SILURIAN CONODONTS FROM THE GOŁDAP CORE, POLAND

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The conodont faunas from the Silurian interval of the Gołdap core range from the Rhuddanian (*Distomodus kentuckyensis* Zone) into the middle Ludlow (*Polygnathoides siluricus* Zone), and probably higher. The *D. kentuckyensis, Pranognathus tenuis, Pterospathodus* sp. n. E, *Pt. celloni* and *Pt. amorphognathoides* zones were recognized in the Llandovery part of the section. The probable position of the boundaries between the Upper *Pseudooneotodus bicornis* and Lower *Pt. pennatus procerus* zones, and between the Upper *Pt. p. procerus* and Lower *Kockelella ranuliformis* zones were established. Taxa indicating the *K. walliseri*, and possibly also the *K. patula* and *Ozarkodina sagitta sagitta* zones, were found. In the upper part of the sequence, the *Pol. siluricus* Zone faunas of the early–Late Ludlow age, were determined.

K e y w o r d s : Conodonta, stratigraphy, Silurian, Poland.

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INTRODUCTION

The Gołdap core in the NE Poland (about 230 km NNE of Warszawa; Fig. 1A) was drilled by the State Geological Institute, Warszawa, in 1961. Preliminary results were published by MODLIŃSKI (1974). The 1656.8 m deep section reaches the pre-Cambrian crystalline rocks at 1629.4 m. The oldest sedimentary strata drilled are Cambrian in age. The interval from 1419 m to 1120 m corresponds to the Silurian.

The Silurian strata are mainly represented by grey and greenish-grey mudstones with rare interbeds of marls and argillaceous limestones at some levels (H. TOMCZYK in MODLIŃSKI 1974; Fig. 1B). Mudstones contain rich graptolite faunas (identified by H. TOMCZYK). Five bentonites (at 1245.8, 1244.2, 1161.0, 1144.0, and 1143.6 m; see Fig. 1B) were recognized. The lowermost surely Silurian strata (above 1419.0 m) are underlain by argillaceous limestones partly rich in pyrite and glauconite. However, the uppermost part of these limestones may still be of Silurian age (see below). At 1120.0 m, the Silurian mudstones are unconformably overlain by coarse-grained, terrigeneous sediments of Permian age (Fig. 1B).

In the early 1980s, the Gołdap core was sampled by K. MAŁKOWSKI for conodonts. Unfortunately, the method used in the documentation of the samples (no exact levels of samples were recorded, but only up to 6–7 m intervals, from which several samples, as a rule from every meter, were taken) does not provide sufficiently detailed information to identify their precise positions. Because the exact levels of graptolites identified are also not available (see MODLIŃSKI 1974), the correlations between conodonts and graptolites (below) are approximate.

From 49 studied samples, up to 7300 identifiable conodont elements were recovered. The number of specimens per sample varied from 1 (sample 769) to 1380 (sample 854). Unbuffered technique was used. In several samples (856, 855, 826, 667) specimens are damaged (surface corrosion) by acid. The conodont specimens are amber in color. Their color alteration index (CAI) is about 1, reflecting burial temperatures less than 50–80°C (see EPSTEIN *et al.* 1977).

The collection studied is deposited in the Institute of Paleobiology of the Polish Academy of Sciences.

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CONODONTS AND STRATIGRAPHY

Llandovery. — In the Gołdap core, the Ordovician–Silurian boundary was considered to occur at 1419.0 m and correspond to the level of distinct lithological changes in the sequence (MODLIŃSKI 1974). At this level, the underlying argillaceous limestones were replaced by dark grey to black mudstones containing the Late Rhuddanian *Coronograptus cyphus* Zone graptolites (MODLIŃSKI 1974). No graptolites were found below that level. However, the conodont faunas studied indicate, that also the uppermost part of the argillaceous limestones might be of early Silurian age.

The youngest Ordovician conodont fauna, including *Amorphognathus* sp., *Eocarniodus* cf. *gracilis* (RHODES), and *Drepanoistodus suberectus* (BRANSON *et* MEHL), was found in sample 859 (1435.0–1428.4 m). The samples from the strata above this level (857, 856, 855 and 854; 1426.1–1420.1 m), collected from the argillaceous limestones, are dominated by elements of *Dapsilodus* spp. and *Panderodus equicostatus* (RHODES). Also *Pand. recurvatus* (RHODES), *Decoriconus fragilis* (BRANSON *et* MEHL), *Pseudooneotodus beckmanni* (BISCHOFF *et* SANNEMANN), and *Walliserodus* sp. are common in these beds. Although the changes in faunas between samples 859 and 857 are distinct, no evidence of a stratigraphical gap (erosional surface, sharp change in lithology) was observed in this interval (Fig. 1B; MODLIŃSKI 1974). The appearance of *Distomodus* cf. *kentuckyensis* in the sample 857 correlates this level, and the strata above, with the *D. kentuckyensis* Zone, and indicates the possibility that the Ordovician–Silurian boundary may lie below that sample (within interval 1426.0–1424.0 m).

Two samples, 851 (1416.4–1415.3 m) and 849 (1414.2–1413.1 m), contain *Distomodus calcar* BISCHOFF (Pl. 1: 30–31) indicating that they came from strata not older than the *C. cyphus* Zone (BISCHOFF

1986). In fact *Aspelundia expansa* ARMSTRONG (1990: 50–52; pl. 3: 13–20; Pl. 1: 34–35), that came from the same strata (Sample 851), suggests that they are even younger and probably represent the lower part of the Aeronian. In several regions (Australia – BISCHOFF 1986; Greenland – ARMSTRONG 1990; Estonia – MÄNNIK 1992), the lowermost occurrence of *A. expansa* (identified as *Oulodus planus* in BISCHOFF 1986) is known from the strata of the earliest Aeronian age, e.g. from the *Pranognathus tenuis* Zone (= *Pterospathodus*? *tenuis* Sub-biozone in ALDRIDGE and SCHÖNLAUB 1989). In Estonia, *A. expansa* appears together with *Panderodus serratus* REXROAD at, or just above, the lower boundary of the *Pr. tenuis* Zone. This boundary coincides with the boundary between the Rhuddanian and Aeronian stages (ALDRIDGE and SCHÖNLAUB 1989). The oldest *Pand. serratus* in the Gołdap core was found in the same sample together with the earliest probable specimens of *Distomodus staurognathoides* (WALLISER) (Fig. 1B).

In sample 848 (1413.1–1412.0 m), together with *D.* cf. *staurognathoides*, *Aspelundia fluegeli* (WALLISER), *Pseudooneotodus* cf. *tricornis* DRYGANT, *Pand. serratus*, and *Oulodus*? sp. n. B appear. In eastern Baltic, *A. fluegeli, Ps. bicornis* and *Oulodus*? sp. n. B are not known from strata below the *Pterospathodus* sp. n. E Zone (MÄNNIK 1992, 1996). Because the elements of *Pterospathodus* are missing in this complex, this fauna may possibly come from the upper part of the *Distomodus staurognathoides* Zone. However, because *Pterospathodus* is quite rare in the strata corresponding to the lowermost part of its range (particularly in the offshore regions of the basin – MÄNNIK 1992), a Telychian age for these beds cannot be excluded.

The appearance of *Pterospathodus* sp. n. E (Pl. 1: 19, 23–25, 27; identified as *Pt. celloni* ssp. n. 1 in MÄNNIK 1995: fig. 1, and *Pt. eopennatus* in MÄNNIK 1996) in sample 847 (1412.0–1410.9 m) indicates a Telychian age for the strata above this level (MÄNNIK 1995, 1996). The morphology of the **Pa** elements of *Pterospathodus* sp. n. E in sample 844 (1408.5–1407.3 m; Pl. 1: 23) allows us to correlate this level with the upper part of the *Pterospathodus* sp. n. E Zone, that is, with the *Apsidognathus tuberculatus* ssp. n. 2 Subzone (MÄNNIK 1995, 1996, unpublished data).

Most likely, the lower part of the *Pterospathodus* sp. n. E Zone, i.e. the *Astropentagnathus irregularis* and probably also the *Aulacognathus kuehni* subzones (MÄNNIK 1995, 1996), are missing in the Gołdap section. A considerable gap corresponding to the same stratigraphical interval was established by H. JAEGER in the När core, Gotland (JEPPSSON personal communication). In that core, the gap lasted even longer – the Telychian sedimentation in this region started not before the *Pterospathodus amorphognathoides angulatus* time (MÄNNIK, unpublished data).

In the Gołdap core only one sample, 835 (1395.8–1394.7 m), contains *Pt.* cf. *amorphognathoides angulatus* (WALLISER), correlating this level with the lower part of the *Pt. celloni* Zone *sensu* MÄNNIK (1996), that is, with the *Pt. a. angulatus* Subzone (Fig. 1B; Pl. 1: 20–22). In the next sample (sample 831; 1383.0–1382.0 m), *Pt. a. amorphognathoides* WALLISER (Pl. 1: 10, 14–17) appears, indicating that the lower boundary of the *Pt. a. amorphognathoides* Zone lies somewhere between samples 835 and 831, that is in the interval from 1394.7 to 1383.0 m. The morphology of the Pa element of *Pt. a. amorphognathoides* (Pl. 1: 17) suggests that the single sample which contains this taxon did not come from the lowermost part of the *Pt. a. amorphognathoides* Zone, but rather represents the middle part of the *Pt. a. amorphognathoides* lineage (MÄNNIK 1996).

The *Pt. amorphognathoides* ssp. n. (MÄNNIK 1995; fig.1) and *Pt. a. lithuanicus* BRAZAUSKAS (1983; figs 1–7) subzones of the *Pt. celloni* Zone (MÄNNIK 1996) were not identified in the studied section, most likely, due to the lack of information from the corresponding strata (i.e. the interval from 1394.7 to 1383.0 m between samples 835 and 831; Fig. 1B).

The Ireviken Event interval. — The upper boundary of the *Pt. a. amorphognathoides* Zone, as drawn by JEPPSSON 1994 (= Datum 1 of the Ireviken Event – JEPPSSON 1993), can not be identified without an additional, detailed sampling. However, the occurrence of *Pseudooneotodus tricornis* DRYGANT in samples 831 and 827, and its absence in the younger strata (sample 826 and higher up), may indicate that Datum 1 lies between samples 827 and 826 (Fig. 1A). *Ps. tricornis* is continuously present below, and becomes extremely rare at Datum 1 (JEPPSSON and MÄNNIK 1993; JEPPSSON 1997). Datum 3 (= the boundary between the Upper *Ps. bicornis* and Lower *Pt. pennatus procerus* zones – JEPPSSON 1994, and in press), and also Datum 4, of this event lie probably between samples 826 and 820, in the core interval from 1377.0 to 1367.5 m (Fig. 1A). This is suggested by the occurrence of the youngest specimens of *Panderodus* sp. n. N (JEPPSSON and MÄNNIK 1993: fig. 5) and *Pand. langkawiensis* IGO *et* KOIKE in sample 826 (1378.0–1377.0 m). *Panderodus* sp. n. N disappears just below or at Datum 3 of the Ireviken Event and *Pand. langkawiensis* at Datum 3.3 (JEPPSSON and MÄNNIK 1993; JEPPSSON 1997). The single probable

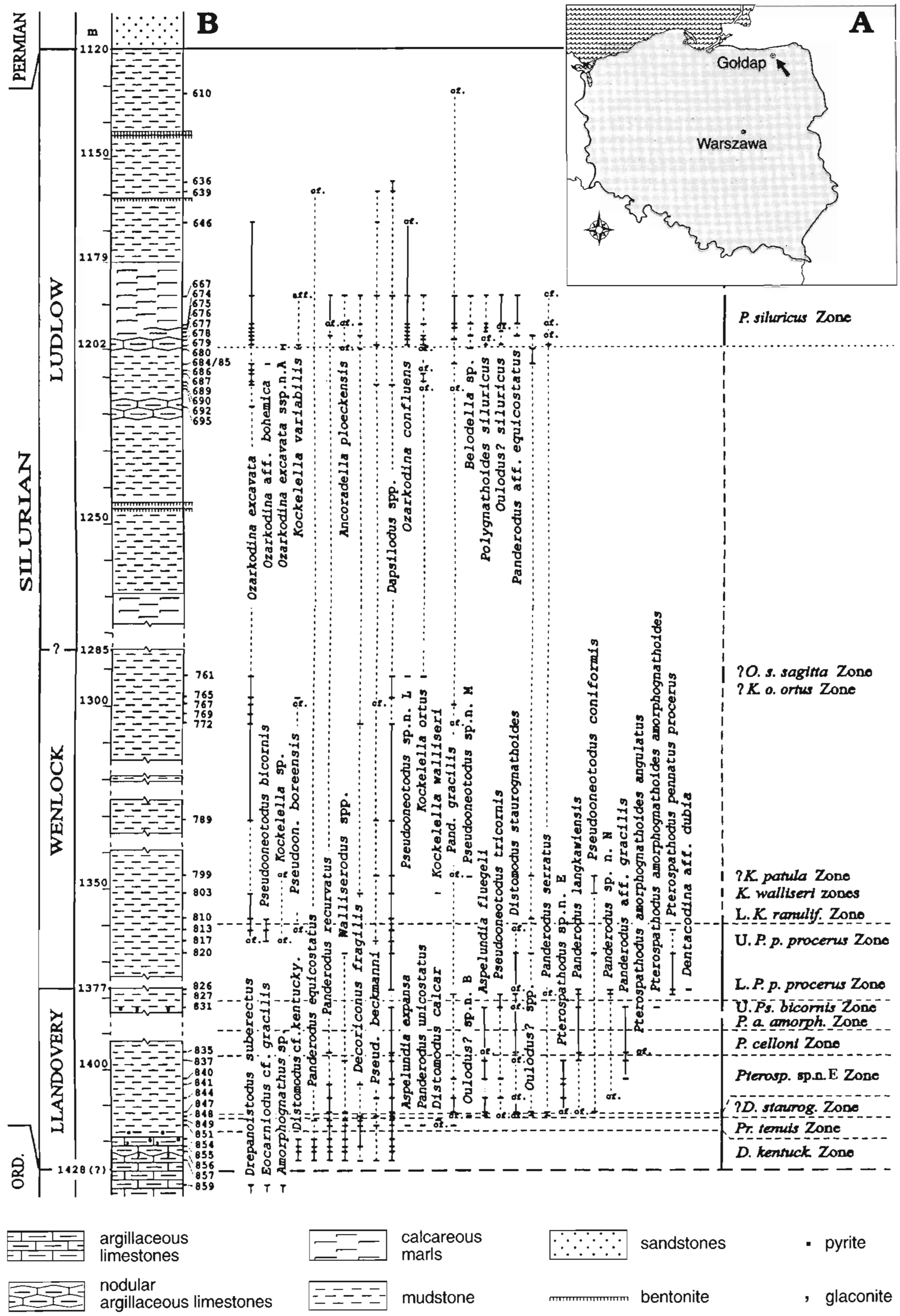

Fig. 1

A. Location of the Gołdap well. B. Distribution of conodonts in the Gołdap core and correlation with the conodont zonation. To the right from the column: positions of samples marked by their numbers; distribution of taxa (solid line marks a continous occurrence of a taxon in all samples from a given interval); and recognized conodont zones.

specimen of *Panderodus* sp. n. N from the Viki core just above Datum 3 (sample from 113.1 to 113.0 m), mentioned in JEPPSSON and MÄNNIK (1993: fig. 2), was misidentified and in reality belongs to *Pand. serratus*. The lack of *Pt. a. amorphognathoides* in samples 827 and 826 in the Gołdap core has evidently ecological reasons: the *Pt. amorphognathoides* lineage was replaced by the *Pt. pennatus* lineage in the offshore environments (MÄNNIK 1992, 1996).

The lack of core data in the 1392.5–1384.0 m and 1377.0–1374.5 m intervals (Fig. 1B) does not allow for any detailed analysis of the changes in lithology just below and within the Ireviken Event interval. However, in the mudstones, from 1384.0 to 1383.0 m, a high concentration of pyrite has been noticed (MODLIŃSKI 1974). High pyrite concentration is known to be a characteristic of the earliest Wenlock strata (the uppermost part of the Lower Visby Beds), especially at Datum 4 in Gotland (JEPPSSON 1997, personal communication).

In the higher strata, within the Ireviken Event interval distinct lithological changes were recorded: light-grey mudstones (1383.0–1377.0 m) were replaced by dark-grey to black varieties (1374.5–1364.0 m). This change indicates considerable changes in the environmental conditions in the basin. The appearance of almost black, microlaminated deposits at, or very close to, the Llandovery–Wenlock boundary is known from many parts of Baltoscandia (AALOE and KALJO 1962; AALOE 1970; SNÄLL 1978).

Pterospathodus pennatus procerus appears in sample 827 (1379.0–1378.0 m). This sample came from the interval from 1383.0 to 1377.0 m, in which H. TOMCZYK (in MODLIŃSKI 1974) had previously identified a complex of graptolites including *Retiolites geinitzianus angustidens* ELLES *et* WOOD, *Stomatograptus grandis* (SUESS), and *Monoclimacis vomerina* (ELLES *et* WOOD), indicative of the latest Telychian *St. grandis* and *Cyrtograptus insectus* zones (ŠTORCH 1994; SUBCOMMISSION ON SILURIAN STRATIGRAPHY 1995). From the overlying mudstones (1374.5–1368.0 m), H. TOMCZYK listed, among other graptolites, also *Cyrt. murchisoni* CARRUTHERS and *Barrandeograptus pulchellus* (TULLBERG) correlating this interval with the *Cyrt. murchisoni* Zone.

A number of conodont taxa, *Ozarkodina excavata* (WALLISER), *Kockelella* sp., and *Ps. bicornis* DRYGANT, appear for the first time in sample 817 (1364.6–1363.7 m). *Ps.* cf. *boreensis* BISCHOFF appears for the first time in sample 813 (1361.1–1360.2 m). The complex of graptolites from this core interval (1368.0–1364.0 m) contains *Monograptus riccartonensis* LAPWORTH. The subsequent strata (1364.0–1360.0 m) contain *Pristiograptus dubius latus* BOUČEK and *Streptograptus antennularius* (MENEGHINI). The graptolites indicate the *M. riccartonensis* Zone for the former interval and the uppermost *Pr. dubius* or the lowermost *M. belophorus* Zone for the latter one (ŠTORCH 1994). This interpretation agrees with the conclusions of D. KALJO (personal communication) that the specimens of *Monograptus* in sample 816 (1364.6–1363.7 m; not processed for conodonts) represent morphologies characteristic of the strata younger than the *M. riccartonensis* Zone.

The last specimens of *Pt. p. procerus* and *D. staurognathoides* were found in sample 813. Thus, both Datum 6 (= the boundary between the Upper *Pt. p. procerus* and Lower *K. ranuliformis* zones) and Datum 7 (= the boundary between the Lower and Upper *K. ranuliformis* zones – JEPPSSON 1994, in press) occur in the core interval from 1360.2 to 1358.3 m (between samples 813 and 810). However, *D. staurognathoides* is rather rare towards the end of its range (JEPPSSON and MÄNNIK 1993), and a longer range for this species cannot be excluded. The occurrence of *Pt. p. procerus* in sample 813 (1361.1–1360.2 m), in the strata above the *M. riccartonensis* Zone (see above), is unusual. So far, this taxon has not been found in strata younger than the *Cyrtograptus murchisoni* Zone (JEPPSSON in press).

Wenlock. — The strata between the Upper *Pt. p. procerus* and the *Polygnathoides siluricus* zones are poorly represented by conodonts, mostly due either to their very rare occurrences in the samples (the Wenlock part of the section) or to the lack of samples themselves (the lower part of the Ludlow beds – Fig. 1B). The Wenlock conodont fauna is dominated by *Oz. excavata*. Also, several coniforms (*Dapsilodus, Panderodus, Decoriconus*, and *Pseudooneotodus*) are occasionally present.

A single broken **Pa** element of *Kockelella walliseri* (HELFRICH) from sample 803 (1352.1–1350.1 m; Pl. 1: 1) correlates this level with the *K. walliseri* Zonal group *sensu* JEPPSSON (1994, and in press) and indicates a Middle Sheinwoodian age for these strata. However, the occurrence of *Monograptus belophorus* (MENEGHINI) at the same level, determined by A. URBANEK (personal communication), restricts the possible interval of this sample to the Lower or Middle *K. walliseri* Zone (JEPPSSON 1994, and in press).

In sample 799 (1346.9–1345.9 m), a specimen of *Pseudooneotodus* of very specific morphology has been found. Its elements, in upper view, do not have distinct denticles, but instead an almost undenticulated curved ridge in a horseshoe configuration. Identical specimens were figured by BISCHOFF (1986; pl. 27:

20a–b; Boree section, sample B89) from the Borenore Limestone. From the same samples *K. walliseri* has been recorded (BISCHOFF 1986; table 8). *Pseudooneotodus* of similar morphology has been also found in Gotland, where it occurs together with *K. walliseri* and *K. patula* WALLISER in the *K. patula* Zone (JEPPSSON in press). The *K. patula* Zone is Late Sheinwoodian in age and correlates with the *Cyrtograptus rigidus* Zone (JAEGER 1975; JEPPSSON in press). Also, the association of graptolites listed by H. TOMCZYK (in MODLIŃSKI 1974) from the interval from 1353.0 to 1345.0 m in the Gołdap core, includes *C. rigidus* TULLBERG, *Pristiograptus* cf. *pseudodubius* BOUČEK, and some other taxa characteristic of the *C. rigidus* Zone. Thus, most likely sample 799 came from a level corresponding (or very close) to the *Kockelella patula* Zone.

Pseudooneotodus sp. n. L (Pl. 1: 8a, b) occurs together with *K.* cf. *ortus* (WALLISER) in sample 761 (1293.0–1292.0 m). *Pseudooneotodus* sp. n. L has a short range in the upper part of the Slite Beds in Gotland, where it appears in the very uppermost *K. o. ortus* Zone and ranges through the *Oz. s. sagitta* Zone (JEPPSSON in press). This find indicates an Early Homerian age for this level and correlates it either with the uppermost part of the *K. ortus ortus* Zone or with the *Ozarkodina sagitta sagitta* Zone *sensu* JEPPSSON (1994, in press).

In the Gołdap core, interval from 1294.0 to 1285.0 m, H. TOMCZYK recognized among other graptolites, also *Testograptus testis* (BARRANDE) and *Cyrtograptus* cf. *lundgreni* TÖRNQUIST (in MODLIŃSKI 1974), indicating a late Early Homerian age for these strata. These data agree with those available from other regions showing that the *Oz. s. sagitta* Zone correlates with the *Cyrtograptus lundgreni* Zone (JEPPSSON in press).

Ludlow. — No sample from the ca 70 m interval between the level with *Pseudooneotodus* sp. n. L and the strata of middle(?) Ludlow age (i.e. interval 1292.0–1218.0 m) has been processed (Fig. 1B). The faunas from the middle part of the Ludlow, from 1218.0 to 1205.8 m, are dominated by *Oz. excavata*; characteristic is the occurrence of *K. ortus*.

In the Gołdap section, distinct lithological changes take place at 1202.0 m (Fig. 1B). At that level, the graptolitic mudstones, dominating in the Silurian part of the core, are replaced by carbonate marls with rare interbeds of nodular, argillaceous, partly bioclastic limestones which continue up to 1179.0 m. Large fragments of crinoids and shells of the cephalopod *Orthoceras* sp. are common in the limestones. An interval of unusual lithologies, corresponding to the *Ancoradella ploeckensis* and *Polygnathoides siluricus* zones, is known in sequences from many regions of the world (for references see JEPPSSON 1987). In the Gołdap core the number of conodont specimens increases considerably in that interval and reaches up to several hundred per sample. The interval also marks the first appearance of several conodont taxa.

Oz. excavata ssp. n. A, represented by morphologically distinct elements (Pl. 2: 2, 6), appears in sample 680 (1202.4–1201.3 m). This species has a short range in the Hemse Marls, in the NW part (Early Ludlow) of Gotland, but has also been recognized in several other regions (JEPPSSON *et al.* 1994; JEPPSSON personal communication). In the same sample (680), a few specimens of *Ancoradella* cf. *ploeckensis* WALLISER were also found. However, unquestionable specimens of this taxon appear higher in the core (see below).

A number of new taxa – including *Polygnathoides siluricus* BRANSON *et* MEHL, the index taxon of the *Polygnathoides siluricus* Zone – appear in the sample 679 (1201.3–1200.2 m). In this sample, *K. variabilis* WALLISER, *Oulodus*? *siluricus siluricus* (BRANSON *et* MEHL), and *Oz. confluens* (BRANSON *et* MEHL) appear for the first time, whereas *Pand. serratus* reappears. Also, *Oz. excavata* ssp. n. A is still quite abundant. In the uppermost(?) part of this interval (sample 677) *Belodella* sp. and *Pand.* aff. *equicostatus* make their first appearances. Most characteristic taxa of the rich faunas, that occur up to 1187.9 m, are *Pol. siluricus, Oz. excavata, Oul.? s. siluricus, Oz. confluens, K. ortus, Pand. gracilis*, and *Pand.* aff. *equicostatus*. *Ancoradella ploeckensis* is well represented in the sample 667 (1189.0–1187.9 m) and *Belodella* sp. is occasionally present at some levels.

The age of the "traditional" *Pol. siluricus* Zone (e.g. the interval of co-occurrence of *Pol. siluricus* and *Coryssognathus dubius* (RHODES), coupled with the absence of *A. ploeckensis*) was discussed in detail by JEPPSSON (1983). Based on the analysis of data from Gotland, Great Britain, Cellon, Bohemia and several regions of North America, he concluded that this zone is of Leintwardinian age and correlates either with the upper part of the *Saetograptus fritschi linearis* Zone or with the strata just above it. For example, in Mušlovka quarry (Bohemia), the known range of *Pol. siluricus* is above that of *"Monograptus" fritschi linearis* (SCHÖNLAUB 1980: p. 155). Furthermore, according to H. JAEGER (JEPPSSON personal communication), the *"M". f. linearis* record from that section is 0.5 m below lowermost level sampled by SCHÖNLAUB.

The occurrence of *Pol. siluricus* together with *A. ploeckensis* and the total lack of elements of *Coryssognathus dubius*, most likely, indicate that only the oldest part of the *Pol. siluricus* range is represented, or studied so far, in the Gołdap core. In the lower part of the strata with *Pol. siluricus*, the graptolites *Lobograptus expectatus* URBANEK, *Lobograptus* sp., *Pristiograptus dubius* (SUESS), *Bohemograptus bohemicus* (BARRANDE), *Holoretiolites mancki* (MÜNCH), and *Saetograptus chimaera* (BARRANDE) were identified by A. URBANEK (personal communication). This complex is characteristic of the *Pristiograptus tumescens* Zone and suggests a Bringewoodian age for this interval (URBANEK 1966; TELLER 1969).

The overlying strata, up to the boundary between the Silurian and Permian, are poorly studied. Four samples, collected from this, 60 m thick, mudstone unit, contain a fauna of low diversity and low abundance. The fauna is distinctly different from the preceding complex. Only a few specimens of *Dapsilodus* spp., *Oz.* cf. *confluens*, and *Panderodus* cf. *equicostatus* were found. The lack of any diagnostic taxa does not allow for detailed correlations, but suggests only that this fauna may be from strata younger than the *Polygnathoides siluricus* Zone.

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SILURIAN CONODONTS FROM THE GOŁDAP CORE, POLAND

PLATE 1

All specimens from the Gołdap core. 1–7, 9–25, 27–32, 34, 35 × 60; 8, 26, 33 × 120.

1. *Kockelella walliseri* (HELFRICH, 1975), upper wiev of dextral **Pa** element, ZPAL CXVII/1, sample 803 (1351.1–1350.1 m).

2. *Pseudooneotodus bicornis* DRYGANT, 1974, lateral (*2a*) and upper (*2b*) views, ZPAL CXVII/2, sample 817 (1364.6–1363.7 m).

3, 4. *Ozarkodina excavata* (BRANSON *et* MEHL, 1933), *3* inner lateral view of dextral elements, ZPAL CXVII/3, sample 674 (1196.3–1195.3 m); *4* outer lateral view of sinistral element, ZPAL CXVII/4, sample 684/85 (1207.8–1205.8 m).

5. *Pseudooneotodus tricornis* DRYGANT, 1974, upper view, ZPAL CXVII/5, sample 840 (1402.7–1401.1 m).

6, 7, 11–13, 18. *Pterospathodus pennatus procerus* (WALLISER, 1964), *6* outer lateral view of dextral $\mathbf{Pb_2}$ element, ZPAL CXVII/6; *7* upper view of dextral **Pa** element, ZPAL CXVII/7; *11* outer lateral view of dextral **Pc** element, ZPAL CXVII/8; *12* outer lateral view of dextral $\mathbf{Pb_1}$ element, ZPAL CXVII/9; *13* outer lateral view of sinistral $\mathbf{Sc_1}$ element, ZPAL CXVII/10; *18* inner lateral view of sinistral $\mathbf{M_1}$ element, ZPAL CXVII/11. Specimen ZPAL CXVII/11 from sample 827 (1379.0–1378.0 m), all others from sample 826 (1378.0–1377.0 m).

8. *Pseudooneotodus* sp. n. L, lateral (8a) and upper (8b) views, ZPAL CXVII/12, sample 761 (1293.1–1292.0 m).

9. *Kockelella* cf. *ortus* (WALLISER, 1964), inner lateral view of dextral element, ZPAL CXVII/13, sample 667 (1189.0–1187.9 m).

10, 14–17. *Pterospathodus amorphognathoides amorphognathoides* WALLISER, 1964, *10* outer lateral view of sinistral modified carnulusform element (short morph), ZPAL CXVII/14; *14* outer lateral view of sinistral $\mathbf{Pb_1}$ element, ZPAL CXVII/15; *15* posterior view of dextral $\mathbf{Sb_2}$ element, ZPAL CXVII/16; *16* inner lateral view of dextral $\mathbf{Sc_3}$ element, ZPAL CXVII/17; *17* upper view of sinistral Pa element, ZPAL CXVII/18. All specimens from sample 831 (1383.0–1382.0 m).

19, 23–25, 27. *Pterospathodus* sp. n. E, *19* lateral view of dextral $\mathbf{Pb_1}$ element, ZPAL CXVII/19; *23* lateral view of dextral **Pa** element, ZPAL CXVII/20; *24* outer lateral view of sinistral $\mathbf{Sc_1}$ element, ZPAL CXVII/21; *25* inner lateral view of sinistral **Pa** element, ZPAL CXVII/22; *27* inner lateral view of dextral $\mathbf{Sc_2}$ element, ZPAL CXVII/23. Specimen ZPAL CXVII/20 from sample 844 (1408.5–1407.3 m), all other specimens from sample 840 (1402.7–1401.1 m).

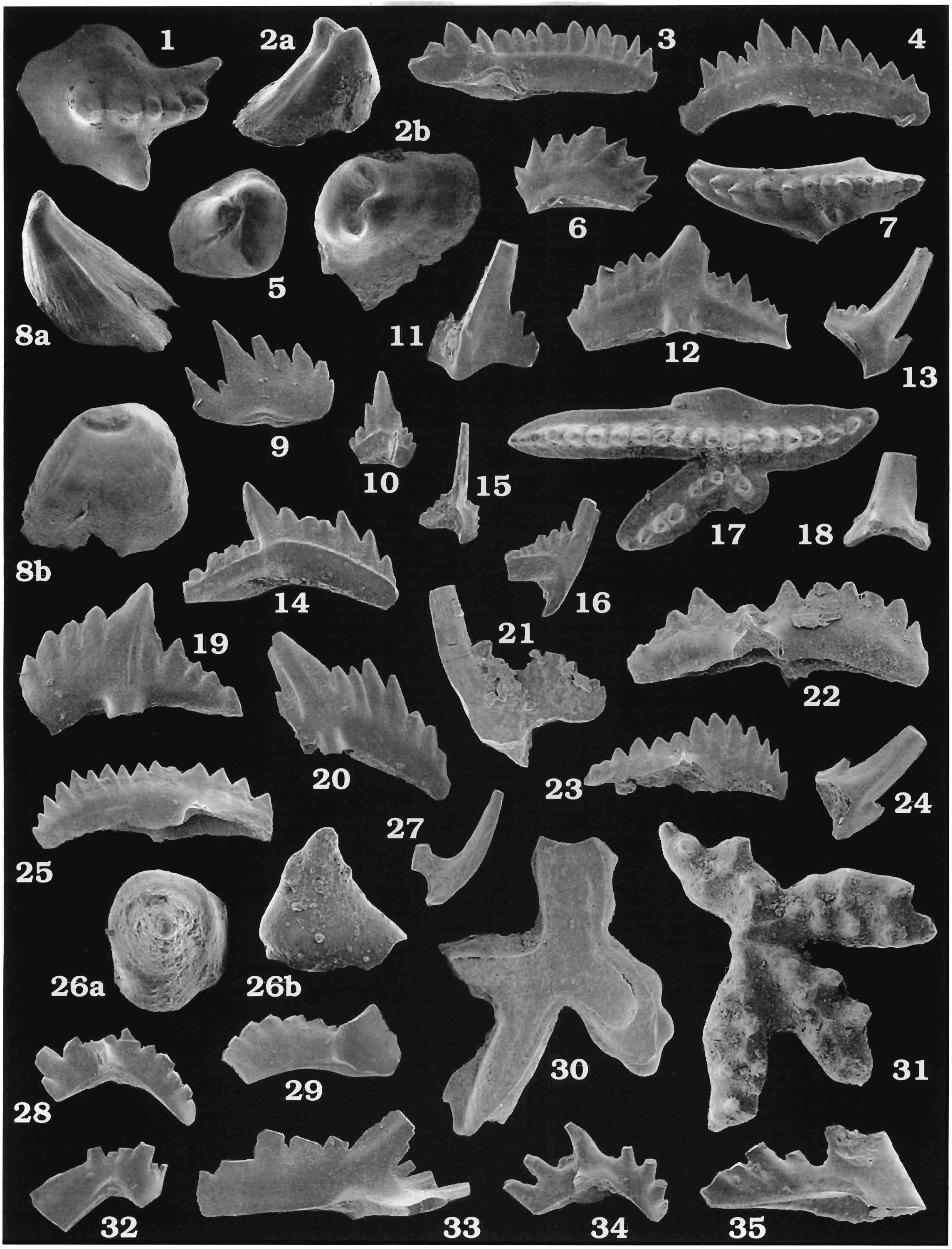
20–22. *Pterospathodus* cf. *amorphognathoides angulatus* (WALLISER, 1964), *20* outer lateral view of sinistral $\mathbf{Pb_1}$ element, ZPAL CXVII/24; *21* inner lateral view of sinistral $\mathbf{Sc_2}$ element, ZPAL CXVII/25; *22* inner lateral view of dextral **Pa** element, ZPAL CXVII/26. All specimens from sample 835 (1395.8–1394.7 m).

26. *Pseudooneotodus beckmanni* (BISCHOFF *et* SANNEMANN, 1958), upper (26a) and lateral (26b) views, ZPAL CXVII/27, sample 857 (1426.1–1423.8 m).

28, 29, 32, 33. *Aspelundia fluegeli* (WALLISER, 1964), *28* posterior view of sinistral **Sb** element, ZPAL CXVII/28; *29* inner lateral view of dextral **M** element ZPAL CXVII/29; *32* inner lateral view of **P**(?) element, ZPAL CXVII/30; *33* inner lateral view of sinistral **Sc** element, ZPAL CXVII/31. All specimens from sample 847 (1412.0–1410.9 m).

30, 31. *Distomodus calcar* BISCHOFF, 1986, *30* lower view of sinistral **Pa** element, ZPAL CXVII/32; *31* upper view of sinistral **Pa** element, ZPAL CXVII/33. Both specimens from sample 849 (1414.2–1413.1 m).

34, 35. *Aspelundia expansa* ARMSTRONG, 1990, *34* posterior view of sinistral **Sb** element, ZPAL CXVII/34; *35* inner lateral view of dextral **M** element, ZPAL CXVII/35. Both specimens from sample 851 (1416.4–1415.3 m).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SILURIAN CONODONTS FROM THE GOŁDAP CORE, POLAND

PLATE 2

All specimens from the Ludlow part of the Gołdap core. All × 60.

1, 4. *Polygnathoides siluricus* BRANSON *et* MEHL, 1933, *1* inner lateral view of sinistral **Pb** element, ZPAL CXVII/35; *4* upper view of dextral **Pa** element, ZPAL CXVII/36. Both specimens from sample 674 (1196.3–1195.3 m).

2, 6. *Ozarkodina excavata* ssp. n. A, outer lateral (*2a*) and lower (*2b*) views of sinistral **Pa** element, ZPAL CXVII/37, sample 679 (1201.3–1200.2 m); *6* outer lateral view of dextral **Pa** element, ZPAL CXVII/38, sample 680 (1202.4–1201.3 m).

3, 7, 9, 11, 14. *Ancoradella ploeckensis* WALLISER, 1964, *3* posterior view of dextral **Sb** element, ZPAL CXVII/38; *7* inner lateral view of sinistral **Sc** element, ZPAL CXVII/39; *9* posterior view of **Sa** element, ZPAL CXVII/40; *11* outer lateral view of sinistral **Pb** element, ZPAL CXVII/41; *14* upper view of dextral(?) **Pa** element, ZPAL CXVII/42. All specimens from sample 667 (1189.0–1187.9 m).

5, 8. *Kockelella variabilis* WALLISER, 1964, *5* outer lateral (*5a*) and upper (*5b*) views of sinistral **Pa** element, ZPAL CXVII/43, sample 679 (1201.3–1200.2 m); *8* upper view of dextral **Pa** element, ZPAL CXVII/44, sample 680 (1202.4–1201.3 m).

10. *Kockelella* aff. *variabilis*, outer lateral (*10a*) and upper (*10b*) views of dextral **Pa** element, ZPAL CXVII/45, sample 667 (1189.0–1187.9 m).

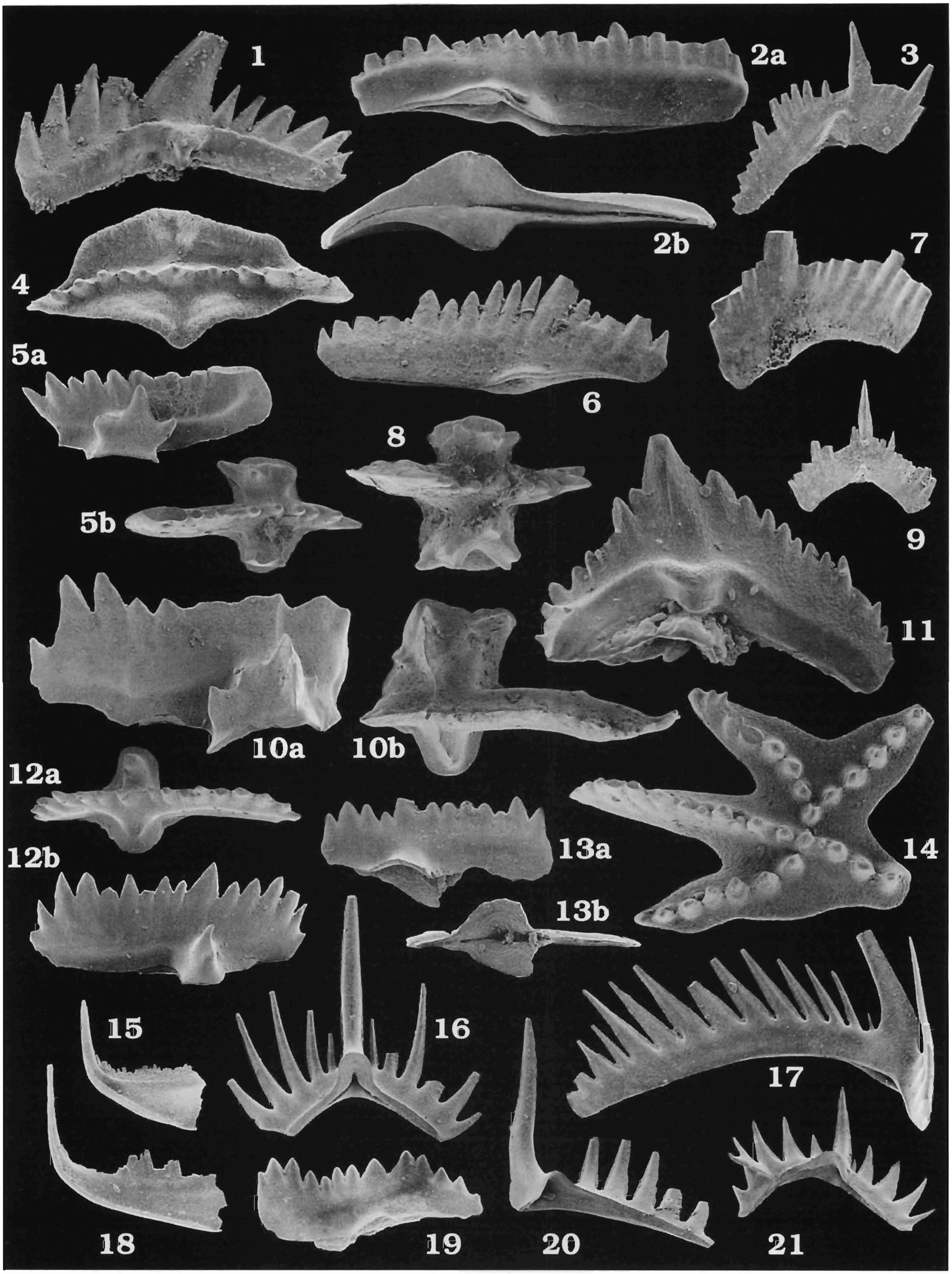
12. *Kockelella* sp., upper (*12a*) and outer lateral (*12b*) views of dextral **Pa** element, ZPAL CXVII/46, sample 675 (1197.3–1196.3 m).

13. *Ozarkodina* aff. *bohemica*, outer lateral (13a) and lower (13b) views of sinistral **Pa** element, ZPAL CXVII/47, sample 684/85 (1207.8–1205.8 m).

15, 18. *Belodella* sp., inner lateral views of sinistral **Sc**? elements, ZPAL CXVII/48 and ZPAL CXVII/49. Both specimens from sample 674 (1196.3–1195.3 m).

16, 17, 20, 21. *Oulodus*? *siluricus siluricus* (BRANSON *et* MEHL, 1933), *16* posterior view of **Sa** element, ZPAL CXVII/50; *17* inner lateral view of dextral **Sc** element, ZPAL CXVII/51; *20* inner lateral view of sinistral **M** element, ZPAL CXVII/52; *21* inner lateral view of dextral **Pb**(?) element, ZPAL CXVII/53. All specimens from sample 674 (1196.3–1195.3 m).

19. *Ozarkodina confluens* (BRANSON *et* MEHL, 1933), outer lateral view of dextral **Pa** element, ZPAL CXVII/54, sample 679 (1201.3–1200.2 m).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