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Late Devonian Conodont Fauna of the Gümüşali Formation, the Eastern Taurides, Turkey

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Abstract: The Late Devonian Gümüşali formation of the eastern Taurides is a terrigenous-carbonate rock sequence about 600 m thick, consisting mainly of quartz sandstone, quartz siltstone, shale, and carbonate rocks. Palaeontologic and sedimentologic data mainly indicate a shallow subtidal depositional environment. This sequence generally represents the shallow-water polygnathid-icriodid biofacies, and contains conodont faunas that range from the Upper *falsiovalis* Zone into the Upper *praesulcata* Zone. However, they do not correlate well to the Late Devonian standard conodont zonation because of the lack of zonally diagnostic species and the irregular vertical distributions of the present taxa. Herein, 54 taxa belonging to nine genera are described and illustrated from the studied section. *Icriodus adanaensis, Icriodus fekeensis*, and *Polygnathus antecompressus* are the newly described species.

Key Words: Late Devonian, conodont, Gümüşali formation, eastern Taurides, Turkey.

Gümüşali Formasyonu'nun (Doğu Toroslar, Türkiye) Geç Devoniyen Konodont Faunası

Özet: Doğu Toroslar boyunca yaygın yüzeylemeleri olan Geç Devoniyen yaşlı Gümüşali formasyonu, yaklaşık 600 metre kalınlığa ulaşan bir kırıntılı-karbonat kaya dizisidir. Litolojisini başlıca kuvars kumtaşı, kuvars miltaşı, şeyl ve karbonat kayalarının oluşturduğu bu birimin paleontolojik ve sedimantolojik özellikleri, çökelmenin başlıca sığ, gel-git altı ortamda geliştiğine işaret eder. Konodont faunası genellikle kıyı-yakını polygnathid-icriodid biyofasiyesini temsil eder, ve Üst *falsiovalis* Zonu'ndan Üst *praesulcata* Zonu içine kadar uzanan bir aralığı temsil eder. Bununla beraber, zon belirleyici taksonların yokluğu ve mevcut taksonların düzensiz dikey dağılımından dolayı, Geç Devoniyen standard konodont zonlaması ile tam bir korelasyon sağlanamamıştır. İncelenen stratigrafik kesitteki kireçtaşı katmanlarından alınan 107 örnekten, 9 cinse ait toplam 54 tür ve alttür tanımlanmıştır. Tanımlanan taksonlardan 3 tanesi (*Icriodus adanaensis* n.sp., *Icriodus fekeensis* n.sp. ve *Polygnathus antecompressus* n.sp.) yeni türdür.

Anahtar Sözcükler: Geç Devoniyen, Konodont, Gümüşali formasyonu, Doğu Toroslar, Türkiye.

Introduction

Conodont biostratigraphy is one of the most important tools in the correlation of Palaeozoic and Triassic rocks on local, regional, and global scales. In spite of the presence of rocks of this age in Turkey, the studies of their conodont biostratigrahy are few. However, some papers have previously been published on conodonts of Turkey (e.g., Abdüsselâmoğlu 1963; Gedik 1975, 1977; Önder 1982; Çapkınoğlu 1991, 1997; Kozur 1997). This paper describes conodont faunas obtained from 107 samples of a single stratigraphic section of the Upper Devonian Gümüşali Formation of the eastern Taurides, and correlates this fauna to the global standard Late Devonian conodont zones (Ziegler & Sandberg 1990). The studied section is located in the village of Çürükler, about 9 km northeast of the town of Feke, Adana (Turkey), on the 1/25.000 Kozan M35-b2 topographic map, and crops out along the valley of Göbelli Creek flowing through the village of Çürükler (Figure 1). The section was measured using a Jacob's staff. Its lower 32.50 meters were sampled along the road on the southwestern side of Göbelli Creek and the rest along a path on the northeastern side. Through most of the section, the beds strike N10-20°E and dip 60-70°NW. A total of 170 samples were collected, but only 107 samples yielded conodont faunas. The samples were processed using standard acidizing techniques with 10 percent formic acid. Residues were washed through nested sieves of 63, 100 and 850 microns, but conodonts were only picked from the residue on the 100-micron sieve.

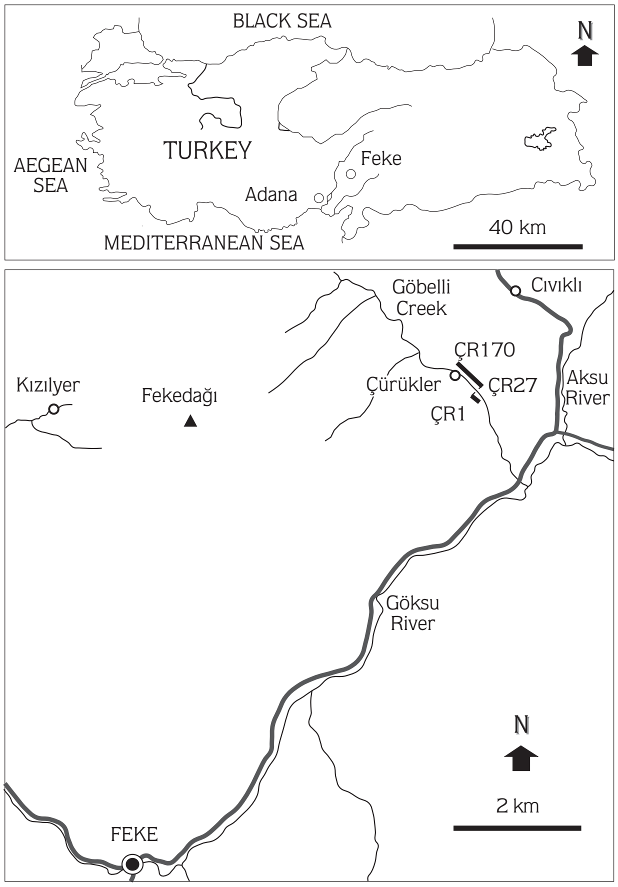

Figure 1. Location map for the studied stratigraphic section.

Lithostratigraphy

The Devonian sequence of the eastern Taurides has been divided into three formation in the previous works: the Lower Devonian Ayıtepesi formation (limestone-shale-sandstone), the Middle Devonian Şafaktepe formation (dolomitic limestone), and the Upper Devonian Gümüşali formation (sandstone-shale-limestone) (Özgül *et al.* 1973; Metin *et al.* 1983). The Gümüşali Formation, on which this study is based, has been named for an approximately 600-m-thick terrigenous-carbonate rock sequence overlying the Şafaktepe Formation (Figure 2). In the study area, it has a faulted contact at its base, and the top is lithologically gradational into the overlying Lower Carboniferous Ziyarettepe Formation. The lithologic sequence consists generally of thin-medium bedded, light grey quartz-sandstone and quartz-siltstone, dark grey marl and laminated shale and limestones, and contains a rich macrofauna consisting mainly of brachiopods, bryozoans and solitary or massive corals (Figure 2). Corals are abundant in the limestones, and brachiopods and bryozoans in both limestones and other lithologies. The basal portion of the formation is made up of dark grey limestones interbedded with shale or marly shale. The middle part consists of an alternation of limestone and shale with quartz sandstone and siltstone interbeds. The upper 85 meters is dominated by dark grey, silty-sandy, spiculitic limestones.

The carbonate rocks range from mudstone to boundstone. Many samples have packstone and grainstone texture (Figure 2). Skeletal grains and *Girvanella*-oncoids are the abundant types. Pellets and intraclasts are scarce. Brachiopods (shells and spines), echinoderms (crinoids, echinoids), bryozoans, cyanophycean algae (generally *Girvanella* sp.), corals and ostracods (*Cryptophyllus* sp. and others) are the most abundant skeletal particles. Non-carbonate components are generally represented by detrital quartz that locally reaches 30 volume % in some samples. Dolomitization, micritization, silicification, pyritization, and limonite and hematite impregnation were the most widespred diagenetic events. Geopetal structures, sheltering effects and stylolitic structures are the most widespread sedimentologic structures. Abundant bioturbation fabrics are indicated by the arrangement of bioclasts in a circular pattern and by the different packing of particles. Borings are especially abundant in brachiopod shells. Fossil content and sedimentologic characteristics of the Gümüşali Formation indicate a shallow subtidal depositional environment (Çapkınoğlu 1990, 1991).

Biostratigraphy

The Gümüşali Formation is dominated by conodont species of the polygnathid-icriodid biofacies, together with a few species of the palmatolepid-polygnathid biofacies. Conodonts are generally not abundant, and many parts of the section yielded few or no specimens. Because of the influence of biofacies, the scarcity or absence of zonally diagnostic taxa and the irregular vertical distributions of many taxa, the standard Late Devonian conodont zones (Ziegler 1962; Ziegler & Sandberg 1984, 1990) are not readily applicable to the Gümüşali Formation. However, some of them have been described.

The lowest sample (Table 1, sample ÇR2) of the studied stratigraphic section is of Frasnian age, no older

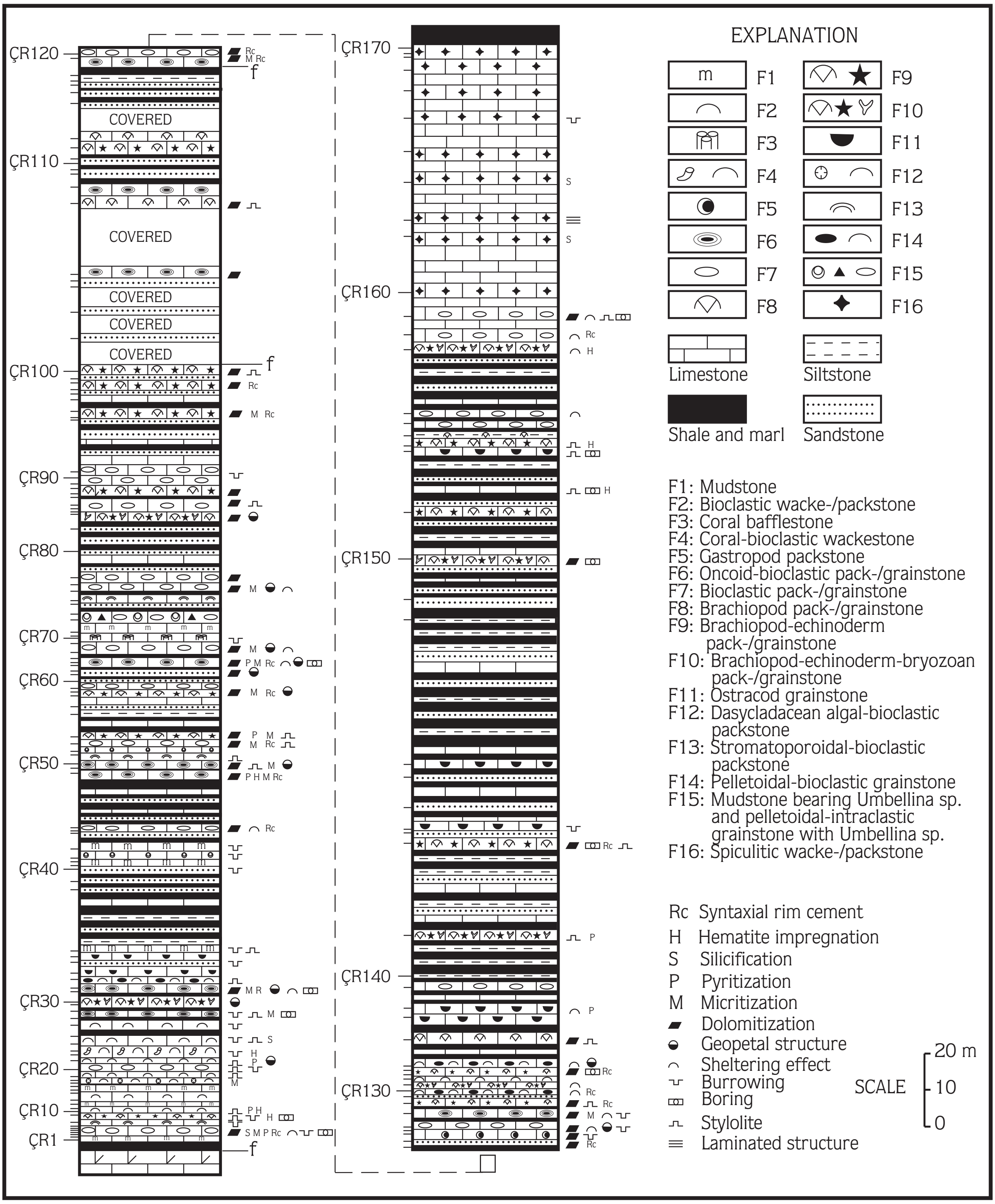

Figure 2. Lithologic development of the studied stratigraphic section and the sample locations.

than the upper *falsiovalis* zone because of the presence of *Icriodus subterminus* YOUNGQUIST, 1947, which first appears within the upper *falsiovalis* zone (Sandberg & Dreesen 1984, p. 157; Ziegler & Sandberg 1990, p. 16). Sample ÇR25 contains the last occurrence of *Ancyrodella rotundiloba* (BRYANT, 1921), which does not range above the *punctata* zone (Ziegler & Sandberg 1990, p. 17). Therefore, the stratigraphic interval beginning with *Icriodus subterminus* and ending with *Ancyrodella rotundiloba* (Table 1, samples ÇR2-ÇR25) can be correlated with the upper *falsiovalis*, *transitans* and *punctata* zones of Ziegler & Sandberg (1990). Based on the occurrence of *Icriodus expansus* BRANSON & MEHL, 1938, which ranges into the lower *hassi* zone, the overlying two samples (ÇR26 and ÇR27) can be assigned to the lower *hassi* zone (Ziegler & Sandberg 1990, p. 18). Sample ÇR47 (Table 2) includes the lowest occurrence of *Polygnathus buddingtoni* SAVAGE, 1987, which does not occur below the lower *hassi* zone (Savage 1987, p. 2324; 1992, p. 278). Therefore, the interval ranging from sample ÇR26 to sample ÇR46 probably comprises the lower *hassi*, upper hassi and *jamieae* Zones (Ziegler & Sandberg 1990).

Samples ÇR47 to ÇR90 (Table 2) can be correlated with the lower to upper *rhenana* Zones of Ziegler & Sandberg (1990) on the basis of the occurrence of *Polygnathus buddingtoni*, which was reported from these zones by Savage (1987, p. 2324, 1992, p. 278). Sample ÇR58 is within the lower *rhenana* zone as it contains the youngest *Icriodus subterminus* (Ziegler & Sandberg 1984, p. 157, 1990, p. 20). Sample ÇR65 (Table 2) contains the lowest occurrence of *Icriodus alternatus*

Table 1. Distribution and abundance of Pa elements of conodont taxa. See Figure 2 for sample intervals. '?' indicates questionable identification.

CONODONT ZONE	upper *falsiovalis to punctata*																					?	lower *hassi* to *jamieae*									
SAMPLE (ÇR)	2	3	4	5	6	7	9	10	11	12	13	14	15	17	18	19	20	21	22	23	24	25	26	27	28	29	30	32	33	35	36
Ancyrodella binodosa									1?								1?		1		1	3									
Ancyrodella rotundiloba															2						1	3									
Icriodus aff. *brevis*		3	1	2			3										1														
Icriodus excavatus																						3			8			2	10		5
Icriodus expansus	2	1		9		12	2	45			3	14	3			2	6	1			3	6		3							
Icriodus subterminus	1	1	3	7	1	2	2	33			5	29	5	10		1	10	1	3	1	5			2	11			4		8	
Polygnathus aequalis																														1	
Polygnathus alatus			1					14	1	2		2	1	1	3	4	3		2		6		1	3	33	1	2	2		42	
Polygnathus aff. *dubius*							1	4	12			4	3				2				2	6									
Po. webbi								15	2				1																		
Polygnathus aff. xylus		6	3	2	1	1	26	127	26	2	42	100	114	63		15	58	2	3		15	2									

Table 2. Distribution and abundance of Pa elements of conodont taxa. See Figure 2 for sample intervals. '?' indicates questionable identification.

CONODONT ZONE	lower *hassi* to *jamieae*			?	lower to upper *rhenana*																									
SAMPLE (ÇR)	37	42	43	46	47	48	49	50	53	54	58	59	62	63	65	66	67	68	69	77	78	79	82	83	85	86	87	88	89	90
Ancyrodella curvata																														2
Ancyrodella lobata												1							1											
Ancyrodella nodosa																						1								
Icriodus alternatus alternatus															1	13	24	5	136	5	5	1		1	3	8	3	3	10	38
Icriodus alternatus helmsi																									1	4	5	1	2	4
Icriodus excavatus	7					8		2		13	54	13		13	9	8	12	39	10	28	31									
Icriodus iowaensis																							1				3	2		
Icriodus subterminus	2			3	2				1		4																			
Icriodus symmetricus				4	1																									
Icriodus aff. *I. symmetricus*						12																								
Polygnathus aequalis				5	3																									
Polygnathus alatus		1		27	26	13	1		7	7	66	20	1	4	3	18	13	8	128	14	4	2		1	9	8				
Polygnathus buddingtoni					1	4	1	1	3	4	9	3			1	1			7	1	1	1			4				1?	1?
Polygnathus pacificus											1										6								2	5
Polygnathus aff. *Po. procerus*		1	1																											
Polygnathus webbi				6		6	1	1	1	4	8	2		3	1	12	2	5	21	7	11	3	3	2	6	1		6	15	9

alternatus BRANSON & MEHL, 1934, which first occurs at or just after the start of upper *rhenana* zone (Ziegler & Sandberg 1990, p. 21). Therefore the faunas with *Icriodus alternatus alternatus* within the *rhenana* zone can be assigned to the upper *rhenana* zone (Table 2, samples ÇR65-ÇR90).

Although the first occurrence of P*almatolepis triangularis* SANNEMANN, 1955a, which defines the base of the *triangularis* zone, is in sample ÇR135 (Table 4), its base must be below this sample. Another indication of the beginning of the *triangularis* zone may be the highest range of *Polygnathus webbi* STAUFFER, 1938, which disappears at the end of the *linguiformis* zone (the Frasnian-Famennian boundary). Therefore, the range of *Polygnathus webbi* above the upper *rhenana* zone (Table 3, sample ÇR91) may represent the *linguiformis* zone (Ziegler & Sandberg 1990). However, the boundary between the *linguiformis* zone and the overlying *triangularis* zone is questionable because of the lack of the diagnostic taxa. Due to the occurrence of *Icriodus cornutus*, which first appears in the middle of the middle *triangularis* zone (Ziegler & Sandberg 1990, p. 22), sample ÇR123 can be assigned to the middle *triangularis* zone.

The first appearence of *Palmatolepis crepida*, which indicates the base of the *crepida* zone, is in sample ÇR142 (Table 4). However, a lower sample, ÇR139, contains the first *Pelekysgnathus inclinatus* THOMAS, 1949 and *Polygnathus depressus* METZGER, 1989, which have yet to be reported below the *crepida* zone (Metzger 1989, p. 520; Sandberg & Dreesen 1984, p. 23). Therefore the interval below the lowest occurrence of *Palmatolepis crepida* SANNEMANN, 1955b, characterized by these two species, belongs to the *crepida* zone. Because of the presence of *Palmatolepis termini* SANNEMANN, 1955b which does not appear before the middle *crepida* zone, sample ÇR142 is also within the middle *crepida* zone.

Zonal indices for the *rhomboidea* zone are not present. Sample ÇR156 is not younger than the *marginifera* zone because of the last occurrence of *Icriodus cornutus*, which became extinct within this zone. A higher sample (Table 4, sample ÇR159) contains the last occurrence of *Polygnathus depressus*, which ranges from somewhere within the *crepida* zone to the middle *expansa* zone (Metzger 1989, p. 520). Therefore, this sample can be assigned to the *expansa* zone (Ziegler & Sandberg 1990), if the last occurrence of *Polygnathus depressus* in sample ÇR159 is not facies-controlled.

Zonal indices for the *trachytera, postera* and *raesulcata* Zones are not present. However, based on the presence of *Polygnathus zikmundovae* ZHURAVLEV, 1991, which first appears at the base of the upper *praesulcata* zone (Vorontsova 1993, fig. 1), the uppermost two samples (Table 4, samples ÇR168 and ÇR170) of the studied stratigraphic section can be assigned to the upper *praesulcata* zone (Ziegler & Sandberg 1984, 1990).

Systematic Palaeontology

A total of 54 conodont species and subspecies has been identified from 107 samples in this study. Herein, only new taxa are discussed. Other generally well known species are illustrated in Plates 1-5, and listed in Tables 1-4. The multi-element notation and familial classification of Sweet (1988) are used in this paper. All studied and/or

Table 3. Distribution and abundance of Pa elements of conodont taxa. See Figure 2 for sample intervals. '?' indicates questionable identification. * Reworked samples.

CONODONT ZONE	*li.*	? *triangularis*																				
SAMPLE (ÇR)	91	93	94	97	98	10	10	10	10	11	12	12	12	12	12	12	12	12	13	13	13	13	13
Ancyrodella curvata															1*	1*					2*		
Ancyrognathus primus																					1*		
Icriodus alternatus alternatus	9			1	9								1		1	3		1					2
Icriodus alternatus helmsi	2	1																					
Icriodus cornutus													1?		1	1				3	4		
Icriodus iowaensis	1	5	3	4	18	1		6	3	1	1	9	1	1	2			2	1	21	61	2	4
Polygnathus alatus	2																						
Polygnathus brevilaminus					3			2		2		3		1	3	6	3	1	3	6	8		8
Polygnathus pacificus			1		4																		
Polygnathus aff. *subnormalis*					1	1?	1	3		1		3		1	5	3	1	5	3	15	70	5	
Polygnathus webbi	1																						

Table 4. Distribution and abundance of Pa elements of conodont taxa. See Figure 2 for sample intervals. '?' indicates questionable identification.

CONODONT ZONE	*triangularis* ?				*crepida*												? *expansa* to *praesulcata*						
SAMPLE (ÇR)	135	136	137	138	139	141	142	144	147	150	151	153	155	156	157	158	159	162	163	164	167	168	170
Ancyrognathus cryptus			1																				
Ancyrognathus sinelaminus			1	1																			
Bispathodus stabilis																			3		2		8
Icriodus adanaensis									13	9			19										
Icriodus alternatus alternatus	19	1	110	110	6	44	20	1?	1?														
Icriodus alternatus helmsi	7		31	28	1																		
Icriodus cornutus			46	36	7	19	55	2	13				9	21									
Icriodus fekeensis n.sp.							25																
Icriodus iowaensis		2	56	4	139	2	16				1	1	1										
Icriodus aff. *pectinatus*									1														
Mehlina strigosa							2						2	1		1	3						
Mehlina sp.A																	1						
Palmatolepis canadensis			3	2																			
Palmatolepis crepida							3		1														
Palmatolepis delicatula delicatula			2	2																			
Palmatolepis quadrantinodosalobata						28	7																
Palmatolepis tenuipunctata							1		1														
Palmatolepis termini							13		1														
Palmatolepis triangularis	12	3	36	9																			
Palmatolepis sp.A			1																				
Pelekysgnathus inclinatus					2		5		7	4			4				2						
Pelekysgnathus planus			1																				
Pelekysgnathus serradentatus		2	10				1																
Polygnathus antecompressus n.sp.					86+																		
Polygnathus brevilaminus	11	6	208	87	70	77	20																
Polygnathus aff. *buzmakovi*			9		2																		
Polygnathus communis communis																		1	7		3		12
Polygnathus depressus					3	17	43	4	61	8	1		12	10	3	3	15						
Polygnathus semicostatus						1	4			1							2						
Polygnathus aff. *inornatus*																			2	2	1		1
Polygnathus aff. *nodocostatus*																	1						
Polygnathus zikmundovae																						1	13
Pseudopolygnathus aff. *controversus*																			1				

illustrated specimens are stored at Karadeniz Teknik Üniversitesi in the Jeoloji Mühendisliği Bölümü, Trabzon, Turkey.

Order Ozarkodinida DZIK, 1976

Family Spathognathodontidae HASS, 1959

Genus *Mehlina* YOUNGQUIST, 1945

Type Species. - *Mehlina irregularis* YOUNGQUIST, 1945

Mehlina sp. A

Plate 5, Figure 20

Diagnosis: Pa element nearly straight longitudinally, with irregular upper surface denticulation consisting of 14 denticles of unequal size; upper margin profile highest near anterior end, decreasing gradually posteriorward except for slight rising located approximately on middle part of posterior half; pit at mid-length of the unit, slightly inverted on posterior part: lower margin straight except for slight rising anteriorly of the pit; anterior margin forming an angle of 70 degree with lower margin.

Remarks: The present species is treated in open nomenclature because only a single specimen was found.

Material: 1 Pa element.

Family Palmatolepidae SWEET, 1988

Genus *Palmatolepis* ULRICH & BASSLER, 1926

Type species. - *Palmatolepis perlobata* ULRICH & BASSLER, 1926

Palmatolepis sp. A

Plate 3, Figure 6

Diagnosis: Pa element with upper platform surface ornamented with relatively coarse nodes, with incipient lateral lobe; free blade very short; inner platform with strongly convex outline, with bulged anterior part ornamented with coarse nodes; inner platform with coarser and more densely nodular than rest of platform; incipient outer lobe; outer platform nearly triangular, with slightly concave anterior and posterior margins; blade-carina slightly sigmoidal; carina consisting of small, low row of nodes posterior of central node; posterior part of platform flexed upward after central node.

Remarks: The present species is treated in open nomenclature because only a single specimen was found.

Material: 1 Pa element.

Family Polygnathidae BASSLER, 1925

Genus *Polygnathus* HINDE, 1879

Type species.- *Polygnathus dubius* HINDE, 1879

Polygnathus antecompressus n. sp.

Plate 2, Figures 6-11

Etymology: From Latin, *ante*, in front and *compressus*, compression; for its definite lateral constriction on the anterior platform margin.

Holotype: The Pa element illustrated on Plate 2, Figures 9-11.

Type locality: The northeast side of the Göbelli Creek passing through the village of Çürükler, about 9 km northeast of the town of Feke, Adana, Turkey (Figure 1).

Type stratum : Bed of dirty yellow, densely packed, ostracod-brachiopod grainstone, 357.75 m above the base of the studied stratigraphic section; sample ÇR139 (Figure 2).

Material: 86 Pa elements.

Diagnosis: Pa element with platform approximately three-quarters of unit length, constricted in anterior one-third; short carina and adcarinal grooves confined to anterior one-half to one-third of platform; anterior platform margins generally showing rostral development, ornamented by short transverse ridges to nodes or smooth; platform tongue ornamented with many transverse ridges crossing entire platform; free blade relatively short, comprising about one-fourth of element length.

Description: Platform thick, representing about three-fourths of unit length, with distinct lateral constriction at anterior one-third, with strongly arched lower profile; outer platform margins of dextral and sinistral Pa elements convex; inner margins varying from slightly convex to slightly concave; anterior platform margins with rostral ridge shape in many specimens, smooth or ornamented by short transverse ridges to nodes; platform tongue with transversely planar to slightly convex upper surface, bearing many straight to wavy transverse ridges crossing entire platform; transverse ridges continuous, interrupted or bifurcated; in some of the dextral and sinistral Pa elements, right anterior platform margin distinctly higher than left margin; posterior tip of platform pointed to slightly rounded; carina with fused denticles restricted to about anterior one-half to one-third of platform and adcarinal grooves parallel to carina; short free blade about one-fourth of element length, with robust and irregular denticulation; basal cavity small, elliptical, located on about anterior one-fourth of platform where it is curved inward; keel forming sharp-crested ridge, extending to posterior tip of platform.

Remarks: The free blade is broken on all specimens except in the holotype and one paratype. It comprises about one-fourth of the length of the element, and shows a robust and irregular denticulation. One unillustrated specimen, in which the posterior part of the platform and the anterior part of the free blade are missing, has a more regular denticulation with five denticles on the broken free blade.

Pa elements are similar to those of *Polygnathus semicostatus* BRANSON & MEHL, 1934 in having a platform tongue ornamented with transverse ridges that cross the entire platform, but differ especially in having a distinct lateral constriction on the anterior third of the platform and the anterior platform margins of the rostral ridge shape.

Range: Polygnathus antecompressus n.sp., which was obtained only from sample ÇR139, belongs to the lower *crepida* zone. Evidence for this assignment is its occurrence below a sample containing *Palmatolepis crepida, Pa. termini, Pa. tenuipunctata*, and its association with *Pelekysgnathus inclinatus* and *Polygnathus depressus*, which have yet to be reported below the *crepida* zone (Metzger 1989, p. 520; Ziegler & Sandberg 1990, p. 23).

Polygnathus zikmundovae ZHURAVLEV, 1991

Plate 5, Figures 23-24

1991 *Polygnathus zikmundovae* ZHURAVLEV,

p. 129-130, Pl. 1, figs. a-d.

Remarks: *Polygnathus zikmundovae*, which is a member of the "*Polygnathus varcus*" group of Vorontsova (1993), is characterized by Pa element with a smooth platform with raised margins, a long free blade, and a basal cavity located at the junction of the free blade and the anterior end of the platform.

Material: 13 Pa elements.

Polygnathus aff. *xylus* STAUFFER, 1940

Plate 1, Figures 1-3

Remarks: The platform, which is generally smooth or ornamented with subdued nodes, has strongly upturned margins with parallel sides. The carina extends beyond the platform margins. The free blade is equal to platform. The elliptical basal pit is located on the anterior end of the platform. The unit is slightly curved and moderately arched.

According to Kononova & Ovnatanova (personal communication 1996), these Pa elements correspond to the species *Polygnathus pseudoxylus* of Kononova *et al.* (1996).

Material: 608 Pa elements.

Order Prioniodontida DZIK, 1976

Family Icriodontidae MÜLLER & MÜLLER, 1957

Genus *Icriodus* BRANSON & MEHL, 1938

Type species. - *Icriodus expansus* BRANSON & MEHL, 1938

Icriodus adanaensis n. sp.

Plate 4, Figures 23-29

Etymology: From Adana, where these specimens occur.

Holotype: The Pa element illustrated on Plate 4, Figures 23-25.

Type locality: The village of Çürükler, Feke, Adana, Turkey (Figure 1).

Type stratum: Bed of dirty yellow, oxidized, 25-cm-thick, bioclastic packstone, 517.07 m above the base of the studied stratigraphic section; sample ÇR155 (Figure 2).

Material: 32 Pa elements.

Diagnosis: Pa element with a reclined horny cusp of the same height as or slightly higher than other denticles on posterior end of median row; median row denticles alternated by lateral row denticles; element longitudinally straight; platform of maximum width at posterior end of triangular spindle; basal cavity nearly symmetrical, lachrymiform.

Description: Pa element with triangular spindle; median denticles alternating in alignment with lateral rows; median row of 7-9 denticles, lateral rows of 3-4 denticles; lateral row denticles generally rounded to laterally extended more pronounced posteriorward; median row denticles rounded to extended longitudinally more prominent posteriorward; posterior extension of median row of two to three denticles; horny cusp strongly reclined, of nearly same height as or slightly higher than other denticles, laterally compressed; unit straight or weakly curved laterally; basal cavity nearly symmetrical, with rounded posterior and pointed anterior end.

Remarks: The Pa elements of *Icriodus adanaensis* n.sp. have an upper surface denticulation and a cusp development that are closely similar to that of *Icriodus cornutus* SANNEMANN, 1955b but the former is distinguished by its shorter and wider triangular spindle. The Pa elements of the latter have a more narrow and nearly parallel-sided spindle. Furthermore, the middle row denticles of *Icriodus cornutus* is more poorly developed relative to the lateral row denticles.

The Pa elements of *Icriodus chojnicensis* MATYJA, 1972 possess irregularly developed lateral-row denticles that are neither aligned nor alternating with middle-row denticles.

Range: The specimens were obtained from samples ÇR147, ÇR150, and ÇR155 (Table 4). In sample ÇR147, the presence of *Palmatolepis crepida, Pa. tenuipunctata, Pa. termini* indicates the *crepida* zone. However its upper range may extend into the lower *rhomboidea* zone, because sample ÇR155 marks the highest range of *Icriodus iowaensis*, which ranges into this zone.

Icriodus fekeensis n. sp.

Plate 4, Figures 16-20

Etymology: From type locality.

Holotype: The Pa element illustrated on Plate 4, Figures 16-18.

Type locality: The village of Çürükler, town of Feke, Adana (Figure 1).

Type stratum: Bed of 8-cm-thick, gray bioclastic pack-/grainstone, 398.25 m above the base of the studied stratigraphic section; sample ÇR142 (Figure 2).

Material: 25 Pa elements.

Diagnosis: Pa element long, narrow, with nearly parallel sides, with semi-alternating, middle- and lateral-row denticles; unit longitudinally straight to slightly curved; cusp slightly to strongly backwardly inclined; basal cavity asymmetrical, with more prominent spur on posterior inner side in large specimens.

Description: Platform of Pa element narrow, long, with nearly parallel sides; unit longitudinally straight or slightly curved; median- and lateral-row denticles semi-alternated, discrete; lateral row denticles 7-11, with about equal size varying from round to laterally elongate; median-row denticles 5-8, round to laterally compressed; posterior extension of median row bearing 2 or 3 denticles; cusp slightly to strongly reclined, not prominently larger than other denticles, laterally compressed in some specimens; upper margin straight to slightly convex, parallel to lower margin in lateral view; basal cavity varying from nearly symmetrical, drop shaped in small specimens to asymmetrical with prominent sinus on posterior inner side in large specimens.

Remarks: The Pa element of *Icriodus fekeensis* n. sp. is similar to that of *Icriodus expansus* BRANSON & MEHL, 1938 in having an upper-surface denticulation consisting of semi-alternating, median- and lateral-row denticles but differs in having a narrow and extended platform with more or less parallel sides, and in having a basal cavity with a prominent sinus on the posterior inner side. Some Pa elements assigned to *Icriodus expansus* by Weddige (1984, pl. 4, figs. 67-69) belong probably to *Icriodus fekeensis* n. sp.

The Pa elements of *Icriodus symmetricus* differ from *Icriodus fekeensis* n. sp. in having laterally aligned median- and lateral-row denticles. Furthermore, the former has a characteristic hairline ridge that, in most specimens, connects medial denticles in that part of the platform having three rows of denticles.

Range: Icriodus fekeensis n. sp. has been obtained only from sample ÇR142. Accompanying fauna consist of *Palmatolepis crepida, Palmatolepis quadrantinodosalobata, Palmatolepis tenuipunctata, Palmatolepis termini* and others belonging to the *crepida* zone.

Icriodus aff. *symmetricus* BRANSON & MEHL, 1934

Plate 4, Figures 10-11

Remarks: This species has a nearly straight Pa element with semi-alternating lateral-row and median-row denticles. Posterior extension of median row is of two or three denticles. The laterally compressed median-row denticles are more poorly developed than those of the lateral rows, which are laterally extended and longitudinally discrete.

The Pa elements of *Icriodus symmetricus* have almost perfectly aligned medial-row and lateral-row denticles. The most distinguishing feature is the hairline ridge that in most specimens connects medial denticles in that part of the platform having three rows of denticles (Sandberg & Dreesen 1984).

Material: 12 Pa elements.

Genus *Pelekysgnathus* THOMAS, 1949

Pelekysgnathus serradentatus ÇAPKINOĞLU, 1991

Plate 2, Figures 14-15

1991 *Pelekysgnathus serradentatus* ÇAPKINOĞLU, p. 351-352, Pl. 1, figs. 1-3.

Remarks: The Pa elements of *Pelekysgnathus serradentatus* are distinguished by having an irregular upper surface denticulation consisting of short transverse ridges in different lengths that intersect a thin longitudinal ridge, by the lack of a prominent main cusp, and by a broad, subsymmetrical basal cavity.

Material: 13 Pa elements.

Discussions and Conclusions

According to lithologic, faunal and sedimentologic data, the Gümüşali Formation of the eastern Taurides, Turkey was deposited chiefly in a shallow subtidal environment. Therefore, its conodont fauna generally represents the nearshore polygnathid-"icriodid" biofacies (Sandberg 1976; Sandberg & Dreesen 1984). However, a few conodont species of the palmatolepid-polygnathid biofacies (Sandberg 1976; Sandberg & Dreesen 1984) also occur in some beds. Because of the influence of the biofacies, the samples of the nearshore polygnathid-"icriodid" and polygnathid-pelekysgnathid biofacies (Sandberg 1976; Sandberg & Dreesen 1984) are difficult to correlate with the standard Late Devonian conodont zonation (Ziegler 1962; Ziegler & Sandberg 1984, 1990), which was developed for the pelagic or offshore palmatolepid-bispathodid and palmatolepid-polygnathid biofacies (Sandberg 1976; Sandberg & Dreesen 1984). Also, because of the scarcity of zone fossils and the irregularity of the stratigraphic ranges of present taxa, the direct and accurate correlation of the Gümüşali Formation with the alternate shallow-water conodont zonation (Sandberg & Dreesen 1984) - based on the nearshore facies - is not possible. However, using the stratigraphic ranges of some of the present taxa, an indirect correlation with the standard zonation, was confirmed, and it was determined that the Gümüşali Formation probably belongs to an interval extending from within the Upper *falsiovalis* zone into the Upper *praesulcata* zone. These zones were defined from a total of 54 species and subspecies, three of which are new. The approximate zonal boundaries were discussed in the text and presented in Tables 1-4.

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PLATE 1

Figures 1-3.	*Polygnathus* aff. *xylus* STAUFFER, 1940
	1. Upper view, ÇR3, x90; 2-3. Upper and lower views, ÇR3, x60.
Figure 4.	*Polygnathus* aff. *dubius* HINDE, 1879
	Upper view, ÇR10, x55.
Figure 5.	*Polygnathus aequalis* KLAPPER and LANE, 1985
	Upper view, ÇR35, x60.
Figures 6-8.	*Polygnathus alatus* HUDDLE, 1934
	6-7. Upper and lower views, ÇR35, x55; 8. Upper view, ÇR28, x55.
Figures 9-10.	*Polygnathus brevilaminus* BRANSON and MEHL, 1934a
	9. Upper view, ÇR137, x62; 10. Lateral view, ÇR137, x62.
Figures 11-14.	*Polygnathus depressus* METZGER, 1989
	11-12. Upper and lower views, ÇR147, x62; 13-14. Upper and lower views, ÇR147, x62.
Figure 15.	*Polygnathus semicostatus* BRANSON and MEHL, 1934a
	Upper view, ÇR142, x45.
Figures 16-19.	*Polygnathus pacificus* SAVAGE and FUNAI, 1980
	16-17. Upper and lower views, ÇR90, x60; 18-19. Oblique-lateral and lateral views, ÇR78, x60.
Figure 20.	*Polygnathus* aff. *procerus* SANNEMANN, 1955b
	Inner-lateral view, ÇR43, x62.
Figures 21-22.	*Polygnathus* aff. *subnormalis* VORONTSOVA and KUZMIN, 1984
	Upper and lower views, ÇR132, x62.

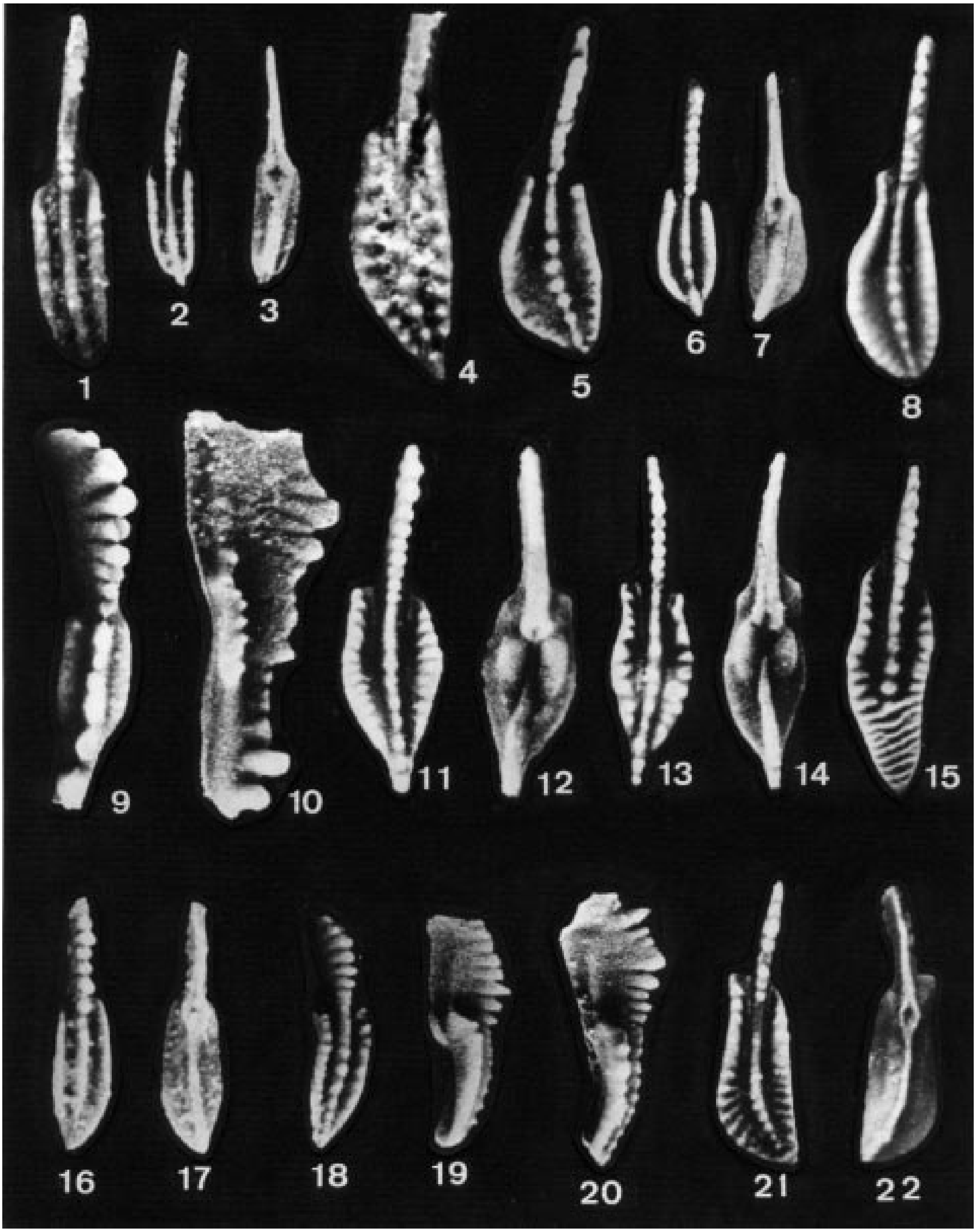
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PLATE 2

Figures 1-2. *Polygnathus* aff. *inornatus* BRANSON, 1934

Upper and lower views, ÇR167, x45.

Figure 3. *Polygnathus* aff. *nodocostatus* BRANSON and MEHL, 1934a

Upper view, ÇR159, x62.

Figures 4-5. *Polygnathus* aff. *buzmakovi* KUZMIN, 1990

4. Oblique-upper view, ÇR137, x58; 5. Upper view, ÇR137, x58.

Figures 6-11. *Polygnathus antecompressus* n. sp.

6. Upper view of paratype, ÇR139, x45; 7. Upper view of paratype, ÇR139, x45; 8. Oblique-lateral view of paratype, ÇR139, x45; 9-11. Upper, oblique-lateral and lower views of **holotype**, ÇR139, x45.

Figures 12-13. *Polygnathus buddingtoni* SAVAGE, 1987

12. Upper view, ÇR58, x45; 13. Upper view, ÇR54, x45.

Figures 14-15. Pelekysgnathus *serradentatus* ÇAPKINOĞLU, 1991

Upper and lateral views, ÇR137, x40.

Figures 16-17. *Polygnathus webbi* STAUFFER, 1938

Upper and inner-lateral views, ÇR89, x45.

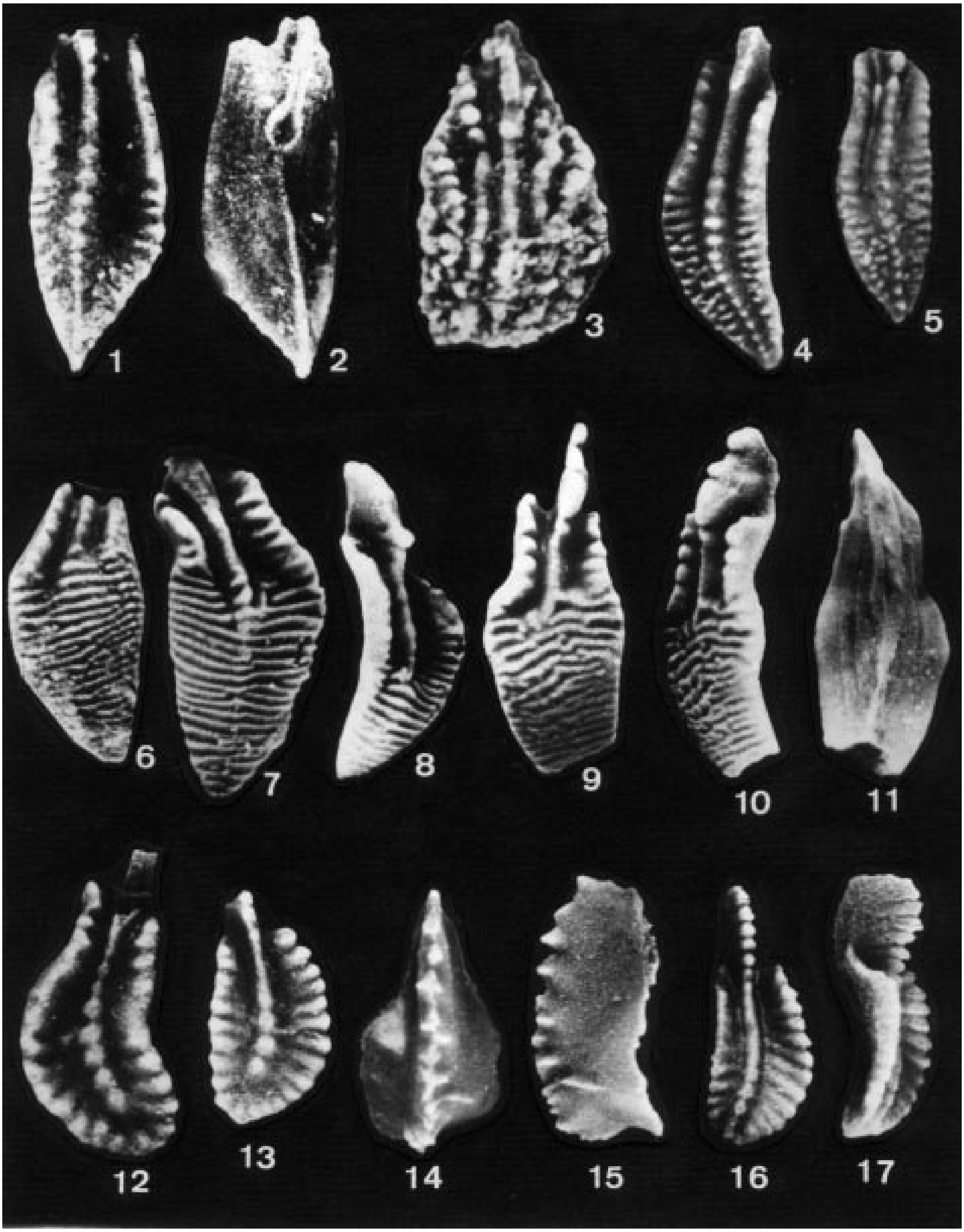
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PLATE 3

Figure 1.	*Palmatolepis canadensis* ORCHARD, 1989
	Upper view, ÇR137, x62.
Figure 2.	*Palmatolepis delicatula delicatula* BRANSON and MEHL, 1934a
	Upper view, ÇR137, x62.
Figure 3.	*Palmatolepis termini* SANNEMANN, 1955b
	Upper view, ÇR147, x62.
Figure 4.	*Palmatolepis tenuipunctata* SANNEMANN, 1955b
	Upper view, ÇR142, x62.
Figure 5.	*Palmatolepis crepida* SANNEMANN, 1955b
	Upper view, ÇR142, x62.
Figure 6.	*Palmatolepis* sp. A
	Upper view, ÇR137, x66.
Figures 7-8.	*Palmatolepis triangularis* SANNEMANN, 1955a
	7. Upper view, ÇR137, x45; 8. Upper view, ÇR135, x62.
Figure 9.	*Palmatolepis quadrantinodosalobata* SANNEMANN, 1955a
	Upper view, ÇR141, x62.
Figure 10.	*Ancyrognathus sinelamina* (BRANSON and MEHL, 1934a)
	Upper view, ÇR137, x45.
Figure 11.	*Ancyrodella nodosa* ULRICH and BASSLER, 1926
	Upper view, ÇR79, x60.
Figure 12.	*Ancyrognathus primus* JI, 1986
	Upper view, ÇR132, x60.
Figures 13-14.	*Ancyrognathus cryptus* ZIEGLER, 1962
	Upper and lower views, ÇR137, x60.
Figure 15.	*Ancyrodella lobata* BRANSON and MEHL, 1934a
	Upper view, ÇR59, x60.
Figure 16.	*Ancyrodella curvata* (BRANSON and MEHL, 1934a)
	Upper view, ÇR90, x60

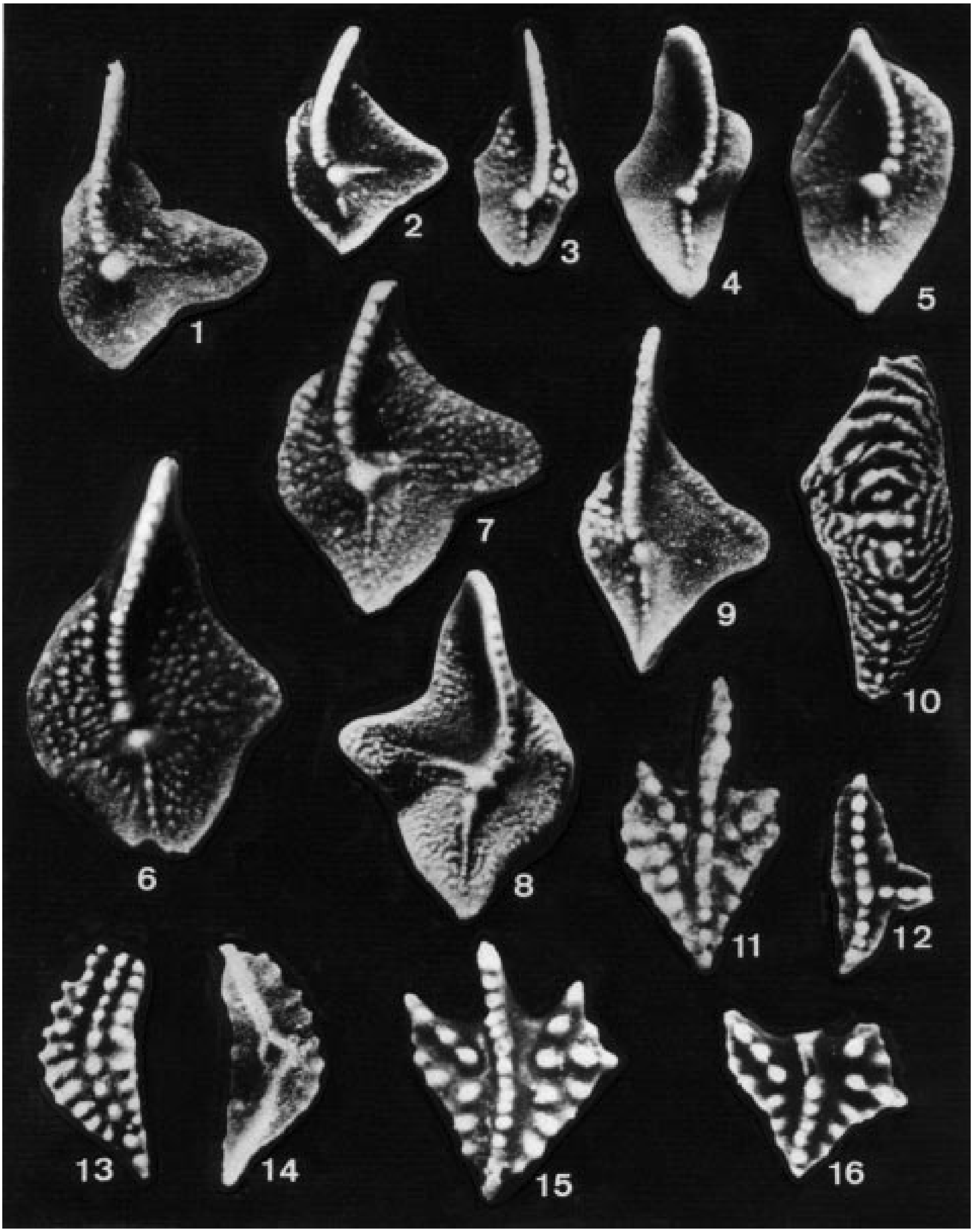
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PLATE 4

Figures 1-4. *Icriodus expansus* BRANSON and MEHL, 1938
1-2. Upper and lower views, ÇR10, x62; 3-4. Upper and lower views, ÇR10, x62.

Figure 5. *Icriodus alternatus alternatus* BRANSON and MEHL, 1934a
Upper view, ÇR137, x62.

Figures 6-7. *Icriodus alternatus helmsi* SANDBERG and DREESEN, 1984
6. Upper view, ÇR137, x62; 7. Upper view, ÇR137, x62.

Figures 8-9. *Icriodus subterminus* YOUNGQUIST, 1947
8. Lateral view, ÇR46, x62; 9. Lateral view, ÇR14, x62.

Figures 10-11. *Icriodus* aff. *symmetricus* BRANSON and MEHL, 1934a
Upper and lower views, ÇR48, x62.

Figures 12-15. *Icriodus cornutus* SANNEMANN, 1955b
12-13. Upper and inner-lateral views, ÇR132, x62; 14-15. Upper and lateral views, ÇR138, x62.

Figures 16-20. *Icriodus fekeensis* n. sp.
16-18. Upper, outer-lateral and lower views of **holotype**, ÇR142, x62; 19-20. Upper and lower views of paratype, ÇR142, x62.

Figures 21-22. *Icriodus symmetricus* BRANSON and MEHL, 1934a
21. Upper view, ÇR46, x62; 22. Upper view, ÇR46, x62.

Figures 23-29. *Icriodus adanaensis* n. sp.
23-25. Upper, lateral and lower views of **holotype**, ÇR147, x60; 26-27. Upper and lateral views of paratype, ÇR155, x60; 28-29. Upper and lateral views of paratype, ÇR155, x60.

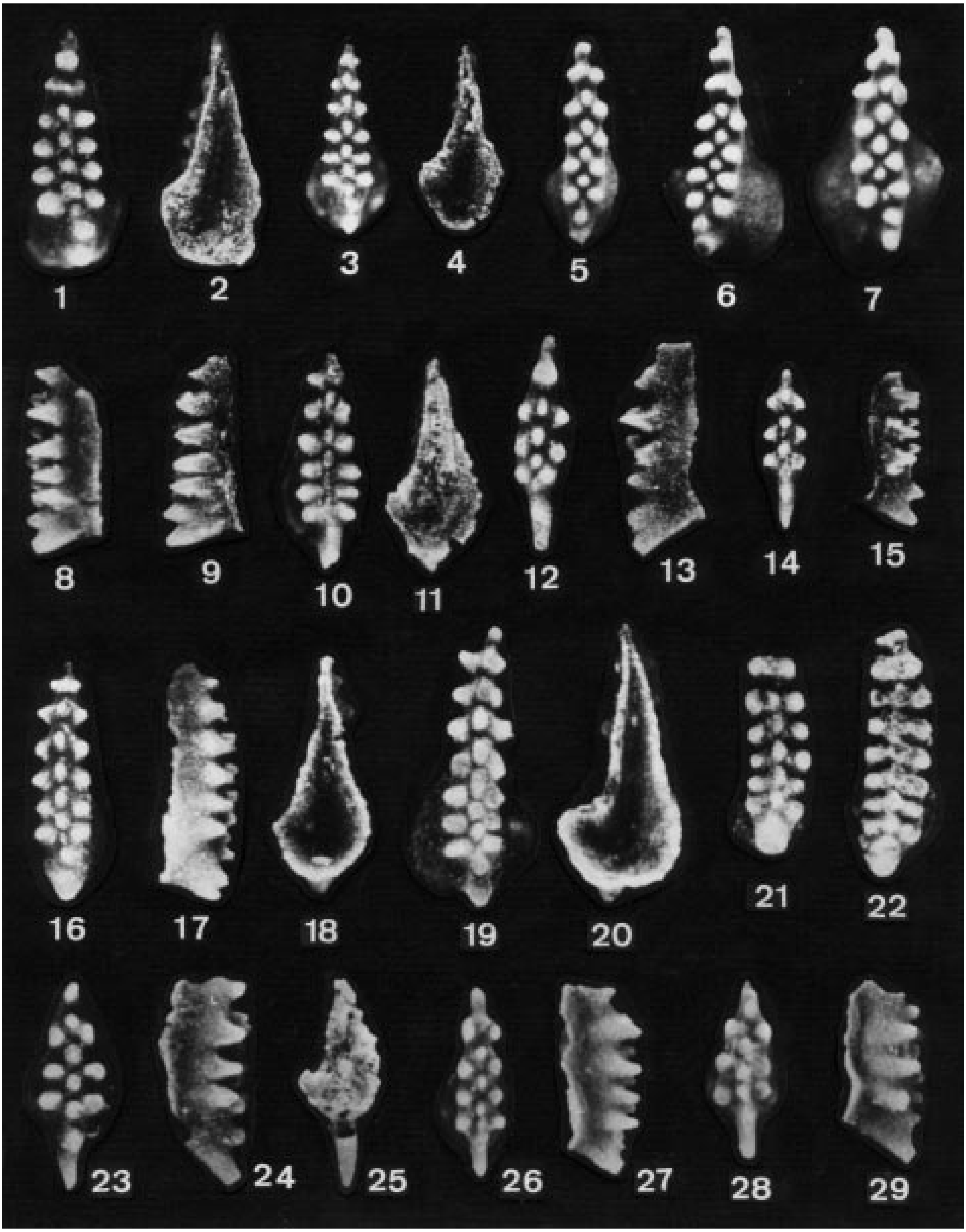
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PLATE 5

Figures 1-2. *Bispathodus stabilis* (BRANSON and MEHL, 1934a)
Lateral and lower views, ÇR170, x60.

Figure 3. *Pseudopolygnathus* aff. *controversus* SANDBERG and ZIEGLER, 1979
Upper view, ÇR163, x60.

Figure 4. *Pelekysgnathus inclinatus* THOMAS, 1949
Lateral view, ÇR142, x55.

Figures 5-6. *Ancyrodella binodosa* UYENO, 1967
Upper and inner lateral views, ÇR25, x60.

Figure 7. *Ancyrodella rotundiloba* (BRYANT, 1921)
Upper view, ÇR25, x60.

Figures 8-12. *Icriodus excavatus* WEDDIGE, 1984
8. Upper view, ÇR77, x55; 9. Upper view, ÇR78, x55; 10-12. Upper, outer-lateral, and lower views, ÇR77, x62.

Figures 13-14. *Icriodus* aff. *brevis* STAUFFER, 1938
Upper and lateral views, ÇR77, x62.

Figures 15-16. *Icriodus* aff. *pectinatus* DREESEN and HOULLEBERGHS, 1980
Upper and lateral views, ÇR147, x62.

Figures 17-19. *Icriodus iowaensis* YOUNGQUIST and PETERSON, 1947
17-18. Upper and lateral views, ÇR131, x62; 19. Upper view, ÇR133, x62.

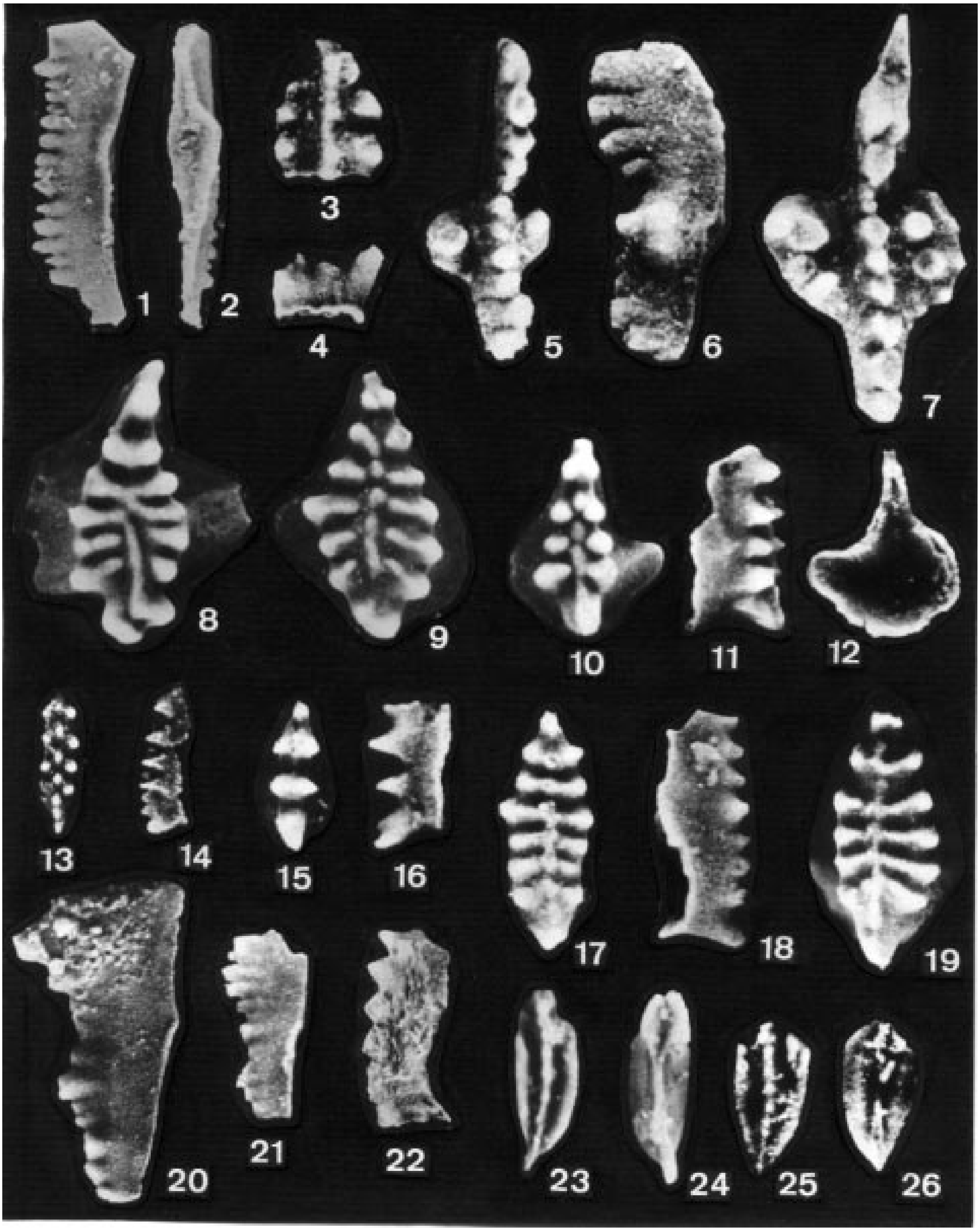
Figure 20. *Mehlina* sp. A
Lateral view, ÇR159, x45.

Figure 21. *Mehlina strigos*a (BRANSON and MEHL, 1934a)
Lateral view, ÇR156, X45.

Figure 22. *Pelekysgnathus planus* SANNEMANN, 1955b
Lateral view, ÇR137, x55.

Figures 23-24. *Polygnathus zikmundovae* ZHURAVLEV, 1991
Upper and lower views, ÇR170, x60.

Figures 25-26. *Polygnathus communis communis* BRANSON and MEHL, 1934b
Upper and lower views, ÇR167, x50.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