



Systematic Palaeontology (Micropaleontology)

# New Middle Permian foraminifers (Chitralinidae) from the Karakaya Complex, in northwestern Turkey

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## Abstract

One new foraminiferal genus, *Rectoformata* gen. nov., with two new species, has been described from a Permian limestone block in the Karakaya Complex in the South of the Balya district (Balikesir, northwestern Turkey). The type species of *Rectoformata*, *Rectoformata tekini* sp. nov., is characterized by a quadrangular transverse section having a calcareous microgranular wall with fine alveolar structures, whereas *Rectoformata acari* sp. nov. is recognized by a pentagonal transverse section having a calcareous microgranular wall with fine alveolar structures. The age of the described taxa is assigned as Midian (=Capitanian) based on the association with small foraminifers and fusulinids. These new taxa are included in the family Chitralinidae, which is emended herein. **To cite this article:** C. Okuyucu, C. R. Palevol 6 (2007).

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## Résumé

**Nouveaux foraminifères (Chitralinidae) du Permien moyen du complexe de Karakaya en Turquie nord-occidentale.** Un nouveau genre de foraminifère, *Rectoformata* gen. nov., avec deux nouvelles espèces, a été décrit dans un bloc calcaire Permien du complexe de Karakaya, dans le Sud du district de Balya (Balikesir, Turquie nord-occidentale). L'espèce type de *Rectoformata*, *Rectoformata tekini* sp., est caractérisée par une section transversale quadrangulaire, qui présente un mur microgranulaire calcaire à fines structures alvéolaires, tandis que *Rectoformata acari* sp. nov. se reconnaît par une section transversale pentagonale, avec un mur microgranulaire calcaire à fines structures alvéolaires. L'âge des taxons décrits est attribué au Midien (= Capitanien) sur la base d'une association avec de petits foraminifères et des fusulinidés. Ces nouveaux taxons font partie de la famille des Chitralinidae, ce qui est ici amendé. **Pour citer cet article :** C. Okuyucu, C. R. Palevol 6 (2007).

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**Keywords:** Foraminifera; Chitralinidae; Permian; Guadalupian; Capitanian; Karakaya Complex; Turkey

**Mots clés :** Foraminifères ; Chitralinidae ; Permien ; Guadalupien ; Capitanien ; Karakaya Complex ; Turquie

## 1. Introduction

One new Middle Permian (Guadalupian) genus and two species of foraminifers are described from a Permian limestone block in the Karakaya Complex from the southwest of the Asagicakallar village, south of the

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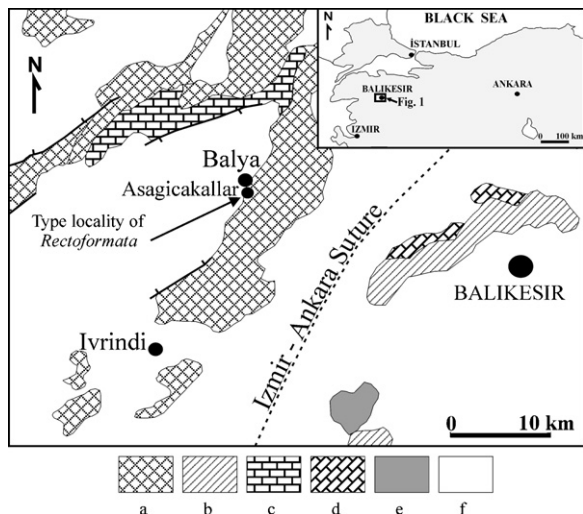


Fig. 1. Tectonic map of the Balıkesir and Balya regions (simplified after Okay and Altiner [24]). Legend: (a) Karakaya Complex, (b) Bornova Flysch Zone, (c) Jurassic–Lower Cretaceous rock units, (d) Upper Triassic–Cretaceous rock units, (e) ultramafic rock units, (f) Tertiary rock units.

Fig. 1. Carte tectonique des régions de Balıkesir et Balya (d'après [24], simplifiée). Légende : (a) complexe de Karakaya, (b) zone de flysch de Bomova, (c) formations du Jurassique–Crétacé inférieur, (d) formations du Trias supérieur–Crétacé, (e) Roches ultramafiques, (f) formations tertiaires.

Balya district (Balıkesir, northwestern Turkey) in the Balıkesir I29-d1 quadrangle (Fig. 1). The UTM coordinates of the studied Permian olistolith are between 49 703 N/97 000 E and 49 700 N/97 300 E.

Biostratigraphical studies concerning fusulinids and other foraminifers from Permian blocks within the Karakaya Complex were first carried out by Erk [12] and Aygen [6] in the Bursa and Balya regions. Later, Lys [23], Kahler and Kahler [18], Leven and Okay [20], Altiner [1], Altiner and Ozkan–Altiner [3], and Leven and Ozkan [21] described several new genera and species from the Bergama, Balya, Kinik, Bandırma, and Orhaniye regions (northwestern Turkey).

This study presents a systematic description of a new Permian genus of small foraminifers included in the family Chitralinidae Angiolini and Rettori [5], and discusses the evolutionary trends and chronostratigraphic value.

## 2. Geological setting

The Karakaya Complex is a tectonostratigraphic term for a highly deformed and partly metamorphosed clastic and volcanic series of Permian and Triassic age on the Biga Peninsula, northwestern Turkey [25]. The term 'Karakaya' was initially introduced by Bingöl [7], as the 'Karakaya Series', for a slightly metamorphic suc-

cession at Karakaya Hill to the south of the Beyobasi village in the Edremit area. Later, the name 'Karakaya Formation' was applied by Bingöl et al. [8] to include the 'detrital unit with Permian olistoliths' and the 'spilites with Permian olistoliths' [31]. The Karakaya Complex is generally subdivided into two parts, a lower and an upper one [25].

The Upper Permian rocks within the Karakaya Complex are known from previous studies, and many authors have reported the blocky nature of the Carboniferous and Permian strata present [2,4,8,19,29,30]. There are different opinions about the provenance of these blocks [2,4,20,29]. According to Altiner et al. [4], Upper Palaeozoic (Carboniferous–Permian) carbonate exposures of non-metamorphosed siliciclastic rocks of the Karakaya Orogen are olistoliths deposited during the Late Triassic. The likely provenance of the blocks is from the south and from the northern margin of a carbonate platform of Gondwanan origin. The wide range of the ages of carbonate blocks from Viséan to the Latest Permian and the harmony of their chronostratigraphic order with the Carboniferous and Permian stratigraphy of the Taurus carbonate platform are proposed as evidence for their southern origin by these authors.

Previously, many rift-related models were proposed for the evolution of the Karakaya units [2,8,15,26]. Goncuoglu et al. [14] have reported syndimentary radiolarian cherts (Changhsingian in age) within the proximal turbidites and olistostromes of the Karakaya Complex, and they concluded that the rifting of this basin within the Sakarya Composite Terrane [13] took place between the deposition of the Midian platform carbonates (e.g., [31]), and that of the Changhsingian rift-related sediments and volcanism.

The present new taxa of small foraminifers are described from the Upper Karakaya Complex, and are known in northwestern Turkey only from the Asagıcakallar locality, where Permian rocks are found as olistoliths in debris flow deposits of Triassic age (Fig. 1). The basal part of the olistolith is composed of thin- to medium-bedded grey limestone. Above is grey, medium-bedded brecciated limestone with abundant fusulinids and algae. The middle part of the section consists of grey, fusulinid, and hemigordiopsid-bearing limestone. The upper part of the olistolith is represented by yellow–light grey, thin- to medium-bedded clayey limestone. The total thickness of the olistolith is 59 m (Fig. 2).

## 3. Systematic palaeontology

The author follows the systematic classification of Loeblich and Tappan [22]. All holotypes and paratypes

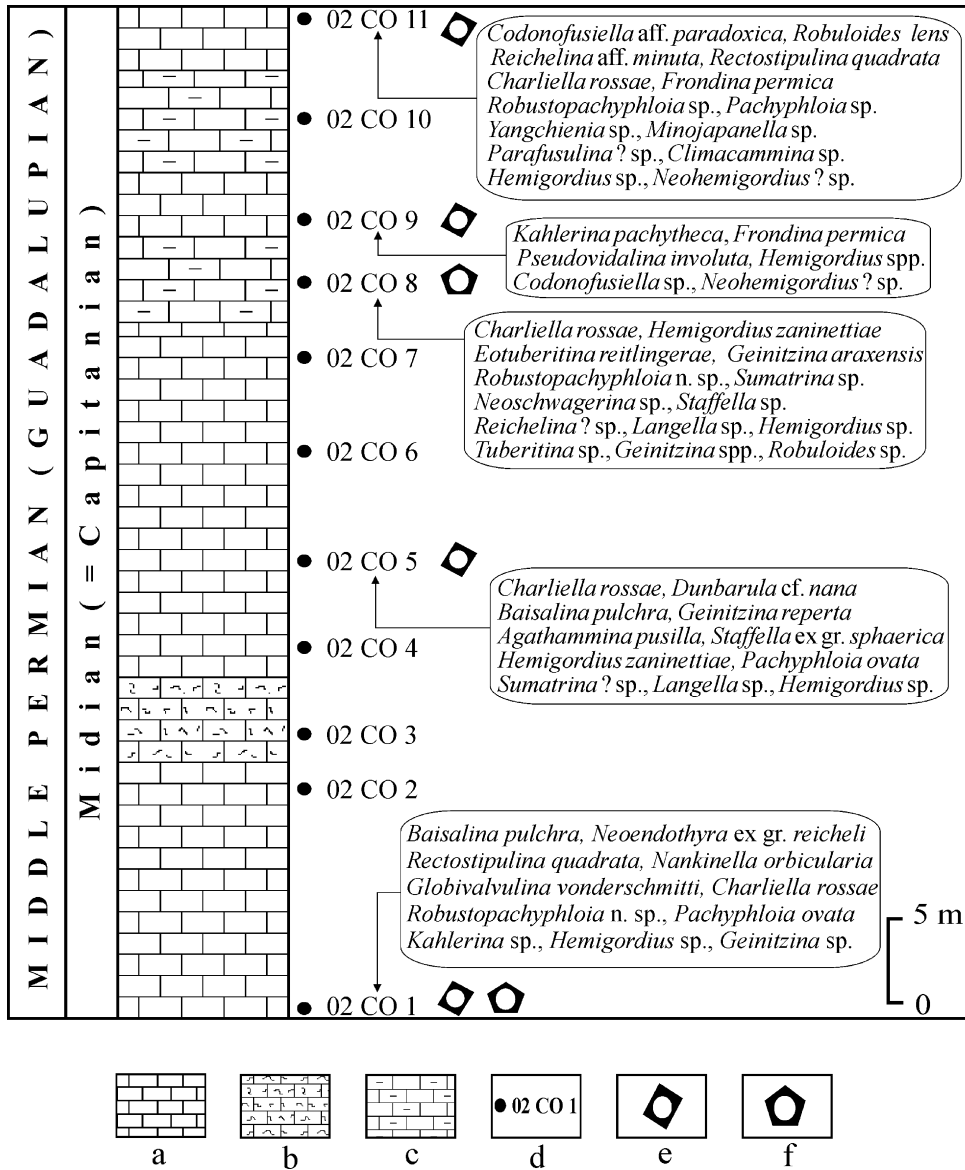


Fig. 2. Columnar stratigraphic section of the studied Middle Permian limestone block in the Karakaya Complex and faunal content of the particular samples. Legend: (a) limestone, (b) breccial limestone, (c) clayey limestone, (d) sampling levels, (e) *Rectoformata tekini* sp. nov.-bearing samples, (f) *Rectoformata acari* sp. nov.-bearing samples.

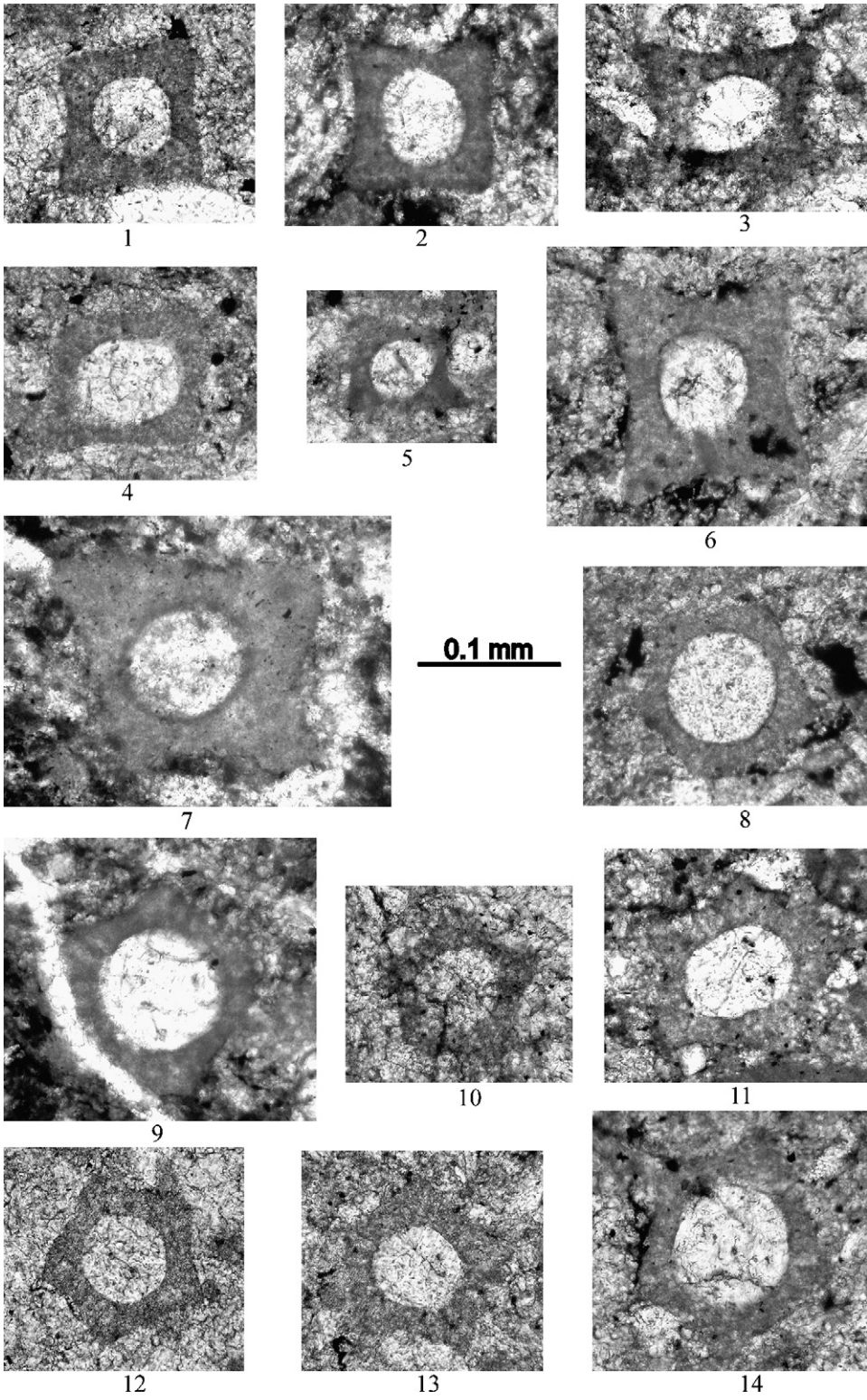
Fig. 2. Colonne stratigraphique du bloc calcaire du Permien moyen étudié, et contenu faunique d'échantillons particuliers. Légende: (a) calcaire, (b) calcaire bréchiq. (c) calcaire argileux, (d) niveaux d'échantillonnage, (e) échantillons contenant *Rectoformata tekini* sp. nov., (f) échantillons contenant *Rectoformata acari* sp. nov.

are stored in the collection of the Natural History Museum of MTA (General Directorate of Mineral Research and Exploration of Turkey), Ankara, Turkey, under No. MTA2002/CO3.

Order Foraminifera d'Eichwald [11]  
Suborder Fusulinina Wedekind [33]  
Superfamily Earlandiacea Cummings [10]

Family Chitralinidae Angiolini and Rettori [5] emend. herein

*Emended diagnosis.* Test-free, globular proloculus followed by a long undivided tubular chamber. Central cavity of tube circular or slightly quadrangular in transverse section. Marked longitudinal rounded or acute costae on the test surface. Wall is calcareous microgran-



ular, sometimes with fine alveolar structures and very finely agglutinated particles. Aperture simple terminal opening.

*Included genera.* *Chitralina* Angiolini and Rettori [5], *Giraliarella* Crespin [9] and *Rectoformata* gen. nov.

*Discussion.* The Chitralinidae distinguish themselves from the original diagnosis of Angiolini and Rettori [5] by having a circular central cavity, longitudinal acute costae and a very finely agglutinated wall. The new emended family differs from the other families included in the superfamily Earlandiaceae Cummings [10] by having rounded or acute longitudinal costae on the test surface.

*Stratigraphic and geographic range.* Permian of Karakorum (Pakistan), western Australia, and northwestern Anatolia (Turkey).

Genus *Rectoformata* gen. nov.

*Type species.* *Rectoformata tekini* sp. nov.

*Derivation of the name.* From the Latin, *recto*, straight; *formata*, shaped, in reference to the straight shape of the test.

*Diagnosis.* Test-free, globular proloculus followed by a long undivided tube with circular central cavity. Septation or pseudoseptation absent. Test surface characterized by four or five longitudinal acute costae. Wall is calcareous microgranular with fine alveolar structures. Aperture simple terminal opening.

*Composition.* *Rectoformata tekini* sp. nov. and *Rectoformata acari* sp. nov.

*Comparisons.* The new genus differs from the Middle Permian (= Guadalupian) genus *Chitralina* Angiolini and Rettori [5] by having a calcareous microgranular wall with fine alveolar structures (Figs. 3.1–3.7) and the presence of a circular central cavity, four or five longitudinal acute costae. *Chitralina* Angiolini and Rettori [5] is characterized by a triangular to quad-

rangular test in transverse sections, a calcareous dark uniform microgranular wall, a slightly quadrangular central cavity and longitudinal rounded costae. *Rectoformata* gen. nov. is also distinguished from the similar species *Giraliarella* Crespin [9] by having a calcareous microgranular wall with a fine alveolar structure, whereas *Giraliarella* Crespin [9] has a very finely agglutinated wall (Figs. 3 and 4).

*Stratigraphic and geographic range.* Middle Permian (= Guadalupian), Midian (= Capitanian) of northwestern Anatolia (Turkey).

*Rectoformata tekini* sp. nov. (Figs. 3.1–3.7)

*Derivation of the name.* This species is named after Associate Professor Dr. U. Kagan Tekin (Hacettepe University), in honour of his contributions to the knowledge of Mesozoic Radiolarian biostratigraphy.

*Holotype.* Sample MTA2002/CO3-02 CO 1-1-3 (Fig. 3.1).

*Paratypes.* MTA2002/CO3-02 CO 9-2-1, MTA2002/CO3-02 CO 5-2-1, MTA2002/CO3-02 CO 1-2-2, MTA2002/CO3-02 CO 1-2-6, MTA2002/CO3-02 CO 9-1-2, MTA2002/CO3-02 CO 11-1-1.

*Type locality.* Southwest of Asagicakallar village, south of Balya district, Balikesir, NW Turkey.

*Type level.* Midian (= Capitanian).

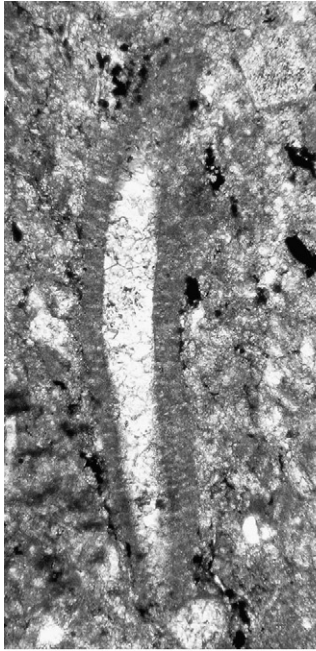
*Material.* Eight specimens (only seven specimens illustrated herein).

*Diagnosis.* *Rectoformata* with quadrangular transverse section and calcareous microgranular wall with fine alveolar structure.

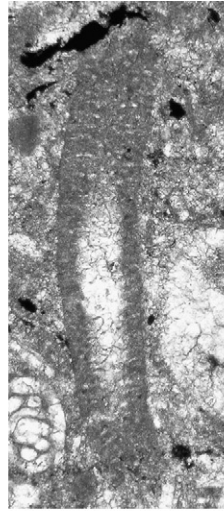
*Description.* Test-free, elongate, globular proloculus followed by a long undivided tubular chamber with circular central cavity, increasing in width during the growth. Quadrangular test, characterized by the presence of four longitudinal acute costae on the test surface. Septation or pseudoseptation not seen in longitudinal

Fig. 3. Photomicrograph of *Rectoformata tekini* sp. nov. and *Rectoformata acari* sp. nov., Midian (= Capitanian), South of the Balya district, Balikesir, northwestern Turkey; all transverse sections except 4 and 11. 1–7. *Rectoformata tekini* sp. nov. 1. Holotype, sample MTA2002/CO3-02 CO 1-1-3. 2. Paratype, sample MTA2002/CO3-02 CO 9-2-1. 3. Paratype, MTA2002/CO3-02 CO 5-2-1. 4. Paratype, oblique transverse section, sample MTA2002/CO3-02 CO 1-2-2. 5. Paratype, sample MTA2002/CO3-02 CO 1-2-6. 6. Paratype, sample MTA2002/CO3-02 CO 9-1-2. 7. Paratype, sample MTA2002/CO3-02 CO 11-1-1. 8–14. *Rectoformata acari* sp. nov. 8. Paratype, sample MTA2002/CO3-02 CO 1-2-3. 9. Paratype, sample MTA2002/CO3-02 CO 1-2-8. 10. Paratype, sample MTA2002/CO3-02 CO 8-1. 11. Paratype, oblique transverse section, sample MTA2002/CO3-02 CO 1-2-4. 12. Holotype, sample MTA2002/CO3-02 CO 1-1-1. 13. Paratype, sample MTA2002/CO3-02 CO 1-3-2. 14. Paratype, sample MTA2002/CO3-02 CO 1-2-5.

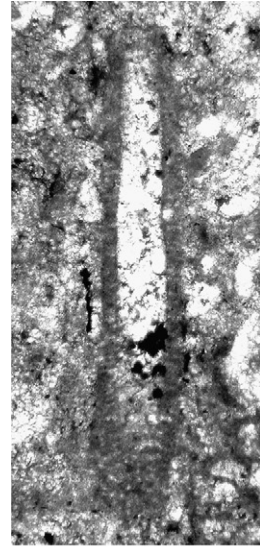
Fig. 3. Microphotographies de *Rectoformata tekini* sp. nov. et *Rectoformata acari* sp. nov., Midian (= Capitanien), Sud du district de Balya, Balikesir, Nord-Ouest de la Turquie; toutes les sections sont transversales, excepté 4 et 11. 1–7. *Rectoformata tekini* sp. nov. 1. Holotype, échantillon MTA2002/CO3-02 CO 1-1-3. 2. Paratype, échantillon MTA2002/CO3-02 CO 9-2-1. 3. Paratype, MTA2002/CO3-02 CO 5-2-1. 4. Paratype, section transversale oblique, échantillon MTA2002/CO3-02 CO 1-2-2. 5. Paratype, échantillon MTA2002/CO3-02 CO 1-2-6. 6. Paratype, échantillon MTA2002/CO3-02 CO 9-1-2. 7. Paratype, échantillon MTA2002/CO3-02 CO 11-1-1. 8–14. *Rectoformata acari* sp. nov. 8. Paratype, échantillon MTA2002/CO3-02 CO 1-2-3; 9. Paratype, échantillon MTA2002/CO3-02 CO 1-2-8. 10. Paratype, échantillon MTA2002/CO3-02 CO 8-1. 11. Paratype, section transversale oblique, échantillon MTA2002/CO3-02 CO 1-2-4. 12. Holotype, échantillon MTA2002/CO3-02 CO 1-1-1. 13. Paratype, échantillon MTA2002/CO3-02 CO 1-3-2. 14. Paratype, échantillon MTA2002/CO3-02 CO 1-2-5.



1

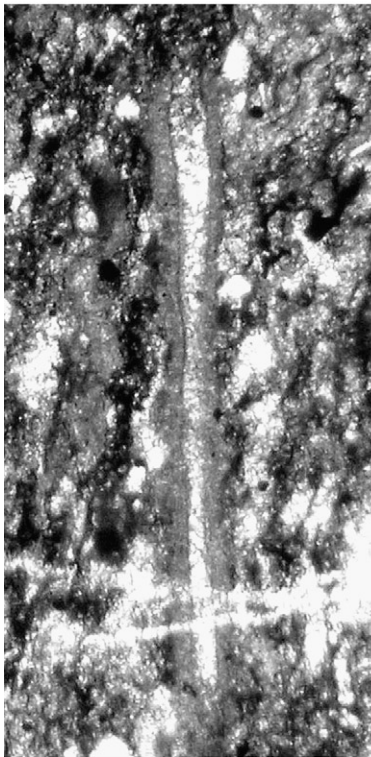


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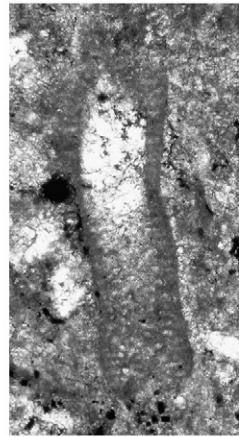


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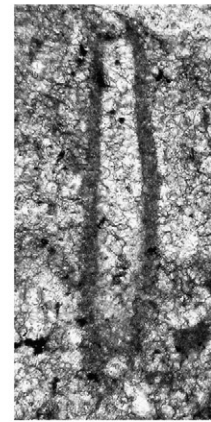
0.1 mm  
1, 2, 3, 4, 5, 6, 7



4

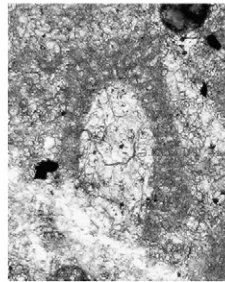


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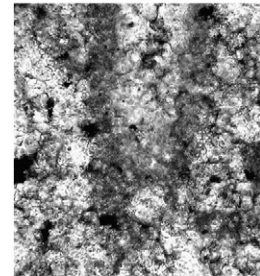


6

0.1 mm  
8



7



8

sections. Calcareous microgranular wall with fine alveolar structures. Aperture simple terminal opening.

### 3.1. Dimensions

Diameter of the central cavity: 0.03–0.06 mm, thickness of the wall: 0.01–0.02 mm, becoming thicker at the corners of the tube where it may bulge outwardly to produce longitudinal acute costae.

**Comparisons.** *Rectoformata tekini* differs from the *Rectoformata acari* by having quadrangular shape (Figs. 3.1–3.7). It is also distinguished from *Chitralina undulata* Angiolini and Rettori [5] by having fine alveolar microgranular wall structure, four longitudinal acute costae on the test surface and circular central cavity. *Rectoformata tekini* is however similar to *Giraliarella angulata* Crespin [9] in the shape of the test; the present new species differs from *Giraliarella angulata* Crespin [9] by its calcareous microgranular wall with fine alveolar structures.

**Stratigraphic and geographic range.** Middle Permian (= Guadalupian), Midian (= Capitanian) of northwestern Anatolia (Turkey).

*Rectoformata acari* sp. nov. (Figs. 3.8–3.14)

**Derivation of the name.** This species is named after Dr. Sukru Acar (General Directorate of Mineral Research and Exploration, MTA), in honour of his contributions to the knowledge of Tertiary benthic foraminiferan biostratigraphy.

**Holotype.** Sample MTA2002/CO3-02 CO 1-1-1 (Fig. 3.12).

**Paratypes.** MTA2002/CO3-02 CO 1-2-3, MTA2002/CO3-02 CO 1-2-8, MTA2002/CO3-02 CO 8-1, MTA2002/CO3-02 CO 1-2-4, MTA2002/CO3-02 CO 1-3-2, MTA2002/CO3-02 CO 1-2-5.

**Type locality.** Southwest of the Asagicakallar village, south of the Balya district, Balikesir, northwestern Turkey.

**Type level.** Midian (= Capitanian).

**Material.** Eight specimens (only seven specimens illustrated herein).

**Diagnosis.** *Rectoformata* with pentagonal shape as seen in transverse section and a calcareous microgranular wall with a fine alveolar structure.

**Description.** Test-free, elongate, globular proloculus followed by a long, undivided tubular chamber with a circular central cavity. Test increasing in width during the growth. Test pentagonal in transverse section and characterized by the occurrence of five longitudinal acute costae on the test surface. Septation or pseudoseptation not seen in longitudinal sections. Calcareous microgranular wall with fine alveolar structures. Aperture simple terminal opening.

**Dimensions.** Diameter of the central cavity: 0.045–0.070 mm; thickness of the wall: 0.012–0.020 mm, becoming thicker at the corners of the tube where it may bulge outwardly to produce longitudinal acute costae.

**Comparisons.** *Rectoformata acari* sp. nov. distinguishes itself from similar species *Rectoformata tekini* sp. nov. and *Chitralina undulata* Angiolini and Rettori [5] by having a pentagonal test (Figs. 3.8–3.14). It also differs from *Giraliarella angulata* Crespin [9] by its pentagonal test and different wall structure.

**Stratigraphic and geographic range.** Midian (= Capitanian), Middle Permian (= Guadalupian) of northwestern Anatolia (Turkey).

## 4. Phylogenetic considerations

The new genus *Rectoformata* appears for the first time in the Middle Permian (Guadalupian) and represents a descendant of *Earlandia* Plummer [27]. Angiolini and Rettori [5] discussed the phylogenetic relationships between *Chitralina* Angiolini and Rettori [5] and *Rectostipulina* Jenny-Deshusses [17], and they claimed that both were derived from *Earlandia*. The two genera can be distinguished based on the wall. The wall of *Chi-*

Fig. 4. Photomicrograph of longitudinal and oblique longitudinal sections of *Rectoformata* spp., Midian (= Capitanian), south of the Balya district, Balikesir, NW Turkey. 1. Longitudinal section, sample MTA2002/CO3-02 CO 1-2-1. 2. Oblique longitudinal section, sample MTA2002/CO3-02 CO 1-1-2. 3. Longitudinal section, sample MTA2002/CO3-02 CO 1-3-1. 4. Longitudinal section, sample MTA2002/CO3-02 CO 11-1-3. 5. Oblique longitudinal section, sample MTA2002/CO3-02 CO 1-2-9. 6. Longitudinal section, sample MTA2002/CO3-02 CO 8-2. 7. Oblique longitudinal section, sample MTA2002/CO3-02 CO 1-1-4. 8. Enlargement of the proloculus of the specimen in sample MTA2002/CO3-02 CO 8-2, appearance of a globular proloculus in longitudinal section.

Fig. 4. Microphotographies de sections longitudinales et longitudinales obliques de *Rectoformata* spp., Midien (= Capitanien), Sud du district de Balya, Balikesir, Nord-Ouest de la Turquie. 1. Section longitudinale, échantillon MTA2002/CO3-02 CO 1-2-1. 2. Section longitudinale oblique, échantillon MTA2002/CO3-02 CO 1-1-2. 3. Section longitudinale, échantillon MTA2002/CO3-02 CO 1-3-1. 4. Section longitudinale, échantillon MTA2002/CO3-02 CO 11-1-3. 5. Section longitudinale oblique, échantillon MTA2002/CO3-02 CO 1-2-9. 6. Section longitudinale, échantillon MTA2002/CO3-02 CO 8-2. 7. Section longitudinale oblique, échantillon MTA2002/CO3-02 CO 1-1-4. 8. Élargissement du proloculus du spécimen dans l'échantillon MTA2002/CO3-02 CO 8-2, apparition d'un proloculus globulaire en section longitudinale.

*tralina* is simple and microgranular, whereas that of *Rectostipulina* is hyaline radial. However, the genus *Rectostipulina* was attributed to the Nodosariida, family Syzraniidae by Vachard in [32]. Recently, Groves et al. [16] have also indicated to the similarity of the *Rectostipulina* with *Syzrania* Reitlinger [28] and other syzraniids. In this case, the validity of the phylogeny of Angiolini and Rettori [5] is doubtful.

*Rectoformata* gen. nov., *Giraliarella* Crespini [9] and *Chitralina* are homeomorphic genera, with the main differences among them being wall structure. The wall of *Rectoformata* gen. nov. is calcareous microgranular, with fine alveolar structures, whereas *Chitralina* has a simple dark microgranular wall, and *Giraliarella* contains a very finely agglutinated wall with large quantities of cement. *Giraliarella* also differentiates itself from the other genera by a more complex morphology, due to the development of transverse growth constrictions.

*Earlandia* appears for the first time in the Silurian (Loeblich and Tappan [22]) and *Chitralina* in the Kuberbandian (= Roadian) [5], in both cases earlier than the first appearance of new genus *Rectoformata*. It is clear that the new genus differs from the homeomorphic Guadalupian genus *Chitralina* mainly by its calcareous microgranular wall with fine alveolar structures. Fine alveolar structure in the wall of the new genus is possibly indicative of an evolutionary stage in this lineage. The possible lineage can be formulated as *Earlandia–Chitralina–Rectoformata*.

*Chitralina* and *Rectoformata* are of Middle Permian (Guadalupian) age. *Chitralina undulata* Angiolini and Rettori [5] is restricted to the Kuberbandian/Late Murgabian–Midian. The new species, *Rectoformata tekini* and *Rectoformata acari*, are only known from the Middle Permian (= Guadalupian), Midian (= Capitanian) deposits of northwestern Anatolia (Turkey) and are not known from older or younger strata.

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