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Triassic conodonts from Jordan

ABSTRACT: First finds of generally Middle Triassic (Ladinian) conodonts from Jordan are reported. Biometric analysis of the genus *Pseudofurnishius* shows that the conodonts hitherto assigned to the species *P. huddlei* van den BOOGAARD & SIMON fall within the limits of intrapopulation variability of the species *P. murcianus* van den BOOGAARD. The record of *Gondolella transitia* KOZUR & MOSTLER, *Metapolygnathus mungoensis* (DIEBEL), and *Pseudofurnishius murcianus* van den BOOGAARD, made possible time correlation of the Iraq-al-Amir Formation from Jordan and the Saharonim Formation from Israel.

INTRODUCTION

In Jordan, the Triassic rocks have been first identified at the north-eastern margin of the Dead Sea by COX (1924, 1932) and, subsequently, in Lower Wadi Zarqa, 40 km north of the former area, by BLAKE (1936). Sections from Wadi Zarqa Main and Wadi Hisban at the Dead Sea margin and the Wadi Zarqa area (see Text-fig. 1) were correlated by BENDER (1968), who estimated the thickness of the Triassic deposits in Jordan at about 500 m. This value is markedly lower than those obtained in neighboring areas in southern Israel, studied by DRUCKMAN (1974) and PICARD & FLEXER (1974).

Recently, BANDEL & KHOURY (1981) restudied the Triassic sequence of Jordan to find it thicker (about 1000 m) than previously assumed, and surprisingly close in its lithology to some sections from Negev in southern Israel, described by DRUCKMAN (1974). The latter region was situated much closer to central Jordan in times of deposition of the Triassic sequence. The offset of these areas, estimated at about 110 km, has been done due to tectonic movements at a fault separating Palestine from the rest of the Arabian Peninsula, and continuing along the Jordan — Dead Sea — Wadi Araba rift (BANDEL 1981).

Although BANDEL & KHOURY (1981) distinguished 9 formations in the Triassic rock column in Jordan, their biostratigraphic record is rather poor. Up to the present, there were reported only some Scythian conodonts from the Dardun Formation (BENDER 1968) and Anisian ammonites from the Hisban Formation (see PARNES 1975).

The investigated Ladinian conodonts, first reported from Jordan, have been found in some layers of the Iraq-al-Amir Formation in the Naur section (SW of Amman). This made possible the dating of the formation (except of its lowermost part) and to improve a former correlation (BANDEL & KHOURY 1981) with the Triassic sequences from the western side of the Jordan Rift (*see* Text-figs 1—2 and 9).

K. BANDEL is responsible for locational and lithostratigraphic data, whereas B. WAKSMUNDZKI for a conodont study.

GEOLOGIC SETTING

An almost 160 m Triassic sequence comprising the major part of the Iraq-al-Amir Formation and lower member of the Um-Tina Formation is exposed near Naur. The section comprises the upper part of the Bahhath Member (26 m of 106 m attaining by this member), Abu-Yan (38 m), and Shita (25) Members and it ends with the lower member (70 m) of the Um-Tina Formation, truncated by Lower Cretaceous Kurnub sandstones.

The rocks of the Bahhath Member, originated in a terrestrial coastal and a shallow marine environment, consist of fine-grained sandstones and clays with intercalations of fossiliferous and bioturbated limestones. The Abu-Yan and Shita Members display dominance of open marine carbonate deposits (limestones and marls) with sandy and clayey intercalations. The Um-Tina Formation reflects a change of depositional environment from open marine to evaporitic.

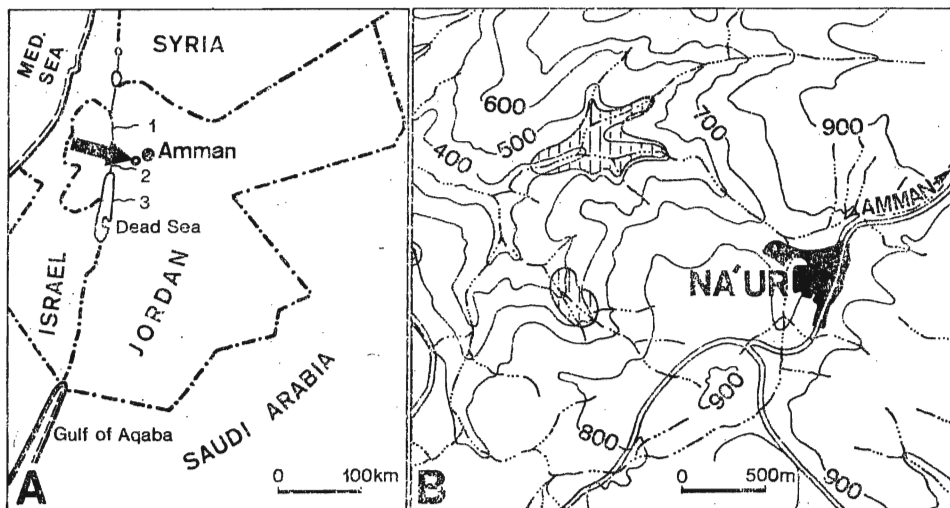


Fig. 1. Location of the study area in Jordan

- A — General map of Jordan: 1 — Wadi Zarqa, 2 — Wadi Hisban, 3 — Wadi Zarqa Main; arrowed is the Naur area
 B — Detailed map of the vicinities of Naur; outcrops of the Iraq-al-Amir Formation are hatched

THE INVESTIGATED MATERIAL

The sample *J38* has been taken in the lowermost part of the exposed section of the Bahhath Member, sample *J34* in the middle part of the Shita Member, and samples *T13* and *T12* in the top part of the latter (Text-fig. 2). After etching the

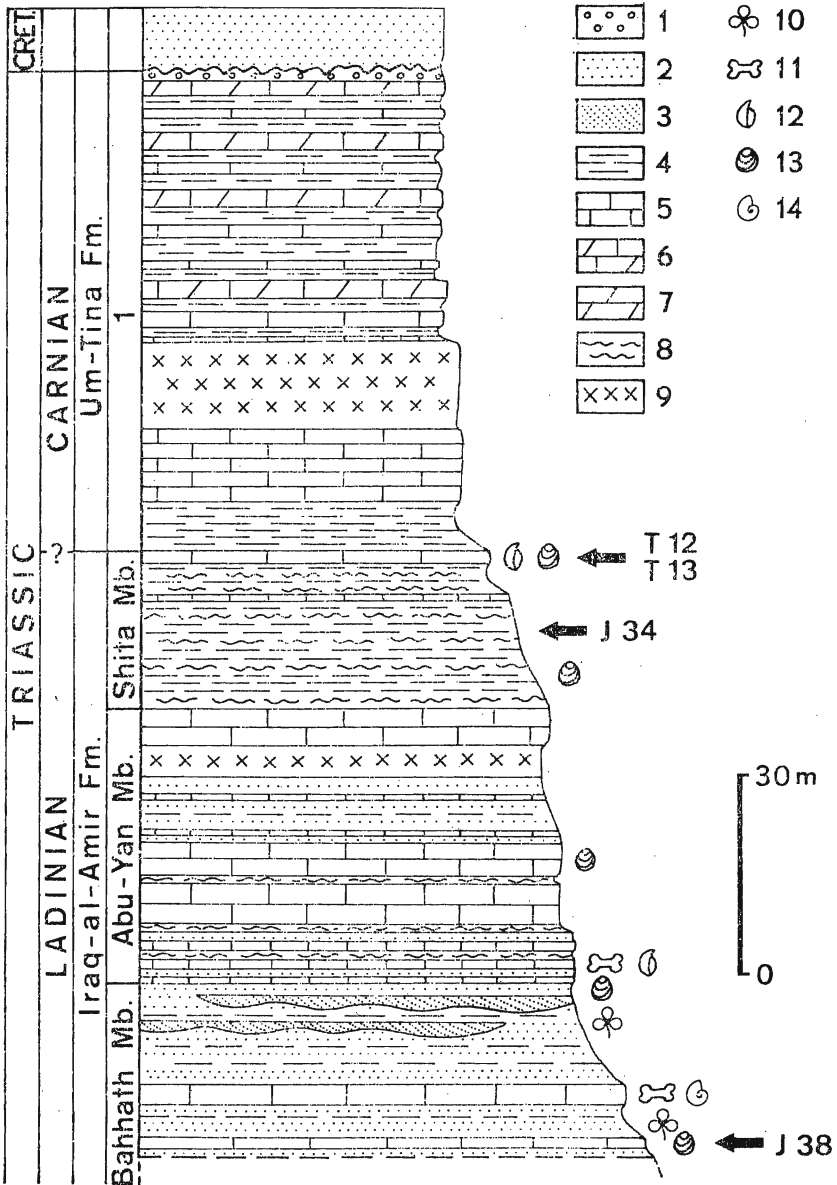


Fig. 2. Columnar section of the exposures west of Naur

1 — gravels, 2 — sandstones, 3 — cross-bedded sandstones, 4 — claystones, 5 — limestones, 6 — dolomitic limestones, 7 — dolomites, 8 — marls, 9 — igneous rocks, 10 — plant remains, 11 — bone fragments, 12 — brachiopods, 13 — bivalves, 14 — ammonites

Species	Number of the sample			
	J38	J34	T13	T12
<i>Enantiognathus jungi</i>			1	
<i>Enantiognathus</i> sp.		1	3	3
<i>Gondolella mombergensis</i>	1			
<i>G. transita</i>	1			
<i>Hibbardella magnidentata</i> ...		1	1	
<i>Hindeodella suevica</i>			5	
<i>Hindeodella</i> sp.		2	3	1
<i>Metapolygnathus mungoensis</i> .			14	78
<i>Ozarkodina?</i> <i>torta</i>			1	
<i>Ozarkodina?</i> sp.			3	
<i>Pollognathus?</i> sp.			1	
<i>Prioniodina muelleri</i>			10	4
<i>Pseudofurnishius murcianus</i> .		26	> 1150	90

Fig. 3. Frequency of conodonts in the samples

samples with acetic acid, over 1.400 conodonts have been obtained. The bulk of the material (over 1.150 specimens) comes from 1 kg sample T13.

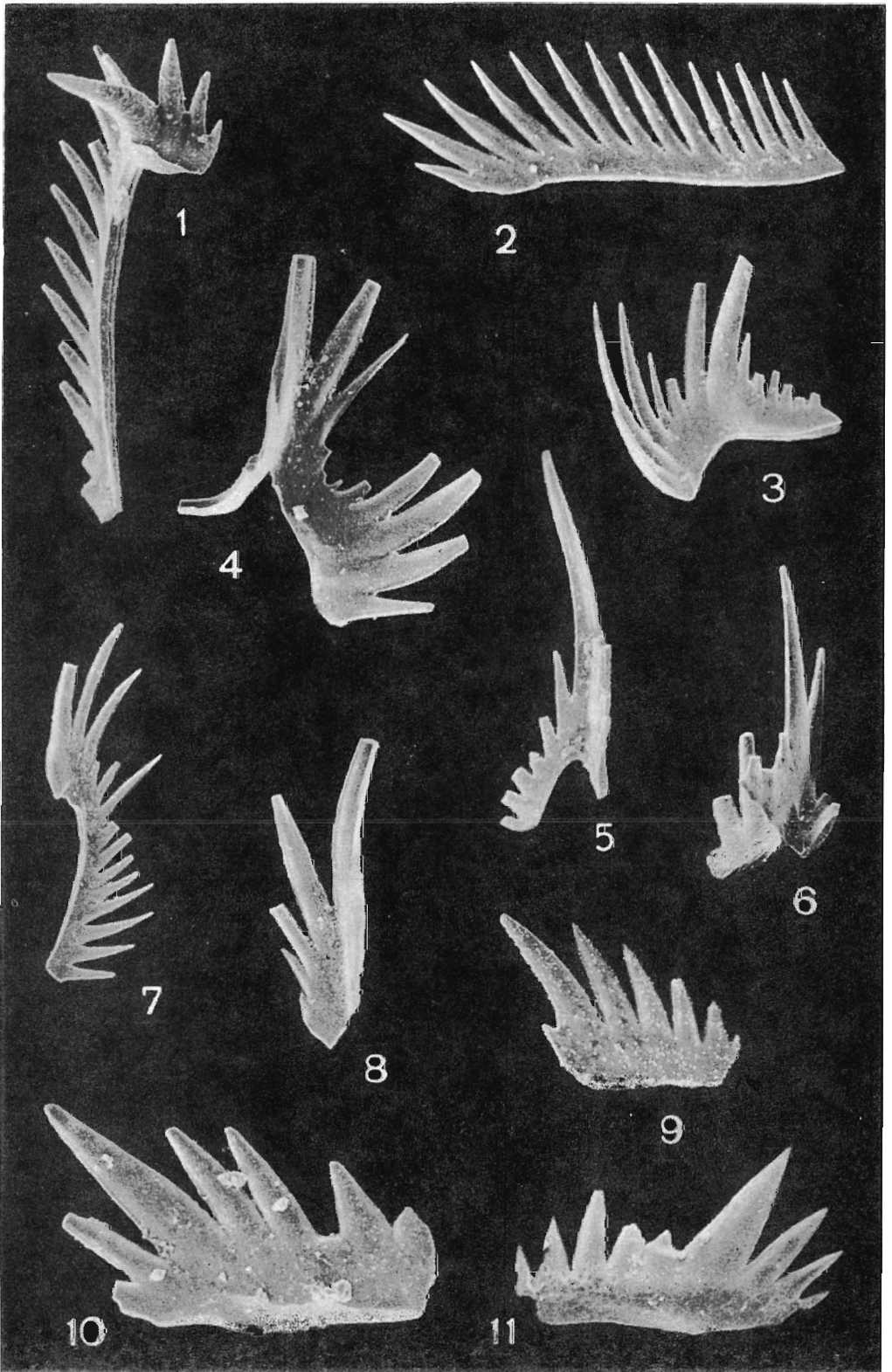
The list of the identified conodonts comprises:

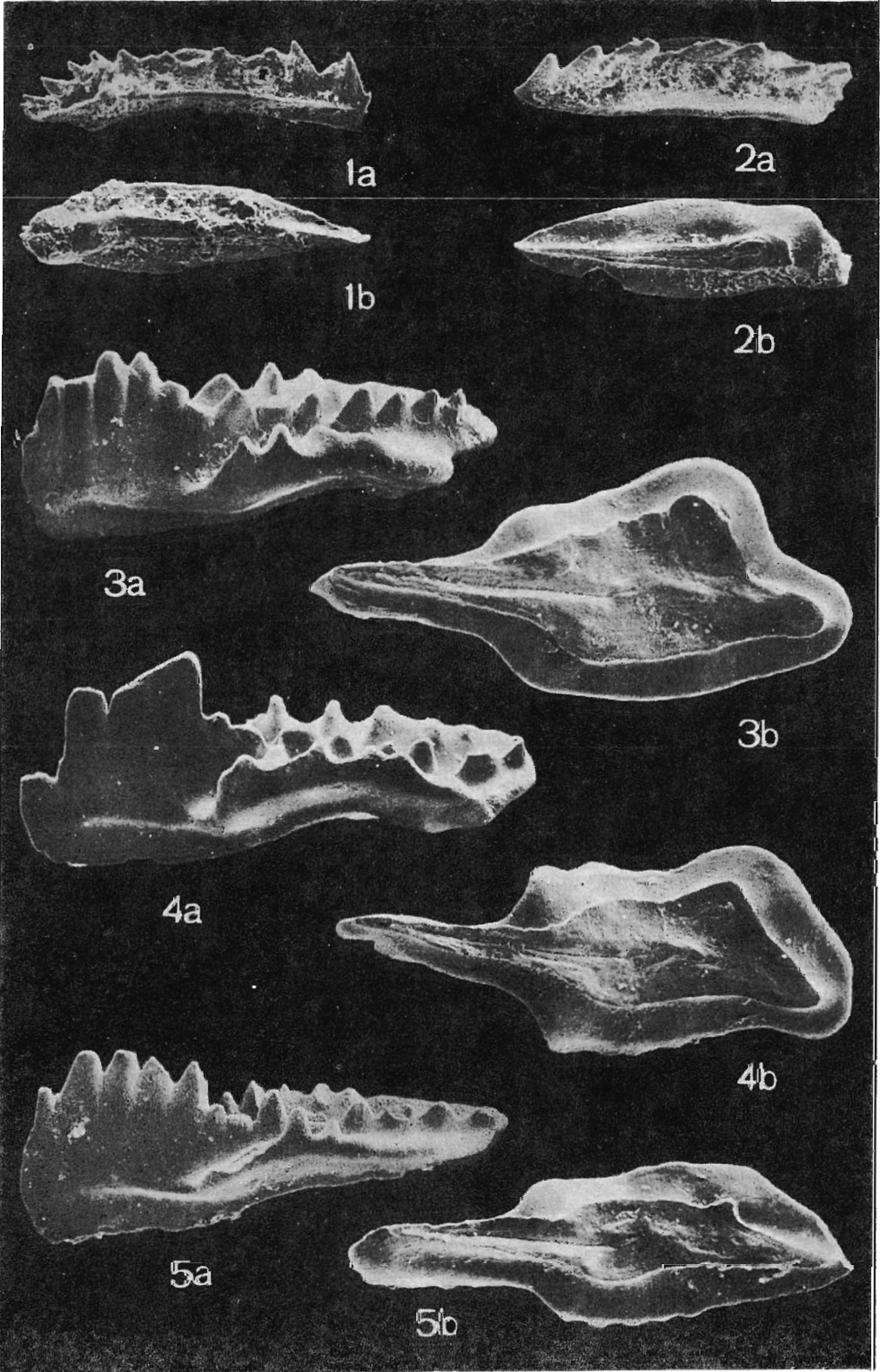
- Enantiognathus jungi* (MOSHER, 1968) — Pl. 1, Fig. 4;
Enantiognathus sp. — Pl. 1, Figs 5, 8;
Gondolella mombergensis TATGE, 1956 — Pl. 2, Fig. 1;
Gondolella transita KOZUR & MOSTLER, 1971 — Pl. 2, Fig. 2;
Hibbardella magnidentata (TATGE, 1956) — Pl. 1, Fig. 6;
Hindeodella suevica (TATGE, 1956) — Pl. 1, Fig. 3;
Hindeodella sp. — Pl. 1, Fig. 2;
Metapolygnathus mungoensis (DIEBEL, 1956) — Pl. 2, Figs 3—5 and Pl. 3, Figs 1—5;
Ozarkodina? *torta* (MOSHER, 1968) — Pl. 1, Fig. 11;
Ozarkodina? sp. — Pl. 1, Fig. 10;
Pollognathus? sp. — Pl. 1, Fig. 9;
Prioniodina muelleri (TATGE, 1956) — Pl. 1, Figs 1, 7;
Pseudofurnishius murcianus van den BOOGAARD, 1966 — Pl. 4, Figs 1—7; Pl. 5, Figs 1—5 and Pl. 6, Figs 1—6.

PLATE 1

- 1—*Prioniodina muelleri* (TATGE), 2—*Hindeodella* sp., 3—*Hindeodella suevica* (TATGE),
4—*Enantiognathus jungi* (MOSHER), 5—*Enantiognathus* sp., 6—*Hibbardella magnidentata*
(TATGE), 7—*Prioniodina muelleri* (TATGE), 8—*Enantiognathus* sp., 9—*Pollognathus?* sp.,
10—*Ozarkodina?* sp., 11—*Ozarkodina?* *torta* (MOSHER)

All specimens from Shita Member (sample T13), $\times 100$





The two species, *Metapolygnathus mungoensis* (DIEBEL) and *Pseudofurnishius murcianus* van den BOOGAARD, are described in the present paper because of their stratigraphic significance and previous taxonomic and stratigraphic misinterpretations. The high frequency of the studied conodonts makes possible an analysis of the intrapopulation variability of these species.

SYSTEMATIC ACCOUNT

Genus *Metapolygnathus* HAYASHI, 1968

Type species: *Metapolygnathus communisti* HAYASHI, 1968

Metapolygnathus mungoensis (DIEBEL, 1956)

(Pl. 2, Figs 3—5 and Pl. 3, Figs 1—5)

1956. *Polygnathus mungoensis* n. sp.; K. DIEBEL, pp. 431—432, Pl. 1, Figs 1—20; Pl. 2, Figs 1—4; Pl. 3, Fig. 1; Pl. 4, Fig. 1.
- non 1967. *Polygnathus mungoensis* DIEBEL; A. POMESANO CHERCHI, p. 229, Pl. 16, Figs 5—17.
1966. *Gondolella catalana* n. sp.; F. HIRSCH, pp. 86—90, Pl. 1, Figs 1—3.
1968. *Epigondolella mungoensis* (DIEBEL); L. C. MOSHER, pp. 936—937, Pl. 116, Figs 16—19.
1970. *Epigondolella mungoensis* (DIEBEL); J. W. HUDDLE, p. 127, Pl. 2, Figs a—h.
1972. *Tardogondolella mungoensis catalana* (HIRSCH) subsp. nov.; F. HIRSCH, p. 816, Pl. 1, Figs 7—10.
1972. *Tardogondolella mungoensis mungoensis* (DIEBEL) subsp. nov.; F. HIRSCH, pp. 815—816, Pl. 2, Figs 1—2.
1972. *Metapolygnathus mungoensis* (DIEBEL); H. KOZUR, Pl. 2, Figs 1—4.
1973. *Epigondolella mungoensis mungoensis* (DIEBEL); L. KRYSZYN, pp. 137—138, Pl. 1, Figs 1—2.
- non 1973. *Epigondolella mungoensis catalana* (HIRSCH); L. KRYSZYN, p. 138, Pl. 1, Fig. 3.
1973. *Tardogondolella mungoensis mungoensis* (DIEBEL); M. van den BOOGAARD & O. J. SIMON, p. 17, Pl. 1, Fig. c; Pl. 2, Figs a—b.
1975. *Epigondolella mungoensis* (DIEBEL); E. KRISTAN-TOLLMANN & L. KRYSZYN, pp. 272—273, Pl. 2, Fig. 1 [non Figs 2—4].
- 1976a. *Carinella mungoensis* (DIEBEL); K. J. BUDUROV, Pl. 2, Figs 1—5.
- 1976b. *Carinella mungoensis* (DIEBEL); K. J. BUDUROV, pp. 102—103, Pl. 2, Figs 24—26.
- 1976b. *Carinella catalana* (HIRSCH); K. J. BUDUROV, p. 103, Pl. 2, Figs 27—29.
1980. *Metapolygnathus mungoensis* (DIEBEL); S. KOVÁCS & H. KOZUR, Pl. 7, Fig. 3.
1982. *Metapolygnathus mungoensis* (DIEBEL); P. MIETTO, Pl. 2, Figs 1—3.
1983. *Epigondolella mungoensis* (DIEBEL); T. KOLAR-JURKOVŠEK, pp. 330—332, Pl. 1, Fig. 1; Pl. 2, Fig. 1.

MATERIAL: 92 well-preserved specimens from samples T13 (14 specimens) and T12 (78 specimens).

DIMENSIONS (in mm): length 0.34—0.88, width 0.16—0.31, height 0.18—0.26.

DESCRIPTION: Conodont with an asymmetric platform, and a marked trend to form a single lobe. The platform does not comprise the whole carina, being reduced in its anterior part (a third of length) where the free blade develops. The platform varies in shape to display a gradual transition from specimens with an elongate slender platform (ratio of width to total length of a specimen

PLATE 2

- 1 — *Gondolella momburgensis* TATG E: 1a — lateral view, 1b — aboral view; Bahhath Member (sample J38)
- 2 — *Gondolella transita* KOZUR & MOSTLER: 2a — lateral view, 2b — aboral view; Bahhath Member (sample J33)
- 3-5 — *Metapolygnathus mungoensis* (DIEBEL): a — lateral views, b — aboral views; Shita Member (sample T12)

All micrographs × 100 (except of Fig. 3a taken × 90)

equals 1:3.8), asymmetrically elongate in the form of a sharp cusp in its posterior part, to specimens with a wide platform (ratio of width to total length of a specimen equals 1:2.2), rounded in its posterior part. The oral surface in the marginal part of the platform is ornamented with nodes or denticles arranged in two rows, by one in each side of the platform (see Text-fig. 4). The number

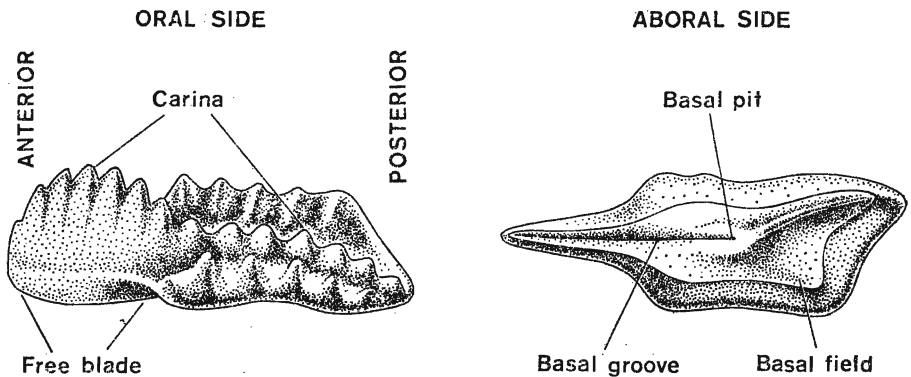


Fig. 4. Morphological terms of *Metapolygnathus* used in the text

of nodes or denticles ranges from 2 to 8 in each row. Nodes are usually laterally flattened, with their longer axis normal to the carina, and these from the anterior part of the platform are usually higher than the remaining ones. Ornamentation becomes less clear in adult forms with a wide, massive platform.

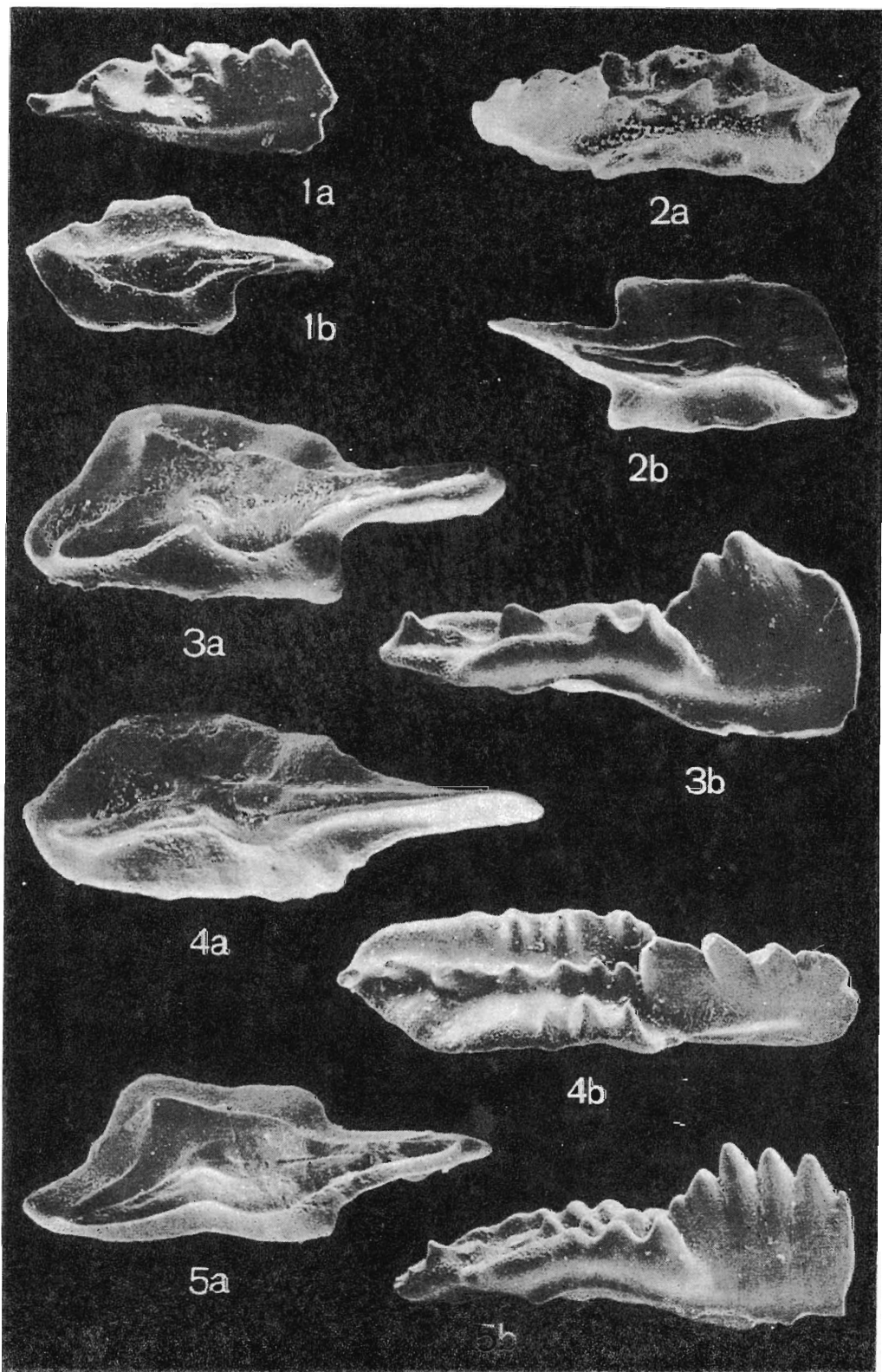
Carina straight or bent towards the posterior lobe of the platform, higher anteriorly and consisting of 3 to 6 denticles in the part corresponding to the free blade. The total number of denticles ranges from 7 in juvenile to 13 in adult specimens. Denticles merged into a ledge, except of their top parts, usually developed in the form of isolated nodes in the part comprised by the platform. The last posterior denticle is situated terminally or in the proximity of the platform margin. Denticles set normal to the platform or, sometimes, slightly bent backwards in the anterior part of the carina.

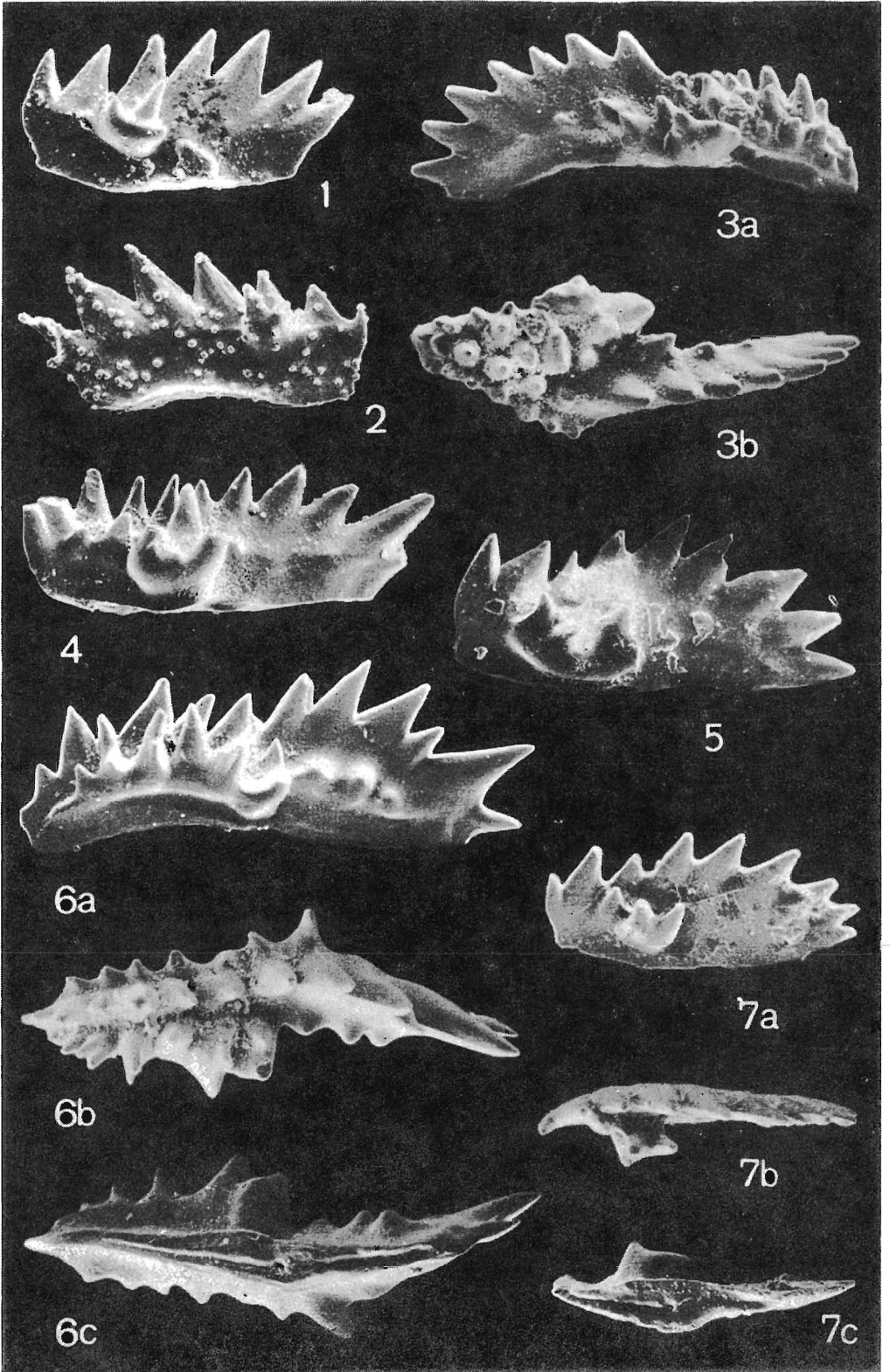
Aboral surface of the platform not ornamented. The basal field is more or less wide (occupying almost the whole width of the platform in some specimens), asymmetric, with a tendency to bifurcation traceable in its posterior part; an arm running towards the platform lobe is usually better developed than the second one (see Text-fig. 5). The basal cavity is situated in a posterior quarter or in a half of the conodont, extending forwards into a deep basal groove as far as the anterior part of the free blade. The aboral margin is slightly S-shaped in side view, and convex downwards in a part corresponding to the free blade. The height-to-length ratio for adult specimens varies from 1:2.4 to 1:3.7.

PLATE 3

Metapolygnathus mungoensis (DIEBEL)

- 1 — Juvenile specimen in lateral (1a) and aboral (1b) views; Shita Member (sample T13), × 120
- 2 — Juvenile specimen in oral (2a), and aboral (2b), views; Shita Member (sample T13), × 120
- 3 — Aboral (3a) and lateral (3b) views; Shita Member (sample T12), × 100
- 4 — Aboral (4a) and oral (4b) views; Shita Member (sample T12), × 100
- 5 — Aboral (5a) and lateral (5b) views; Shita Member (sample T12), × 100





Platform asymmetry is well visible in juvenile forms, in which the platform is ornamented with denticles less numerous than in the adults. The platform is elongate and sharp-pointed. The width-to-length ratio for juvenile specimens ranges from 1:2.1 to 1:2.8, and the height-to-length ratio from 1:2.1 to 1:2.9.

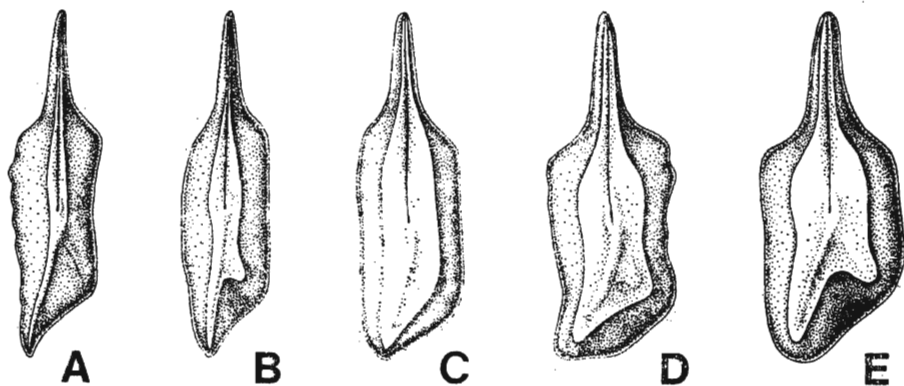


Fig. 5. Variability in shape of the platform and basal field in *Metapolygnathus mungoensis* (DIEBEL)

REMARKS: From the Middle Triassic of Sardinia, POMESANO CHERCHI (1967) reported *Polygnathus mungoensis* DIEBEL. The therein figured specimens (Pl. 16, Figs 5—17) markedly differ from the holotype (DIEBEL 1956, Pl. 4, Fig. 1) in their platform more symmetric and not ornamented at oral side, the basal cavity displaced towards the posterior, and the carina high along its whole length. Moreover, the same specimen (*sic!*) was illustrated as *P. mungoensis* DIEBEL and *Gondolella navicula* HUCKRIEDE (see POMESANO CHERCHI 1967, Pl. 16, Fig. 9 and Pl. 17, Fig. 17, respectively).

From the Middle Triassic of Catalonia (NE Spain), HIRSCH (1966) described the species *Gondolella catalana*, which subsequently he put (HIRSCH 1972) into synonymy of *Tardogondolella mungoensis* regarding it as a subspecies. The subspecies *T. mungoensis catalana* (HIRSCH) differs from *T. mungoensis mungoensis* in less numerous denticles in carina (up to 12 and 17, respectively), the presence of the major denticle, the height-to-length ratio (1:2.5 and 1:4, respectively), and less numerous denticles at the platform margin (up to 4 or 4 and more, respectively). KRYSSTYN (1973, Pl. 1, Fig. 3) illustrated as *Epigondolella mungoensis catalana* (HIRSCH) a specimen from the Cordevolian of Someraukogel near Hallstatt (Austria), characterized by a symmetric platform, a weakly marked free blade, and by the absence of the major denticle in carina. The taxon *E. mungoensis catalana* of KRYSSTYN (1973) was subsequently put by KOZUR (1974) into synonymy of his species *Metapolygnathus mostleri*.

PLATE 4

Pseudofurnishius murcianus van den BOOGAARD

- 1-2 — Juvenile specimens, lateral view, inner side; Shita Member (sample T13), × 150
- 3 — Lateral (3a) and oral (3b) views; Shita Member (sample T13), × 100
- 4 — Lateral view, inner side; Shita Member (sample T12), × 100
- 5 — Lateral view, inner side; Shita Member (sample J34), × 100
- 6 — Lateral (6a), oral (6b), and aboral (6c) views; Shita Member (sample T13), × 100
- 7 — Juvenile specimen in lateral (7a), oral (7b), and aboral (7c) views; Shita Member (sample T13), × 120

The studied material from Jordan comprises specimens with features regarded as characteristic of "*Gondolella catalana*" (HIRSCH 1966) or "*Tardogondolella mungoensis catalana*" (HIRSCH 1972) along with those close to the holotype of "*Polygnathus mungoensis*" DIEBEL. No morphological gap was found in number and development of denticles in carina, ornamentation of platform and height-to-length ratio in this material. Therefore, specimens with the features of "*catalana*" of HIRSCH (1966, 1972) fall within the limits of intrapopulation variability of *Metapolygnathus mungoensis* (DIEBEL).

All discussed forms are assigned in the present paper to the genus *Metapolygnathus* HAYASHI, as already given by KOZUR (1972). BUDUROV (1973) described the genus *Carinella* with its type species "*C.* *mungoensis* (DIEBEL). The original description of the genus *Carinella* BUDUROV, 1973, matches characteristics of the genus *Metapolygnathus* HAYASHI, 1968, as given by KOZUR (1972); the former is here treated as a younger synonym of the latter.

OCCURRENCE: Betic Cordilleras, Catalonia, Balearic Islands (Spain), Eastern Alps (Austria, Italy), Balaton Upland (Hungary), Taurus Mts (Turkey), Sinai (Egypt), Negev (Israel), Naur (Jordan), Ashio Mts (Japan), Nevada (USA): Langobardian through (?) lower Cordevolian.

The specimens of *Polygnathus mungoensis* from the Cretaceous of Cameroun cited by DIEBEL (1956) actually come from the Triassic of Spain, as it was shown by FÖRSTER & WEDDIGE (1979).

Genus *Pseudofurnishius* van den BOOGAARD, 1966

Type species: *Pseudofurnishius murcianus* van den BOOGAARD, 1966

Pseudofurnishius murcianus van den BOOGAARD, 1966

(Pl. 4, Figs 1—7, Pl. 5, Figs 1—5 and Pl. 6, Figs 1—6)

1956. *Spathognathodus?* sp.; K. DIEBEL, pp. 432—433, Pl. 4, Figs 6—7.
 1966. *Pseudofurnishius murcianus* n. sp.; M. van den BOOGAARD, pp. 696—697, Pl. 1, Figs 6—8; Pl. 2, Figs 1—5.
 1970. *Pseudofurnishius murcianus* van den BOOGAARD; J. W. HUDDLE, pp. 129—130, Pl. 2, Figs *i—o*.
 1972. *Pseudofurnishius murcianus* van den BOOGAARD; F. HIRSCH, p. 814, Pl. 2, Figs 4—8.
 1972. *Pseudofurnishius murcianus* van den BOOGAARD; H. KOZUR, Pl. 2, Figs 14—18.
 1972. *Pseudofurnishius* n. sp.; H. KOZUR, Pl. 2, Figs 10—13.
 1973. *Pseudofurnishius huddlei* n. sp.; M. van den BOOGAARD & O. J. SIMON, pp. 14—16, Pl. 1, Fig. *a*; Pl. 2, Figs *c, d, i*.
 1973. *Pseudofurnishius murcianus* van den BOOGAARD; M. van den BOOGAARD & O. J. SIMON, pp. 16—17, Pl. 1, Figs *b, d—f*; Pl. 2, Figs *f, g, k, l*.
 1973. *Pseudofurnishius regularis* n. sp.; K. J. BUDUROV & S. PANTIĆ, p. 61, Pl. 1, Figs 16—18.
 1974. *Pseudofurnishius murcianus* van den BOOGAARD; D. B. EICHER & L. C. MOSHER, p. 737, Pl. 1, Figs 1—14, 17, 19, 23, 26, 32, 33, 35—38, 41—44; Pl. 2, Figs 1—5.
 1977. *Pseudofurnishius murcianus* van den BOOGAARD; A. RAMOVŠ, pp. 364—374, Pl. 3, Figs 1—4; Pl. 4, Figs 1—7; Pl. 5, Figs 1—4; Pl. 6, Fig. 1.
 1978. *Pseudofurnishius murcianus* van den BOOGAARD; A. RAMOVŠ, Pl. 1, Figs 1—3.
 1980. *Pseudofurnishius huddlei* van den BOOGAARD & SIMON; S. KOVÁCS & H. KOZUR, Pl. 6, Fig. 1.
 1980. *Pseudofurnishius murcianus murcianus* van den BOOGAARD; S. KOVÁCS & H. KOZUR, Pl. 7, Figs 4—5.
 1980. *Pseudofurnishius murcianus* n. subsp.; S. KOVÁCS & H. KOZUR, Pl. 7, Fig. 6.
 1981. *Pseudofurnishius murcianus* van den BOOGAARD; A. NICORA, pp. 773—774, Pl. 90, Figs 1—3.

MATERIAL: Over 1260 specimens from samples *J34* (26 specimens), *T13* (over 1150 specimens), and *T12* (90 specimens).
DIMENSIONS (in mm): length 0.28—0.78, width 0.04—0.29, height 0.13—0.26.

DESCRIPTION: Conodont with a blade formed of 9—13 sharp-pointed and laterally flattened denticles in adult forms and generally with the major denticle not developed. Denticles are merged into a ledge up to two-thirds or even three-fourths of the blade height; those of the posterior part of the blade are lower and vertical. The last denticle sometimes slightly bent backwards; other denticles higher and wider at the base and bent in a fan-like way so that the first is oriented almost horizontally or slightly bent downwards. The aboral margin of the blade is straight or somewhat bent upwards. The blade is slightly bent in a third or a half of the posterior part; some specimens are almost straight in outline.

The platform is developed in the posterior part of the conodont (see Text-fig. 6) and it is irregular in its outline, generally being the widest in its anterior part. The platform sometimes reaches the posterior end of the blade and it attains up to a half of the conodont length. The platform is built of denticles fused at the base. The denticles are cusp- or node-like, lower than or in extreme

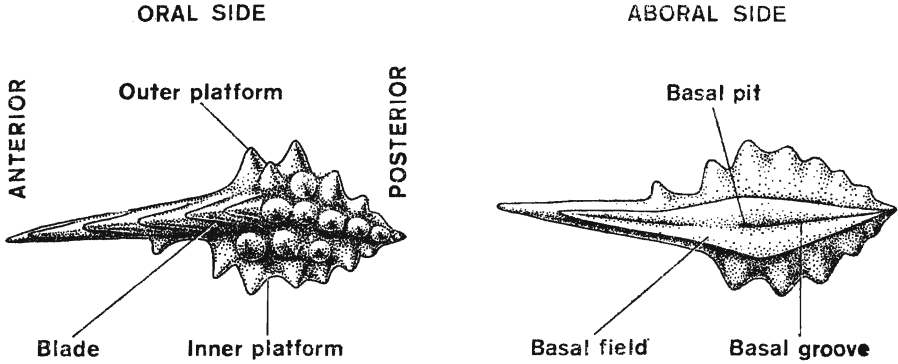


Fig. 6. Morphological terms of *Pseudofurnishius* used in the text

cases equal to the height of neighboring denticles of the blade; they are vertical in proximity of the blade and outwardly oblique in the marginal part of the platform. The lower part of the platform is situated at a fifth to a third of the blade height, usually passing into swellings. In fully grown specimens, a few isolated denticles or nodes merged with the blade are found beyond the platform.

The studied material comprises both monoplatform-type specimens, with a platform developed at the inner side of the blade, and these of the biplatform-type, with their platforms developed both at inner and outer side of the blade (see Text-fig. 7). Forms which have only the inner platform

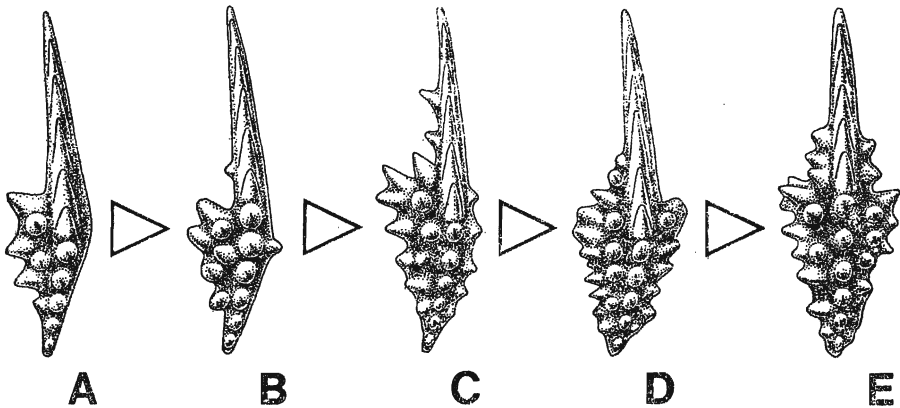


Fig. 7. A series of coeval specimens of *Pseudofurnishius murci anus* van den BOOGAARD from the mono- to the biplatform-type with an almost symmetric sculpture

predominate (84%). In such forms the outer side displays usually a narrow ledge, either smooth or with innumerable nodes. The maximum number of denticles in the inner platform equals 13, whereas in the outer platform 8. The ratio of width of the outer platform to that of the inner platform ranges from nil to 1.0, the last value being however rare. The ratio of number of denticles from the outer and inner sides ranges from nil to 1.33. When number of denticles from opposite

sides of the blade is comparable, the outer platform is narrower and characterized by denticles lower than those at the inner platform.

The basal field is developed along the whole length of the base, and the basal pit is situated centrally or slightly displaced along the antero-posterior line. The basal field is the widest in a half of its length, narrowing both posteriorly and anteriorly. The basal pit extends into the basal groove as far as the posterior part of the field. The basal groove becomes shallow or it disappears anteriorly.

In juvenile forms, only the inner platform with a single denticle is developed. Intense growth of denticles at the inner side begins when the number of denticles in the blade reaches 7. The ratio of height to length of the conodont during growth of an individual decreases from 1:2.0 to 1:3.6.

OCCURRENCE: Betic Cordilleras, Balearic Islands (Spain), Southern Alps (Italy), Taurus Mts (Turkey), Sinai (Egypt), Negev (Israel), Naur (Jordan): Langobardian through (?) Cordevolian.

The specimens "*Spathognathodus*" sp. (= *P. murcianus*) reported from the Cretaceous of Cameroun by DIEBEL (1956) actually come from the Triassic of Spain (see FÖRSTER & WEDDIGE 1979).

BIPLATFORM-TYPE CONODONTS OF THE GENUS *PSEUDOFURNISHIUS*

The monotypic genus *Pseudofurnishius*, with its type species *P. murcianus*, when established by van den BOOGAARD (1966), was characterized by a monoplatform development. Subsequently, some authors have assigned to that genus also the biplatform-type conodonts co-occurring with those of the monoplatform-type, and they have variously interpreted their specific position and stratigraphic significance. In this chapter discussed are previous interpretations and presented are results of the biometric analysis of the genus *Pseudofurnishius* to explain the specific position of these biplatform-type conodonts and to verify their stratigraphic significance.

HUDDLE (1970) assigned the biplatform-type specimens from the Triassic of Israel to the species *Pseudofurnishius murcianus* van den BOOGAARD. These specimens (HUDDLE 1970, Pl. 2, Figs *j, m, l*, and *i*) were refigured by KOZUR (1972, Pl. 2, Figs 10—13, respectively) who established a separate species of *Pseudofurnishius* (but without any description) and a new regional stratigraphic zone (for the west-Mediterranean conodont province), viz. the "*Pseudofurnishius* n. sp. Zone", corresponding to the mid-Langobardian.

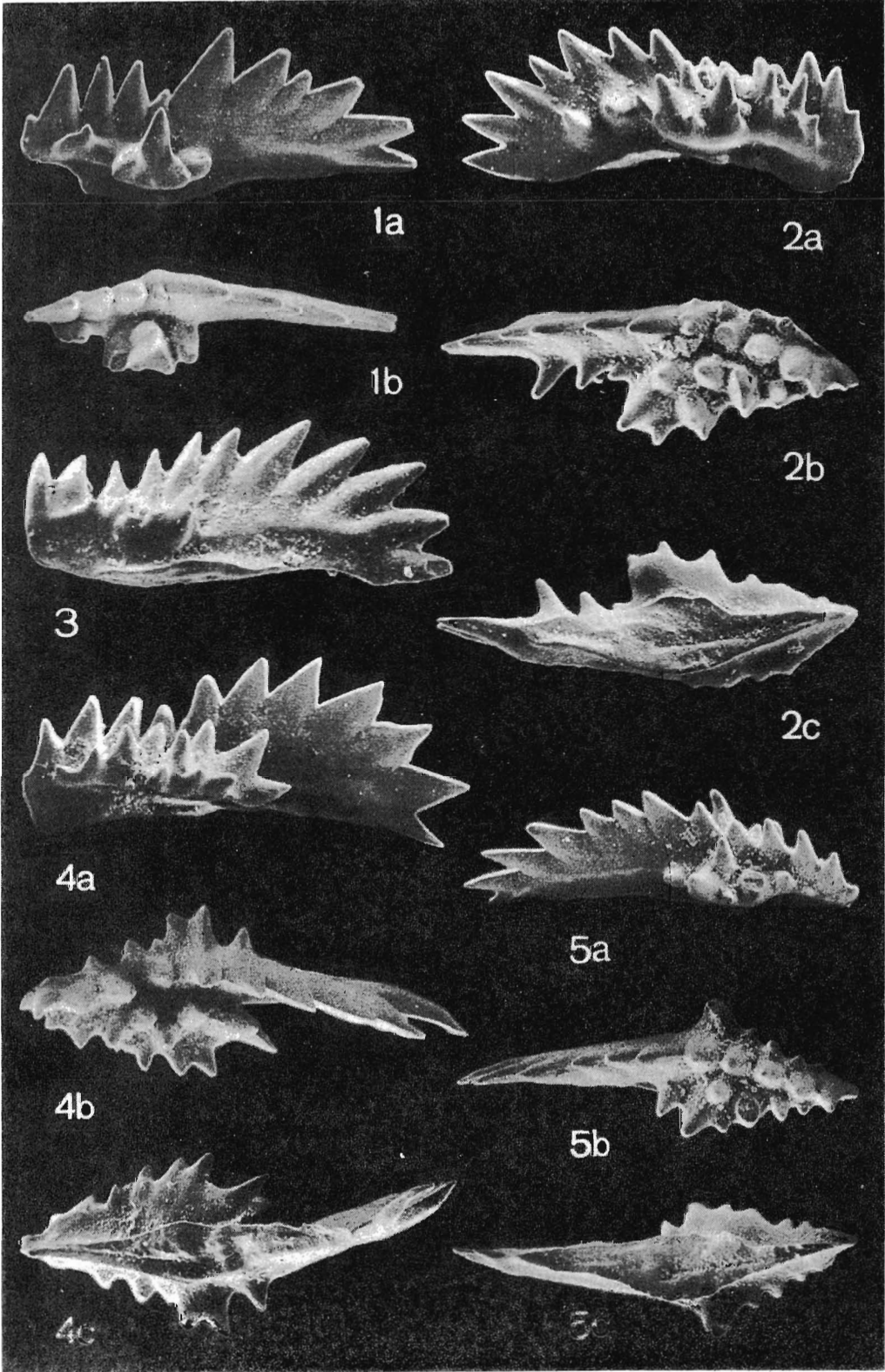
From the Triassic of Spain, van den BOOGAARD & SIMON (1973) described the species *Pseudofurnishius huddlei*, differing from *P. murcianus* in a two-platform development, a similar number of denticles at the inner and outer sides, a straighter blade, and a more symmetric aboral side. The synonymy given by van den BOOGAARD & SIMON (1973) comprises one of the specimens figured by HUDDLE (1970, Pl. 2, Fig. *m*), that is one of those assigned by KOZUR (1972)

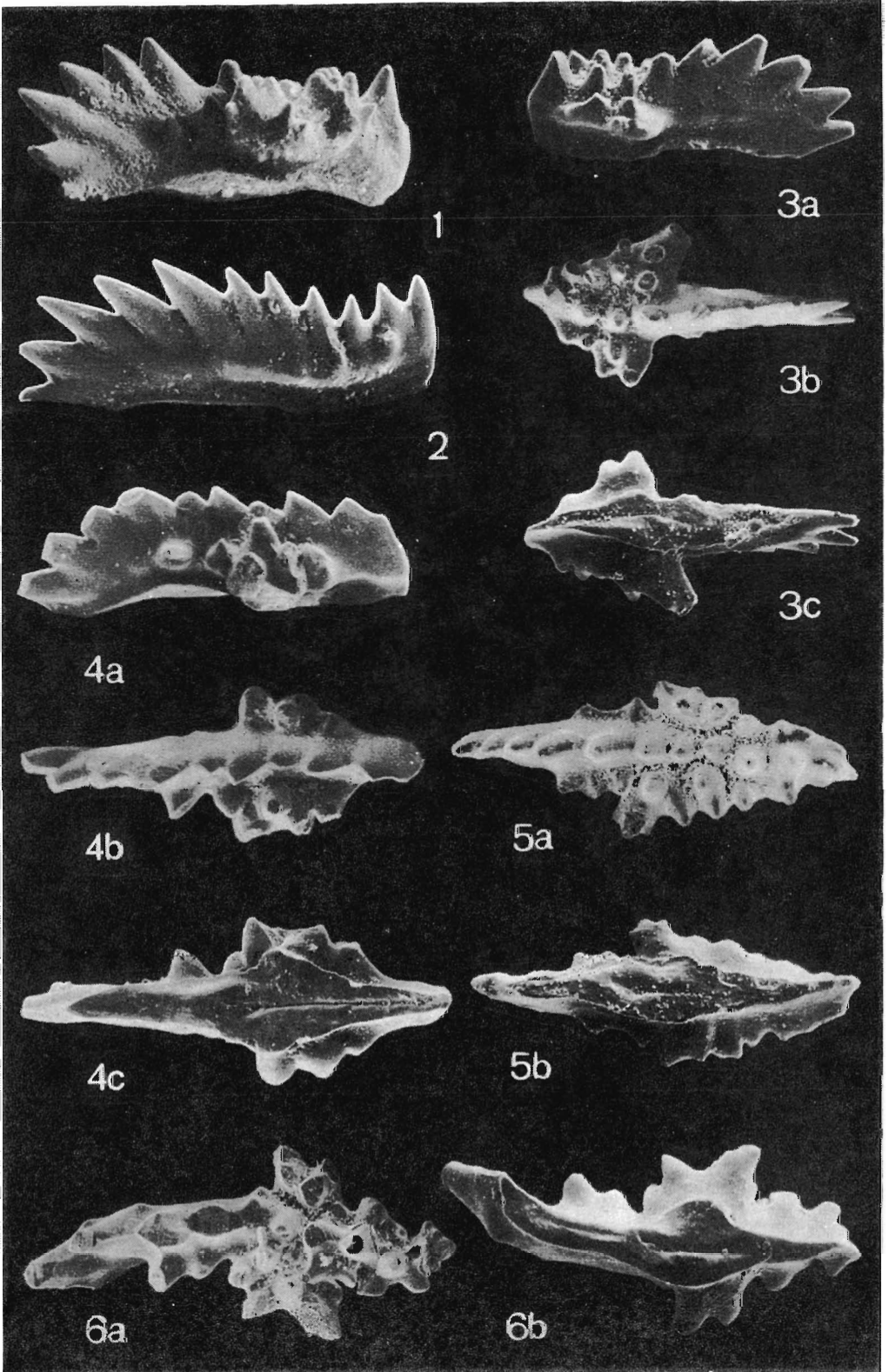
PLATE 5

Pseudofurnishius murcianus van den BOOGAARD

- 1 — Lateral (*1a*) and aboral (*1b*) views
- 2 — Lateral (*2a*), oral (*2b*), and aboral (*2c*) views
- 3 — Lateral view, inner side
- 4-5 — Biplatform-type specimens, a — lateral views, b — oral views, c — aboral views

All specimens from Shita Member (sample T13), ×100





to his species "*Pseudofurnishius* n. sp.". In the opinion of van den BOOGAARD & SIMON (1973, pp. 13—14), the monoplatform-type species *P. murcianus* evolved from the biplatform-type *P. huddlei* in result of the reduction of the outer platform. This interpretation was offered on the basis of studies on the Ladinian section from Sierra de Carrascoy, SE Spain, where biplatform-type conodonts were found in lower stratigraphic levels (3 samples), and monoplatform-type conodonts in higher levels (5 samples). Contrary to the data of van den BOOGAARD & SIMON (1973), the studies on the Saharonim Formation (Ladinian) in southern Israel (HIRSCH & GERRY 1974) showed a decrease of the monoplatform-type specimens at the advantage of the biplatform-type ones: ratio of mono- to biplatform-type conodonts changes from 10:1 for 2 older samples to 1:1 for a younger one. In the light of data given by HIRSCH & GERRY (1974), contradictory to those of van den BOOGAARD & SIMON (1973), it is unjustified to precise any evolutionary trend in the genus *Pseudofurnishius*.

BUDUROV & PANTIĆ (1973) described the species *Pseudofurnishius regularis* from the Ladinian strata [dated at the Campilian in the text, but corrected as the Ladinian with a handwriting in the reprints] of western Serbia (Jugoslavia). This species was established on the basis of 4 specimens characterized by an almost symmetric development of the platforms and by a wide basal field (see BUDUROV & PANTIĆ 1973, Pl. 1, Figs 16—18). KOZUR & MOSTLER (1973) assigned these specimens to the genus *Platyvillosus* CLARK, SINCAVAGE & STONE, arguing this decision by a suggested phylogenetic lineage "*Pseudofurnishius*" *regularis* BUDUROV & PANTIĆ → *Platyvillosus gardenae* (STAESCHE). However, the specimens of "*P.*" *regularis* assigned by KOZUR & MOSTLER (1973) to the genus *Platyvillosus* and those of the genus *Pseudofurnishius* characterized by a two-platform development are identical. Moreover, the Scythian genus *Platyvillosus* is separated from the Ladinian species *P. regularis* by a long spanned gap. That is why the interpretation of KOZUR & MOSTLER (1973) was already questioned by RAMOVŠ (1977).

KOVÁCS & KOZUR (1980) accepted the species *P. huddlei* van den BOOGAARD & SIMON, defining its stratigraphic range at the mid-Langobardian. They also introduced (KOVÁCS & KOZUR 1980, Tables 1—2 and Pl. 7, Fig. 6) a separate subspecies (but without any description) of *P. murcianus*, with its stratigraphic range from the uppermost Langobardian through the lowermost Cordevolian, in comparison with that of *P. murcianus murcianus*, extending up to the Cordevolian/Julian boundary. However, there are no features which would enable differentiation of separate subspecies in the *P. murcianus* population presented by KOVÁCS & KOZUR (1980).

The biometric analysis of over 500 specimens of the genus *Pseudofurnishius* was performed to recognize a taxonomic structure of the population. The studied material comes from sample T13 (the scarce material from samples J34 and T12 was omitted) and it comprises both monoplatform-type specimens (corresponding to *P. murcianus* of van den BOOGAARD & SIMON 1973) and biplatform ones

PLATE 6

Pseudofurnishius murcianus van den BOOGAARD

- 1 — Lateral view, inner side; Shita Member (sample T13)
- 2 — Lateral view, outer side; Shita Member (sample T13)
- 3 — Biplatform-type specimen in lateral (3a), oral (3b), and aboral (3c) views; Shita Member (sample T13)
- 4 — Biplatform-type specimen in lateral (4a), oral (4b), and aboral (4c) views; Shita Member (sample T12)
- 5 — Biplatform-type specimen in oral (5a) and aboral (5b) views; Shita Member (sample T13)
- 6 — Biplatform-type specimen in oral (6a) and aboral (6b) views; Shita Member (sample T12)

All micrographs × 100

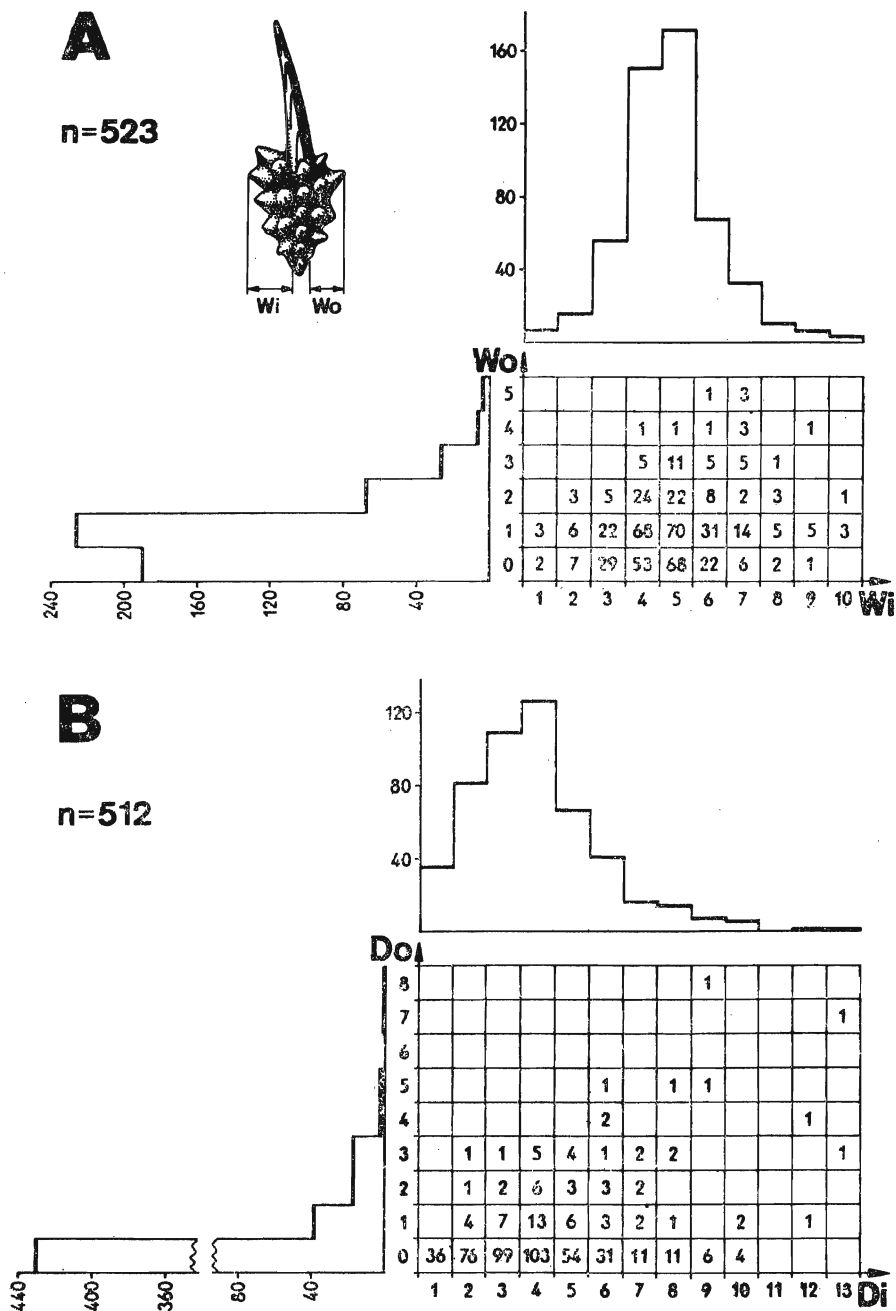


Fig. 8. Biometric analysis of conodonts of the genus *Pseudofurnishius* from sample T13

A—Frequencies of specimens with a given width of inner (W_i) and outer (W_o) platforms and histograms for the two parameters; width of platforms in units equal 0.014 mm

B—Frequencies of specimens with a given number of denticles on inner (D_i) and outer (D_o) platforms and histograms for the two parameters

matching the diagnosis of *P. huddlei* van den BOOGAARD & SIMON. The parameters of the width of platforms and the number of denticles at the inner and outer sides in the studied specimens (see Text-fig. 8) give no basis of separation of the representatives of *P. huddlei* van den BOOGAARD & SIMON from the *P. murcianus* population. Distribution of the features regarded by van den BOOGAARD & SIMON (1973) as indicative of the two species is uniformly scattered and single specimens from peripheries of the population are separated from the remaining ones by a minor gap only. The specimens with an almost symmetric development of platforms and with the comparable number of denticles at the outer and inner sides are connected with the monopatform ones by a continuous series of forms displaying intermediate features (see Text-fig. 7). Comparisons of the number of denticles on platforms and in the blade, and the measurement of the length, width and height of conodonts give a further support for this statement. Similarly, such unmeasurable features as the mode of development of the basal pit, the field, and the groove failed to give any basis to split the population. All the studied specimens are assigned to *P. murcianus* van den BOOGAARD, and thus both the species *P. huddlei* van den BOOGAARD & SIMON and *P. regularis* BUDUROV & PANTIĆ are treated as younger synonyms. This is compatible with the opinions of EICHER & MOSHER (1974) and RAMOVŠ (1977, 1978), according to whom the biplatform-type specimens fall within the limits of intrapopulation variability of the species *P. murcianus* van den BOOGAARD.

REGIONAL CORRELATION

In the course of sedimentation of the Iraq-al-Amir Formation in Jordan, a supply of clastic material from the Arabian-Nubian continent began to decrease. The deposits of the Bahhath Member, originating under terrestrial coastal conditions disturbed by short-lasting ingressions, are replaced upwards by predominantly marine deposits of the Abu-Yan and Shita Members. Similarly, the Middle and Upper Members of the Gevanim Formation in Israel also reflect a decrease in supply of clastic material (DRUCKMAN 1974). That is why BANDEL & KHOURY (1981) correlated the Iraq-al-Amir Formation from Jordan with the Gevanim Formation from Israel, dated at Anisian. The species *Gondolella transita* KOZUR & MOSTLER, found in sample J38, indicates Fassanian (=Lower Ladinian) age of the upper part of the Bahhath Member. The species of *Pseudofurnishius murcianus* van den BOOGAARD found in the middle part of the Shita Member (sample J34), and *P. murcianus* and *Metapolygnathus mungoensis* (DIEBEL) from the top part of that member (samples T13 and T12) are the most characteristic of the Lango-bardian (=Upper Ladinian).

The Anisian/Ladinian boundary passes presumably in the lower part of the Bahhath Member and the Ladinian/Carnian boundary is close to that of the Iraq-al-Amir and Um-Tina Formations (see Text-fig. 9). It is therefore thought that the major part of the Iraq-al-Amir Formation corresponds to the Ladinian (even through

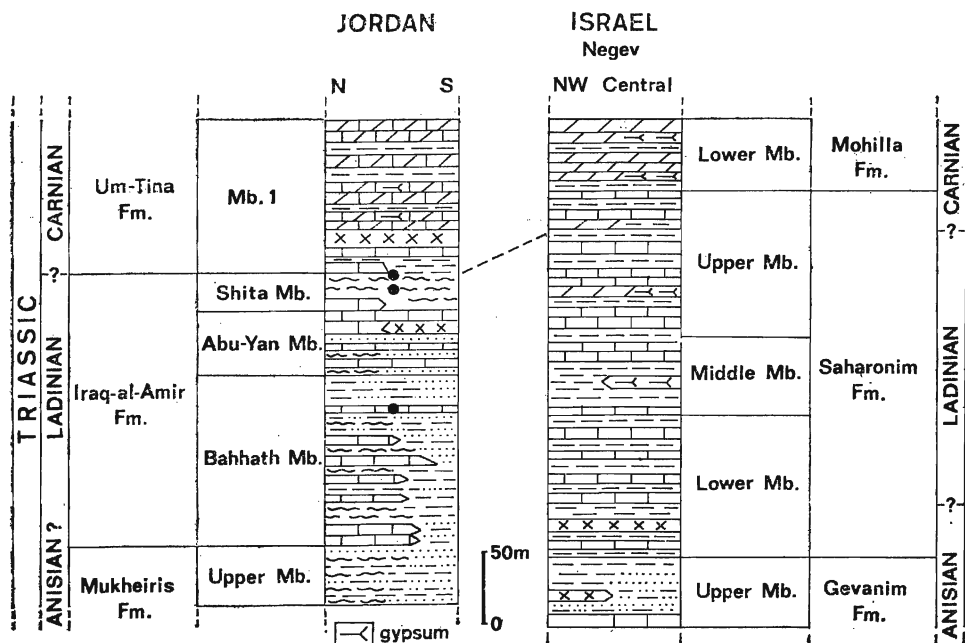


Fig. 9. Correlation of Triassic sections in Jordan and Israel (after BANDEL & KHOURY 1981; slightly modified)

Dots — sampling sites; other explanations as for Text-fig. 2

the lowermost Carnian), and not to the Anisian as it has hitherto been assumed (see BANDEL & KHOURY 1981) on the basis of lithological analogies to the Gevanim Formation of Israel. Consequently, the Iraq-al-Amir Formation from Jordan is regarded as a time equivalent of the Saharonim Formation from Israel (see Text-fig. 9).

Acknowledgements

Professor A. RADWAŃSKI (University of Warsaw) and Docent A. GAŹDZICKI (Polish Academy of Sciences), kindly read an early draft of this paper, and offered many helpful comments. E. KLICHOWICZ, M. Sc., helped the authors with preparation of SEM micrographs.

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KONODONTY TRIASOWE JORDANII

(Streszczenie)

Konodonty ladyńskie znalezione w utworach formacji Iraq-al-Amir w profilu Naur położonym na południowy-wschód od Ammanu (patrz fig. 1—3) są pierwszymi konodontami tego wieku opisanymi z Jordanii. Rozpoznano (patrz fig. 4—6 oraz pl. 1—6): *Enantiognathus jungi* (MOSHER), *Enantiognathus* sp., *Gondolella mombergensis* TATGE, *G. transita* KOZUR & MOSTLER, *Hibbardella magnidentata* (TATGE), *Hindeodella suevica* (TATGE), *Hindeodella* sp., *Metapolygnathus mungoensis* (DIEBEL), *Ozarkodina? torta* (MOSCHER), *Ozarkodina? sp.*, *Pollognathus? sp.*, *Priodina muelleri* (TATGE) oraz *Pseudofurnishius murcianus* van den BOOGAARD. Okazy o cechach "catalana" sensu HIRSCH (1966, 1972) zaliczono do *Metapolygnathus mungoensis* (DIEBEL). Duża frekwencja okazów w próbie T13 umożliwiła przeprowadzenie badań biometrycznych konodontów z rodzaju *Pseudofurnishius* van den BOOGAARD. Wykazano (patrz fig. 7—8), iż konodonty dwuplatformowe, zaliczane do gatunku *P. huddlei* van den BOOGAARD & SIMON mieszczą się w obrębie zmienności wewnątrzpopulacyjnej gatunku *P. murcianus* van den BOOGAARD.

Utwory formacji Iraq-al-Amir prawie w całości odpowiadają lądynowi, a nie zaś anizykowi, jak dotychczas przyjmowano (patrz BANDEL & KHOURY 1981) na podstawie analogii z formacją Gevanim w Izraelu. Wiekowym odpowiednikiem formacji Iraq-al-Amir są w Izraelu utwory formacji Saharonim (patrz fig. 9).
