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Original article

Two new species of canaliculate rudists (Dictyoptychidae) from southeastern turkey

Deux nouvelles espèces de rudiste à canaux (Dictyoptychidae) du sud-est de la Turquie

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Abstract

Two new species of canaliculate rudist genus *Dictyoptychus* Douvillé: *Dictyoptychus quadrizonalis* n. sp. and *Dictyoptychus vanensis* n. sp., are described from the Maastrichtian limestone block of the ophiolitic unit of the Gevaş-Van area, southeastern Turkey. The new species are mainly characterized by the complex structure of the canal layer of the lower valve, and also they seem to be most primitive species of *Dictyoptychus* and transitional between *Dictyoptychus* Douvillé and its presumed ancestor, *Eodictyoptychus* Skelton and El-Asa'ad. Many specimens of the *Dictyoptychus paronai* (Kühn), allows us to first determination of the upper valve shape and to study also of the lower valve canal layer.

Résumé

Deux nouvelles espèces de rudiste à canaux du genre *Dictyoptychus* Douvillé : *Dictyoptychus quadrizonalis* n. sp. et *Dictyoptychus vanensis* n. sp., sont décrites dans les blocs de calcaires du Maastrichtien de l'unité ophiolitique des environs de Gevaş-Van, sud-est de la Turquie. Les nouvelles espèces sont caractérisées par la structure complexe de la couche à canaux de la valve inférieure, et aussi ils paraissent le plus primitif de *Dictyoptychus* et transitionnel entre les *Dictyoptychus* Douvillé et son ancêtre présumée *Eodictyoptychus* Skelton et El-Asa'ad. Plusieurs échantillons de l'espèce *Dictyoptychus paronai* (Kühn) permettent, pour la première fois, une détermination de la forme de la valve supérieure et aussi de la couche à canaux de la valve inférieure.

Keywords: Dictyoptychus; Rudist; Taxonomy; Maastrichtian; Southeastern Turkey

Mots clés : Dictyoptychus ; Rudiste ; Taxonomie ; Maastrichtien ; Sud-est de la Turquie

1. Introduction

Dictyoptychus Douvillé, 1905 is a canaliculate rudist genus characterized by the presence of canals in both valves, the absence of a ligamental ridge, and a localized distribution in the Tethyan region (Douvillé, 1905, 1910; Kuhn, 1929; Cox, 1934; Tavani, 1949; Moore, 1969; Kauffman, 1973; Karacabey-Öztemür, 1979; Grubić, 1979; Skelton and Wright, 1987; Philip and Platel, 1987, 1994; Skelton and El-Asa'ad, 1992; Pons et al., 1992; Özer, 1992a, 1993; Morris and Skelton, 1995). The occurrence of this genus in Turkey, including two new species, was first established by Karacabey-Öztemür (1979) from the Adıyaman and Antakya areas (Fig. 1). The presence also of some species and the more wide-spread geo-

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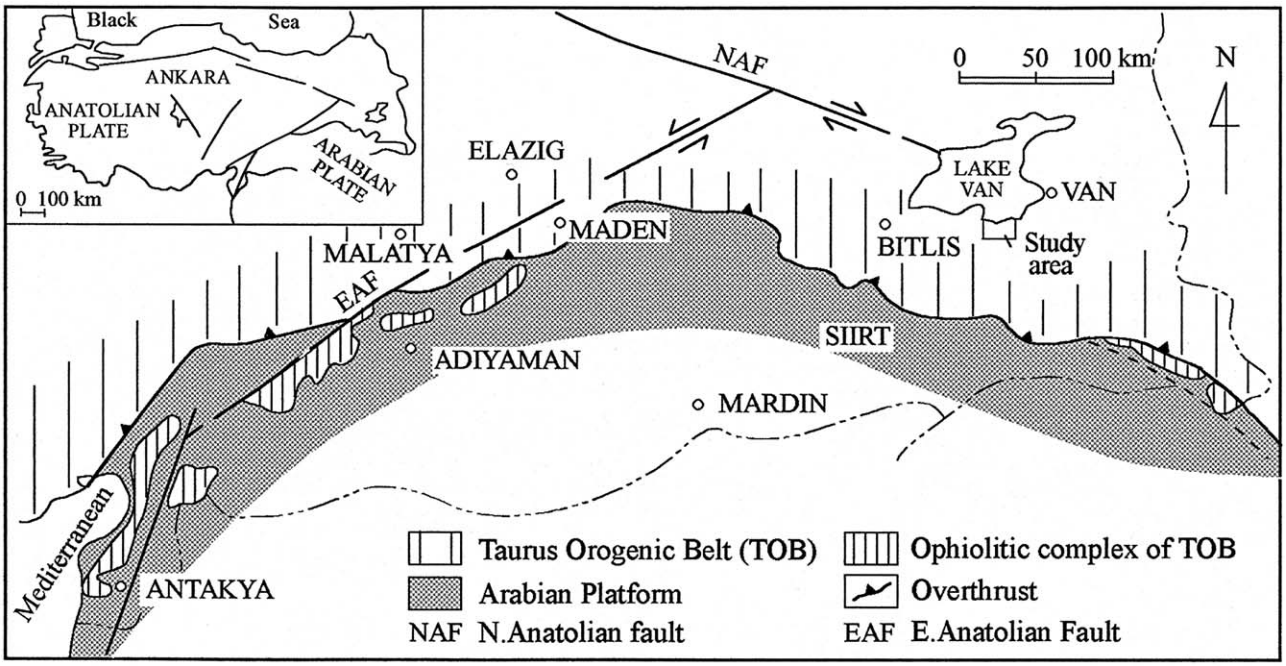

Fig. 1. Geologic map of southeastern Turkey showing main structural features (simplified from Perinçek, 1979; Yılmaz, 1993; Aktaş and Robertson, 1990) and the study area.

graphic distribution of the genus in southeastern Anatolia, was shown by Özer (1986, 1991, 1992a, 1992b). A *Dictyoptychus*-bearing limestone block was also discovered by Özer (1992c) from the Gevaş area (Figs. 1 and 2).

The purpose of this study is mainly to describe the new species of *Dictyoptychus* Douvillé from the Gevaş-Van area (Figs. 1 and 2). However, the species *Dictyoptychus paronai* (Kühn) is also examined because of the presence of many samples there.

The holotype and the paratypes are deposited at the Paleontology Laboratory of the Dokuz Eylül University, İzmir.

2. Geological setting and stratigraphy

The southeastern Anatolian orogenic belt may be divided mainly into two tectonic units from north to south. The Taurus orogenic belt and Arabian platform (Fig. 1).

The Taurus orogenic belt consists of metamorphic and ophiolitic rocks, carbonate sequences, Upper Cretaceous-Eocene volcanic arc complex, Upper Mesozoic ophiolitic rocks, tectonic melange, mafic volcanics and Tertiary sediments. The Arabian platform represents thick Palaeozoic siliciclastics, Mesozoic-Tertiary shallow sea carbonates and siliciclastics, and also ophiolitic complex belonging to the Taurus

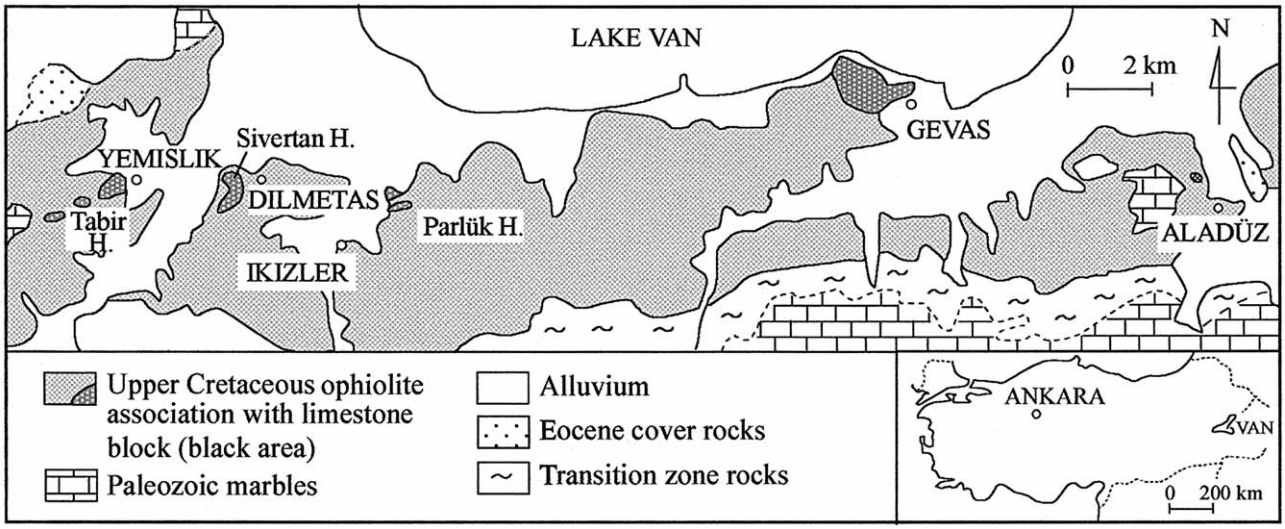

Fig. 2. Simplified geologic map of the Gevaş area (from Yılmaz et al., 1981). Sivertan Hill indicates *Dictyoptychus* locality.

orogenic belt (Righo de Righi and Cortesini, 1964; Sungurlu, 1974; Perinçek, 1979; Şengör and Yılmaz, 1981; Aktaş and Robertson, 1990; Yılmaz and Yiğitbaş, 1990; Görür et al., 1991; Yılmaz, 1993).

The rudist collection was made in the easternmost part of the Taurus orogenic belt, around Gevaş-Van area (Figs. 1 and 2).

The Gevaş area is situated to the south of Lake Van, where four units belonging to the Taurus orogenic belt have been differentiated by Yılmaz et al. (1981). These are: (1) Permian metamorphic rocks, (2) Upper Cretaceous ophiolite association, (3) transition zone between the ophiolite and metamorphic rocks, and (4) the overlying sedimentary Eocene cover rocks (Fig. 2).

The rudists were first observed in the limestone blocks of the ophiolite association by Özer (1992c). This unit shows a wide distribution in the Gevaş area and consists of ultramafic serpentinites, gabbros, dark-yellow-red lavas and tuffs, cherts, shales and limestone blocks (Yılmaz et al., 1981; Özer, 1992c). The majority of these limestone blocks are unfossiliferous, however, some blocks containing macro- and microfossils are observed around Parlük and Sivertan hills, near Dilmetaş and İkizler villages (Fig. 2). The rudists are very rare in the limestone block of Parlük Hill, though a few hippuritid fragments have been determined.

The new species of the genus *Dictyoptychus* are found in the limestone block of Sivertan Hill (Fig. 2), which contains abundant macro- and microfossils and forms an anticlinal allowing a measured stratigraphic section as follows.

2.1. Sivertan Hill section

The limestone block of Sivertan Hill is about 90 m thick and it is composed of the following succession from bottom to top (Fig. 3):

- a: grayish-green conglomerates, sandstones and grey sandy limestones (7–8 m);
- b: rudist-bearing limestones (3 m) with a packstone texture. Biostromes constructed by *Hippurites cornucopiae* Defrance, are observed;
- c: gray bioclastic sandy limestones (20–25 m) with rare rudist fragments, corals (small *Cyclolites*), gastropods, and rare *Actaeonella*. The texture is generally wackestone-packstone with various skeletal fragments and quartz lithoclasts. Intense micritization and also geopetal calcites are developed within the gastropod sections;
- d: yellow limestones rich in gastropods (10–12 m). *Actaeonella* beds are frequent. The packstones consist of mainly gastropod fragments, coral fragments, large benthonic foraminifers (*Loftusia* sp.) and rare quartz;
- e: gray massive limestones (7–8 m) characterized by rudists (*Dictyoptychus* cf. *euphratica* Karacabey-Öztemür, *Dictyoptychus vanensis* n. sp., *Dictyoptychus quadrizonalis* n. sp., *D. paronai* (Kühn), *Hatayia* sp., *H. cornucopiae* Defrance, *Hippurites syriaca* Vautrin, *Vaccinites* sp.) and also exogyrids, foraminifers (*Pseudodomia* sp., rotaliids), and red algae. The bafflestone rudist biostromes, and some framestone exogyrid construction are observed. The massive limestone consists of packstones-wackestones;
- f: dark-gray massive limestones (18–25 m) with red algae and/or coral build-ups. Locally sandstones and sandy limestone lenses are also present.

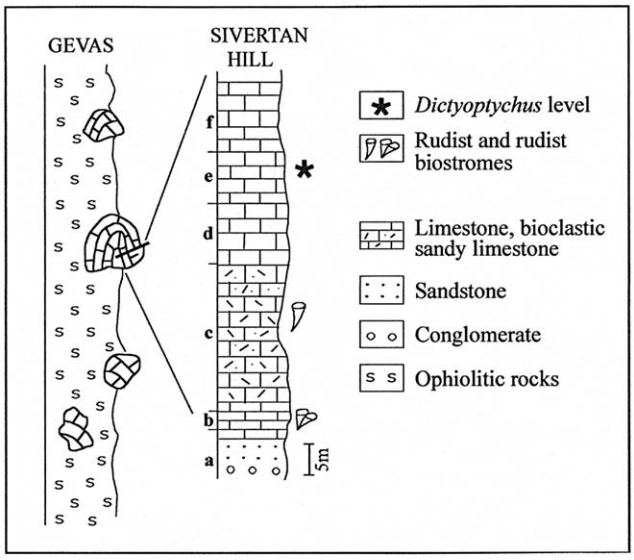

Fig. 3. Sivertan Hill measured stratigraphic section (see the locality to Fig. 2) showing the *Dictyoptychus* level (asterisk). The explanation of the succession (a–f) is given in the text.

The rudist fauna and benthonic foraminifers indicate a Maastrichtian age for the Sivertan Hill limestone block (Karacabey-Öztemür, 1979; Özer, 1986, 1991, 1993; Meriç and Görmüş, 2001). This succession shows also interesting similarities to that of the Simsima Formation, which contain rudist and orbitoid assemblages like Sivertan Hill section, on the western margins of the Oman Mountains-United Arab Emirates (Skelton et al., 2000).

3. Systematic paleontology

Class BIVALVIA
Order HIPPURITOIDA Newell, 1965.
Superfamily HIPPURITOIDEA Gray, 1848.
Family DICTYOPTYCHIDAE Skelton, 1993.
Genus ***Dictyoptychus*** Douvillé, 1905.
Type species: *Polyptychus morgani* Douvillé, 1904.

Dictyoptychus quadrizonalis n. sp.
Figs. 4(1–4), 5(1, 2) and 6.

Material: Two specimens with both valves, and two lower valves.

Holotypus: Figs. 4(1–4) and 5(1, 2), specimen No. SV 88-19, deposited at the Paleontology Laboratory of Dokuz Eylül University, İzmir.

Type locality: Sivertan Hill, Dilmetaş village (Gevaş-Van).

Type level: Maastrichtian.

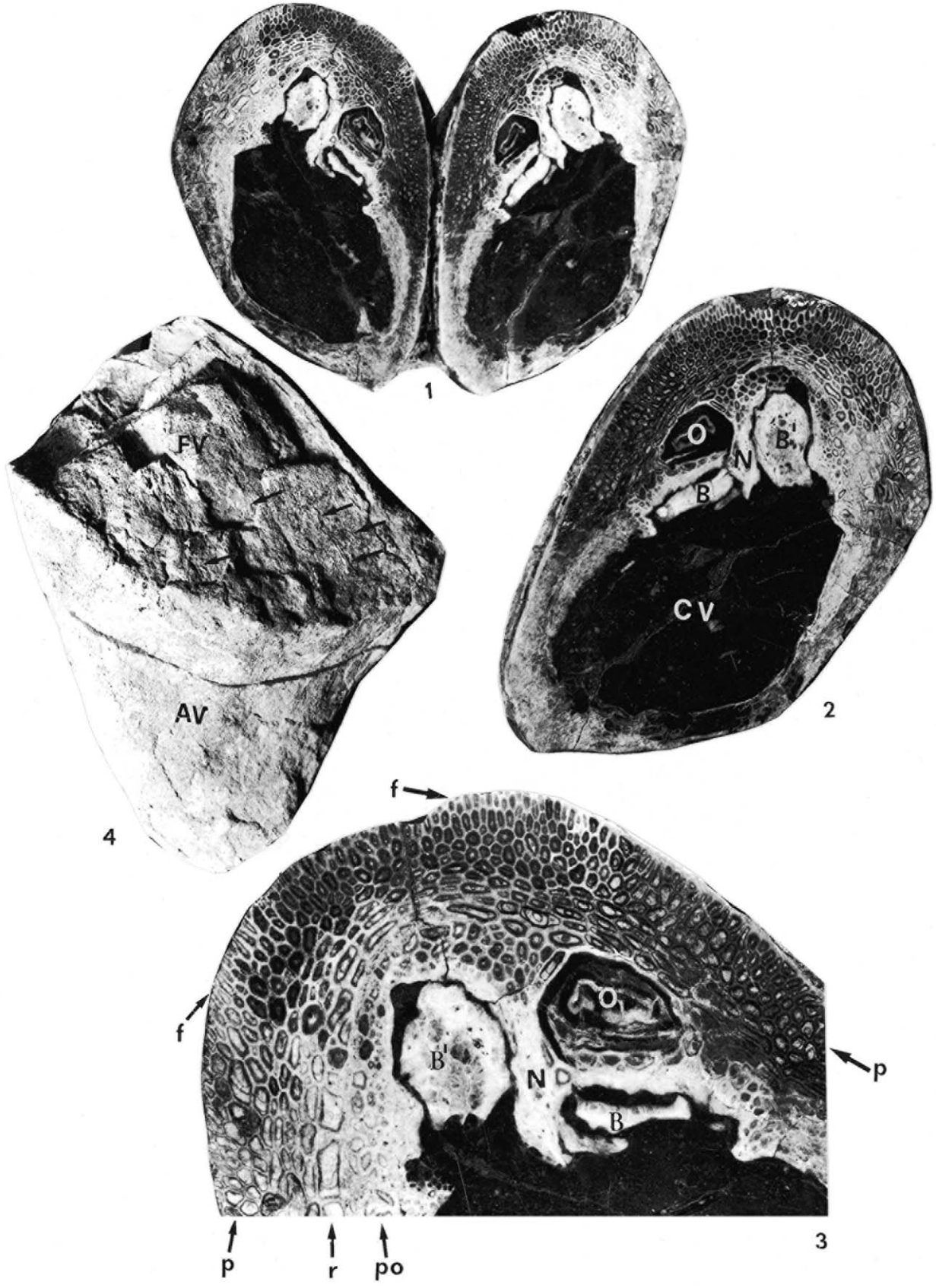

Fig. 4. *D. quadrizonalis* n. sp. Holotype, No. SV 88-19, Sivertan Hill, Dilmetaş village (Gevaş-Van). **1**. Two faces of the same transversal section of the lower valve passing below 12 mm of the commissure, × 0.6. Note the ovaloid shape of the valve section. **2**. Transversal section of the lower valve, × 0.8. Enlargement of the right section of the previous figure. The cardinal apparatus (B, B′ and N) and the accessory cavity (O) are very well developed. Note thickness of the

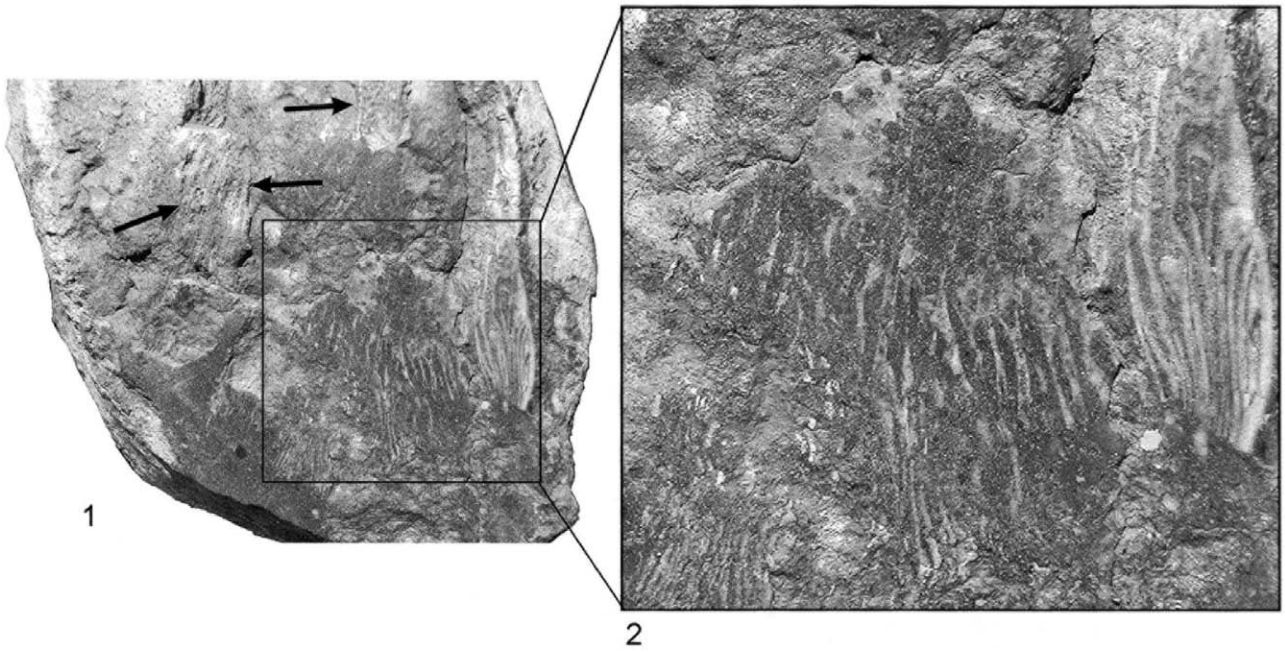

Fig. 5. *D. quadrizonalis* n. sp., holotype. **1**. Partial transversal section of the upper valve showing the longitudinal radial canals, × 0.8. At the eroded parts of the valve these radial canals are also observed (arrows). **2**. Enlargement of the upper valve (indicated area in 1) showing details of the canal arrangement, × 2.4.

Derivatio nominis: Because of the four zones of canals in the internal layer of the lower valve.

Diagnosis: Upper valve depressed cap-like in shape and inclined towards the dorsal margin. Lower valve conical, transversal section oval. Internal layer of the lower valve with four zones of canals from exterior to interior fusiform, polygonal, rectangular, and small polygonal canals. Cardinal apparatus robust and filled in all parts by small canals.

Description: The upper valve is depressed cap-like in shape with a dorsally eccentric apex. The beak is partly broken-out. The height is approximately 15–20 mm. The surface of the valve seems to be smooth. The external layer is thin, about 1.5 mm, and it consists of fine, black or brown colored lamellae. The internal layer consists of radial canals which can be seen in the eroded parts of the external layer and in the transversal section of the upper valve of the holotype (Figs. 4(4) and 5(1, 2)) and paratype.

The lower valve is conical, slightly uncurved towards the ventral side; it is short, the length of holotype being about 135 mm at the dorsal side. The external layer is very thin (1 mm). The postero-ventral region is not clearly observed, however, two shallow swellings maybe mark the place of the radial bands Eb and Sb.

The transversal section of the lower valve is oval (Fig. 4(1,2)); dorso-ventral commissural diameter is 95 mm, and antero-posterior is 70 mm. The central cavity (CV) is elongated in the dorso-ventral direction. The cardinal apparatus is very well preserved (Fig. 4(1–3)); the ridge-like tooth (N) of the lower valve is located between the semi-circular, robust anterior tooth (B′) and dorso-ventrally elongated posterior tooth (B) of the upper valve, and also big accessory cavity (O). Other accessory cavity is not present.

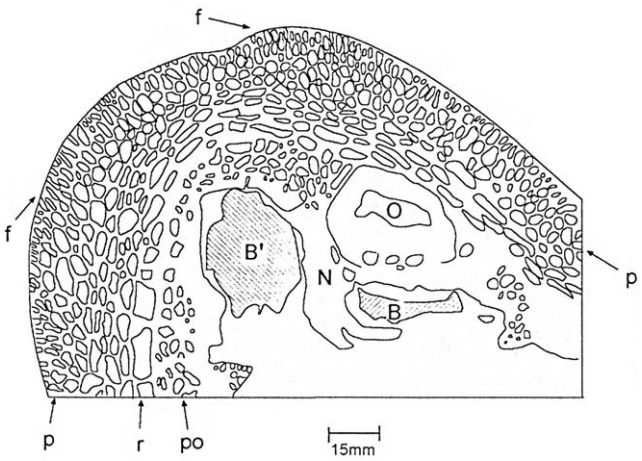

Fig. 6. *D. quadrizonalis* n. sp., holotype. Transversal section of the lower valve showing characteristic structure of the canal layer. f: fusiform, p: polygonal, r: rectangular and po: small polygonal canals. B and B′: posterior and anterior teeths, N: tooth of the lower valve, ma and mp: anterior and posterior myophorus apophyses. Compare with Fig. 4(3).

The internal layer of the lower valve consists of many canals and it is less thick in the ventral part than the other

internal layer filled completely canals, which are reduced towards the ventral parts of the valve. CV: central cavity. **3**. Partial enlargement of the Fig. 4(1) (left section) showing more details of the canal organization and cardinal apparatus, × 1.5. The internal layer consists of four zones of the canals: fusiform (f), polygonal (p), rectangular (r) and small polygonal (po). Compare with Fig. 6. Note preservation of the canals all parts of the cardinal area. The accessory cavity (O) is big and separated by polygonal canals from arm of tooth N. The anterior tooth (B′) is robust, the posterior tooth (B) is elongated. **4**. Ventral side showing lower (AV) and upper (FV) valves, × 0.7. Note the radial canals (arrows) of the upper valve at the eroded parts of the thin external layer.

parts of the valve. Four zones of canals are distinguished from exterior to interior (Figs. 4(1–3) and 6). The first zone consists of little, approximately 2–3 mm in length, two rows of fusiform canals below an immediately external layer. Towards the inner part of the layer, the second zone consisting of four or five rows of polygonal canals, which have very different sizes and forms, such as quadrangular, hexangular, and pentagular, are observed. The third zone is characterized mainly by three or four rows of rectangular canals. At the anterior part, these canals are bigger than those of the dorso-posterior parts. These three zones of canals make rows parallel to the outer periphery of the valve. The fourth zone is composed of irregular, small polygonal canals, which are observed in all parts of the cardinal area and around myophoral apophyses.

Discussion: *D. quadrizonalis* n. sp. shows ressemblances to *Eodictyoptychus arumaensis* Skelton and El-Asa'ad, 1992 by the size and shape of the valves, dorsally eccentric apex of

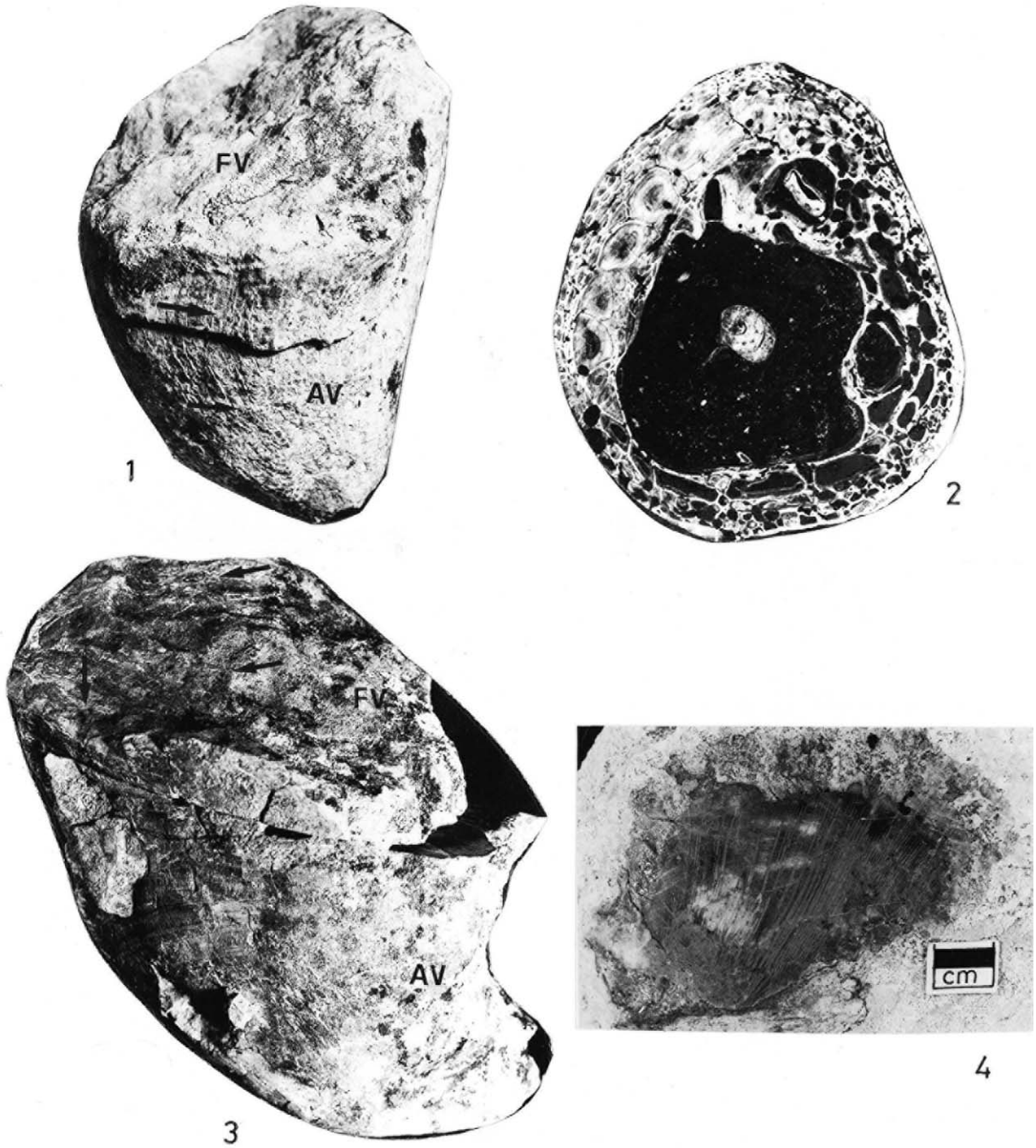

Fig. 7. *D. vanensis* n. sp., holotype, No. SV. 88-11, Sivertan Hill, Dilmetaş village (Gevaş-Van). **1**. Lower (AV) and upper (FV) valves, ventral side, × 0.7. Note the longitudinal section (arrows) of the lower valve observed in the eroded parts of thin external layer. **2**. Transversal section of the lower valve passing below 10 mm of the commissure, same specimen, × 0.7. Compare with Fig. 8. **3**. Lower (AV) and upper (FV) valves. No. SV 88-12, × 0.7. Note the longitudinal canal sections (arrows) of the upper valve. **4**. Partial transversal section of the upper valve showing the longitudinal radial canals, same specimen.

the upper valve, myocardinal arrangements and especially numerous smaller canals in the internal layer of the lower valve. However, our specimens differ from it by the internal layer of the upper valve, which consists only of radial canals not numerous smaller canals like *E. arumaensis*. These similarities and also differences may be indicate the phylogenetic relations between *Eodictyoptychus* and *Dictyoptychus* and also to create a new genus. But, these specimens are determined a new species of *Dictyoptychus* in this study because of the upper valve's canal arrangements.

Dictyoptychus vanensis n. sp.
Figs. 7(1–4) and 8.

Material: One specimen with two valves, one specimen with lower and partly preserved upper valve, and two specimens of lower valves.

Holotypus: Fig. 7(1, 2), specimen No. SV 88-11, deposited at the Paleontology Laboratory of Dokuz Eylül University, İzmir.

Type locality: Sivertan Hill, Dilmetaş village (Gevaş-Van).

Type level: Maastrichtian.

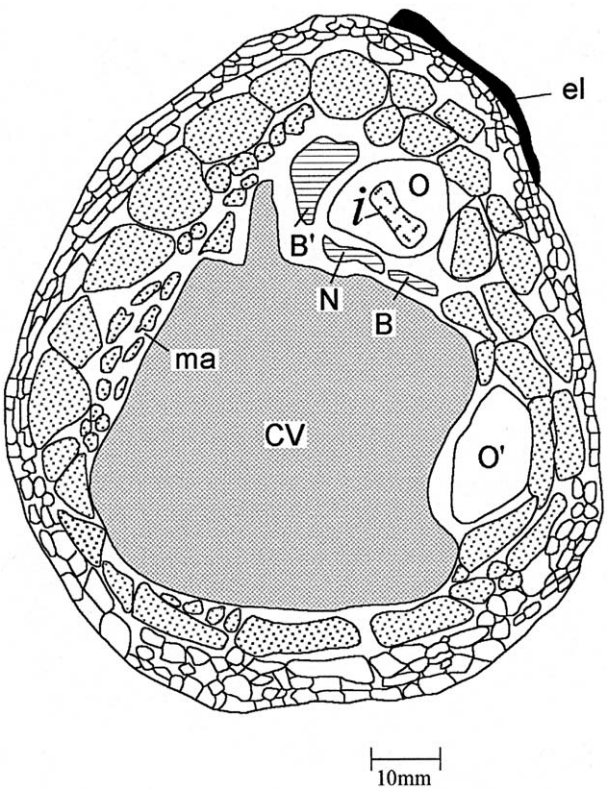

Fig. 8. *D. vanensis* n. sp., holotype. Transversal section of the lower valve, passing below 10 mm at the commissure. B and B′: posterior and anterior teeths, N: tooth of the lower valve, ma: anterior myophoral apophyses, O and O′: accessory cavities, i: island-like projection in accessory cavity O (see Fig. 4 of Cox, 1934), CV: central cavity, el: external layer. Two zones of canals are observed; the exterior zone is composed of small, dense hexagonal and rectangular canals, where as the interior zone is characterized by large, polygonal canals. Note the canals making rows parallel to the periphery of the valve. Compare with Fig. 7(2).

Derivatio nominis: *vanensis*—from Van where the specimens were found.

Diagnosis: Lower valve conical. Internal layer with two zones of canals making rows parallel to the whole periphery of the valve. Canals of exterior zone small, dense, elongate hexagonal and rectangular with three or four rows. Interior zone with large, generally polygonal, somewhat rectangular canals. This zone with only one row in the anterior part, two rows between dorsa-posterior and ventral sides.

Description: The upper valve is depressed with dorsally eccentric apex. The surface is smooth. At the eroded parts of thin external layer where the radial canals can be seen (Fig. 7(1, 3)). The longitudinal sections of these radial canals are also observed in the transversal section of the upper valve (Fig. 7(4)).

The lower valve is conical; the length of holotype is 90 mm. The external layer is partly preserved at the dorsal part where it is about 2 mm thick. At the ventral and posterior parts where the external layer is totally eroded, longitudinal sections of the internal layer canals are observed (Fig. 7(1)). The surface of the valve is probably smooth.

The transversal section of the lower valve is triangular with strongly rounded corners (Fig. 7(2)). The dorso-ventral commissural diameter is approximately 105 mm. The CV is big and it occupies more than half of the valve section. The cardinal apparatus is situated on a line towards the dorsal part of the valve. The lower valve tooth is irregular in shape. The anterior tooth is big, the posterior tooth is thin and elongated. The anterior myophoral apophyses are represented by thin lamellae. There is not any trace of a ligamental ridge. The accessory cavities (O, O′) are large and situated at the dorsal side of the cardinal apparatus.

The internal layer of the lower valve contains many thin walled canals making rows parallel to the outer periphery (Figs. 7(2) and 8). This layer consists of two zones of canals, which are the exterior and interior zones. The exterior zone is composed of small, dense, and elongated, three to four rows of hexagonal and rectangular canals. This zone is regularly observed as a whole periphery of the valve. The interior zone is characterized by large, generally polygonal, sometimes rectangular canals. At the external part of the anterior myophore, one row of great canals (greatest about 14 mm) is observed. These canals lay towards the dorsal side and became much smaller above the accessory cavities, and continue along the posterior margin in two or three rows. The polygonal canals of the dorso-posterior margin change to rectangular shape towards the ventral margin. In some places, the little polygonal canals are present below these great canals, especially around the antero-dorsal side.

Discussion: The new species shows some resemblances to *Dictyoptychus morgani* (Douvillé) and *Dictyoptychus persicus* (Cox) by the presence of numerous enlarged polygonal canals in the lower valve (Douvillé, 1904a, 1904b; Cox, 1933, 1934; Kühn, 1937; Tavani, 1949), and to *Dictyoptychus leesi* (Kühn) and *Dictyoptychus orantica* Karacabey-Öztemür by the perpendicular position of the cardinal apparatus to ante-

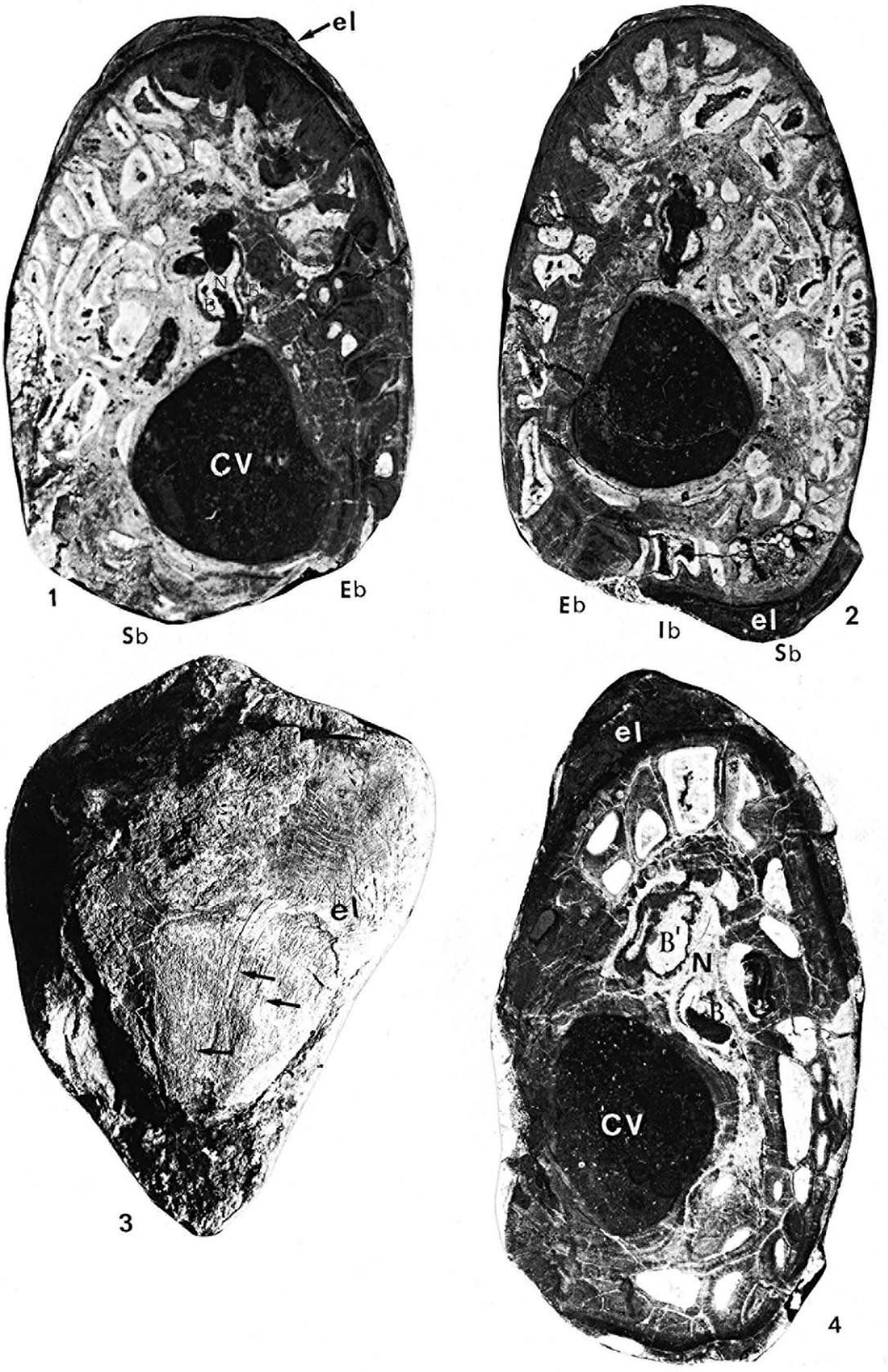

Fig. 9. *D. paronai* (Kühn). Sivertan Hill, Dilmetaş village (Gevaş-Van). **1**. Transversal section of the lower valve passing below 10 mm of the commissure, adult form, No. SV 88-28, × 0.7. Note the X shape of the lower valve tooth (N), and also the irregular disposition of the canals. Compare with Fig. 10. B and B′: Upper valve teeth, CV: central cavity, el: External layer. **2**.Transversal section of the lower valve passing below 20 mm of the commissure, same specimen,

rior margin (Kuhn, 1929; Karacabey-Öztemür, 1979). But, it is easily distinguished from these species by the continuation of the canals in the whole periphery of the lower valve and by the organization of the canals which are little, hexagonal and rectangular in the exterior zone, and great polygonal in the interior zone. These characters show that the new species is possibly the most primitive species of *Dictyoptychus*.

Dictyoptychus paronai (Kuhn, 1929).
Figs. 9(1–4) and 10.

1929. *Hippurites* (*Vaccinites*) *paronai*—Kühn, pp. 25, 26, Pl. 1, Fig. 1; Text-Figs. 1 and 2.

1937. *Anomoptychus paronai*—Kühn, pp. 272–275, Text-Fig. 1.

1949. *Anomoptychus paronai*—Tavani, p. 11.

?1992. *Dictyoptychus paronai*—Pons et al., p. 223, Text-Figs. 5a, b.

Description: Five specimens with lower and upper valves, two specimens with lower and partly preserved upper valve; and also three lower valves from the Maastrichtian limestones of the Sivertan Hill, Dilmetaş village, Gevaş-Van, allow better examination of the external and internal features of the species.

The upper valve is depressed cap-like in shape with an apex strongly inclined towards the dorsal margin. The summit of the valve approaches 25 mm to the commisure. The height is 20–25 mm. At the eroded parts of the thin external layer and also the transversal section of the valve, dense radial canals of the internal layer are clearly observed (Fig. 9(3)).

The lower valve is conical and 120–170 mm in length. Sometimes, it is uncurved towards the ventral part. The transversal section of the lower valve is oval. One of the adult forms has a 150 × 90 mm diameter. The CV is small according to the volume of the valve; it is situated near the ventral margin. The anterior tooth (B′) is big, the posterior tooth (B) is elongated. The lower valve tooth (N) has an X shape showing irregular arms (Figs. 9(1, 2, 4) and 10). There is not any trace of a ligamental ridge.

The internal layer of the lower valve is very large at the antero-dorsal and posterior sides. This layer is composed of rectangular, square, and sometimes polygonal canals having irregular contours and very different greatness (Figs. 9(1, 2, 4) and 10). The disposition of these canals shows different pattern from the adult to young forms (Fig. 9(1, 4)). The variability of the canal shapes is clearly observed at the different levels of the transversal sections in the same specimen (Fig. 9(1, 2)). Around the cardinal apparatus and CV, different size of canals may be observed. The wall of the canals is thick and shows specific character (Fig. 9(1, 2, 4)), which gives the preservation the canal's contours.

Remarks: The internal layer of the lower valve of the species consists of very different in greatness, and form of canals

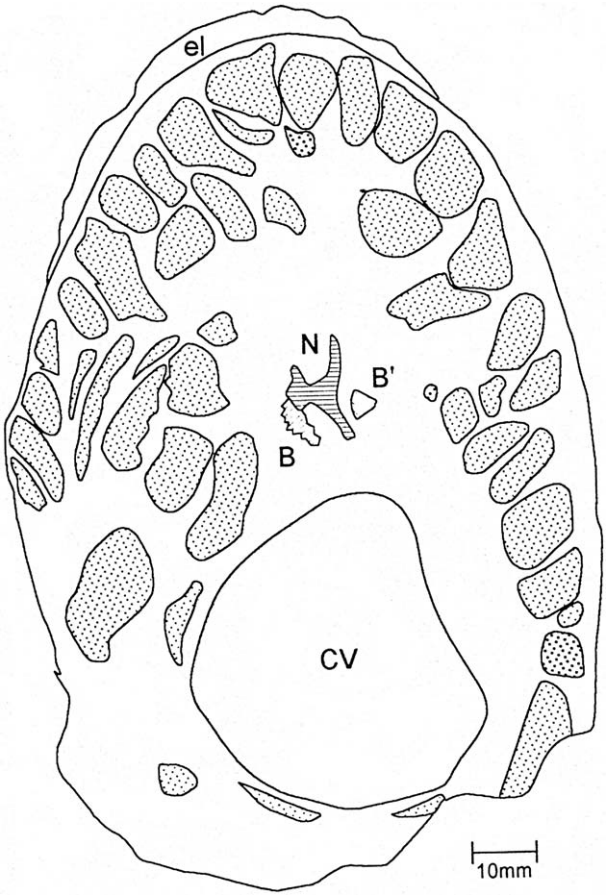

Fig. 10. *D. paronai* (Kühn). Transversal section of the lower valve. Compare with Fig. 9(1).

with thick walls giving an irregular disposition which is characteristic of the species (Kuhn, 1929, 1937). Because of the inclination of the upper valve towards the dorsal margin, which is first presented in this study, *D. paronai* may be correlated with the *D. persicus* and *D. euphratica*. However, it differs from these species by the irregular canal organization and also by the very depressed upper valve.

4. Conclusions

The paleontologic study of the rudist collection from the easternmost of Taurus orogenic belt of Turkey, shows the presence of two new species belonging to the canaliculate rudist genus *Dictyoptychus* Douvillé and also allows to better knowledge of canal organization of the lower valve and the shape of the upper valve of the *D. paronai* (Kühn) as follows:

- The new species are characterized by filling of the different forms of canals in all part of the internal layer and especially by making of these canals rows parallel to the outer periphery of the lower valve.

× 0.6. Note the walls of the canals are typically thick. Compare the changement of the canal organization with previous figure. The interband makes a shallow invagination at the inner margin of the shell layer. **3**. Upper view of the upper valve. No. SV 88-26, × 0.6. Note the inclination of the valve towards the dorsal margin. The summit approaches 25 mm to the margin. The radial canals (arrows) of the valve clearly observed at the eroded parts of the thin external layer (el). **4**. Transversal section of the lower valve passing below 10 mm of the commissure, young form, No. SV 88-13, × 1.

- The specimens of *D. quadrizonalis* n. sp. lack the greatly expanded polygonal canals that are characteristics of the lower valve in *Dictyoptychus*. Instead, they show numerous smaller canals, as seen in *Eodictyoptychus* Skelton and El-Asa'ad (1992). But they also contain radial canals in the upper valve like *Dictyoptychus*. On the other hand, the new species, *D. vanensis* n. sp., includes many smaller canals beside the enlarged polygonal canals in the lower valve (in contrast to *D. morgani*). The data given above appear to be transitional between *Dictyoptychus* and its presumed ancestor, *Eodictyoptychus*. So, the two new species may be of considerable phylogenetic interest, a possibly the most primitive species of *Dictyoptychus*.
- *D. paronai* (Kühn) presents an upper valve depressed cap-like in shape with an apex strongly inclined towards the dorsal margin, which is first determined.
- The canal layer of the lower valve of the *D. paronai* consists of very different greatness and shapes of canals, which is diagnostic characteristic of the species, shows the different pattern between the young to adult forms.

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