

Early Silurian (Llandovery) Trilobite fauna from Kopeh-Dagh, North East Iran

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Abstract

The aim of this study is to analyze the assemblage of trilobites in the Silurian sequences of Iran by exploring stratigraphic section of the Silurian Niur Formation (Asadli section). Based on comprehensive field studies and laboratory investigations three Trilobite genera were identified in the study area including *Calymene blumenbachii*, *Gravicalymene convolva*, *Dalmanites brevigladiolus* and *Calymene* sp. according to this trilobite assemblage a Rhuddanian to Telychian stages (Llandovery) is suggested for deposition of the study strata. The recognized trilobite fauna will be used as a base for future geological studies on the Silurian strata in Kopeh-Dagh Basin. This is the first report of trilobites from the Silurian (Llandovery) Niur Formation in Asadli section, north- east, Iran.

Keywords: Trilobite; *Calymene*; Biostratigraphy; Silurian; Iran.

Introduction

Calymenina were among the most dominant trilobite groups in the Lower Paleozoic. They range from the Tremadoc into the Devonian and have world-wide occurrence. They are well-represented in Tremadoc rocks but often constitute a significant part of many Ordovician and Silurian faunas. During Llandovery times, Calymenidae underwent a dramatic increase in diversity, particularly in the shallow-water oceans covering parts of Gondwana, such as, Turkey, Poland, Kazakhstan, Japan, Italy, Sweden and Iran. The Silurian trilobites have species have been discovered in rare sites in Iran. Alas, Iranian Llandovery trilobite taxa are generally invisible in universal measurement of Silurian biostratigraphy. This article concentrated on the

Llandovery trilobite taxa of Kopeh Dagh (Asadli section).

Although Silurian strata were previously reported well from several regions of Iran, such as Kerman [1], Dajman [2], Isfahan [3], Tabas [4-6], the stratigraphy and fauna of Kopeh Dagh region remains inadequately recognized. Silurian strata were first reported from the Kopeh Dagh region by [7], done the first assessment on the Paleozoic stratigraphy of Iran. They were correlated the Silurian rocks of South East of Asia and the near East. Brice [8] briefly outlined the Silurian and Devonian stratigraphy of the area. Cocks [9] studied and described 23 taxa of brachiopods at the western Kopeh Dagh region. The Lower Paleozoic strata from Kopeh Dagh region were studied by: [10-16] and more recent surveys by Ameri et al. indicate that the Robat-e-

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Gharebil section is also rich in trilobites [31]. The goals of this article are to 1) presented summary lithological description of the Asadli section, and 2) recognition and describe the trilobites.

Geographical and Geological setting

Asadli section is part of the Saluk Mountains on the southern side of the Asadli Valley, about 35 km south of Bojnord city at the Kopeh Dagh basin (Fig. 1). These Mountains trend northeast–southwest and development

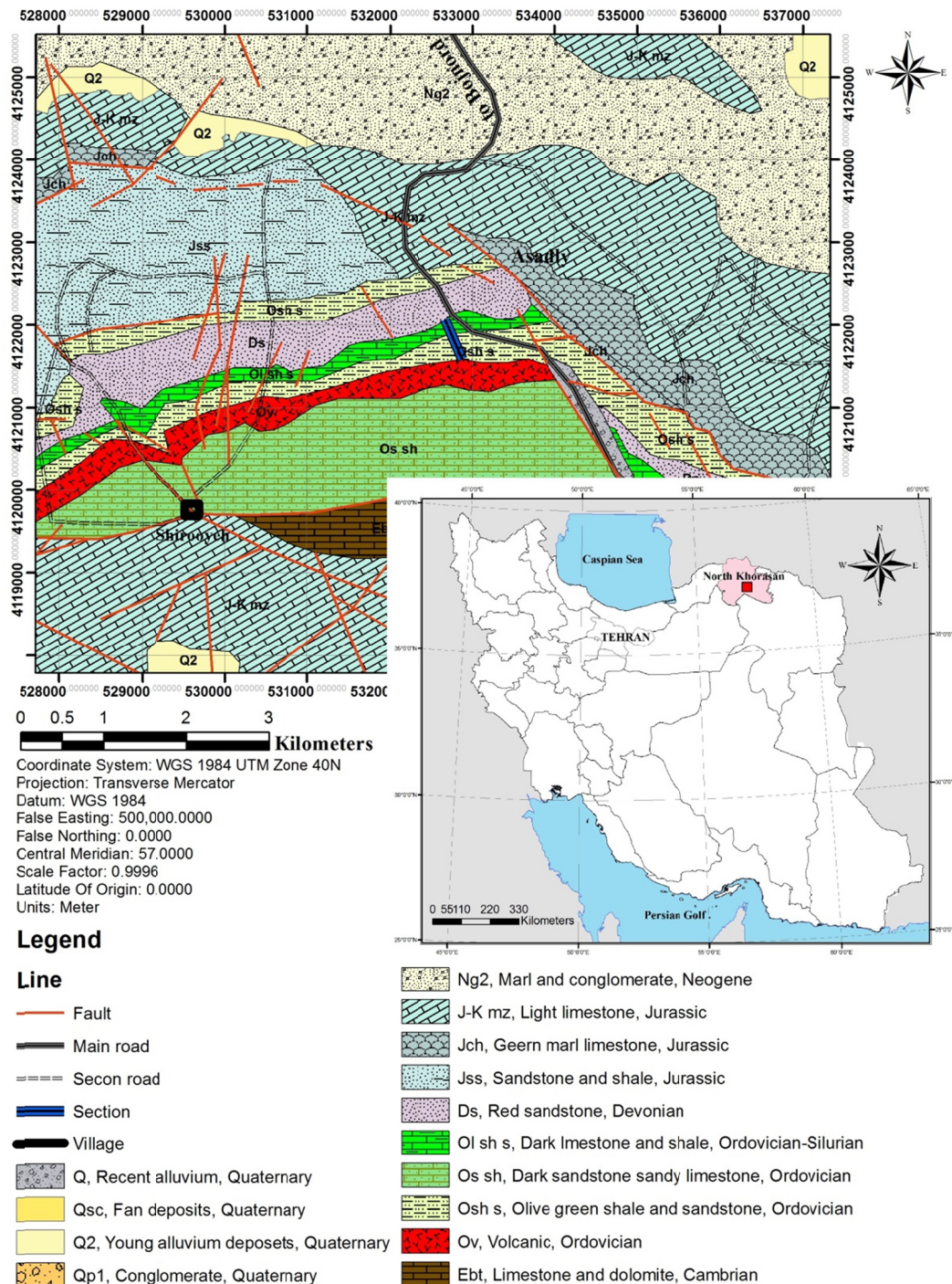


Figure 1. Position of the Asadli area in the northeast of Iran, study section and geological map.

about 20 km. They are bounded by the Firuzeh fault at the north and the Solook fault system and Shiroyeh fault at the south. Asadli section is placed in the southwest of the Sarinow Mountain. In this area the Cambrian to Jurassic deposits cropped out. In the study area (Fig. 1), the Cambrian strata have subdivided into the Barout Formation, partly Zaigon and Lalun Formations. The Cambrian - Ordovician boundary is faulted. The Ordovician strata contained; dark sandstone, olive green shale, minor sandy limestone and volcanic (andesite to basalt), Qelli Formation (Sandbian- Hirnantian). Silurian sequence in this area comprising of more than 300 m of argillites, limestone and siltstones,

Various Ages are proposed for deposition of the Silurian Niur Formation in different areas by many authors on the basis of different fossil groups. They are: Aeronian- Sheinwoodian by conodont; in the Masuleh (western Alborz) [17], Rhuddanian to Homerian, by brachiopods and corals, [9], and as Rhuddanian to Aeronian by conodont, in Rebate Gharebil (western Kopeh Dag region) [18], Aeronian by brachiopods [14], and as Rhuddanian to Telychian, by Acritarchs and chitinozoa in Kuh-e-Saluk [19] and as Aeronian, by brachiopods and cephalopod, in Gerdu Valley section, [16]. The lower contact of the Niur Formation is conformable and transitional with the underlying Qelli Formation and in this section is disconformably overlain with Devonian red and white sandstone and shale of Padeha Formation.

The Asadli section

The Asadli section is located about 35 km south of Bojnord city, at 2 km south east of the Asadli village, at geographic coordinates of 37°19'38" N, 57°20'04" E (Fig. 1). More than 300 m of Silurian deposits measured that can be subdivided into four lithofacies (Fig. 2):

Member 1: comprising of more than 95 m of gray to black sandy argillite with several interbedded of graptolitic argillite and oolitic ironstone levels in the middle part.

Member 2: consisting of 35 m of bedded limestones and argillites. They contain cephalopod, trilobite and brachiopods.

Member 3: consisting of 25 m of bedded limestones intercalating with siltstone, and argillites, with no identified fossils.

Member 4: comprising of about 150 m of bedded limestones and argillites, with a level of 30 m thick, bioclastic limestone in its upper part. This member contains cephalopod, trilobite and scattered brachiopods. The Silurian deposits are overlain unconformably by Padeha Formation (lower Devonian).

Materials and Methods

The Silurian strata were studied and their trilobites taxa, collected systematically in the Asadli section. Only the *in situ* fossils were collected from the study area. The taxa collected from this area are about 45 trilobite taxa. The collected trilobites are deposited in the Graduate University of Advanced Technology, [PEG].

The evoked of taxa were from marl limestone and limestone using a pneumatic pen. The trilobite samples were masked by ammonium chloride and using loop-lamp to raise the contrast. In most specimen, extra highlight from the North West quadrant was used. for The take photo of trilobites taxa were using a digital camera (Nikon D90) with a 105mm objective lens.

Results and Discussion

Systematic Paleontology

Appraisalment, terminology, and abbreviations are derived from [20-24] based on Ameri [24], (Fig. 3).

Family; Calymenidae Milne Edwards 1840

Subfamily; Calymeninae Milne Edwards 1840

Genus; *Calymene* Brongniart, 1822

Pl.1, [a-c and h], Pl.2, [a-c], Pl.3, [a, g]

Type species; *Calymene blumenbachii* Brongniart, 1822

1950. *Calymene boettneri* n. sp. Harrington, p. 73-76, pl. 1, Figs. 1-3.

Material. One complete specimens, six cranidial, and four pygidium

Description: Glabella outstanding high over genal and skeleton fine in foreside of them, frontal lobe slanting steeply onward, with 3 placenta of sidelong lobes, 1L and 2L derived by superficial linear furrows, all a partly outstanding. 2L lobes papillate; eye lobes opposite 2L glabellar lobes; Preglabellar groove narrow, profound; frontal edge equally outstanding, center of frontal lobe of central body. Thorax with 13 sectors, pygidium with six perfect axial rings and six profound, pleural grooves, which develop to edge of borderless pleural zones, Pygidium is slightly minor than double as Width as length. Axis is somewhat, less than moiety the pygidial width, is strongly outstanding (sag.) has seven or 8 axial rings. All axial rings except the final determined posteriorly by full ring grooves which are weakest; last ring groove not continues; final axial segment rounded. Axial groove decidedly impressed, weakest posteriorly. Inner segment of pleural zone falls steeply from axial groove, outer part becomes vertically

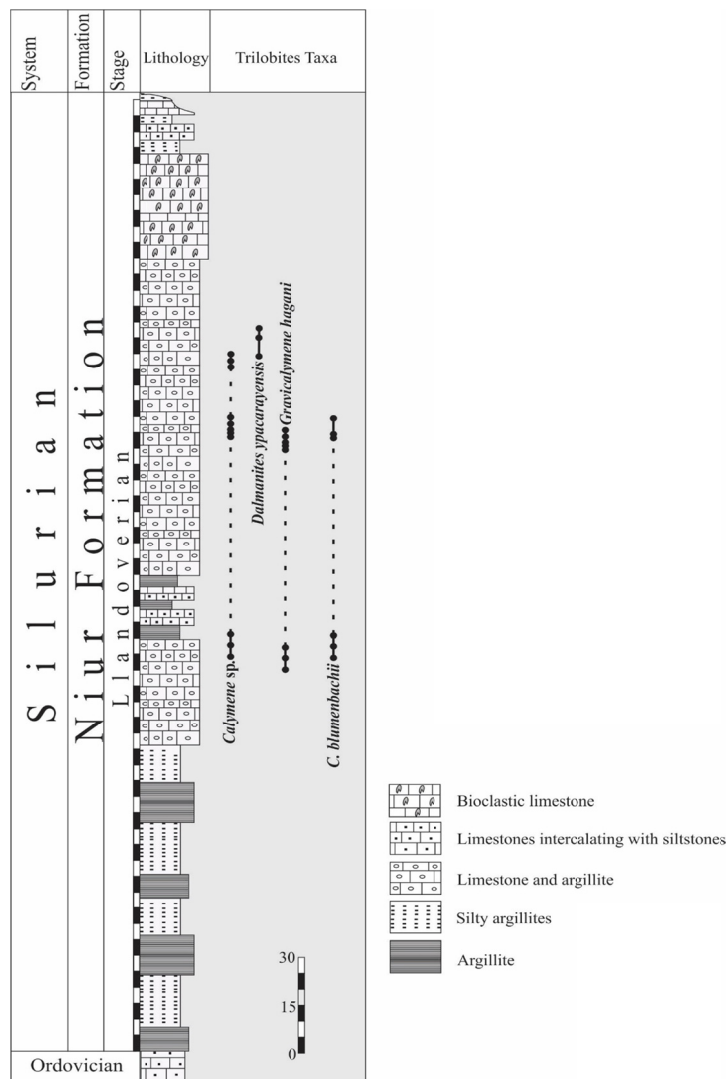


Figure 2. Biotratigraphical log of the Asadli section (Llandovery) in the South side of Asadli village, showing the location of the trilobite taxa discussed in the text

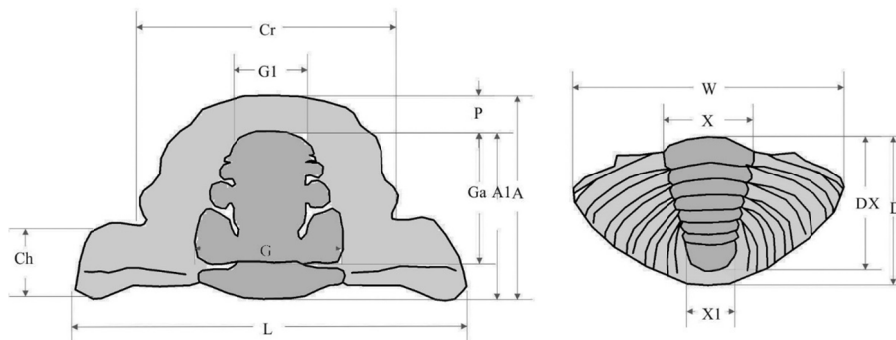


Figure 3. Terminology and measurement derived on the trilobites, portions of cranium and pygidium

oblique. There are 5 distinctly impressed pleural grooves which are best marked at their mid-length and almost reach lateral edge. Interpleural grooves are

slightly effaced are slightly major impressed again directly, adjoining to axial groove, 15 interpleural groove rings on outside of an exsagittally directed ridge

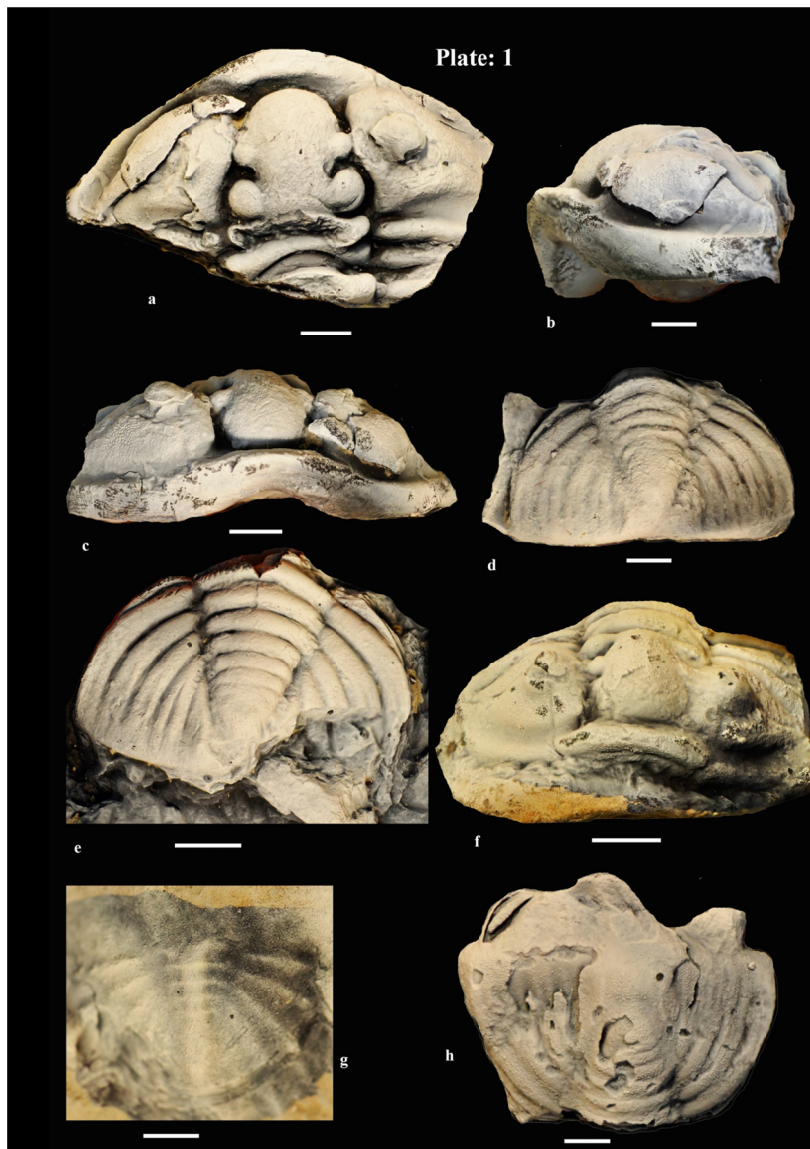


Plate 1. (a- c) *Calymene blumenbachii* (a), (R431) × 2 (b) (R431) × 2 (c), (R431) × 3 (d), *Gravicalymene convolva* (R461) × 2 (e, f) *Dalmanites brevigladiolus* (e) (R473) × 2, (f) (R474) × 2, (g), *Calymene* sp., (R440) × 3, (h) *Calymene blumenbachii*, (R450) × 3.

which maybe demonstrates of frontal pleural band of 16 pleura and limited the postaxial part.

Remarks. Harrington 1950 provided perfect description of this species. *Calymene boettneri* differs from *C. ferrifera* Baldis and Blasco 1976 from the Silurian Lipeon Formation (Argentina) by the attendance of a more rounded Preglabellar groove, a more outstanding anterior lobe of the glabella, subtriangular lateral glabellar lobes (P1 and P2) and an occipital groove of equal width. It can be differentiated from *C. vallecitoensis* (Waisfeld 1988) from the Silurian Los Espejos Formation (Precordillera,

Argentina), by contain, a taller, a not truncated glabella, a forward-curving occipital groove, a slightly less raised pygidial axis which has 5-6 axial rings, less laterally expanded pleural fields, and weaker interpleural grooves.

Genus; *Gravicalymene* Shirley, 1936

Pl.1, [d], Pl.2, [d, f], Pl.3, [b, c, d, and h], Pl.4, [a-c and e] Pl.5, [b-d]

Material. Nine cranidia and four pygidium

Description; Cranidium solely minor than half as

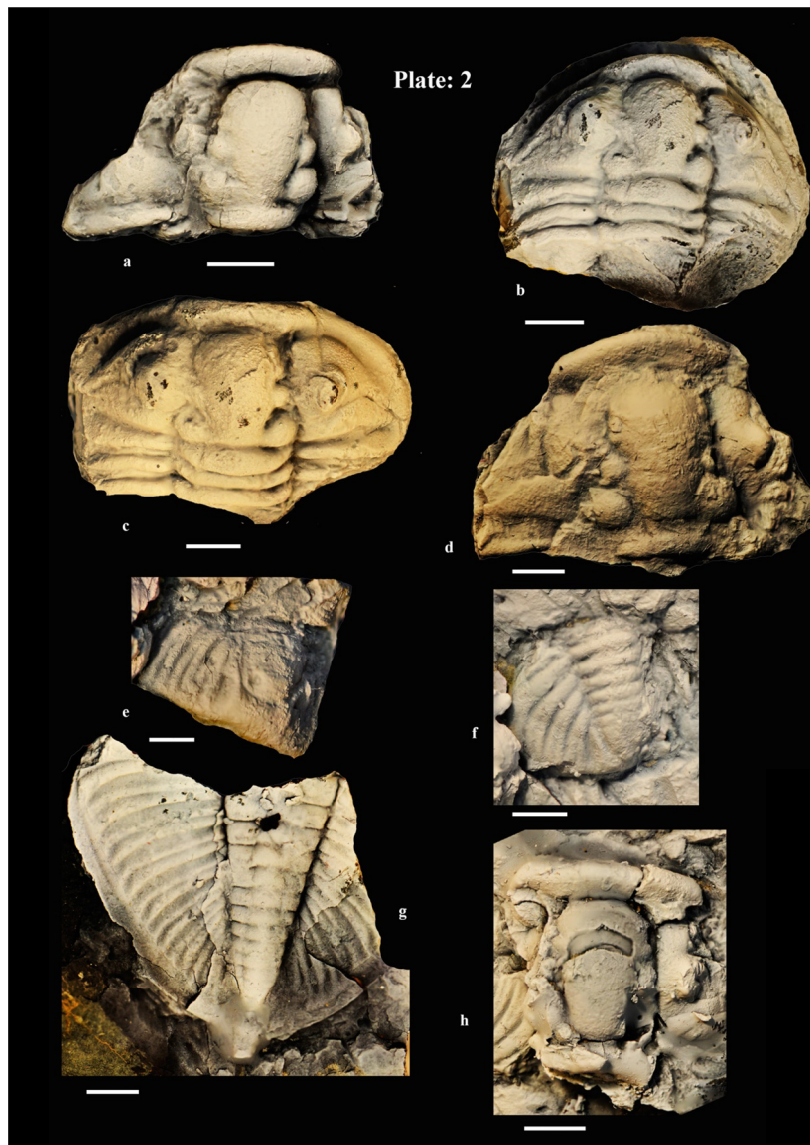


Plate 2. (a- c) *Calymene blumenbachii* (a), R491) $\times 2$ (b), (R463) $\times 3$ (c), (R470) $\times 3$. (d) *Gravicalymene convolva* (R490) $\times 3$ (e), *Calymene* sp., (R481) $\times 2$ (f), *Gravicalymene convolva*, (R432) $\times 3$. (g) *Dalmanites brevigladiolus*, (R444) $\times 2$ (h), *Dalmanites brevigladiolus*, (R475) $\times 2$.

length as wide; glabella within as length as wide, strongly Pear-shaped. Occipital ring is more than 4 steps as wide as length, of fixed abaxially to 1L then gently narrows to axial groove. Occipital groove is a shallow, latitudinal, justly surface groove behind mid glabellar region, deepens quickly as it twists backwards lob1 L., then gently narrows to axial groove. The sidelong is very massive, elliptic, with a well-rounded abaxial edge and some pointed frontal margin. Groove 1L. deep at axial groove, surface as it flexion some inwards and backwards, jointed, to occipital groove by weak indent

lobe 2L. Sub-spherical, within, 1/3 as long as lobe 1L. and semi- isolated from central lobe. Very brief (tr.) groove 2p. Bounded to dorsal lateral glabellar face. Pygidium is slightly more than double as wide as long. Axis is about 1/3 as pygidium, relatively wider on small specimens has 5 or 6 axial rings any of which is longest (sag.) centrally, and a final axial segment. Ring grooves main marked distally, grooves 1 to 4 are perfect, furrows 5 and 6 are unknown and mostly interrupted. Pleural region has 5 pleural and 5 interpleural grooves. Pleural grooves are fractionally thinner than interpleural, at



Plate 3. (a) *Calymene blumenbachii*, (R462), $\times 2$. (b), *Gravicalymene convolva*, (R436) $\times 2$. (c- d) *Gravicalymene convolva*, (R442 and 435) $\times 2$, (e, f), *Calymene* sp. (R438 and 439) $\times 2$, (g) *Calymene blumenbachii*, (R491) $\times 2$, (h) *Gravicalymene convolva*, (R464) $\times 2$.

least the first 3 are rather different proximally than distally, and the first one runs onto flat pleural surface.

Order: Phacopida Salter, 1864
 Family: Dalmanitidae Vogdes, 1890
 Genus: *Dalmanites brevigladiolus* May, 1919
 Pl.1, [e,f], Pl.2, [g, h], Pl.5, [a]

Type species: *Dalmanites brevigladiolus* May, 1919

Material. Three pygidium PEG.R474, PEG.R473 and PEG.R457

Description: Pygidium end in a short but

comparatively very flat spine. In a pygidium whose axial lobe originally must have same at least 8 mm, possibly 10 mm., the width of the pygidium is equal 14 or 15 mm, the width of the pygidium at the posterior final of the axial lobe 7 or 8 mm.; at 3 mm. from this axial lobe the width of the final spine has narrowed 3 mm.; at 2 mm. it has shallow to 4 mm.; It terminates at 11 mm.; with a very blunt curvature. The axial lobe is rather low and depressed; it is crossed by 12 or 13 transverse rings of which the last three tend to be indistinct; the transverse grooves tend to be less distinctly defined along the central line. Pleural lobes

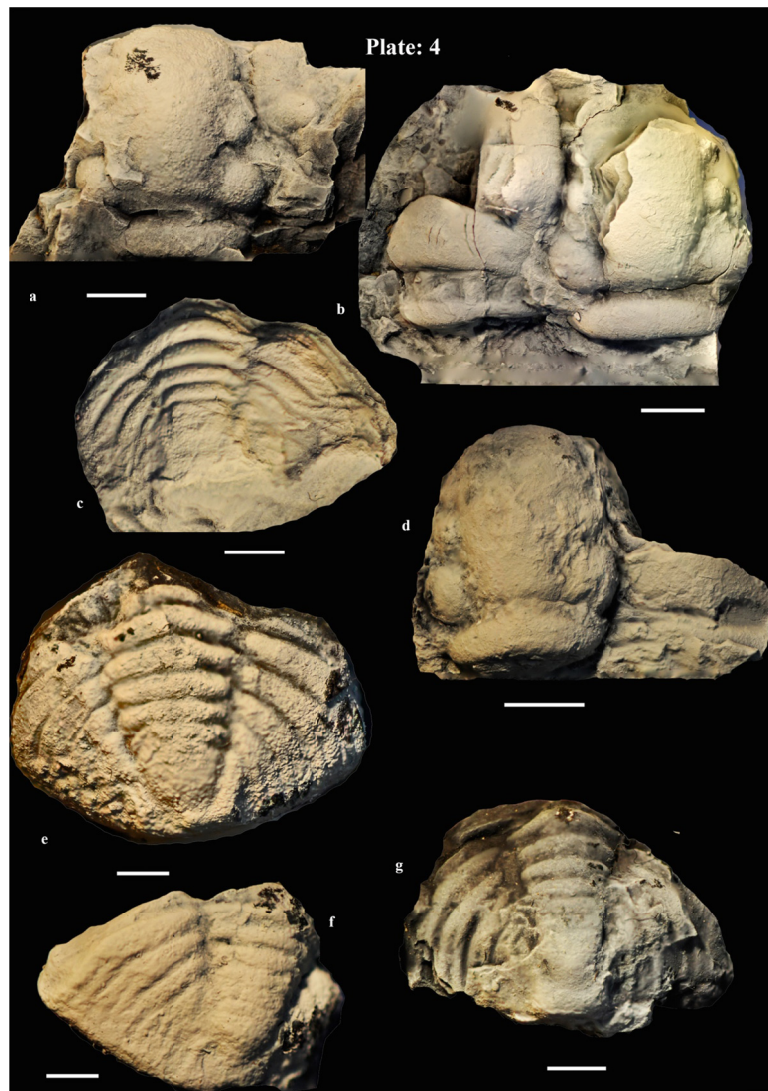


Plate 4. (a-c), *Gravalymene convolva*, (a, b) (R469, 61)× 3, (c), (R44)× 3, (d), *Calymene* sp., (R467)× 3, (e), *Gravalymene convolva*, (R466) × 3, (f-g) *Calymene* sp. (R476 and 477) × 2 .

with at least 8 or 9, sometimes possibly 10 ribs, all of which are marked by a median groove. In some taxa the more posterior grooves start off near the posterior edge of the rib and become central at mid- length. For a width of slightly more than a millimeter the lateral edge of the pygidium tend to be flat. Unmarked by the terminations of the pleural ribs. There is a tendency into very low, practically obsolete tuberculation along the axial lobe.

Genus; *Calymene* Brongniart, 1822

Pl. [1] Fig. [g], Pl. [2] Fig. [e]

Pl. [3] Fig. [e, f], Pl. [4] Fig. [d], Pl. [5] Fig. [e, f]

Type species; *Calymene* sp. Brongniart, 1822

Material. Six pygidium PEG.R474, PEG.R473 and

PEG.R457

Description: Pygidium is some less than twice as broad as long. Axis is certain less than mid the pygidial width reaches well over pleural area, is strongly outstanding, (sag.) has 7 or 8 axial rings. Axial groove obviously effected, weakest posteriorly. Inner portion of pleural zone decline steeply from axial groove, external portion happens vertically oblique. All axial rings are except the final defined posteriorly by perfect, ring grooves which are weakest centrally. Final ring groove discontinuous; end axial section rounded. There are 5 distinctly impressed pleural grooves which are best indexed at their mid- length and approximately reach lateral edge. Interpleural grooves are same longer than pleural grooves, deepest distally, become many faint



Plate 5 (a), *Dalmanites brevigladiolus*, (R450), $\times 3$, (b-d), *Gravicalymene convolva*, (R489, 493 and 497) $\times 2$, (e, f) *Calymene* sp., (c) (R483 and 484) $\times 3$.

more proximally although are never all over, effaced are some better impressed again directly joined to axial groove.

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