

## Geology

# Stratigraphic Spreading of *Mytiloceramus* Fauna in Lower and Middle Jurassic Deposits of Georgia

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**ABSTRACT.** *Mytiloceramus* fauna relicts gathered from Lower and Middle Jurassic sediments of different regions of Georgia gave the possibility to trace their alternation in sections. Along with them finds of index forms of ammonite fauna establishing exact age of the sediments allowed to ascertain stratigraphic boundaries of distribution of *mytiloceramus* fauna. The most ancient species with age restricted to the Sinemurian stage are represented by *Mytiloceramus pholadauriensis* (Sess.) and *M. depressus* (Münst.). The younger forms *M. dzirulensis minimus* (Kakh.) and *M. pseudoinconstans* (Kakh.) are dated to the Toarcian and Aalenian stages respectively. The age of *M. nunuae* (Kakh.) is within the bounds of the Aalenian stage. The age of the younger species *M. djanelidze* (Kakh.) and *M. gurnensis* Kakh. is limited to the Bajocian stage. *M. quenstedti* (Pčel.), *M. falgeri* (Esch.) and *M. dubius* (Sow.) are distinguished for the widest vertical propagation, passing from the Sinemurian into the Toarcian while the first form uninterruptedly moves even into the Bajocian. *M. dzirulensis* (Kakh.) occurs in the Upper Pliensbachian and the Toarcian and *M. gryphoides* (Schloth.) in the Aalenian as well. *M. tshalensis* (Kakh.), *M. cinctus* Goldf. and *M. amygdaloïdes* (Goldf.) occur from the Toarcian to the Bajocian inclusive. Other representatives of *Mytiloceramus* are mainly related to the Toarcian and Aalenian stages. Thus, some *Mytiloceramus* species have wide stratigraphic spreading on the territory of Georgia and are useless for making precise stratigraphic inference. © 2013 Bull. Georg. Natl. Acad. Sci.

**Key words:** ammonites, *mytiloceramus*, stratigraphy, Lower and Middle Jurassic.

The *Mytiloceramus* fauna is one of the most numerous groups of marine organisms met mainly in the sediments in the upper part of the Lower Jurassic and in the Middle Jurassic. They are one of the most important groups of fauna after the cephalopods (ammonites).

First data on the stratigraphic spreading of *Mytiloceramus* in separate parts of Georgia, with sporadic linkage to ammonitic fauna are presented in [1]. The same author describes them in [2], where the

majority of species were considered in the composition of the subgenus *Mytiloides*, one in the genus *Inoceramus* Sow., and two in the subgenus *Mytiloceramus*.

V.I. Zesashvili [3] after I.R. Kakhadze also groups the given bivalves gathered on the territory of the Loki massif in these two subgenera. In [4], only the representatives of the *Mytiloides* subgenus are described. However, as the researches [5] showed, it is not valid to include numerous Jurassic species in the

composition of this subgenus, as their ligament apparatus considerably differs from the ligament of the *Mytiloides* species. It served as a basis for integrating a comparatively small amount of Jurassic equivalve species into the *Mytiloceramus* subgenus subsequently ranked to a genus.

Finds of mollusks of this group in the Lower- and Middle Jurassic sediments are frequent. I have gathered a representative collection of *Mytiloceramus* fauna along with index ammonites in different regions of Georgia, allowing to establish their stratigraphic position in the sections.

The present article is based on the results of treatment mainly of the author's personal material. The considered sediments with the *Mytiloceramus* fauna and ammonites are interpreted pursuant to the scheme of tectonic zoning of the territory of Georgia (Fig.1) produced by [6].

The northernmost outcrops of Lower Jurassic sediments with remnants of bivalve mollusks in Georgia in the eastern part of the Main Range zone on the territory of Tusheti (upper reaches of the river Larovanistskali) are exposed. Here, in the clay shales sometimes arenaceous with interlayers of aleurolites and sandstones (280m) along with *Mytiloceramus cf. amygdaloides* (Goldf.), *M. quenstedti* (Pčel.), *M. falgeri* (Esch.) we have found ammonites *Polyplectus discoides* (Ziet.), *Pseudogrammoceras cottewoldiae* Buck. dating the sediments enclosing them as the Late Toarcian (biozone *Grammoceras thouarsense*).

Southwards, on the territory of the Kazbegi-Lagodekhi zone the Toarcian sediments crop out in the Tushetis Alazani, Oritskali and Khisos Alazani river valleys. In clay shales with intercalations and lenses of fine-grained sandstones exposed on the left bank of the river Kadorisghele (left tributary of the river Tushetis Alazani) Early Toarcian ammonite *Dactylioceras* sp. and *Mytiloceramus quenstedti* (Pčel.), *M. dubius* Sow. were collected.

These species of bivalve mollusks and also *M. cinctus* (Goldf.) together with Early Toarcian ammono-

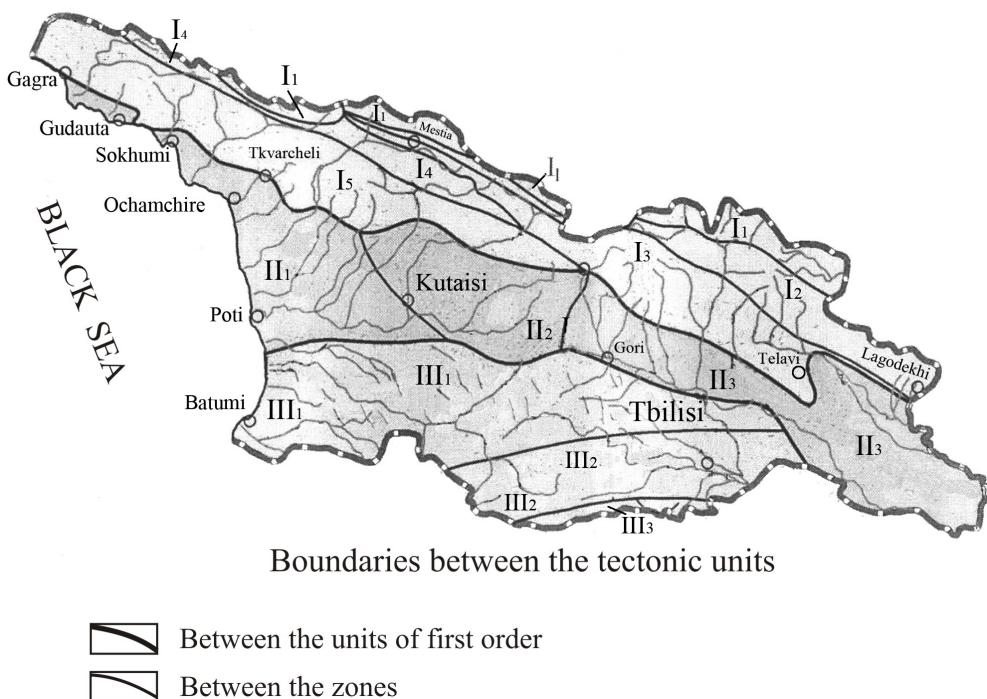
nite *Hildoceras* sp. are recorded in clay shales with sandstone bands and numerous concretions of clayey siderite that are spread on the right side of the Tushetis Alazani river gorge (at the confluence with the sixth right tributary). Stratigraphically higher in analogous sediments dated by ammonite *Costileioceras cf. subcostosum* (Buck.) as Early Aalenian, *Mytiloceramus quenstedti* (Pčel.) and *M. gryphoides* (Schloth.) are collected.

Along the Kvavistskali river gorge, in Upper Toarcian sediments (the Kvavistskali suite) the relation of shales and sandstones somehow changes. These sediments contain *Mytiloceramus dubius* (Sow.), *M. cinctus* (Goldf.), *M. amygdaloides* (Goldf.), *M. quenstedti* (Pčel.) and Late Toarcian ammonites *Grammoceras thouarsense* (d'Orb.), *G. striatum* (Sow.), *Pseudogrammoceras fallaciosum* (Bayle) etc.

To the west, in the gorge of the left tributary of the Tushetis Alazani river and along its right bank among clay shales and sandstones limestone seams occur. They periodically concentrate and dominate over the shales. In clay shales *Mytiloceramus amygdaloides* (Goldf.), *M. quenstedti* (Pčel.), *M. cinctus* (Goldf.), *M. dubius* (Sow.), *M. cf. tshalensis* (Kakh.) and ammonites *Pleydellia cf. aalensis* (Ziet.), *Pleydellia* sp. characteristic of the upper biozone (Levesquei) of the Toarcian are recorded [7].

To the south, on the territory of Kakheti in the Toarcian sediments prevail sandstones grouping in the Duruji suite. On the Sakunrusho mountain ridge, in the sediments of this suite [8] *Mytiloceramus dubius* (Sow.), *M. quenstedti* (Pčel.) and the Early Toarcian *Peronoceras* sp. are discovered.

The Aalenian sediments of Kakheti are represented mainly by clay and argillite-like shales with rare sandstone bands and by heteromorphic concretions of clay siderite (Almati suite). In these sediments (184m), on the right slope of the Intsoba river gorge (environs of the village of Almati) *Mytiloceramus liasicus* Kakh., *M. quenstedti* (Pčel.), *M. amygdaloides* (Goldf.), *M. cinctus* (Goldf.), *M. tshalensis* (Kakh.), *M. Pseudoinconstans* (Kakh.), *M.*



**Fig. 1.** Scheme of tectonic zonation of the territory of Georgia

- I. Fold (fold-overthrust) system of the Greater Caucasus (Kavkasioni). I<sub>1</sub> – Main Range zone; I<sub>2</sub> – Kazbegi-Lagodekhi zone (fold imbricate); I<sub>3</sub> – Mestia-Tianeti zone; I<sub>4</sub> – Chkhalta-Laili zone; I<sub>5</sub> – Gagra-Java (fold) zone;
- II. Transcaucasian intermountain area. II<sub>1</sub> – Western molasse zone of subsidence; II<sub>2</sub> – Central uplift zone; II<sub>3</sub> – Eastern molasse zone of subsidence;
- III. – Fold (fold-thrust) system of the Lesser Caucasus (Anti-Kavkasioni). III<sub>1</sub> – Achara-Trialeti zone; III<sub>2</sub> – Artvin-Bolnisi zone (block); III<sub>3</sub> – Loki-Karabakh zone.

*gryphoides* (Schloth.), *M. samebensis* (Kakh.), *M. nunuae* (Kakh.) and Early Aalenian ammonites *Leioceras opalinum* (Rein.), *Costileioceras costosum* (Quenst.) are collected. Higher, in analogous sediments together with Late Aalenian *Ludwigia* sp. ind. *Mytiloceramus liasicus* Kakh., *M. quenstedti* (Pčel.), *M. amygdaloïdes* (Goldf.), *M. cinctus* (Goldf.) and *M. samebensis* (Kakh.) are discovered.

In the Bolia river gorge, along with the above bivalves occur *M. gryphoides* (Schloth.), *M. pseudoinconstans* (Kakh.) and the ammonites *Brasilia bradfordensis* (Buck.), *Costileioceras costatum* (Horn) index species of the Upper Aalenian.

Within the limits of Kakheti mytiloceramus fauna is recorded in the Bajocian sediments along with index ammonites of its lower part (*Hyperlioceras cf. discites* (Waag.) and *Sonninia crassispiratus* Buck.) discovered in terrigenous and volcanic formations

of the mountain Shakriani [9]. Bivalve mollusks are represented by *Mytiloceramus quenstedti* (Pčel.), *M. cinctus* (Goldf.) and *M. amygdaloïdes* (Goldf.).

On the territory of Khevsureti, the Gudanischala river basin (left tributary of the river Khevsureti Aragvi) packets with different ratio of clay shales contain *M. quenstedti* (Pčel.), *M. cinctus* (Goldf.), *M. dubius* (Sow.), *M. polyplocus* (Roem.) and the ammonite of the Late Toarcian age – *Pleydellia subcompta* (Bran.).

In Racha, the Toarcian makes up the seam with considerable prevalence of clay shales. Here, *M. quenstedti* (Pčel.), *M. amygdaloïdes* (Goldf.), *M. dubius* (Sow.) and *M. gryphoides* (Schloth.) occur along with ammonites characteristic of the Upper Toarcian - *Grammoceras cf. thouarsense* (d'Orb.).

Within the limits of Kazbegi-Lagodekhi tectonic zone the upper horizons corresponding to the Lower

Aalenian are exposed in Svaneti on the left bank of the river Gulichala. They are represented by clay shales with rare aleurolite bands (530m). In the strata *Mytiloceramus quenstedti* (Pčel.), *M. amygdaloides* (Goldf.), *M. pseudoiconstans* Kakh., *M. nunuae* (Kakh.) and Early Aalenian *Leioceras cf. opalinum* (Rein.) are observed.

On the territory of the Chkhalta-Laili tectonic zone within the limits of Abkhazia, the age of separate *Mytiloceramus* species goes down to the Sinemurian stage. In the Lashipse river head, in Upper Sinemurian sediments represented by clay shales with fine-grained sandstone bands (80m) *Mytiloceramus dubius* (Sow.) and Late Sinemurian *Epideroceras cf. steinmanni* (Hug.) occur.

To the north-west of the farmstead Marjvena Ptysh, in one of the right tributaries of the river Atsgara, findings of *M. quenstedti* (Pčel.), *M. falgeri* (Esch.), *M. dubius* (Sow.), *M. gryphoides* (Schloth.), *M. dzirulensis* (Kakh.) and of Late Pliensbachian ammonite *Amaltheus margaritatus* Montf. are confined to aleuritic clay shales with rare streaks of aleurites (30m). These bivalve mollusks and the ammonite are observed in the fourth right tributary of the river Adange.

In sandy-aleuritic clay shales with siderite concretions exposed on the left bank of the river Adange *Mytiloceramus quenstedti* (Pčel.), *M. gryphoides* (Schloth.), *M. amygdaloides* (Goldf.), *M. dzirulensis minimus* (Kakh.) occur along with Early Toarcian ammonite *Harpoceras subplanatum* (Opp.).

In the southernmost part of the Greater Caucasus fold system, within the limits of Gagra-Java tectonic zone (on the territory of Central Abkhazia) sediments of the Chedym suite are spread. They are represented by sandy-aleuritic carbonaceous argillites with interlayers of pelitomorphic limestones (95m). In these sediments in the Chedym river gorge representatives of ammonites *Paltechioceras boehmi* (Hug), *P. studeri* (Hug), *Epideroceras lorioli* (Hug), etc. and mytiloceramus - *M. quenstedti*

(Pčel.), *M. falgeri* (Esch.) and *M. dubius* (Sow.) are collected by me.

In Central Abkhazia the stratum of argillites, frequently carbonaceous and sandy-aleuritic with marl partings and limestone lenses (25m) absolutely imperceptibly replace Sinemurian sediments. They comprise Early Pliensbachian species of ammonite genera (*Uptonia* and *Tropidoceras*) and one *Mytiloceramus falgeri* (Esch.).

Part of the Upper Pliensbachian substage is distinguished in the overlying sediments built up mainly of argillites. In the left limb of the Kodori anticline structure (environs of the village Lata), in the lower part of the section carbonaceous argillites (150m) passing into marls comprising carbonaceous concretions, Late Pliensbachian ammonites of the genus *Amaltheus* and bivalves *Mytiloceramus gryphoides* (Schloth.) are spread. Along with the mentioned ammonite genus in the Zapadnaya Gumista river gorge also *M. falgeri* (Esch.) and more to the south-east the Late Pliensbachian *Arieticeras* sp. and *M. dubius* (Sow.) are recorded.

On the northern slope of the Lechkhumi ridge, above the mineral springs of the village of Sasashi in the aleuritic clay shales with intercalations of Upper Pliensbachian siltstones and sandstones *Amaltheus margaritatus* Montf. and *Mytiloceramus quenstedti* (Pèel.) are found.

The overlying Toarcian sediments are more widespread. Along the Zima river gorge in argillites with sparse sandstone and siltstone partings *Mytiloceramus quenstedti* (Pčel.), *M. cinctus* (Goldf.) and the Late Toarcian ammonite *Grammoceras cf. thouarsense* (d'Orb.) are recorded.

Toarcian sediments involve a considerable area in the southern limb of the Kvemo Svaneti anticlinorium in the Tskhenistskali river gorge. Here, at a distance of 1200m thick-layered sandstones with intercalations of micaceous-aleuritic clay shales are exposed. In the base of the outcrop *Mytiloceramus quenstedti* (Pčel.), *M. dzirulensis* (Kakh.), *M. cinctus*

(Goldf.) and Early Toarcian *Hildaites* aff. *serpentinus* (Rein) are discovered.

On the territory of Racha, in the Lukhuni river gorge the Toarcian clay shales interbedding with sandstones and siltstones (35m) include *M. quenstedti* (Péel.) and Late Toarcian *Grammoceras penestriatum* Buck. The higher horizons corresponding to the Aalenian with the *Mytiloceramus* fauna and the ammonite crop out in the Tskhenistskali river gorge, where in argillites with siderite concretions (Sori suite) *Mytiloceramus quenstedti* (Pčel.), *M. amygdalooides* (Goldf.), *M. gryphoides* (Schloth.) and Late Aalenian *Leioceras cf. opalimum* (Rein.) are found.

The last outcrop of Aalenian sediments is traced on the territory of Kartli, in the Lekhuri-Aragvi interfluve. Here, in the northern limb of the Korinta anticlinal fold in thin-layered argillites with sparse fine-grained sandstone partings are observed *Mytiloceramus cinctus* (Goldf.), *M. liasicus* Kakh., *M. gryphoides* (Schloth.), *M. quenstedti* (Pčel.) and *Costileioceras costosum* (Quenst.) characteristic form of the Lower Aalenian biozone.

To the south, in the Central uplift zone on the Dzirula salient of the pre-Jurassic crystalline basement red limestones (17m) of the Shrosha suite are spread. On the right slope of the river Glinavishghele (environs of the village of Tsiolavake) they contain *Mytiloceramus cf. falgeri* (Esch.) and Lower Pliensbachian ammonite *Protogrammoceras isse-li* (Fuc.). Further above in analogous limestones (10m) *Mytiloceramus dzirulensis* (Kakh.), *M. samebensis* (Kakh.), *M. fuscus* (Quenst.), *M. liasicus* Kakh., *M. cinctus* (Goldf.), *M. amygdalooides* (Goldf.), *M. dzirulensis minimus* Kakh are collected. Along with the mentioned *Mytiloceramus* the ammonites *Hildoceras bifrons* (Brug.) and *Grammoceras quadratum* (Haug) characteristic of biozones of the Lower and Upper Toarcian occur at different levels of 10 m thick red limestones.

In red limestones (5m) exposed in the Kvirila river gorge *Mytiloceramus gryphoides* (Schloth.), *M. cinctus* (Goldf.), *M. amygdalooides* (Goldf.), *M.*

*quenstedti* (Pčel.), *M. dzirulensis* Kakh. and Late Toarcian *Polyplectus subplanatus* (Opp.) are discovered. In the upper layers of limestones (5m) directly under the tuffogene rocks of the Bajocian, along with the last two representatives of *Mytiloceramus* also an Early Aalenian ammonite *Hammatoceras fallax* (Benecke) occurs.

On the northern periphery of the Dzirula salient Lower Aalenian red limestones characterized by fossil fauna remnants, outcrop in the Katskhura river gorge (environs of the Katskhi village). Here, in the 6m thick packet of these sediments *Mytiloceramus liasicus* Kakh., *M. amygdalooides* (Goldf.), *M. cinctus* (Goldf.) and an index form of the Lower Aalenian - *Leioceras costosum* (Quenst.) are discovered [10].

The higher horizons corresponding to the Bajocian stage with bivalve mollusk and ammonite fauna are spread on the southern periphery of the Dzirula salient along the Dzirula river where a thick stratum of brecciated lavas, layered tuff-breccias and tuff sandstones contain *Mytiloceramus quenstedti* (Pčel.), *M. tshalensis* (Kakh.) and Bajocian ammonite genera *Emileia* and *Stephanoceras* [9].

Further to the west in the Okriba-Khreiti region of the Central uplift zone volcanogenic stratum (220m) represented by the alternation of tuff-breccias and compact tuffogene sandstones with *Mytiloceramus djanelidze* Kakh. And the late Bajocian ammonite *Garantia garantiana* (d'Orb.) is exposed in the environs of the village of Zhoneti. In the eastern Okriba, along the Tskaltsitela river gorge (Mukhura-Khreiti environs) the given stratigraphic level is confirmed with findings of *Mytiloceramus gurnensis* (Kakh.), *Parkinsonia depressa* (Quenst.) and other ammonite species [11].

The southernmost exposures of Lower and Middle Jurassic sediments occur in the Artvin-Bolnisi and Loki-Karabakh zones, where they are confined to the peripheries of the Loki salient of the pre-Jurassic crystalline basement.

The most ancient representatives of *Mytiloceramus* along with Sinemurian ammonites are observed

along the second left tributary of the river Giulmagometchai in the micaceous sandstones (200m) of the Lockchai suite. Present fauna is represented by *Mytiloceramus pholadauriensis* (Sess.), *M. depressus* (Münst.), *M. quenstedti* (Pčel.) and Early Sinemurian ammonites of the genera *Metophioceras*, *Arnioceras* etc. Finds of Late Pliensbachian ammonite *Pleuroceras* cf. *spinatum* (Brug.) and *Mytiloceramus dubius* (Sow.) belong to the lower horizons of overlying flyschoid stratum of the Jandara suite. In 30m from the base of the suite *Mytiloceramus fuscus* (Quenst.) and the Early Toarcian ammonite *Harpoceras* sp. are established. On the left slope of the river Moshevani, in siltstones alternating with micaceous sandstones along with the Early Toarcian ammonite *Phymatoceras* cf. *narbonense* (Buck.) *Mytiloceramus cinctus* (Goldf.) and *M. amygdalooides* (Goldf.) are recorded. The last species and *M. gryphoides* (Schloth.) and also the ammonite *Ludwigia* sp. defining the Late Aalenian age of the enclosing rocks are collected in sandy siltstones of the roof of the Jandara suite [12] in Damblut section.

From the above material it is obvious that collecting *Mytiloceramus* fauna relicts together with index species of ammonites enabled to establish the limits of their stratigraphic extent. The most ancient spe-

cies with age restricted to Sinemurian stage are represented by *Mytiloceramus pholadauriensis* (Sess.) and *M. depressus* (Münst.). The younger forms *M. dzirulensis* *minimus* (Kakh.) and *M. pseudooinconstans* (Kakh.) are attributed to the Toarcian and Aalenian stages respectively. The age of *M. nunuae* (Kakh.) is within the bounds of the Aalenian stage. The age of the youngest species *M. djanelidze* (Kakh.) and *M. gurnensis* Kakh. is limited to the Bajocian stage.

*M. quenstedti* (Pčel.), *M. falgeri* (Esch.) and *M. dubius* (Sow.) are distinguished for the widest vertical propagation, passing from the Sinemurian into the Toarcian while the first form ascends even into the Bajocian uninterruptedly. *M. dzirulensis* (Kakh.) from the Upper Pliensbachian passes into the Toarcian and *M. gryphoides* (Schloth.) even into the Aalenian. *M. tshalensis* (Kakh.), *M. cinctus* Goldf. and *M. amygdalooides* (Goldf.) occur from the Toarcian to the Bajocian inclusive. Other representatives of *Mytiloceramus* are mainly attributed to the Toarcian and Aalenian stages.

Thus, some *Mytiloceramus* species have wide stratigraphic spreading on the territory of Georgia and are useless for making precise stratigraphic inferences.

## გეოლოგია

# მიტილოცერამუსების ფაუნის სტრატიგრაფიული გავრცელება საქართველოს ქვედა- და შუაიურულ ნალექებში

## მ. თოფჩიშვილი

ო.ჯავახიშვილის ხახ. თბილისის სახელმწიფო უნივერსიტეტის ა. ჯანელიძის გეოლოგიის ინსტიტუტი,  
თბილისი

საქართველოს სხვადასხვა რეგიონის ქვედა- და შუაიურული ნალექებიდან შეგროვებულმა მიტილოცერამუსების ფაუნის ნაშთებმა შესაძლებელი გახსადა დაგვედგინა მათი ცვალებადობა პრილებში. მათთან ერთად აღმოჩენილი ამონიტების ფაუნის სახელმძღვანელო ფორმებმა, რომლებიც ზუსტად განსაზღვრავენ ნალექების ასაკს, საშუალება მოგვცა დაგვედგინა მიტილოცერამუსების ფაუნის სტრატიგრაფიული გავრცელების საზღვრები. ყველაზე ძველი სახობები, რომელთა ასაკი სინემურული სართულით შემოისაზღვრება, *Mytiloceramus pholadauriensis* (Sess.) და *M. depressus* (Müns.) არიან. შედარებით ახალგაზრდა ფორმები *M. dzirulensis minimus* (Kakh.) და *M. pseudoinconstans* (Kakh.) შესაბამისად მიეკუთვნებიან ტრარსულ და აალენურ სართულებს. აალენური სართულის საზღვრებით შემოიფარგლება აგრეთვე *M. nunuae* (Kakh.) ასაკი. უფრო ახალგაზრდა სახეობები *M. djanelidze* (Kakh.) და *M. gurnensis* Kakh. ბაიოსური სართულის საზღვრებს არ სცილდებიან. ყველაზე უფრო ფართო ვერტიკალური გავრცელებით გამოირჩევან *M. quenstedti* (Pčel.), *M. falgeri* (Esch.) და *M. dubius* (Sow.), რომლებიც სინემურული სართულიდან გადადიან ზევით ტრარსულში, ხოლო პირველი სახობა უწევება დაიოსურ სართულშიც. *M. dzirulensis* (Kakh.) ზედა პლინსბაზურში და ტრარსულში გვხვდება, ხოლო *M. gryphoides* (Schloth.) აალენურ სართულშიც. *M. tshalensis* (Kakh.), *M. cinctus* Goldf. და *M. amygdalooides* (Goldf.) განვითარებული არიან ტრარსული სართულიდან ბაიოსურის ჩათვლით. მიტილოცერამუსების დანარჩენი წარმომადგენლები ძირითადად დაკავშირებულია ტრარსულ და აალენურ სართულებთან. ამრიგად, მიტილოცერამუსების ფაუნის ზოგი სახობა საქართველოს ქვედა- და შუაიურული ნალექებიდან გამოირჩევა ფართო სტრატიგრაფიული გავრცელებით და მათი გამოყენება ზუსტი სტრატიგრაფიული დასკვნებისათვის შეუძლებელია.

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