid worms which had been figured by Dr. Antonín Frič in his series of publications on the strata of the Bohemian Cretaceous Basin and which are kept in the collection of the National Museum in Prague are re-described, re-figured, re-determined and discussed in detail. The specimens belong to seven species: *Glomerula serpentina* (GOLDFUSS), *Glomerula plexus* (J. DE C. SOWERBY), *Filograna socialis* (GOLDFUSS), *Neovermilia* cf. *ampullacea* (J. DE C. SOWERBY), *Dorsoserpula wegneri* (JÄGER), *Dorsoserpula conjuncta* (GEINITZ)?, and Serpulidae gen. et sp. indet. In addition, those species and specimens mentioned but not figured by Dr. Antonín Frič are listed and partially discussed although these specimens had not been found in the collection and are presumably lost.

■ Sabellidae, Serpulidae, *Glomerula*, *Filograna*, *Dorsoserpula*, *Neovermilia*, *Serpula*, Dr. Antonín Frič, Bohemian Cretaceous Basin

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Introduction

Dr. Antonín Frič, his life, scientific career and stratigraphical scheme for the Cretaceous of the Bohemian Cretaceous Basin

Antonín Frič was born in Prague on 30 July 1832 as the second son of Dr. Josef Frič, a lawyer and politician who played an important role in Czech public life, parliament and Prague municipal council. His house was a centre of patriotic life. Perhaps the fact that Dr. J. Frič had held the position of treasurer for the Society of the Czech Patriotic Museum (today the National Museum) and *Malice česká* since 1842 and continued to do so for many years was the reason why the young Antonín came into contact with the Czech Patriotic Museum at an early age. In 1848 Antonín Frič became a volunteer at the museum and helped the custodian Maxmillian Dormitzer in structuring the collections. In his early twenties he became the unpaid assistant of Dormitzer and worked in the museum's zoological collections.

Following his father's profession, young Antonín began to study law at the Prague University. However, his passion for nature and the natural sciences was greater. In 1854 he started medical school which at that time was the best route for studying natural sciences. He became a qualified doctor in 1860.

When Dormitzer died prematurely, Frič became his successor.

Frič was primarily a zoologist. First he worked on birds, and began publishing the unique detailed book, "Birds of Europe", which includes 708 beautiful colour plates of all the bird species of Europe. In 1872 he completed a publication about the birds of Bohemia. Later Frič's main interest shifted to Czech fish. In 1863 he qualified at the medical faculty of Prague University in comparative anatomy and physiology, and the following year also at the Technical University for zoology. In 1871 the Prague University appointed him associate professor of zoology teaching in Czech language, and in 1881 the Czech University appointed him ordinary professor.

In 1864, the Society of the Czech Patriotic Museum together with the Patriotic economical society founded the "Committee for natural science research of Bohemia" ("Komitét pro přírodovědecký výzkum Čech"), under the leadership of Karel Kořistka and Jan Krejčí. Dr. Antonín Frič was among the founder members of the Committee and, at times, he was the secretary of the president, Karel Kořistka. Then his attention turned to the extinct fauna of the Czech geological formations and thus to geology. Together with Dr. Jan Krejčí he began studying the Czech Cretaceous formation. By 1869 Krejčí had already published his new stratigraphical scheme for subdividing the Cretaceous sediments of the Bohemian Cretaceous Basin (BCB) into eight stratigraphical units ("Schichten") which were named after localities. In the same year Frič started publishing his much more detailed descriptions of

the geology and palaeontology of Krejčí's "Schichten", one unit after the other. The paper by Krejčí (1869) and the eight volumes published by Frič (1869–1911); the seventh volume (1901) with Edwin Bayer named as a co-author together formed a series of publications entitled "Studien im Gebiete der Böhmisches Kreideformation". Thus, Krejčí and Frič together, although in separate papers in the same series and the same journal, founded, established and spread their stratigraphical scheme. From a geologist's point of view, this series may be considered as Frič's main work. Each volume was first published in German and in Czech, differing in pagination and, in part, in the year of publication. In the present paper, we refer to the year and pagination of the German versions only. In the Czech as well as in the German versions of the eight volumes, Frič's name is given in its Czech spelling, although elsewhere his publications are cited with his name in the German spelling, "Fritsch".

His other publications include a monograph, published with the support of the "Committee", on cephalopods, co-authored by U. Schlönbach (1872), a later publication on reptiles and fish (1878), and another about crustaceans with J. Kafka (1887). Frič's biggest honour in the field of palaeontology came from his four-volume work, "Fauna der Gaskohle Kalkstein und der Permformation Böhmens" (1879–1901). With the Czech translation of his research Frič practically founded the Czech paleontological school as his work could then be read in the mother language of Czech geologists and interested layman and thus was spread among the general public. Antonín Frič died on November 15th, 1913 in Prague.

Due to radical facies changes within the Cretaceous of BCB and due to lithological similarities of rock strata of different geological ages and sparsity of index fossils in some thick rock units, stratigraphical work on the Cretaceous of the Czech Republic has always been a difficult task, progressing only gradually from the publications of Reuss and Geinitz in the first half of the 19th century until today. Krejčí's and Frič's scheme was amongst the most important milestones. The stratigraphic extent of the individual units was redesigned by many authors. The history of Czech Cretaceous stratigraphy was summarized by Dvořák (1958). Čech et al. (1980) introduced a severely revised scheme of stratigraphical Formations and (a few) Members which follows the rules of modern lithostratigraphy. Čech (2011) provided the most recent summary of the stratigraphy and paleogeography of BCB. It compares the schemes of rock stratigraphy presented by Frič (1877, 1889, 1893), sequence stratigraphy by Uličný et al. (2009) and Čech et al.'s (1980) lithostratigraphy, and, moreover, presents chronostratigraphy; see Čech (2011:19, fig. 2).

Material and methods

All of the nine specimens described by A. Frič were studied by one of us (T. K.) in the collections of the National Museum (NM) in Prague. They belong to seven species, of sabellid and serpulid worm tubes which were figured by Frič in his "Studien im Gebiete der böhmischen Kreideformation (1869–1911)" which were measured, re-described and re-photographed. The modern systematical and taxonomical descriptions of these nine specimens are the main topic of the present publication. However, in most

cases Frič's stratigraphical data ("Schichten") have been cited by us in its original form. This is because apart from the type localities of modern lithostratigraphy and a few other well-known and re-studied localities, it would have required much fieldwork and literature study to try to reconstruct the stratigraphical provenience of the specimens in terms of modern lithostratigraphy, especially in those cases where outcrops do not exist anymore.

Moreover, Frič had mentioned sabellids and serpulids in the text or in fossil lists but without a figure or description. A minor part were citations of earlier data published by earlier authors, but the major part were specimens either collected by Frič himself or presented to him by colleagues or local fossil collectors. In contrast to the sabellid and serpulid specimens which are figured in Frič's publications and which were all found by T. K. in the National Museum's collection, despite some considerable effort, T. K. did not manage to find or identify any of the non-figured but only mentioned specimens in the National Museum. It seems that they had either been lost, or, in part, may have not even been removed from the outcrop. Of course, if neither a specimen nor a figure nor a description exists anymore, it is not possible to control and revise Frič's genus and species determinations. However, all the specimens mentioned are cited by us, with locality names given in Czech as well as (in brackets) in old German. In many cases, we have tried to give at least a "best guess" opinion of which species Frič may have had in his hands, based on our own experience with species occurrences in BCB.

In the six tables below we list all sabellids and serpulids mentioned by Frič in his eight volumes, except for Frič's (1911, p. 101) citation of Geinitz' species list from Saxony, which is omitted here, because one of us (M. J.) is preparing a revision of the Saxony sabellids and serpulids from the Geinitz collection. We affiliate the citations to the six tables according to Frič's scheme of "Schichten". Page numbers are given without adding the year of publication for the "main" volume of the respective "Schichten" mentioned in the caption, with the exception of Table 1 because Frič described the Korycaner "Schichten" in detail in two of his volumes. In Table 1, page numbers 181–242 are from volume one (1869), whereas page numbers 1–101 are from volume eight (1911). Moreover, Frič gave lists of the stratigraphical ranges of the fossil species providing data on occurrence or non-occurrence in the other "Schichten" which were not the topic of the respective volume. We list such citations from "foreign" volumes in the form of: year of publication plus page numbers, both in brackets. "*Serpula*" *amphisbaena* Goldfuss which is a bivalve is listed by us only once because Frič had used the correct combination *Gastrochaena amphisbaena* (or, rarely, *Teredo amphisbaena*) elsewhere, this indicates that Frič clearly recognised that the species *amphisbaena* is a bivalve. In our tables, we corrected the species name "*ampulacea*" to "*ampullacea*". Frič used both spellings, but most often the wrong spelling with only one "l". Occasionally Frič cited the (in his time) correct species names, but combined it with the wrong author. These errors occur irregularly and are therefore considered only typing errors. We corrected them without comment. Locality names, as far as is known, are given with the modern spelling (some of them with old German names or old Czech names in brackets).

Table 1. Sabellids and serpulids from the Korycaner “Schichten” mentioned by Frič (1869, pp. 181–242, and 1911, pp. 1–101), and in some of his other volumes (years and page numbers in brackets).

Pages	Name used by Frič	Stratigraphy according to Frič	Localities	Determinations and remarks
197, 206, 220, 221, (1883, 82) (1889, 58), (1893, 61), (1897, 33)	<i>Serpula gordialis</i> , Schl.	Korycaner Schichten	Zálabí near Kolín, Kolín, Kamajka near Chotusice, Zbyslav, Želenice (Schillinge) near Bílina, Teplice region: Kopfhügel hill near Řetenice (Settzen) and Jeníkov (Janegg or Janig), above Teplice-Šanov (Teplitz-Schönau) (in part Frič cited Reuss)	<i>Glomerula</i> sp., presumably <i>G. serpentina</i>
72 incl. fig. 304	<i>Serpula gordialis</i> (in figure caption), resp. var. <i>serpentina</i> (in the text)	Korycaner Schichten	Kamajka near Chotusice, Zbyslav, Kolín, Velim, Skutičko near Skuteč (Skuč), Kojetic, Kněžívka (Kleinherrendorf)	<i>Glomerula serpentina</i>
208, 211, 212, 231, 237	<i>Serpula plexus</i> , Sow., <i>Serpula (plexus)</i> , <i>Serpula</i> (cf. <i>plexus</i>)	Korycaner Schichten	Ronov near Čáslav, southwest of Koryčany, Skutičko near Skuteč (Skuč), between Kněževs (Kněžoves, Herrendorf) and Kněžívka (Kleinherrendorf)	<i>Glomerula</i> sp., probably <i>G. plexus</i>
206, 221, 223, 235	<i>Serpula filiformis</i> , Sow.	Korycaner Schichten	Zbyslav, Želenice (Schillinge) near Bílina, south foot of Trupelník hill (Trippelberg) near Kučlín, Zlosejn (in part Frič cited Reuss)	<i>Filograna socialis</i>
(1883, 81)	<i>Serpula socialis</i> , Goldf.	Korycaner Schichten	(general list)	<i>Filograna socialis</i>
197, 231	<i>Serpula</i> (cf. <i>canteriata</i> , Hagenow)	Korycaner Schichten	Zálabí near Kolín, Kolín, southwest of Koryčany	indeterminable (maybe <i>Nogrobs</i> sp.?)
220	<i>Serpula fluctuata</i> , Sow.	Korycaner Schichten	near Novosedlice (Weisskirchlitz) near Teplice	maybe <i>Filogranula cincta</i>
221	<i>Serpula cristata</i> , Duj.	Korycaner Schichten	Želenice (Schillinge) near Bílina	<i>Filogranula cincta</i>
221	<i>Serpula Leonhardi</i> , Reuss	Korycaner Schichten	Želenice (Schillinge) near Bílina	<i>Vermiliopsis leonhardi</i> (syn. <i>Vermiliopsis dorsolineata</i>)
206, 221	<i>Serpula antiquata</i> , Sow.	Korycaner Schichten	Kamajka near Chotusice, Zbyslav, Želenice (Schillinge) near Bílina	indeterminable (maybe <i>Neovermilia</i> sp.?)
220	<i>Serpula annulata</i> , Reuss	Korycaner Schichten	near Novosedlice (Weisskirchlitz) near Teplice	maybe <i>Neovermilia</i> sp. aff. <i>ampullacea</i>
(1883, 81), (1889, 58, 97)	<i>Serpula ampullacea</i> , Sow.	Korycaner Schichten	Želenice (Schillinge) near Bílina (Frič cited Reuss)	maybe <i>Neovermilia</i> sp. aff. <i>ampullacea</i>
72 incl. fig. 305	<i>Serpula ampullacea</i> , Sow.	Korycaner Schichten	Skuteč (Skuč), Radovesnice, Kojetice, Čáslav, Třebenice, Kamajka near Chotusice, Přemyslení (Přemyslan) at the northern periphery of Prague, Želenice (Schillinge) near Bílina (citation of Reuss)	<i>Dorsoserpula conjuncta</i> ?
18 incl. fig. 75	<i>Burtinella</i> ? <i>Reussii</i> , Weinz. (in the text), resp. <i>Burtinella Reussii</i> , Weinz. (in the caption)	Korycaner Schichten	Kamajka near Chotusice, Zbyslav	copies of Weinzettl's figs 46 and 47. Will be described elsewhere by us as <i>Laqueoserpula reussi</i> .
201, 231, 237	<i>Serpula conjuncta</i> , Gein.	Korycaner Schichten	Nebovidy, southwest of Koryčany, between Kněževs (Kněžoves, Herrendorf) and Kněžívka (Kleinherrendorf)	<i>Dorsoserpula conjuncta</i> ?
207, 208	<i>Serpula</i> (cf. <i>conjuncta</i> Gein.)	Korycaner Schichten	‘Na svornosti’ lake near Čáslav, Ronov near Čáslav	<i>Dorsoserpula conjuncta</i> ?
200	riesigen Serpulen	Korycaner Schichten	Nebovidy	<i>Dorsoserpula conjuncta</i> ?
197	<i>Serpula bipartita</i> , Reuss	Korycaner Schichten	Zálabí near Kolín, Kolín	<i>Dorsoserpula bipartita</i> (Reuss)
228	<i>Serpula septemsulcata</i> , Reich	Korycaner Schichten	Holubic	<i>Pyrgopolon (Pyrgopolon) septemsulcata</i>
206, 217	<i>Serpula</i> sp., <i>Serpula</i>	Korycaner Schichten	Zbyslav, Tyssa	indeterminable
221	<i>Serpula unilineata</i> , Röm. (<i>Rotula</i> Reuss)	Korycaner Schichten	Želenice (Schillinge) near Bílina	indeterminable
231	<i>Serpula</i> (cf. <i>quinquecarinata</i> , Röm.)	Korycaner Schichten	southwest of Koryčany	indeterminable
231	<i>Serpula</i> n. sp. and <i>Serpula</i> n. sp. (large, triangular)	Korycaner Schichten	southwest of Koryčany	indeterminable
72 incl. fig. 306	<i>Serpula</i> sp. (in the text), respectively n. sp. (in figure caption)	Korycaner Schichten	Skuteč (Skuč)	<i>Serpulidae</i> gen. et sp. indet.
223	<i>Serpula amphisbaena</i> , Goldfuss	Korycaner Schichten	south foot of Trupelník hill (Trippelberg) near Kučlín (Frič cited Reuss)	Bivalve <i>Gastrochaena amphisbaena</i>

Table 2. Sabellids and serpulids from the Weissenberger “Schichten” (with subunits in brackets) and Malnitzer “Schichten” mentioned by Frič (1878), and in some of his other volumes (years and page numbers in brackets).

Pages	Name used by Frič	Stratigraphy according to Frič	Localities	Determinations and remarks
(1889, 58), (1893, 61), (1897, 33)	<i>Serpula gordialis</i> , v. Schl.	Weissenberger Schichten and Malnitzer Schichten	(general list)	<i>Glomerula</i> sp., presumably <i>G. serpentina</i>
47	<i>Serpula gordialis</i>	Weissenberger Schichten (Dřinower Knollenschicht)	Base of the Pětihorka	<i>Glomerula</i> sp., presumably <i>G. serpentina</i>
48	<i>Serpula gordialis</i>	Weissenberger Schichten (Wehlowitzer Pläner) – Malnitzer Schichten	path to the Kirchberg hill near Hodkovice (Liebenau)	<i>Glomerula</i> sp., presumably <i>G. serpentina</i>

71	<i>Serpula gordialis</i>	Weissenberger Schichten (Wehlowitzer Pläner)	Strahov gate (Strahöwer/Strahover Tor) on the Bílá hora hill (Weisser Berg) near Teinka in Prague	<i>Glomerula</i> sp., presumably <i>G. serpentina</i>
45	<i>Serpula</i> sp.	Weissenberger Schichten (Semitzer Mergel)	above Svatoňovice (Schwadowitz)	indeterminable
64	<i>Serpula</i>	Weissenberger Schichten (Wehlowitzer Pläner)	Peruc (Perutz)	indeterminable
76	<i>Serpula</i> sp.	Weissenberger Schichten (Dřinower Knollen)	vineyard Zděňčina above Nové Dvorce (Neuhof)	indeterminable

Table 3. Sabellids and serpulids from the “Ierschichten” (with subunits in brackets) mentioned by Frič (1883), and in some of his other volumes (years and page numbers in brackets).

Pages	Name used by Frič	Stratigraphy according to Frič	Localities	Determinations and remarks
129, (1889, 58), (1893, 61), (1897, 33)	<i>Serpula gordialis</i> , Schloth.	Ierschichten	Brandýs nad Orlicí (Brandeis an der Adler) (and general list)	<i>Glomerula</i> sp., presumably <i>G. serpentina</i>
13, 82	<i>Serpula gordialis</i> , Sch.	Ierschichten (Zwischenpläner within the Kokořiner Quader)	Řepín, Nosadlov = Novosedlov?	<i>Glomerula</i> sp., presumably <i>G. serpentina</i>
31, 82, 129	<i>Serpula gordialis</i>	Ierschichten (Trigoniaschichten)	Choroušky (Choroušek)	<i>Glomerula</i> sp., presumably <i>G.</i>
18, 31, 82, 129	<i>Serpula gordialis</i>	Ierschichten (Bryozoenschichten)	Kanina region, Choroušky (Choroušek), Vtelno, Husovodol (Husodol), Živonín	<i>Glomerula</i> sp., presumably <i>G. serpentina</i>
138, (1897, 33)	<i>Serpula socialis</i> , Goldf.	Ierschichten	(general list)	<i>Filograna socialis</i>
13, 81	<i>Serpula socialis</i> , Goldf.	Ierschichten (Zwischenpläner, Kokořiner Quader)	Řepín	<i>Filograna socialis</i>
15, 16, 31, 39, 41, 43, 47, 53, 74, 81, 128 with fig. 113	<i>Serpula socialis</i> , Goldf.	Ierschichten (Trigoniaschichten)	Choroušky (Choroušek), Labe (Elbe) region, Jizera (Iser) region, Orlice (Adler) region, Jizera (Iser) valley in Zámostí, Mladá Boleslav (Jungbunzlau), Čejtic station near Mladá Boleslav (Jungbunzlau), below Bezděz (Bösig) village, Dolánky (Dolanek) near Turnov, Báčův quarry near Choceň (Chotzen), near Česká Třebová (Böhmisch Trübau), Desná	<i>Filograna socialis</i>
61, 128	<i>Serpula socialis</i> , Goldf.	Ierschichten (Trigoniaschichten, Callianassaschichten)	between Třebovice (Triebitz) and Rybník near Česká Třebová (Böhmisch Trübau)	<i>Filograna socialis</i>
71, 73	<i>Serpula socialis</i> , Goldf.	Ierschichten (either top of Trigonienschichten or base of Bryozoenschichten, with <i>Callianassa</i>)	Vraclav, Desná	<i>Filograna socialis</i>

57, 128	<i>Serpula filiformis</i>	Irserschichten (either top of Trigonienschichten or base of Bryozoenschichten)	Brandýs nad Orlicí (Brandeis an der Adler)	<i>Filograna socialis</i> (<i>Serpula filiformis</i> was affiliated to <i>socialis</i> by Frič on page 128)
18, 31, 54, 81	<i>Serpula socialis</i> , Goldf.	Irserschichten (Bryozoenschichten and equivalents)	Kanina region, Choroušky (Choroušek), ?Újezd, Báčův quarry near Choceň (Chotzen), Choceň (Chotzen) graveyard	<i>Filograna socialis</i>
128-129, (1889, 58)	<i>Serpula ampullacea</i> , Sow.	Irserschichten	Mladá Boleslav (Jungbunzlau)	<i>Dorsoserpula wegneri</i> (or <i>Neovermilia ampullacea</i>)
31, 39, 43, 53, 81, 128-129 incl. fig. 114	<i>Serpula ampullacea</i> , Sow.	Irserschichten (Trigonienschichten)	Choroušky (Choroušek), Bezno, Písník near Česká Lípa (Böhmisch Leipa), Báčův quarry near Choceň (Chotzen), Choceň (Chotzen) graveyard	Fig. 114 is <i>Dorsoserpula wegneri</i> . Some other specimens may either be <i>Dorsoserpula wegneri</i> or <i>Neovermilia ampullacea</i>
62, 128-129	<i>Serpula ampullacea</i> , Sow.	Irserschichten (Trigonienschichten, Callianassaschichten)	near Česká Třebová (Böhmisch Trübau)	<i>Dorsoserpula wegneri</i> (or <i>Neovermilia ampullacea</i>)
18, 31, 81	<i>Serpula ampullacea</i> , Sow.	Irserschichten (Bryozoenschichten)	Kanina region, Choroušky (Choroušek), Živonín	<i>Dorsoserpula wegneri</i> (or <i>Neovermilia ampullacea</i>)
128-129, (1889, 57)	<i>Serpula macropus</i> , Sow.	Irserschichten	Dalovice (Dalovic), Písník near Česká Lípa (Böhmisch Leipa)	<i>Neovermilia</i> cf. <i>ampullacea</i>
31, 40, 53, 58, 82, 128-129 incl. fig. 115	<i>Serpula macropus</i> , Sow.	Irserschichten (Trigonienschichten)	Choroušky (Choroušek), Čejtic station near Mladá Boleslav (Jungbunzlau), Báčův quarry near Choceň (Chotzen), Brandýs n. Orlicí (Brandeis an der Adler)	<i>Neovermilia</i> cf. <i>ampullacea</i> (<i>triangularis</i> was affiliated to <i>macropus</i> by Frič on page 128)
18, 31, 82, 128-129	<i>Serpula macropus</i> , Sow.	Irserschichten (Bryozoenschichten)	Kanina region, Choroušky (Choroušek), Živonín, Vteln	<i>Neovermilia</i> cf. <i>ampullacea</i> (<i>triangularis</i> was affiliated to <i>macropus</i> by Frič on page 128)
71	<i>Serpula adhaerens</i>	either Weissenberger Schichten (Wehlowitzer Pläner) or Irserschichten (lower portion of Trigonienschichten)	Vinary (Vinar) quarry	indeterminable

Table 4. Sabellids and serpulids from the Teplitzer “Schichten” mentioned by Frič (1889), and in some of his other volumes (years and page numbers in brackets).

Pages	Name used by Frič	Stratigraphy according to Frič	Localities	Determinations and remarks
(1883, 82), 11, 22, 40, 42, 48, 51, 58, (1893, 61), (1897, 33)	<i>Serpula gordialis</i> , v. Schl.	Teplitzer Schichten	Teplice region, including Hudcov (Hundorf), Řetenice (Settanz) and Lahošt (Loosch), Čížkovice near Lovosice, Vevěří (Gaubenhof) near Litoměřice (Leitmeritz), Sedlec near Benátky (Benatek), near Smiřic on road to Smržov	<i>Glomerula</i> sp.
96 incl. fig. 122	<i>Serpula gordialis</i> , v. Schl.	Teplitzer Schichten	Třtěno (Kröndorf) near Chožov	<i>Glomerula plexus</i>

96	<i>Serpula gordialis</i> , v. Schl., var. <i>infibulata</i>	Teplitzer Schichten	Hudcov (Hundorf) (Frič cited Reuss)	<i>Glomerula</i> sp.
96	<i>Serpula gordialis</i> , v. Schl., var. <i>implicata</i>	Teplitzer Schichten	Brozánky (Brozan) (Frič cited Reuss)	<i>Glomerula</i> sp.
(1883, 81), 7	<i>Serpula socialis</i> , Goldf.	Teplitzer Schichten. However, on page 7 Frič stated that <i>Serpula socialis</i> is absent in the Teplitzer Schichten.	(general list)	<i>Filograna socialis</i>
(1883, 81), 58, 97	<i>Serpula ampullacea</i> , Sow.	Teplitzer Schichten	Dresden-Strehlen in Saxony (Frič cited Geinitz)	<i>Neovermilia ampullacea</i>
(1883, 82), 57, 96	<i>Serpula macropus</i> , Sow.	Teplitzer Schichten	Dresden-Strehlen in Saxony (Frič cited Geinitz)	<i>Neovermilia ampullacea</i>
22, 58, 96	<i>Serpula pustulosa</i> , Gein.	Teplitzer Schichten	Teplice region, including Hudcov (Hundorf), Řetenice (Settenz) and Lahošt (Loosch), Dresden-Strehlen in Saxony (Frič cited Reuss and Geinitz)	<i>Neovermilia ampullacea</i>
22, 57	<i>Serpula biplicata</i> , Reuss	Teplitzer Schichten	Teplice region, including Hudcov (Hundorf), Řetenice (Settenz) and Lahošt (Loosch)	<i>Serpula?</i> (<i>Cementula?</i>) <i>biplicata</i>
22, 57, 96	<i>Serpula depressa</i> , v. Münst.	Teplitzer Schichten	Teplice region, including Hudcov (Hundorf), Řetenice (Settenz) and Lahošt (Loosch)	<i>Laqueoserpula reussi</i>
24, 40, 58, 97	<i>Serpula granulata</i>	Teplitzer Schichten	Kyselka (Sauerbrunnberg) near Bílina, Čížkovice near Lovosice	<i>Neomicrorbis crenatostriatus crenatostriatus</i>
57, 96	<i>Serpula umbilicata</i> , v. Hag.	Teplitzer Schichten	(general list), Dresden-Strehlen in Saxony (Frič cited Geinitz)	<i>Neomicrorbis crenatostriatus</i> , subsp. indet.
22, 58, 97	<i>Serpula rotula</i> , Goldf.	Teplitzer Schichten	Teplice region, including Hudcov (Hundorf), Řetenice (Settenz) and Lahošt (Loosch), Kučlín (Kutschlin) near Bílina	? <i>Neomicrorbis crenatostriatus</i> , subsp. indet.
48	Serpularöhren	Teplitzer Schichten	Sedlec near Benátky (Benatek)	indeterminable

Table 5. Sabellids and serpulids from the Priesener “Schichten” mentioned by Frič (1893), and in some of his other volumes (years and page numbers in brackets).

Pages	Name used by Frič	Stratigraphy according to Frič	Localities	Determinations and remarks
61, (1897, 33)	<i>Serpula gordialis</i> , Schl.	Priesener Schichten	(general list)	<i>Glomerula</i> sp.
109	<i>Serpula gordialis</i> , Schl. var. <i>tuba</i> Sow.	Priesener Schichten	Lužice (Luschitz), Březno (Priesen) (Frič cited Reuss)	? <i>Glomerula</i> sp.
7, 61, 109	<i>Serpula tetragona</i> , Sow.	Priesener Schichten (not in older Schichten)	Lužice (Luschitz) (Frič cited Reuss)	<i>Nogrobs</i> sp.
7, 61, 109	<i>Serpula subtorquata</i> , v. Münster	Priesener Schichten (not in older Schichten)	Lužice (Luschitz) (Frič cited Reuss)	<i>Pentaditrupa subtorquata</i>
7, 61, 109	<i>Serpula subinvoluta</i> , Reuss	Priesener Schichten (not in older Schichten)	Březno (Priesen) (Frič cited Reuss)	needs revision
61, 109	<i>Serpula spinulosa</i> , Reuss	Priesener Schichten	Lužice (Luschitz) (Frič cited Reuss)	needs revision
41, 61	<i>Serpula</i> , <i>Serpula?</i>	Priesener Schichten, topmost layers	near Vinařice near Doubravice	indeterminable

Table 6. Sabellids and serpulids from the Chlomeker Schichten mentioned by Frič (1897), and in some of his other volumes (years and page numbers in brackets).

Pages	Name used by Frič	Stratigraphy according to Frič	Localities	Determinations and remarks
19, 23, 33, 71	<i>Serpula gordialis</i> , v. Schloth.	Chlomeker Schichten	Chlomek hill near Vinařice, Jedlová (Tannenberg) near Česká Kamenice (Böhmisch Kamnitz), Chřibská (Kreibitz), Idzików (Kieslingswalde) in Poland	<i>Glomerula</i> sp.
19, 23, 33, 71	<i>Serpula socialis</i> , Goldf.	Chlomeker Schichten	Chlomek hill near Vinařice, Jedlová (Tannenberg) near Česká Kamenice (Böhmisch Kamnitz), Chřibská (Kreibitz), Idzików (Kieslingswalde) in Poland	<i>Filograna socialis</i>

Systematic palaeontology

Classification of ranks higher than genus level follows that of the World Register of Marine Species (WoRMS), see <http://www.marinespecies.org>. Much information on systematics and taxonomy of living serpulids can be found in ten Hove and Kupriyanova (2009). Classic work on European Cretaceous sabellids and serpulids include, among others, J. de C. Sowerby (1826–1829, 1840–1846), Goldfuss (1826–1844), von Hagenow (1840), Brünnich Nielsen (1931), Regenhardt (1961), Ware (1975), Lommerzheim (1979) and Jäger (1983, 1993, 2005). Important publications about sabellids and serpulids of BCB, beside those of Frič dealt with in the present paper are, among others, Reuss (1845–1846), Geinitz (1839–1842, 1843, 1871–1875), Ziegler (1967, 1969, 1973, 1974, 1978, 1984), Kočí (2007, 2010, 2012) and Sklenář et al. (2013). The species from the Teplitzer Schichten have only recently been revised in the two last mentioned publications.

Class **Polychaeta** GRUBE, 1850

Subclass **Canalipalpata** ROUSE et FAUCHALD, 1997

Order **Sabellida** FAUCHALD, 1977

Family **Sabellidae** LATREILLE, 1825

Subfamily **Sabellinae** CHAMBERLIN, 1919

Genus **Glomerula** BRÜNNICH NIELSEN, 1931

Glomerula serpentina (GOLDFUSS, 1831)

Pl. 3, figs 1a–c, figs 2 a–c

- 1831 *Serpula gordialis* SCHLOTH. varietas *serpentina*; Goldfuss: p. 240, pl. 71, fig. 4.
 1840 *Serpula implicata* nob; von Hagenow: p. 668, pl. 9, fig. 17.
 1845 *Serpula serpentina* GOLDF; Reuss: p. 106, pl. 42, fig. 22.
 1911 *Serpula gordialis*, [resp.] var. *serpentina*; Frič: p. 72, fig. 304.
 pars 1983 *Glomerula gordialis* (SCHLOTHEIM, 1820); Jäger: p. 26, pl. 2, figs 1–10, 13–18, non figs 11–12.
 1984 *Glomerula gordialis* (SCHLOTHEIM, 1820); Ziegler: p. 215, pl. 1, figs 3–5.
 2005 *Glomerula serpentina* (GOLDFUSS, 1831); Jäger: p. 130, pl. 1, fig. 1.

M a t e r i a l. The three original specimens figured by Frič (1911, p. 72, fig. 304) from the lowermost Turonian Korycaner “Schichten” of Kamajka (originally named Kamajk or Kamýk) near Chotusice, coll. National Museum, Prague, left specimen NM O7127, middle specimen NM O7128, right specimen NM O7129 according to the original illustrated by Frič.

D e s c r i p t i o n. The two specimens figured by Frič on the left and on the right (on our pl. 3, figs 1a, 1c, 2a and 2c) are irregular planar spirals whereas the specimen in the middle (figs 1b and 2b) is a 3D coiled ball. Specimen figs 1a and 2a measures 12.5 mm x 10.5 mm, specimen figs 1b and 2b is about 8.4 mm high, and specimen figs 1c and 2c is 8.7 mm x 9 mm. Tube diameters for the same order of specimens are respectively, 1.8 mm, 1.4 mm and 1.6 mm. All tubes have a smooth surface and lack trilobate lumina.

R e m a r k s a n d r e l a t i o n s h i p s. A natural scheme of differentiation between species of the genus *Glomerula* is almost impossible because the tubes are palaeogeographically widespread and have existed since circa 200 million years from the lowermost Jurassic (Hettangian) until today with little change in the general construction of the tube. The more or less smooth tubes lack the most common features, for example ornamentation, which normally enable differentiation between serpulid species. The only obvious phylogenetic progress within *Glomerula* was the optional introduction of trilobate constrictions into the tube’s lumen somewhere around the Jurassic/Cretaceous transition (the hitherto geologically oldest specimens with trilobate narrowings are found in the uppermost Valanginian) enabling differentiation between a Jurassic set and a Cretaceous to Recent set of *Glomerula* species. Within the Cretaceous to Recent set further differentiation between fossil species is very artificial, based on distinguishing between small (*G. lombricus*) versus large (*G. serpentina* and *plexus*) tube diameter and more or less solitary (*G. lombricus* and *G. serpentina*) versus more or less social, cluster forming (*G. plexus*) occurrence. This artificial scheme had been introduced by one of us (M. J.) and had been slightly modified several times by Jäger (1983, 1993, 2005, 2012), with the latest slight modification introduced by T. K. (in Sklenář et al. 2013), see remarks in the chapter on *Glomerula plexus*.

Glomerula lombricus (DEFRANCE) occurring in offshore facies on fine-grained sediments is a similar but smaller species with a smooth tube surface. Its tube diameter ranges from 0.4 to 1 mm and is usually 0.5–0.9 mm. The tube diameter of *Glomerula serpentina* most often ranges from ca. 1 to ca. 2 mm and usually does not exceed 2 mm. Occasionally larger tubes occur, for example in nearshore shallow water deposits in BCB, for example at the locality Velim, where tube diameter may become very large, but when occurring in clusters the number of individual tubes in a cluster is less compared to typical specimens of *Glomerula plexus*. More detailed remarks and discussion of relationships was published by Kočí (2012) and Sklenář et al. (2013).

Palaeoecology. See Seilacher et al. (2008).

Occurrence in BCB. Upper Cenomanian – Bílina, Brázdím, Hodkovice (Ve skalách), Korycany, Miskovice, Velim, Kamajka, Vítězov. Lower Turonian – Běstvína u Ronova nad Doubravou, Chrtníky, Kamajka, Kaňk, Turkaňk, Nová Ves u Kolína, Předboj, Velim – Skalka, Starkoč, Nová Lhota u Kutné Hory. Middle Turonian – Benátky nad Jizerou, Brandýs nad Orlicí, Česká Třebová, Dolánky u Turnova, Klokočské Loučky, Kokořín, Libuň, Kněžnice, Nouzouv u Svitav, Rovensko pod Troskami, Turnov. Upper Turonian – Čížkovice, Oškobrň, Přerovská hůra, Teplice, Vinařice. Coniacian – Hrdoňovice, Prachovské skály, Valdštejn, Mašov u Turnova.

Glomerula plexus (J. DE C. SOWERBY, 1829)

Pl. 1, fig. 1; Pl. 2, fig. 1

- ? 1820 *Serpulites contorquatus*; von Schlotheim: p. 96.
 1829 *Serpula Plexus*; J. de C. Sowerby: p. 201, pl. 598, fig. 1.
 1831 *Serpula vibicata* MÜNSTER; Goldfuss: p. 240, pl. 71, fig. 3 a–b.
 pars 1875 *Serpula gordialis* SCHL; Geinitz, II: p. 200, pl. 37, fig. 4, non fig. 3.
 1889 *Serpula gordialis*, v. SCHL; Frič: p. 96, fig. 122.
 1961 *Filograna congesticia* n. sp.; Regenhardt: p. 23, pl. 2, fig. 3.
 non 1973 *Filogarana* [sic!] *congesticia* REGENHARDT, 1961; Ziegler: pp. 34–35, pl. 5, fig. 3.
 1983 *Glomerula plexus* (SOWERBY, 1829); Jäger: p. 31, pl. 3, figs 1–3.
 pars 1984 *Filograna congesticia* REGENHARDT, 1961; Ziegler: p. 214, pl. 1, fig. 1, non fig. 2.
 non 1984 *Sarcinella plexus* (SOWERBY, 1829); Ziegler: p. 220, pl. 2, fig. 6.
 2005 *Glomerula plexus* (J. DE C. SOWERBY, 1829); Jäger: p. 131.
 2013 *Glomerula plexus* (J. DE C. SOWERBY, 1829); Sklenář et al., p. 678, figs 3A–F, 5A, 6Fa.

Material. The original specimen figured by Frič (1889, p. 96, fig. 122) from the Upper Turonian Teplitzer Schichten of Třtěno (Kröndorf) near Chožov, coll. National Museum, Prague, registration number NM O4378.

Description. The specimen is a ball-shaped mass of irregularly intertwined tubes. It measures 37 mm x 31.2 mm. Tube diameter is very large: 3.3–3.5 mm. All tube have a smooth surface and, as far as visible from outside, lack trilobate lumina.

Remarks and relationships. Differentiation between the more or less solitary *G. serpentina* and the more or less social, cluster-forming *G. plexus* is at least in part artificial. The most typical *G. plexus* clusters from England, Germany and Sweden consist of dozens or even hundreds of tubes, with the whole cluster showing a tendency to form either a bundle or a large ball or dome. However, at many localities where *Glomerula* tubes are common, small clusters occur composed of two to circa five tubes, thereby standing morphologically between *serpentina* and *plexus*. Are these finds small examples of *G. plexus*, or are they only by-chance aggregates of a few *G. serpentina* tubes which attached to each other due to dense spatfall in this area of the sea-floor, sparsity of solid substrates on a generally soft sea-floor, and general tendency of the genus *Glomerula* to adnate its tube closely to solid objects of any kind, including earlier-built portions of its own tube or tubes of other *Glomerula* individuals? While M. J. generally tends to affiliate the small clusters composed of two to circa five tubes to *G. serpentina*, we nevertheless agreed with the suggestion of T. K. (in Sklenář et al. 2013) that in the Teplice Formation of the Úpohlavý quarry all finds of large tube diameter should be determined as *G. plexus* and that *G. serpentina* does not occur at Úpohlavý. The reason for our decision was that medium-sized clusters composed of two to circa five tubes are relatively common here and that many of the tube fragments found in a solitary state seem to be only fragments of such clusters or fragments of ‘seeking’ tubes growing off from a cluster so that differentiation between the two species seems senseless here. The medium-sized cluster figured by Frič clearly matches the finds from Úpohlavý and was found in the Teplitzer Schichten and therefore presumably in the same layer, even though there are, of course, differences in the detailed ranges of Teplitzer Schichten and Teplice Formation. However, it must be stated that even in the Teplitzer Schichten or Teplice Formation the *Glomerula plexus* clusters are on one hand never composed of as many tubes as in typical *plexus* clusters found in England, Germany or Sweden, but that on the other hand in the Teplitzer Schichten or Teplice Formation the tube diameter may grow much larger compared to the moderate size of tubes in typical *plexus* clusters. For more detailed remarks and discussion of *Glomerula* and its species see Sklenář et al. (2013).

Palaeoecology. This species was adapted to life on the soft bottom. The thin-walled sabellids use the same strategy as corals, which use dead portions of their own skeleton as an anchor. Similarly, sabellids use previously built, abandoned portions of their own tube or other tubes within their cluster as an anchor for attachment, after the primary attachment had been to a lithoclast or bioclast of any kind. The spaghetti-form, smooth tubes of the sabellid cluster grow fast in length but relatively slowly in diameter so that in a fragment one can often not decide which end had been posterior and which anterior (for example, Seilacher et al. 2008, fig. 3A).

Occurrence in BCB. Upper Turonian – Křtěnov, Čížkovice, Úpohlavý, Radovesice.

Family **Serpulidae** RAFINESQUE, 1815

Subfamily **Filigraninae** RIOJA, 1923

Genus **Filigrana** OKEN, 1815

Filigrana socialis (GOLDFUSS, 1831)

Pl. 1, fig. 2; Pl. 2, fig. 2

- 1831 *Serpula socialis* nobis; Goldfuss: p. 235, pl. 69, fig. 12 a–c.
1836 *Serpula filiformis*; Sowerby in Fitton: p. 340, pl. 16, fig. 2.
1845 *Serpula filiformis* SOW; Reuss: p. 20, pl. 5, fig. 26.
1846 *Serpula filiformis* SOW. bei FITTON; Geinitz: p. 253, pl. 16, fig. 25.
1875 *Serpula socialis* GOLDF; Geinitz: p. 200, pl. 37, fig. 2.
1883 *Serpula socialis* GOLDF; Frič: p. 128, text–fig. 113.
1961 *Sarcinella socialis* (GOLDFUSS, 1831); Regenhardt: p. 29, pl. 1, fig. 5.
1961 *Filigrana sollistima* n. sp; Regenhardt: p. 24, pl. 2, fig. 4.
1973 *Sarcinella socialis* (GOLDFUSS); Ziegler: p. 36, pl. 5, figs 4–6; pl. 6, fig. 1.
1978 *Sarcinella socialis* (GOLDFUSS); Ziegler: p. 218, pl. 50, fig. 4.
1979 *Filigrana plexus* (SOWERBY, 1829); Lommerzheim: p. 128.
1983 *Filigrana socialis* (GOLDFUSS, 1831); Jäger: p. 20, pl. 1, figs 3–8.
1984 *Sarcinella socialis* (GOLDFUSS, 1831); Ziegler: p. 219, pl. 2, figs 7–8.
2005 *Filigrana socialis* (GOLDFUSS, 1831); Jäger: p. 135.
2012 *Filigrana socialis* (GOLDFUSS); Kočí: p. 9, pl. 1, fig. 5.

Material. The original specimen figured by Frič (1883, pp. 128–129, fig. 113) from the Middle Turonian Iserschichten of Mladá Boleslav (Jungbunzlau), coll. National Museum, Prague, registration number NM O6051.

Description. A staghorn- or Y-shaped bundle composed of more than sixty tubes attached to each other and oriented more or less parallelly. All tubes have a smooth surface and are more or less circular in cross-section. The width of the right branch of the staghorn-shaped bundle is 11 mm, and height is 7.5 mm in oval cross-section. Total length of the specimen is circa 30 mm. Tube diameter ranges from 1 to 1.8 mm.

Remarks and relationships. *Filigrana filosa* (DUJARDIN) forms similar staghorn-shaped bundles consisting of many tubes, but differs from *F. socialis* by its smaller tube diameter which is only 0.2–0.4 mm.

Palaeoecology. The staghorn-shaped colonial bundles composed of many thin-walled *Filigrana* tubes growing more or less parallel to each other represent another adaptation for living on a soft substratum by forming ‘reeflets’ heavy enough to remain stable on a soft bottom, with the anterior portions of their Y-like dividing branches, as in staghorn corals, ascending above the sea-floor (Seilacher et al. 2008, fig. 3C–D). However, in contrast to staghorn corals, the *Filigrana* bundles not only divide, but sometimes unite to form a kind of ‘noose’ or 3D ‘web’. This is seen, for example, also in Frič’s original specimen. In the fossil state, such large web-shaped colonies are often found broken into cylindrical or Y-shaped fragments of bundles, and it is hard to distinguish if an isolated Y-shaped fragment represents a division or rather a

uniting of bundles. More detailed remarks and discussion of relationships were published by Jäger (1983, 2005) and Kočí (2012).

Occurrence in BCB (data mainly from different volumes of Frič’s work and from Ziegler (1973, 1978). The genus *Filigrana* is easily recognised by its bundle-shaped colony fragments consisting of many small parallel tubes, therefore it is very probable that locality data provided in the literature represent true occurrences of *Filigrana* even if the specimens are neither described nor figured. *Filigrana socialis* is widespread in the Middle Turonian of BCB and is especially common at Dolánky u Turnova, Klokočské Loučky, Jizerní Vtělno, Sychrov. General list: Lower Turonian – Kaňk. Middle Turonian – Dolánky near Turnova, Malá Skála, Klokočské Loučky, Vápeník near Turnov, Libuň, Železnice (quarry – “Na Váze”), Rovensko pod Troskami, Jizerní Vtělno, Sychrov, Mladá Boleslav, Benátky nad Jizerou, Kokořín, Brandýs nad Orlicí, Desná, Bezno near Zámostí, Čejtice, Česká Lípa, Choceň, Písník, Česká Třebová, Dalovice, Svitavy area.

Subfamily **Serpulinae** RAFINESQUE, 1815

Genus **Neovermilia** DAY, 1961

Neovermilia cf. ampullacea (J. DE C. SOWERBY, 1829)

Pl. 1, figs 4 a–b; Pl. 2, fig. 4

- 1883 *Serpula macropus* SOW; Frič: p. 128, fig. 115 a–b.
1889 *Serpula macropus*, SOW; Frič: p. 96.

Material. The original specimen figured and mentioned by Frič (1883, p. 129, fig. 115) from the Middle Turonian Iserschichten of Choroušky (Choroušek), but labelled from Živonín, coll. National Museum, Prague, registration number NM O6050.

Description. A curved tube, attached to a substrate along its entire preserved length. Frič oriented the specimen so that the posterior tube portion is situated in the lower part of the drawing and seen from above, whereas the less well preserved anterior tube portion is situated in the upper part of the drawing and seen in lateral aspect. The tube has a small but distinct keel which is undulated in the posterior tube portion but straight in the anterior tube portion. Tube width at the base is 5 mm. Diameter of the lumen is 1.4 mm. The transverse ornamentation consists of densely packed parallel striae and ribs which are curved so that they protrude anteriorly at the base and at the keel. However, in Frič’s drawing the transverse ornamentation is shown idealized and a bit too regular. The tube is triangular in cross-section. The lumen is circular. The cells of the basal cellular layers are broad.

Remarks and relationships. Following Geinitz (1875), Frič and other authors of the 19th century and first decade of the 20th century misdetermined the morphological variety of *Neovermilia ampullacea* with a keel and triangular cross-section as *Serpula macropus* J. DE C. SOWERBY. However, this species, which today is named *Pyrgopolon (Septenaria) macropus* (J. DE C. SOWERBY) and is well defined by morphological as well as structural features, occurs only very rarely in BCB. Frič’s tube is a

triangular keeled specimen of the very variable group of *Neovermilia* cf. *ampullacea* (J. DE C. SOWERBY). However, its distinct and curved transverse ribs are rather unusual for *Neovermilia* cf. *ampullacea* and resemble the genus *Placostegus* PHILIPPI instead, but the tubes of *Placostegus* are usually smaller, therefore *Neovermilia* cf. *ampullacea* seems to be the more reliable determination.

P a l a e o e c o l o g y . Like most serpulids, *Neovermilia ampullacea* is an epibiont usually attached to a litho- or bioclast, for example an oyster or inoceramid valve, an ammonite shell or a sponge. However, some specimens are attached to a foreign object with only a short posterior tube portion and later are attached to their own previously built tube portions and/or may built a more or less long free anterior tube portion. For more detailed informations see Sklenář et al. (2013).

O c c u r r e n c e i n B C B . Middle Turonian – Živonín.

Genus *Dorsoserpula* PARSCH, 1956

Dorsoserpula wegneri (JÄGER, 1983)

Pl. 1, figs 3a-b, Pl. 2, fig. 3

- 1883 *Serpula ampulacea* [sic!] SOWERBY; Frič: p. 128, fig. 114 a–b.
 1905 *Serpula carinata* nov. sp.; Wegner: p. 152, pl. 8, fig 3 a–c.
 1983 *Parsimonia wegneri* nom. nov.; Jäger: p. 38, pl. 4, figs 1–9.
 pars 1984 *Sarcinella minor* nov. spec; Ziegler: p. 220 pl. 2, fig. 4, non fig. 5.
 1984 *Martina parva* nov. spec; Ziegler: p. 227, pl. 3, fig. 9.
 1984 *Spirorbis asper* (VON HAGENOW), 1840; Ziegler: p. 242, pl. 7, fig. 6.
 1984 *Spirorbis subrugosus* (MÜNSTER), 1831; Ziegler: p. 244, pl. 8, fig. 2.
 1984 *Spirorbis superminor* nov. spec; Ziegler: p. 245, pl. 8, fig. 3.
 2005 *Dorsoserpula wegneri wegneri* (JÄGER, 1983); Jäger: p. 163, pl. 4, figs 3–6.

M a t e r i a l . The original specimen figured by Frič (1883, p. 129, fig. 114) from the Middle Turonian Iserschichten of Choroušky, coll. National Museum, Prague, registration number NM O6057.

D e s c r i p t i o n . The tube is coiled to form an irregular 3D spiral consisting of 3, 5 whorls lying upon each other. Tube diameter is 4.5 mm. The surface of the tube has a delicate but distinct transverse striation with the striae densely packed and parallel to each other. The tube has a thin wall and is circular in cross-section. During examination of this specimen, one of us (T. K.) detected the very small cross-section of a side tube ('Nebenröhre'; Jäger, 1983) at the base of the tube (on the lower left side of the figures).

R e m a r k s a n d r e l a t i o n s h i p s . During joint fieldwork in 2006 at the serpulid-rich Middle Turonian locality Klokočské Loučky we noted in addition to the striking predominance of the species *Filograna socialis* which is usual for the 'Iserschichten', the absence of

Neovermilia ampullacea, and only a single find of the rare *Filograna cincta* (GOLDFUSS) by M. J., and the frequent occurrence of a species which resembles *Dorsoserpula wegneri*. However, all the *wegneri*-like specimens we found at Klokočské Loučky lack the optional special features of the genus *Dorsoserpula*, that is the presence of the 'Nebenröhre' and the tube coiling spirally around an upright cylindrical substrate. Similar tubes displaying some variability were found at the same locality during fieldwork between 2001 and 2010 by T. K., one of them has a tube shape similar to *D. wegneri* and another one (donated to Dr. R. Vodrážka in 2007) has a fine but sharp keel. Determination of our finds had remained uncertain for several years. We even discussed possible affiliation to *Parsimonia* REGENHARDT, a genus which is indeed similar to *Dorsoserpula*, but always lacks a "Nebenröhre" and should be considered separate (Jäger 2005, p. 162) from *Dorsoserpula* and be restricted to thin-walled, more or less large-sized species in general similar to the type species *Parsimonia parsimonia* REGENHARDT. For example, the specimens we collected at Klokočské Loučky as well as Frič's specimen, resemble *Parsimonia* sp. as described and figured by Jäger (1983; Taf. 4, fig. 10) from the Lower Campanian of Merfeld in northern Germany. However, the recent discovery of a "Nebenröhre" in Frič's original specimen by one of us (T. K.) clarified the situation: Frič's original specimen and very probably also our specimens from Klokočské Loučky, which are found in rocks of similar geological age and in similar facies, belong to *Dorsoserpula wegneri*.

P a l a e o e c o l o g y . Frič's original specimen as well as many other specimens are attached to a more or less large solid object, for example an oyster valve, which generally is the most common situation in the family Serpulidae. Some other specimens of the genus *Dorsoserpula*, although only a few specimens in BCB during the Middle Turonian, had become specialized and coiled their tube in the shape of a low 3D spiral around an upright cylindrical object, thereby managing to live a short distance above the sea-floor. Moreover, some specimens of *Dorsoserpula* form a similar 3D spiral or a less regular 'ball', but without coiling around an upright substrate, being attached only in the juvenile state to some tiny solid object lying on the sea-floor.

O c c u r r e n c e i n B C B . Middle Turonian – Choroušky, Klokočské Loučky.

Dorsoserpula conjuncta? (GEINITZ, 1843)

Pl. 3, figs 3 a–b

- 1843 *Serpula conjuncta* m; Geinitz: p. 7, pl. 4, figs 6–9.
 1849 *Serpula conjuncta* GEIN; Geinitz: p. 106.
 1875 *Serpula conjuncta* GEIN; Geinitz: p. 283, pl. 63, figs 6–9.
 1911 *Serpula ampulacea* [sic!], SOW; Frič: p. 72, fig. 305.
 1969 *Serpula conjuncta* [sic!] GEINITZ; Ziegler: p. 38, text-figs 1–4.
 ? 1984 *Serpula conjuncta* [sic!] GEINITZ, 1846 [sic!]; Ziegler: p. 223, pl. 3, fig. 2.
 1984 *Mucroserpula velimia* nov. spec; Ziegler: p. 229, pl. 4, fig. 6.

M a t e r i a l . The original specimen figured by Frič (1911, p. 72, fig. 305) from the Upper Cenomanian or

Lower Turonian Korycaner Schichten of Kojetice, coll. National Museum, Prague, specimen NM O7130, collected by J. Petrbock.

Description. The specimen is limonitised. It is a slightly irregularly curved fragment of the free portion of a large robust tube. The tube diameter is 12.2 mm in the anterior portion of the fragment and 11.5 mm in the posterior portion. The transverse ornamentation is distinct and well developed, consisting of many densely packed small rings.

Remarks and relationships. According to Ziegler (1984) the tube diameter of *Dorsoserpula conjuncta* (GEINITZ) is 13–17 mm, the diameter of the lumen is 12–14 mm, and thickness of the tube wall is 0.9–1.2 mm. Some specimens from the type area in Saxony grew to a larger tube diameter, and the thickness of the tube in these specimens is usually several millimetres (Jäger, in prep.) *Protula planianica* ZIEGLER, 1984 resembles *D. conjuncta*, but remains somewhat smaller in diameter and differs by its much thinner tube wall. Although Ziegler (1984) stated that *D. conjuncta* is attached along its entire length, specimens with a free anterior tube portion are found in Saxony (Jäger, in prep.), so that absence of a free portion can no longer be stated as a feature distinguishing *D. conjuncta* from *P. planianica* which possesses an attached portion and also a free portion. Such *P. planianica* specimens were previously mentioned by Ziegler (1984). Among the *P. planianica* specimens collected by one of us (T. K.) there are tubes with an attached and a free portion as well as tubes attached for their entire length which are developed as 3D coiled and meandering tubes, for example from the localities Velim and Uhelná Příbram. *D. conjuncta* has a more distinct transverse ornamentation in the middle and anterior parts of the tube compared to the weaker transverse ornamentation of *P. planianica*. T. K. noted that in the material he collected specimens of *Dorsoserpula cf. conjuncta* from the locality Kaňk can be distinguished from specimens of *D. conjuncta* from Kojetice, Velim and Uhelná Příbram by their more developed cellular layers.

Palaeoecology. According to Ziegler (1969, 1984) *D. conjuncta* was adapted to life on sandy, marly-sandy and marly sediments close to characteristic surf sediment. It attached itself to the soft bottom, pebbles or oyster valves. The specimens of Geinitz's type series and other specimens from the type area in Saxony are found in a rocky coast facies (Jäger, in prep.).

Occurrence in BCB. Upper Cenomanian: Velim, Holubice, Kojetice, Markovice, Nová Ves u Kolína, Plaňany, Radim near Pečky, Uhelná Příbram. Lower Turonian: Kaňk – Na Vrších.

Serpulidae gen. et sp. indet.

Pl. 3, figs 4 a-b

1911 *Serpula* sp; Frič: 72, fig. 306 (as *Serpula* n. sp.).

Material. The original specimen figured by Frič (1911, p. 72, fig. 306) from the Upper Cenomanian or Lower Turonian Korycaner Schichten of Skuteč (Skuč), coll. National Museum, Prague, specimen NM O7131.

Description. The tube which is presumably figured upside down is three-dimensionally coiled, the tube spirals upwards to form a screw-like nearly cylindrical 'tower' consisting of four somewhat 'flattened, turns. The first three turns are coiled regularly, the anteriormost turn elevates obliquely and initially is nearly straight but later continues coiling. In total, the specimen is circa 40 mm high. Tube diameter increases gradually from 4 mm in the posterior part and reaches circa 9.6 mm in the anterior part. Transverse ornamentation consisting of many small, regular, densely shaped rings is not well preserved, but is visible on the surface of one coil.

Remarks and relationships. This specimen, although looking quite impressive at first sight, is only moderately well preserved. No other specimen is available, and therefore variability of the species is unknown. It is indeterminable. It resembles *Dorsoserpula conjuncta* in its large size and by the shape of its three dimensionally coiled tube. Moreover, *Dorsoserpula conjuncta* occurs in strata of similar geological age at some localities of BCB, and also Frič's original specimen (1911, p. 72, fig. 305) described above by us as *Dorsoserpula conjuncta*? was found in the Korycaner Schichten and may represent the same species as Frič's specimen (1911, p. 72, fig. 306). However, in typical *Dorsoserpula conjuncta* specimens the whorls are more closely and smoothly cemented together than in Frič's specimen (1911, p. 72, fig. 306).

Palaeoecology. Presumably the tube had initially been attached to only a small substrate. By using its own previously built tube portions as a substrate, the tube spiralled upward like a screw or tower. By using this strategy, the whole tube became relatively stable in spite of the presumably small initial substrate, and the tube's aperture gained a relatively high position above the sea-floor. Two tubes of an indeterminable species, presumably *Glomerula serpentina* (GOLDFUSS), are attached to the basal portion of the large tube.

Occurrence in BCB Upper Cenomanian or Lower Turonian – Skuteč (Skuč).

Conclusions

We provide a modern revision of the nine specimens figured by Frič, belonging to seven species of sabellid and serpulid tube-worms, all of which are kept in the collection of the National Museum at Prague. Comparison of the old drawings and old photographs figured in Frič's works with our modern photographs made by T. K. prove that Frič's figures are very true to nature. However, the sabellid and serpulid tube-worms figured by Frič represent only a small portion of the many sabellid and serpulid species and specimens mentioned by him in the text of his detailed descriptions of the stratigraphical units of the Cretaceous rocks in BCB, reflecting his broad indepth knowledge of Cretaceous fossils. Unfortunately, all efforts made by T. K. to find these specimens not figured but only mentioned in Frič's text in the collections of the National Museum were in vain, the non-figured specimens seem either not to have been included in the collection, or they were later thrown away or lost. In our six tables we try to reconstruct the actual determination of these no longer existing specimens,

although this reconstruction can only be a 'best guess' trial. However, it is possible to produce the following results which correspond well with our experience with museum specimens collected by authors other than Frič and with specimens collected during our fieldwork. However, we did not try to 'translate' Krejčí's and Frič's historical scheme of stratigraphic units ('Schichten') into modern stratigraphic formations, because with the exception of the stratigraphical type localities and a few other well-studied sites, such a task would be difficult to do due to the fact that many outcrops do not exist anymore.

Frič did not mention any sabellids or serpulids from the Perucer Schichten. This is easily explained by the non-marine facies.

The rocky shore facies of the Korycaner Schichten is very rich in sabellid and serpulid species and specimens.

Note the relative sparsity of data from the Weissenberger Schichten and the extreme sparsity of data from the Malnitzer Schichten.

Frič did not mention any sabellids or serpulids from the Byšicr Übergangsschichten which is the lowermost subunit of the Iserschichten.

In contrast, the other three subunits of the Iserschichten are very rich in sabellid and serpulid specimens, although not very rich in species. The most common species, especially in the Trigoniaschichten subunit, is *Filograna socialis*. However, in BCB this species is absent in the Teplitzer and Priesener Schichten. Frič's (1883, p. 81) mentioning of the occurrence of *Filograna socialis* in the Teplitzer Schichten is an error which he corrected himself (1889, p. 7).

The facies change from the Iserschichten to the Teplitzer Schichten is combined with a moderate change in the sabellid and serpulid fauna.

However, the greatest change in the sabellid and serpulid fauna occurred at the facies change from the Teplitzer Schichten to the offshore marls of the Priesener Schichten. The fauna then became even more dominated by soft-bottom dwellers than in the Teplitzer Schichten. The serpulid fauna of the Priesener Schichten is the least well known of BCB, because after being described by Reuss, only very few new finds were mentioned by Frič (1893) or by Ziegler (1984).

In the Chlomeker Schichten there is only one sabellid species and one serpulid species. The fauna can be considered as an impoverished return of the Iserschichten fauna.

The sabellid genus *Glomerula* occurs in all of Frič's 'Schichten' except in the non-marine Perucer Schichten, whereas each serpulid species occurs in only one unit or a few units.

It is interesting to note that the first modern monograph of serpulids (including sabellids and spirorbins) from BCB was written by Ziegler (1984) almost one hundred years after Frič's work.

Frič's descriptions of the 19th century outcrops (long abandoned quarries and other lost localities) including detailed sections of strata together with their fossil record are an excellent example of the work of a scientist with a vast amount of knowledge. They are of great value for us today because these old descriptions combined with new field data and new fossil finds enable the reconstruction of

palaeoenvironment, facies changes and palaeogeography. The significance of Frič's work is still considerable for new generations of geologists and palaeontologists.

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Explanations of the plates

PLATE 1

1. *Glomerula plexus* (J. DE C. SOWERBY, 1829). Copy of Frič's original drawing (1889, p. 96, fig. 122), specimen originally determined as *Serpula gordialis* v. SCHL., Upper Turonian Teplitzer Schichten, Třtěno (Kröndorf) near Chožov, coll. National Museum, Prague, registration number NM O4378. 3 x.
2. *Filograna socialis* (GOLDFUSS, 1831). Copy of Frič's original drawing (1883, p. 128, fig. 113), specimen originally determined as *Serpula socialis* GOLDF., Middle Turonian Iserschichten, Mladá Boleslav (Jungbunzlau), coll. National Museum, Prague, registration number NM O6051. 3 x.
3. *Dorsoserpula wegneri* (JÄGER). Copy of Frič's original drawing (1883, p. 129, fig. 114), specimen originally determined as *Serpula ampullacea* Sow., Middle Turonian Iserschichten, Choroušky (Choroušek), coll. National Museum, Prague, registration number NM O6057. a – Lateral view showing cross-section of the tube. 2.8 x. b – Detail of the transverse ornamentation. 8.4 x.
4. *Neovermilia cf. ampullacea* (SOWERBY, 1829). Copy of Frič's original drawing (1883, p. 129, fig. 115), specimen originally determined as *Serpula macropus* Sow., Middle Turonian Iserschichten, Choroušky (Choroušek), coll. National Museum, Prague, registration number NM O6050. a – View of posterior portion of the tube. 3 x. b – Detail of the transverse ornamentation. 9 x.

PLATE 2

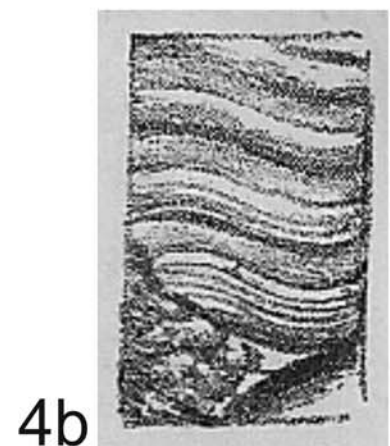
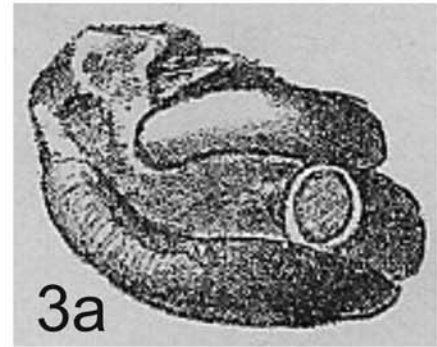
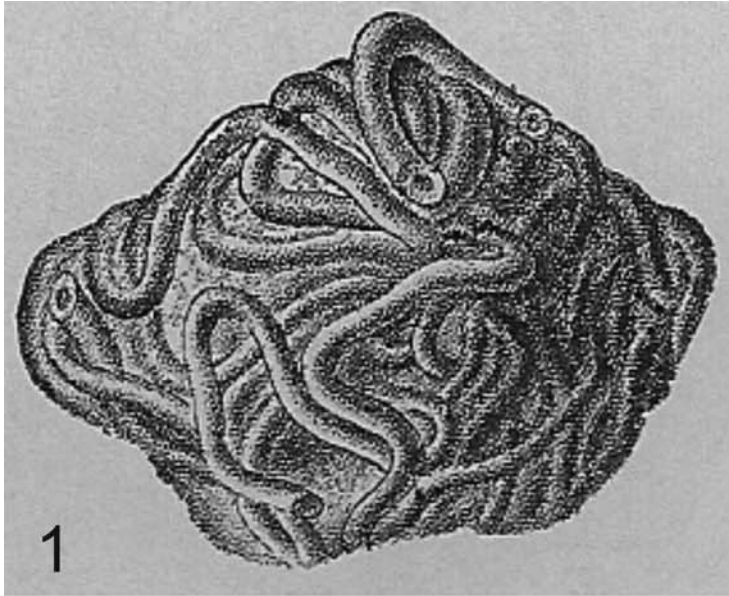
1. *Glomerula plexus* (J. DE C. SOWERBY, 1829). New photograph of Frič's original specimen (1889, p. 96, fig. 122), compare our pl. 1, fig. 1 (this is the only one of the new photographs which shows the specimen from a very different view compared to the view in the original figure), originally determined as *Serpula gordialis* v. SCHLOTH. Upper Turonian Teplitzer Schichten, Třtěno (Kröndorf) near Chožov coll. National Museum, Prague, registration number NM O4378. Scale bar 10 mm.
2. *Filograna socialis* (GOLDFUSS, 1831). New photograph of Frič's original specimen (1883, p. 128, fig. 113), compare our pl. 1, fig. 2, originally determined as *Serpula socialis* GOLDF., Middle Turonian Iserschichten, Mladá Boleslav (Jungbunzlau), coll. National Museum, Prague, registration number NM O6051. Scale bar 10 mm.
3. *Dorsoserpula wegneri* (JÄGER, 1983). New photograph of Frič's original specimen (1883, p. 129, fig. 114), compare our pl. 1, fig. 3, originally determined as *Serpula ampullacea* Sow., Middle Turonian Iserschichten, Choroušky (Choroušek), coll. National Museum, Prague, registration number NM O6057. Scale bar 10 mm.
4. *Neovermilia cf. ampullacea* (SOWERBY, 1829). New photograph of Frič's original specimen (1883, p. 129, fig. 115), compare our pl. 1, fig. 4, originally determined as *Serpula macropus* Sow., Middle Turonian Iserschichten,

Choroušky (Choroušek), labelled from Živonín coll. National Museum, Prague, registration number NM O6050. – view to posterior portion of the tube. Scale bar 10 mm.

PLATE 3

1. a–c Three specimens of *Glomerula serpentina* (GOLDFUSS, 1831). Copy of original drawing by Frič (1911, p. 72, fig. 304), specimens originally determined as *Serpula gordialis* (in the caption of fig. 304) and *Serpula gordialis*, var. *serpentina* (in the text), Lower Turonian Korycaner Schichten, Kamajka (Kamajk) near Chotusice, coll. National Museum, Prague, left specimen NM O7127, middle specimen NM O7128, right specimen NM O7129. Reproduced at same magnification as in Frič's fig. 304.
2. a–c Three specimens of *Glomerula serpentina* (GOLDFUSS, 1831). New photograph of Frič's original specimen (1911, p. 72, fig. 304), compare our pl. 3, fig. 1, originally determined as *Serpula gordialis* (in the caption of fig. 304) and *Serpula gordialis*, var. *serpentina* (in the text), Lower Turonian Korycaner Schichten, Kamajka (Kamajk) near Chotusice, coll. National Museum, Prague, left specimen NM O7127, middle specimen NM O7128, right specimen NM O7129. Scale bars 5 mm.
3. a–b Tube fragment of *Dorsoserpula conjuncta* (GEINITZ)? Frič's original specimen (1911, p. 72, fig. 305), originally determined as *Serpula ampullacea*, Sow., Upper Cenomanian or Lower Turonian Korycaner Schichten, no locality data specified, coll. National Museum, Prague, specimen NM O7130. a – Copy of original drawing by Frič. Reproduced at same magnification as in Frič's fig. 305. b – New photograph of Frič's original specimen. Scale bar 5 mm.
4. a–b Serpulidae gen. et sp. indet. Frič's original specimen (1911, p. 72, fig. 306), originally determined as *Serpula* sp. (in the text) respectively *Serpula* n. sp. (in the caption of fig. 306), Upper Cenomanian of Lower Turonian Korycaner Schichten, Skuteč (Skuč), coll. National Museum, Prague, specimen NM O7131. a – Copy of original drawing by Frič. Reproduced at same magnification as in Frič's fig. 306. b – New photograph of Frič's original specimen. Scale bar 10 mm.

PLATE 1



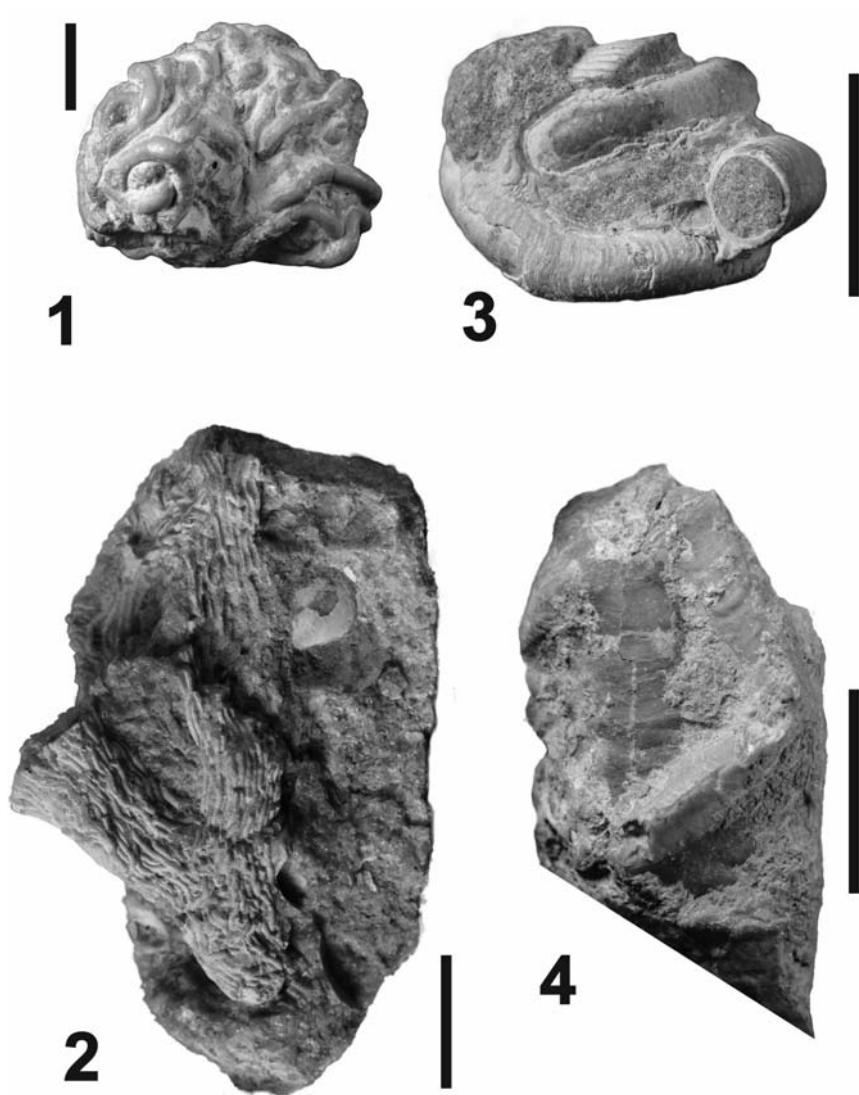


PLATE 3

