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A preliminary account on Devonian trilobites from Arabian Plate, SE Turkey

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Abstract: Recently, several Devonian localities and the related biota occurring from the southeastern Turkey were reinvestigated. Although, the Hakkari-Çukurca and the Diyarbakır-Hazro areas of the Arabian Plate are considered as an important source of the Devonian macrofossils from the north Arabian sector of Gondwana, the existing record of Devonian trilobites in these regions was hitherto unknown. We here report and illustrate for the first time Lower and Middle Devonian trilobites represented by three proetid pygidia and one calymenid pygidium. The morphological features of these pygidia suggest that they can be assigned to undetermined species of *Gravicalymene* (Calymenidae) and *Podoliproetus* (Proetidae), two genera known in the Lochkovian; and *Pseudodechenella* (Proetidae), a genus known in the Givetian.

Key words: Southeastern Turkey, trilobites, Devonian (Lochkovian, Givetian), Arabian Plate

1. Introduction

Paleozoic sequences characterized by siliciclastic rocks with interbedded carbonates are exposed in southern Turkey and constitute a W-E trending outcrop belt (Ghienne et al., 2010; Hoşgör, 2021). The Paleozoic period of the southern Turkey contains a remarkable fossil assemblage that has been studied intensively since the 1950's. As a result, several new discoveries and careful reinvestigations of Paleozoic fossils from the Taurus Chain and the Arabian Plate in southern Turkey have been achieved. Progress regarding the systematic description and stratigraphic position of trilobites, brachiopods, echinoderms, arthropods, bivalves, rugose corals and microfloras, has accelerated significantly in the past few years (e.g., Higgs et al., 2002; Dean, 2006; Gourvennec and Hoşgör, 2012, 2015; Hoşgör et al., 2012; Lamsdell et al., 2013; Denayer and Hoşgör, 2014; Hoşgör, 2014; Zamora et al., 2015; Mergl et al., 2018; Hoşgör, 2021).

The Devonian period is represented in Turkey by almost complete and thick sedimentary successions, which exhibit different lithofacies and especially shallow marine facies of different paleogeographic origin (Yalçin and Yılmaz, 2010). In the fossil record, trilobites may be encountered in sedimentary sequences that accumulated in near-shore environments, although they remain scarce due to the relatively low number of studies dealing with shallow-water sequences. They remain rare with only 26 genera currently reported from the İstanbul area and nothing else from other areas in the Devonian of Turkey. However, trilobites were relatively abundant and diverse in marine habitats along the peri-Gondwanan margin during the Devonian, at a time of climate upheavals (Becker et al., 2016) which triggered significant changes in biodiversity and major biotic crises (Sepkoski, 1996; Bond and Grasby, 2017).

The present paper contributes to the systematic study of few Devonian trilobites, represented by three proetid pygidia and one calymenid pygidium, found in a shallow shelf to tidal flat facies from the Border Folds regarded as the northern part of the Arabian Plate of Gondwana, SE Anatolia, SE Turkey (Figure 1A).

2. Geological and stratigraphical setting

2.1. Devonian of the northern Arabian Plate

Most of Paleozoic units in southeastern Turkey are represented by Cambrian to Permian successions of paraautochtonous and autochtonous units in the Amanos Mountains, Tut, Korudağ, Hazro, Derik and Çukurca outcrops, in the northern edge of the Arabian Plate (Figure 1A). Specifically, the Devonian of the northern Arabian Plate is represented by relatively thick sedimentary sequences observed from west to east in the Amanos Mountains, Hazro High and Hakkari area (Figure 1A). These thick sequences are either eroded at their top, so

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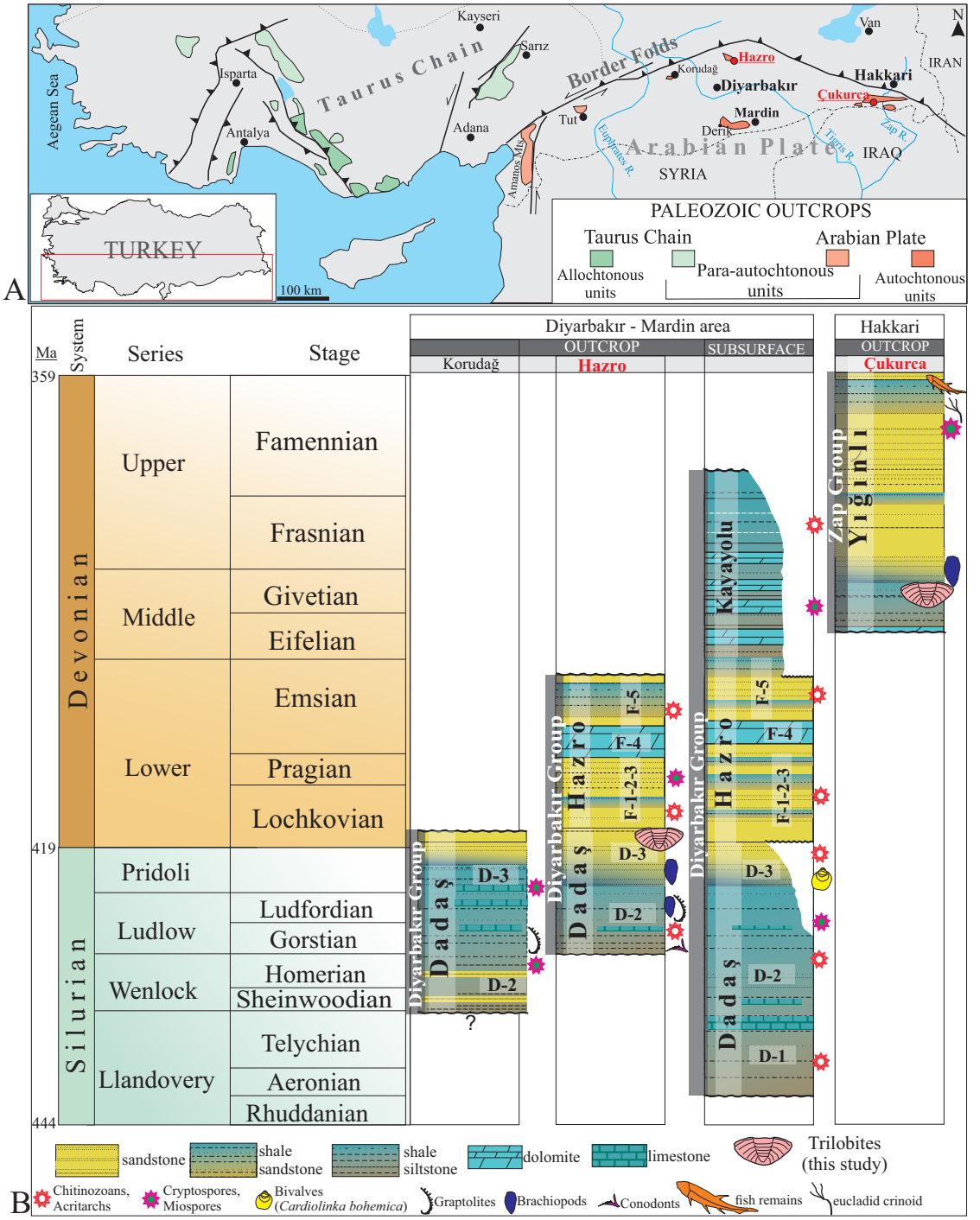

Figure 1. A-Location of the main Paleozoic outcrops in southern Turkey showing the Hazro and Hakkari-Çukurca areas of the Arabian Plate (Ghienne et al., 2010; Hoşgör et al., 2014; Hoşgör and Yılmaz, 2022). B-Generalized stratigraphic sections of the Silurian to Devonian rocks of the Arabian Plate, in southeastern Turkey with the localities studied yielding Devonian trilobites in the Hazro and Çukurca regions. Lithostratigraphical sections showing the main fossils and occurrences of trilobite-bearing levels (Tolun, 1949; Steemans et al., 1996; Higgs et al., 2002; Gourvennec and Hoşgör, 2012; Hoşgör, 2014; Hoşgör et al., 2014; Oktay and Wellman, 2019; Ausich and Göncüoğlu, 2020).

that the Upper Devonian is often missing or they overlap older units, so that the Lower Devonian is missing (Yalçin and Yılmaz, 2010). The examined Devonian sections are located in northern Diyarbakır and southern Hakkari areas in the southeast Anatolian autochthon (Figure 1A). The Devonian of the northerly-located Hazro area is

represented by Lower Devonian, while the Devonian of the Hakkari-Çukurca area consists of Middle to Upper Devonian (Figure 2; Bozdoğan et al., 1987; Yılmaz and Duran, 1997; Gourvennec and Hoşgör, 2012; Ausich and Göncüoğlu, 2020). Devonian sequences at both localities on the Arabian Plate consist of lithological associations representing a shallow shelf to tidal flat facies (Yalçin and Yılmaz, 2010).

Based on the consistency of their lithology and their common sedimentary features, considering from surface geology to subsurface data (Perinçek et al., 1991), the Devonian marine successions of the Diyarbakır (Hazro) and Hakkari (Çukurca) areas are divided into two stratigraphical groups, i.e. Diyarbakır and Zap groups and consist of four formations: Dadaş (oldest), Hazro, Kayayolu, and Yığınlı formations (Figure 1B). The studied trilobites located in the Hakkari-Çukurca (Çukurca anticline) and the Hazro areas came from the upper part of the Dadaş Formation in the Hazro area, and the lower part of the Yığınlı Formation in the Çukurca area (Fig.1B).

2.2. Studied areas, materials and methods

Initial fieldwork was devoted to the Silurian-Devonian Diyarbakır Group, which represents the oldest sedimentary sequence of the northern Diyarbakır area. The Diyarbakır Group is exposed in two geographically separated areas where it forms the core of faulted anticlines, the Korudağ anticlines and the Hazro anticlines in the southeastern Turkey, respectively (Figure 1A). The Diyarbakır Group consists of three formations (Perinçek et al., 1991), i.e. Dadaş, Hazro, and Kayayolu formations (Figure 1B). Surface and subsurface fossil records dominated by acritarch, chitinozoans, cryptospores, miospores, conodonts, graptolites, brachiopods and bivalves indicate that marine conditions prevailed during the Silurian-Devonian time in the Diyarbakır area (Tolun, 1949; Lebkuchner, 1976; Steemans et al., 1996; Hoşgör, 2014; Oktay and Wellman, 2019). The Diyarbakır Group represents a change from the inner shelf to lagoon deposition (Perinçek et al., 1991).

The Dadaş Formation, rich in fossils comprising spores, conodonts, ostracods, brachiopods, crinoids among others (Çoruh et al., 1997; Hoşgör and Yılmaz, 2022) is Early Silurian—Early Devonian (Bozdoğan et al., 1987). Deposition of the Dadaş Formation, which consists of dominantly organic rich shales, sandstones, limestones and dolomite of restricted marine environment, is completed by a regressive cycle during the Early Devonian (Perinçek et al., 1991; Hoşgör, 2014). Lithofacies, sedimentary structures and fossil content suggest a restricted inner shelf, which became shallower and grade to a tidal flat towards the top of the sequence (Yılmaz and Duran, 1997). Hitherto trilobites were unknown from this formation. Within the Dadaş Formation, three members are distinguished based on different lithological composition, which are reflected in log characteristics (Figure 1B). The Dadaş-1 member consists of dark colored, organic rich shales with some limestone interbeds; the Dadaş-2 member is composed of similar shales alternating with some sandstones and the Dadaş-3 member consists of an alternation of sandstones, marls and calcareous siltstones (Hoşgör, 2014; Hoşgör and Yılmaz, 2022). The sedimentary sequences of the Dadaş-1 and Dadaş-2 members cuttings were studied from several deep wells and they are not exposed on the surface, limited top Dadaş-2 and Dadaş-3 are exposed the Korudağ and Hazro outcrops (Bozdoğan et al., 1994; Steemans et al., 1996). The overlying Hazro Formation is subdivided into five members, named F1–F5 from the bottom to the top of the unit (Bozdoğan et al., 1987). The Kayayolu Formation, the upper part of the Diyarbakır Group, is composed mostly of shales, marls and dolomites (Bozdoğan et al., 1987). First trilobite-bearing discoveries are reported from the Dadaş Formation at Hazro anticlines, from a shale dominant lithology with some thin sandstone beds in the uppermost part of the formation (Figure 2A).

A second field excursion has resulted in the description of a previously known macrofossil-bearing outcrop, between the towns of Hakkari and Çukurca which are situated close to the Iraqi border (Hoşgör et al., 2014). Trilobites recently collected from this area (Figure 2B) were found in the lower part of the Yığınlı Formation (Figure 1B) in thin lenticular bioclastic patches that were recorded below a brachiopod bed. In this formation poor in fossil remains, the described brachiopods (Gourvennec and Hoşgör, 2012) allowed establishing a Middle Devonian (upper Givetian) age for the middle part of the Yığınlı Formation, thus making the new trilobite remains older than the brachiopod bed. In previous studies or more recently, palynomorphs, fish remains and crinoids from the upper part of the Yığınlı Formation indicate a Famennian age (Janvier et al., 1984; Higgs et al., 2002; Ausich and Göncüoğlu, 2020). Lithofacies, sedimentary structures and fossil content suggest an intralittoral to shallow marine depositional environment (Bozdoğan et al., 2005). Hitherto trilobites were unknown from this formation.

The illustrated specimens were stained with black ink and then coated with ammonium chloride before being photographed with the use of a digital camera Canon. The described and figured material is housed in the collections of Sivas Cumhuriyet University, Natural History Museum, Turkey (collection numbers "CTF-HY022-01-03"). The morphological terminology follows Whittington and Kelly (1997).

3. Trilobite content from Turkey

Trilobites remain rare in the Devonian of Turkey, with only few families reported from the entire continent. From NW

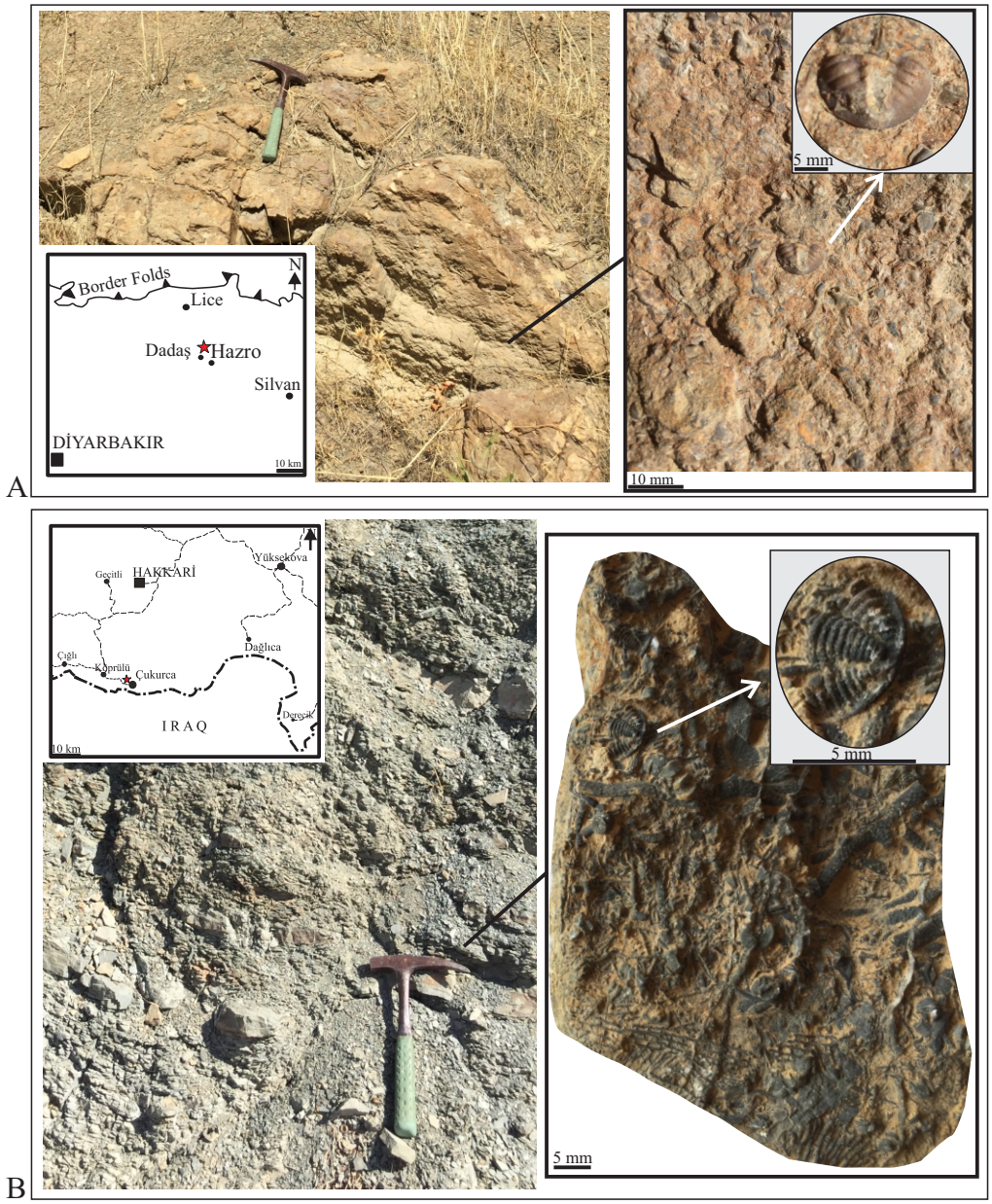

Figure 2. General view of the Devonian trilobite-bearing successions to the northwestern of the A-Hazro and B-Çukurca areas.

Turkey, several trilobite families have been reported by Haas (1968) from the Silurian and Devonian of Bithynia, i.e. İstanbul area (Haas, 1968; Gandl, 1973) and especially in the Early Devonian (upper Emsian; Haas, 1982; van Viersen and Holland, 2016), including *Kettneraspis leucothea* (Haas, 1968) (Odontopleuridae), *Cyphaspis goerlichi* (Haas, 1968) (Otarioninae, Aulacopleuridae), *Gravicalymene euona* Haas, 1968 (Calymenidae), *Echinopyge cathamma* Haas, 1968 (Dalmanitidae), *Centauropyge pronomaea* Haas, 1968 (Dalmanitidae), and potential species of *Morocops* (e.g., Haas, 1968, pl. 30, Figures 6–7; Phacopidae) according to van Viersen et al. (2017). Dalmanitidae is the most diverse and abundant family in this area. *Trimerocephalus mastophthalmus* Richter, 1856 (Phacopidae) was also reported from the Upper Devonian (Gandl, 1973).

From SW Turkey (Eastern Taurides), Yılmaz and Demircan (2005) reported only trilobite trace fossils in the Upper Devonian. *Pseudophillipsia* Gemmellaro, 1892 (Ditomopyginae, Phillipsiidae) was reported in the Antalya Province (Southwestern Taurides) during the Permian (Lerosey-Aubril and Angiolini, 2009).

From NE Turkey, only a pygidium of *Ditomopyge*? sp. indet. (Ditomopyginae, Phillipsiidae) was described in the Carboniferous of Eastern Pontides (Kandemir and Lerosey-Aubril, 2011).

In SE Turkey, trilobites were described from the Cambrian and Upper Ordovician outcrops from the Hakkari-Çukurca area (Dean and Zhou, 1988; Dean, 2006). A poorly preserved pygidium from the Hazro region obviously belongs to an undetermined Permian species of *Pseudophillipsia*, as proposed by Canuti et al. (1970) and accepted by Lerosey-Aubril and Angiolini (2009). Hitherto trilobites were unknown from these areas during the Devonian.

By comparison with other areas from the northern peri-Gondwanan margin, such as Morocco (Crônier and Feist, 1997; Crônier and Clarkson, 2001; Crônier et al., 2013, 2018a, 2018b; Khaldi et al., 2016; Bault et al., 2021), the trilobite remains from the Arabian Plate, SE Anatolia are rare.

4. Systematic paleontology

Order Phacopida Salter, 1864

Superfamily Calymenoidea Milne Edwards, 1840

Family Calymenidae Milne Edwards, 1840

Subfamily Calymeninae Milne Edwards, 1840

Remarks: Siveter (1976) assigned taxa with fixigenal buttresses to the glabellar lobes to Calymeninae and the remainder of taxa to Flexicalymeninae. According to Adrain et al. (2020), Calymeninae is likely monophyletic and Flexicalymeninae paraphyletic, a group left over by removal of Calymeninae. Here we follow Adrain (2013), Adrain et al. (2020), and Holloway et al. (2020) in considering all the taxa in question as Calymeninae. As recognized by Smith and Ebach (2020), classifying calymenids remains a difficulty without a comprehensive analysis using all diagnostic features.

The early history of putative members of the subfamily Calymeninae Milne Edwards, 1840, is sparsely known (see, Adrain, 2013, Adrain et al., 2020). First calymenines are known from the Floian, all from Gondwanan Armorica. The subfamily became increasingly more common thereafter and especially during the Katian. Calymenines appeared in Laurentia during the Dapingian and achieved thereafter a global distribution (Adrain, 2013, Adrain et al., 2020). They are still greater in number during the Siluro-Devonian (Adrain, 2013).

Genus *Gravicalymene* Shirley, 1936

Type species: *Gravicalymene convolva* Shirley, 1936, from the Ashgill, Upper Ordovician, Birdshill Quarry, South Wales; by original designation.

Remarks: *Gravicalymene* is a genus currently known from the Late Ordovician to the Early Devonian (or lowest Eifelian); an unusually long temporal range for a trilobite genus. According to Smith and Ebach (2020), such longevity may be related to occupation of a persistent niche space, such as a stable generalist lifestyle; or an artefact of insufficient morphological characters required for differentiation. *Gravicalymene* has been described from Avalonia, Baltica, Laurentia and East Gondwana (e.g., Chapman, 1915; Etheridge and Mitchell, 1917; Shirley, 1936; Gill, 1940, 1945; Stumm and Kauffman, 1958; Dean, 1962, 1963; Vaněk, 1965; Ross, 1967; Haas, 1968; Alberti, 1969, 1981; Schrank, 1970; Chatterton, 1971; Ingham, 1977; Chatterton et al., 1979; McNamara, 1979; Ross, 1979; Chatterton and Campbell, 1980; Holloway and Neil, 1982; Šnajdr, 1981, 1982; Price, 1982; Holloway, 1994; Sandford, 2000; Edgecombe and Wright, 2004; Zhou and Zhen, 2008; Owens et al., 2010; Smith and Ebach, 2020). Some species of Early Devonian age have been described, i.e. *Gravicalymene euona* Haas 1968 from Bithynia (NW Turkey) and *Gravicalymene maura* Alberti, 1969 from Morocco.

According to Kobayashi and Hamada (1977), *Gravicalymene* is a prominent genus in the macrofaunas of Japan (Koizumi and Kakegawa 1970), South China (Gill, 1945; Lu et al., 1965; Zhang, 1974) and North Viet-Nam. It occurs in North China (Nan, 1980), probably in Eastern Burma (Sahni in Héron, 1936), but unknown in South Asia except for Bithynia, NW Turkey (Haas, 1968). This genus was also reported in Australia and New Zealand from the Lochkovian to early Eifelian (Gill, 1945; Kobayashi and Hamada, 1977). These two areas are closely related to those of Southeastern and Eastern Asia as indicated by *Gravicalymene* and other genera (Kobayashi and Hamada, 1977).

***Gravicalymene?* sp. ind.**

Figures 3a–3d

Material: One poorly preserved pygidium coming from the Lochkovian of Hazro section, Diyarbakır Group, upper part of the Dadaş Formation, southeastern Turkey, north margin of Arabian Plate. Unfortunately, no cephalon is available.

Description: *Gravicalymene?* with a pygidium subrhomboidal in outline in dorsal view, moderately flattened by deformation especially for the left side. Antero-lateral margin moderately rounded. Length (excluding articulating half ring)/width ratio about 60% rather long. Its maximum width behind the midlength (sag.) across fifth segment. Posterior outline apparently broadly rounded backwards. Axial furrows deep and wide, which fade backwards. Pygidial axis not well preserved, strongly tapered (35°), gently convex, and probably not quite reaching the posterior margin. First axial ring very wide (42% sag. as percentage of maximum pygidial width), and flexed slightly forwards. Pseudo-articulating half rings apparently suggested by expanded interring furrows that are

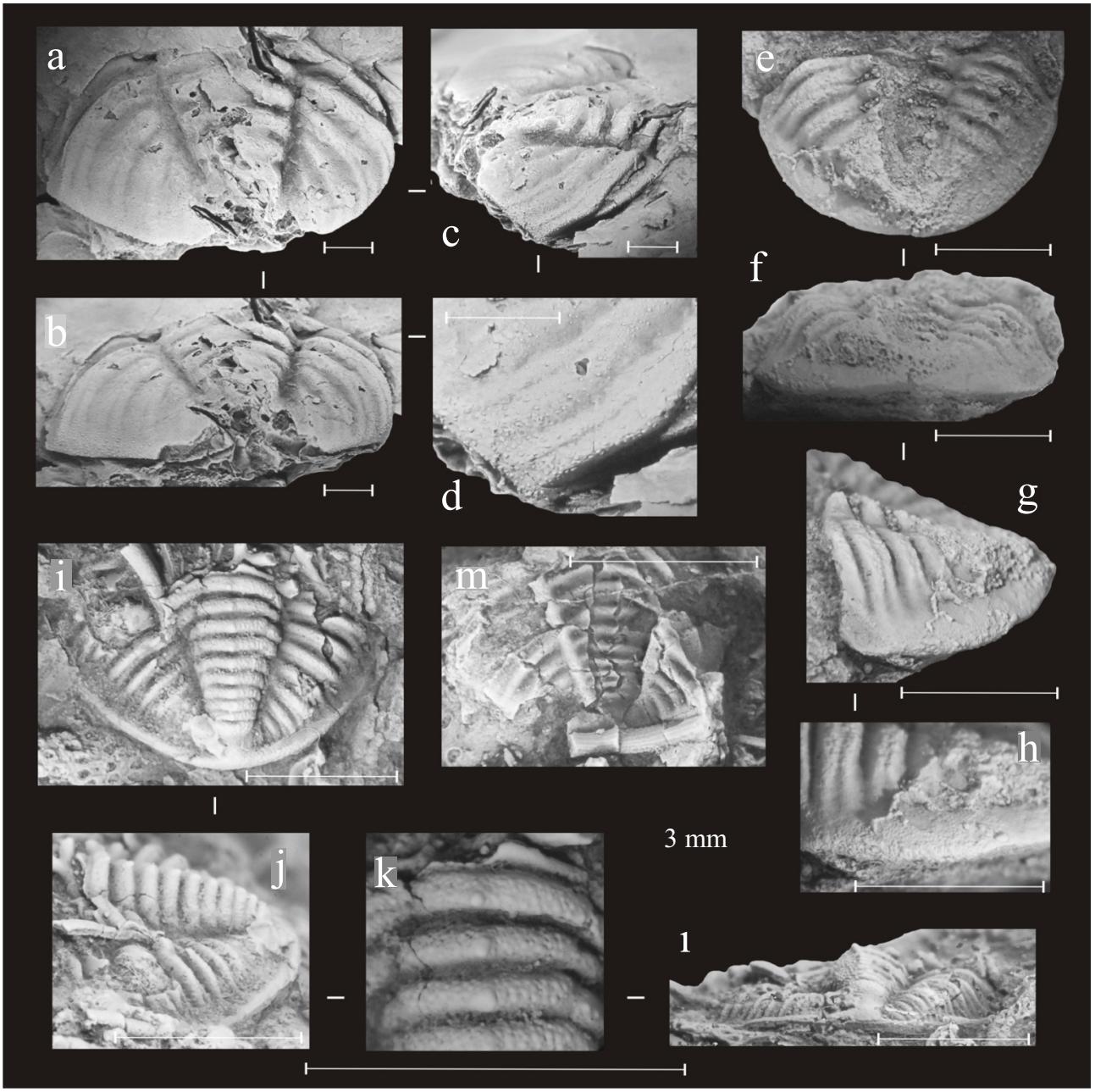

Figure 3. (a–d) *Gravicalymene?* sp. ind., Hazro section, southeastern Turkey, north margin of Arabian Plate, Diyarbakır Group, upper part of the Dadaş Formation, Lochkovian; pygidium, CTF-HY022-01, in (a) dorsal, (b) posterior, (c) and lateral views; (d) detail of postero-lateral border. (e-h) *Podoliproetus*? sp. ind., Hazro section, southeastern Turkey, north margin of Arabian Plate, Diyarbakır Group, upper part of the Dadaş Formation, Lochkovian; pygidium, CTF-HY022-02, in (e) dorsal, (f) posterior, (g) and lateral views; (h) detail of lateral border. (i–m) *Pseudodechenella?* sp. ind., Çukurca section, southeastern Turkey, north margin of Arabian Plate, Zap Group, Yığınlı Formation, Givetian; pygidium, CTF-HY022-03, in (i) dorsal, (j) lateral, and (l) posterior views; (k) detail of pygidial axis; (m) another pygidium from the same block, CTF-HY022-03, in ventral view. Scale: 3 mm.

deepest abaxially. Five preserved axial rings (plus terminal piece not preserved) and four pleural ribs gently but more convex (tr.) anteriorly, shorter posteriorly and depressed abaxially; subsequent pleural segments progressively less clearly defined, overall shorter (exsag.) adjacent to axis. Pleural furrows moderately wide and deep from axis, past fulcrum, shallowing and narrowing abaxially, extending to pygidial margin; subsequent pleural furrows progressively shallower, but remaining deep and discernible adjacent to axial furrow. Interpleural furrows only distinct abaxially,

extending to pygidial margin. Postaxial region and posterior margin not preserved. Pygidium covered with "granule-like" structures, closely spaced on posterior pygidial border (Figure 3d). Such structures are common on internal moulds of homalonotids, especially when only the internal cuticle layer is preserved. They are the infillings of canals that underlie the pits or pitted tubercles of the mineralised cuticle (see, e.g., Dalingwater et al., 1999). These structures are preservational artifacts that remained subsequent to the decortication of the laminated outer layer (Rustán et al., 2020).

Remarks: According to the revised diagnosis provided by Smith and Ebach (2020), *Gravicalymene* is characterized by a pygidium lenticular in dorsal view, strongly convex; a pygidial axis with deep axial furrows, fading around terminal piece; and a pygidial pleural field with faint to distinct pleural ribs. The pygidium figured here is imperfectly preserved showing a slight distortion and matches more or less to this diagnosis. The absence of complete and better preserved specimens prevents a precise assignment.

In comparison with Early Devonian Gondwana taxa, *Gravicalymene maura* Alberti, 1969 from Morocco differs and appears to possess a paradoublural line at which the deep pleural furrows are truncated becoming abaxially narrow and shallow. *Gravicalymene euona* Haas, 1968 from Bithynia (NW Turkey) also seems to possess these features; a feature not observed on our specimen.

Order Proetida Fortey and Owens, 1975

Superfamily Proetoidea Hawle and Corda, 1847

Family Proetidae Salteri, 1864

Subfamily Proetinae Salter, 1864

Remarks: Proetines are among the most widespread and most frequent trilobites on the continental margins of southern Laurussia and peri- and northern Gondwana during the Pragian to Givetian (van Viersen, 2021). Data on the earliest Devonian (Lochkovian) members of the subfamily are relatively limited and the supraspecific classification continues to be a topic of debate (van Viersen, 2021).

Genus *Podoliproetus* Šnajdr, 1980

Type species: *Proetus perinsignis* Chlupáč and Vaněk, 1965 from the Pragian, Early Devonian, Czech Republic; by original designation.

Remarks: Relationships among *Podoliproetus* and its allied genera have been reviewed by Van Viersen (2021). Based on limited and poorly preserved cranidia and pygidia, Šnajdr (1980) erected *Podoliproetus* for Pragian proetines from the Barrandian and Morocco with spiny median nodes on the pygidial axis. More recently, Johnson and Fortey (2012) described two new species on complete specimens from Morocco providing a better description. According to Van Viersen (2021), *Podoliproetus* is characterized by a hypertrophied and posteriorly strongly vaulted glabella with a strongly vaulted (sag., tr.) posterior section of glabella and primitive cephalic traits. *Podoliproetus* and the oldest *Dohmiella* species from the Eifelian share several cephalic characters and spiny median nodes on the anterior pygidial axial rings, narrow (tr.) horizontal plane of pygidial pleural field abaxially demarcated by a steeply inclined part, concave border furrow, and an inflated, primitively broad border.

***Podoliproetus*? sp. ind.**

Figures 3e–3h

Material: One poorly preserved pygidium coming from the Lochkovian of Hazro section, Diyarbakır Group, upper part of the Dadaş Formation, southeastern Turkey, north margin of Arabian Plate. Unfortunately, no cephalon is available.

Description: *Podoliproetus*? with a pygidium semielliptical in outline in dorsal view, with a well-defined border. Length (excluding articulating half ring)/width ratio about 65.5% long. Its maximum width in front of the midlength (sag.). Posterior outline rounded backwards. Axial furrows moderately deep. Pygidial axis not preserved but apparently strongly tapered (around 40°). First axial ring wide (41% sag. as percentage of maximum pygidial width) defined by deep furrows abaxially (not preserved medially). Five discernible pleural ribs anteriorly almost planar (tr.) in adaxial half, and steeply sloping downwards in abaxial half towards border furrow; subsequent pleural segments progressively less clearly defined, overall shorter (exsag.) adjacent to axis and (tr.) posteriorly. Pleural bands of low convexity in crosssection. Pleural furrows moderately wide and deep; the first one crossing the border furrow onto the border, the others dying out at border furrow. Interpleural furrows well defined, dying out at border furrow. Border furrow distinct but moderately shallow. Postaxial region not preserved. Pygidial border moderately wide with rounded egdes. In posterior view, posterior margin curved dorsally medially. Pygidium covered with sculpture of fine granules on the border.

Remarks: According to Van Viersen (2021), *Podoliproetus* is characterized by a pygidium with spiny median nodes on the anterior axial rings, a narrow (tr.) horizontal plane of pleural field abaxially demarcated by a steeply inclined part, concave border furrow, and an inflated, primitively broad border. The pygidium figured here is imperfectly preserved, especially the pygidial axis. The absence of complete and better preserved specimen prevents a reliable assignment.

In comparison with Early Devonian Gondwanan taxa, *Podoliproetus mirdani* Johnson and Fortey, 2012 from the Pragian of Morocco is similar to that of the studied specimen from Turkey but the border seems to be more rounded, and the border widens slightly adaxially as far as

the postaxial area where it becomes narrower. Without a cranidium, it is not possible to say more.

Subfamily Dechenellinae Přibyl, 1946

Remarks: Several authors (Hupé, 1953; Yolkin, 1968, 1983; Maximova, 1970, 1977; Ormiston, 1972, 1976) have considered Dechenellinae to have family status within the Proetoidea. Following Thomas in Thomas and Narbonne (1979) and Zhou et al. (2000), this subfamily, which is closely related to the Proetinae, is maintained within the Proetidae family. The detailed interrelationships between various genera of the Dechenellinae remain to be resolved.

Genus *Pseudodechenella* Pillet, 1972

Type species: *Calymene rowi* Green, 1838, from Middle Devonian, Hamilton Group, Givetian, New York, North America; by original designation.

Remarks: *Dechenella* and relatives including *Pseudodechenella* is one of the most diversified genera among Devonian proetids. The considerable number of species makes the taxonomy and the evolutionary relationships clouded. Lieberman (1994) discussed the group as *Basidechenella* (Richter, 1912). However, the Lieberman's (1994) generic concept of *Basidechenella* was rejected by Adrain (1997) mainly because Lieberman (1994) completely overlooked Pillet's (1972) proposal of *Pseudodechenella*. Indeed, Pillet (1972) erected *Pseudodechenella* with the New York State species *rowi* as type. *Pseudodechenella* encompasses many Devonian species hitherto generally placed in the genus *Basidechenella* including the many Eastern North America species assigned by Lieberman (1994) to *Basidechenella*.

The earliest occurrences of *Pseudodechenella* are known in France (Pillet, 1972) from the Lower Devonian (lower Emsian), and in North America from the Lower Devonian (upper Emsian) and diversified during the Middle Devonian (Eifelian and Givetian) in North America (Stumm, 1953a, 1953b, 1964; Pillet, 1972; Lieberman, 1994).

***Pseudodechenella?* sp. ind.**

Figures 3i–3m

Material: Two pygidia coming from the Givetian of Hakkari-Çukurca area, Yığınlı Formation, southeastern Turkey, north margin of Arabian Plate. Unfortunately, no cephalon is available.

Description: *Pseudodechenella*? with a pygidium subpentagonal in outline in dorsal view, subparabolic in outline posteriorly, moderately vaulted sagittally and transversely, with a well-defined border. Length (excluding articulating half ring)/width ratio about 63% long. Its maximum width in front of the midlength (sag.) across fourth segment. Posterior outline broadly rounded backwards. Axial furrows straight and deep. Pygidial axis strongly tapered (38°), convex and subconical in shape. First axial ring wide (37% sag. as percentage of maximum pygidial width), and flexed strongly forwards and highly convex; subsequent axial rings more weakly forwardly curved and convex. Pseudo-articulating half rings suggested by expanded interring furrows anteriorly. Nine discernable axial rings (plus terminal piece) defined by narrowest furrows posteriorly. Seven pleural ribs more vaulted (tr.) anteriorly and adaxially, shorter posteriorly and depressed abaxially, strongly sloping downwards towards border furrow; subsequent pleural segments progressively less clearly defined, overall shorter (exsag.) adjacent to axis. Pleural furrows moderately wide and deep from axis, dying out at border furrow; subsequent pleural furrows remaining deep and discernible adjacent to axial furrow. Interpleural furrows distinct, dying out at border furrow. Border furrow moderately wide and deep. Pygidial border moderately narrow and convex with terrace lines ventrally. Pygidium covered with sculpture of fine granules. Each axial ring with a distinct axial node medially (Figure 3k).

Remarks: According to the described species provided by Pillet (1972; p. 167, pl. 24, Figure 2), *Pseudodechenella* is a genus characterized by a high number of pygidial axial rings (11–12) with median nodes (e.g., *P. nododa* (Stumm, 1953a) or *P. pulchra* (Stumm, 1953a)) or not (e.g., *P. incerta* (Œhlert, 1889)) and pygidial interpleural furrows weakly incised. The Turkish pygidia figured here are well preserved and match rather well to these features. They may belong to *Pseudodechenella*.

In comparison with Middle Devonian taxa, *Pseudodechenella?* sp. ind. resembles to the Givetian *Pseudodechenella pulchra* (Stumm, 1953a) from North America, by having a similar pygidial outline and medial tubercles on all pygidial axial rings but differs in having 11 pygidial axial rings. As stated by Stumm (1953a), *Pseudodechenella pulchra* was very similar to *Pseudodechenella nodosa* (Stumm, 1953a) in having also medial tubercles on all pygidial axial rings. *Pseudodechenella?* sp. ind. differs from *Pseudodechenella nodosa* by having posterior portion of pygidium straight, transverse in dorsal view and eight pygidial pleural segments.

The closely related *Basidechenella* with the species *kayseri* (Richter, 1912) as type differs in lacking median nodes, in having a broad border and weakly defined border furrow, a more high-parabolic outline, weakly differentiated pleural ribs, among other features. The absence of complete preserved specimens prevents a precise assignment. Only a cephalon would have been helpful here.

5. Conclusion

The present paper contributes to the systematic study of the few Devonian trilobites collected recently on the field

from the northern part of the Arabian Plate of Gondwana, SE Turkey. The freshly collected material comes from two different sections, i.e. Diyarbakır-Hazro and Hakkari-Çukurca, respectively in two different formations, i.e. Dadaş (oldest) and Yığınlı (youngest) formations. Devonian trilobites were hitherto unknown in these areas. According to brachiopods and other organisms, the age of the newly collected trilobites ranges between the Lochkovian and the Givetian. The relatively well-preserved calymenid pygidium and three proetid pygidia are assigned to undetermined species of *Gravicalymene* (Calymenidae) and *Podoliproetus* (Proetidae), two genera known in the Lochkovian; and *Pseudodechenella* (Proetidae), a genus known in the Givetian, taking into account their pygidial outline, axis shape and ornamentation, thus becoming an additional report for a northern peri-Gondwanan margin but also for a worldwide distribution. Their occurrence in the Lower-Middle sequences of Turkey is compatible with a shallow shelf to tidal flat facies. By comparison with other areas from the northern peri-Gondwanan margin, such as Morocco (Bault et al., 2021), the trilobite remains from the Arabian Plate, SE Anatolia remain rare.

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