ISSN 0869-5938, Stratigraphy and Geological Correlation, 2009, Vol. 17, No. 1, pp. 62–67. © Pleiades Publishing, Ltd., 2009.
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Kaeveria fluegeli (Zaninetti, Altiner, Dager et Ducret, 1982) (Foraminifera) from Upper Triassic of the South-East Pamirs

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Received October 20, 2007; in final form, May 27, 2008

Abstract—Foraminifers representing species *Kaeveria fluegeli* have been found in the Zorkaradjilga Formation (*Sagenites quinquepunctatus* Zone) of the upper Norian (or lower Rhaetian) in the central structural-facies zone of the South-East Pamirs. Their occurrence here is an additional criterion substantiating age and correlation of host deposits and an evidence in favor of fauna migration from the southern Tethys during the respective time span not only in northwestern areas of that ocean (Northern Calcareous Alps), but also in its central part (the South-East Pamirs).

DOI: 10.1134/S0869593809010055

Key words: Upper Triassic, Norian, Rhaetian, carbonate platforms, biostratigraphy, foraminifers, Pamirs.

Kaeveria fluegeli (Zaninetti, Altiner, Dager et Ducret, 1982) is a characteristic foraminiferal species from the Norian–Rhaetian carbonate platforms and reefs of the western Tethys. This species of very remarkable morphology is very useful for practice of stratigraphic research aimed at determining age of the Triassic carbonate massifs or their parts, especially when they are lacking ammonoids and conodonts. The species is known at present from the Taurus of southern Turkey (Zaninetti et al., 1982), the Argolis Peninsula and Hydra Island of southern Greece (Senowbari-Daryan et al., 1996), the southern Apennines (Iannace and Zamparelli, 2002), Oman (Bernecker, 1996, 2005), Papua New Guinea (Kristan-Tollmann, 1990), and from the Northern Calcareous Alps, Gosau area (Bernecker, 2005). Age of beds bearing this taxon has been determined not very precisely as corresponding to the Norian–Rhaetian time span.

Presented in this work are the first data on the *Kaeveria fluegeli* occurrence in the Upper Triassic of the South-East Pamirs. Its specimens found are preserved much better than the type species, and their occurrence in association with guide ammonoid taxa is used to specify stratigraphic range of the species. The established occurrence of *Kaeveria fluegeli* in the South-East Pamirs is an evidence of tight paleobiogeographic connections of this region with southern (Peri-Gondwanan) and northwestern areas of the Tethys.

The work is based on materials collected by author during fieldwork. Foraminifers are identified using the conventional method of their study in nonoriented thin sections.

STRATIGRAPHIC DATA

The Central, Intermediate and Marginal structural zones of the South-East Pamirs are distinguished based on changes in lithologic composition and thickness of Triassic deposits (Dronov and Leven, 1960). In the Central zone, the latter are of great thickness, represented mostly by carbonate rocks. According to recent data, the Upper Triassic deposits are attributed here to the Aktash (upper Anisian–Norian) and Lokzun (lower Rhaetian) groups and to the upward succession of the Chichkautek, Karakulashu, and Kyzylgora formations (middle–upper Rhaetian), which overlie the latter group with angular unconformity. The Aktash Group is subdivided (from the base upward) into the Karakungej, Tyutyunsu, and Shaimak formations (*Atlas*…, 2001). The Shaimak Formation is overlain almost everywhere by black to dark gray thin-platy limestones with hydrogen sulfide odor of the Naizatash Formation. In the Intermediate structural-facies zone, the latter is overlain by the Igrimjus Formation, stratigraphic equivalents of which in the Central zone are the Kamarutek and Zorkaradjilga formations of different lithologic composition (*Atlas*…, 2001). The Pordjilga Formation rests on the Zorkaradjilga Formation, whereas the Igrimjus Formation is overlain by the Bostanak Formation of the Lokzun Group of the lower Rhaetian (*Atlas*…, 2001). Deposits of the Zorkaradjilga Formation proper are widespread on the southwest of the Central structural-facies zone, where they overlie with scouring, according to my observations, either the massive limestones of the Shaimak Formation, or black thin-platy limestones of the Naizatash Formation, being overlain, in turn with scouring, by black to dark

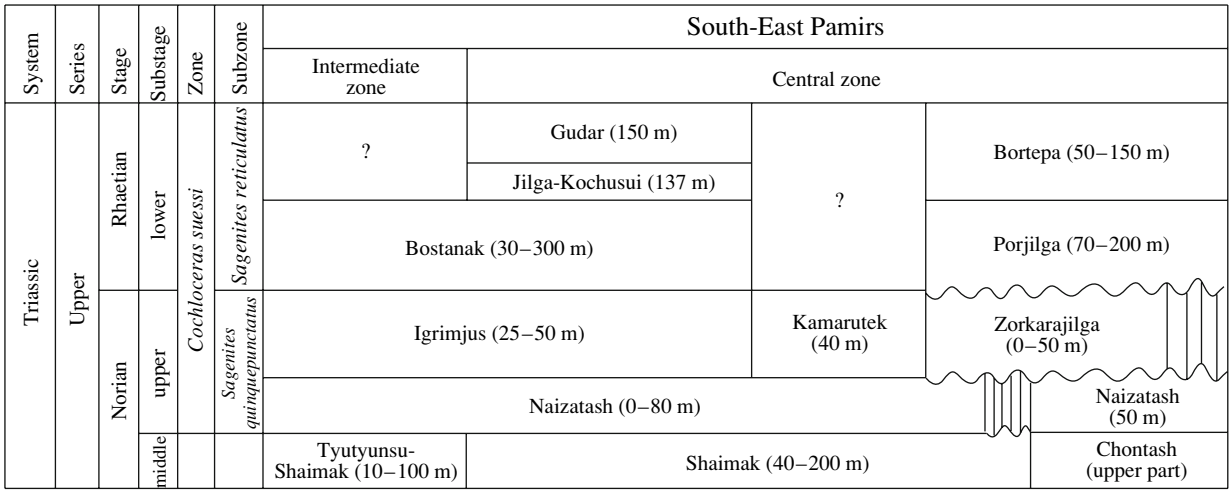

Fig. 1. Correlation chart for the upper Norian–lower Rhaetian formations distinguished in the South-East Pamirs (*Atlas...*, 2001, with modifications).

gray argillites of the Pordjilga Formation. In places (Karakulashu area), the Zorkaradjilga Formation is missing from the succession (Fig. 1).

The Zorkaradjilga Formation is composed of gray to light gray massive coarse-clastic coral-algal limestones and black fine- to medium-layered fine-grained clayey limestones 20 to 50 m thick. Separate limestone blocks up to 0,5–7.0 m across are slightly rounded and encrusted with limonite on the surface. Smaller, usually angular clasts are cemented by light gray calcareous cryptocrystalline matrix close in composition to material of clasts.

Boulders of coral-algal limestones bear abundant coral remains (*Atlas*..., 2001). In the other areas of the Central structural-facies zone, the Zorkaradjilga Formation is replaced by the Igrimjus and Kamarutek formations.

The guide ammonoid forms, including species *Cochloceras suessi* (Hauer), *Paracladiscites multilobatus* (Bronn), and *Cladiscites tornatus* (Bronn), have been collected from the Naizatash, Igrimjus, and Kamarutek formations (*Atlas*..., 2001).

Accordingly it is assumed that the Zorkaradjilga Formation corresponds in range to the *Sagenites quinquepunctatus* Zone of the upper Norian (or to the lower Rhaetian, if the alternative viewpoint on the Rhaetian base is accepted), whereas the overlying Pordjilga and Bortepa formations span interval of the *Sagenites reticulatus* Zone (*Atlas*..., 2001).

In stratigraphic chart accepted for the South-East Pamirs, the Norian–Rhaetian interface is defined at the level of boundary separating the *Sagenites quinquepunctatus* and *Sagenites reticulatus* zones with reference to opinion of A.S. Dagys and A.A. Dagys (1994). In such a case, the Zorkaradjilga Formation (= Kamarutek and Igrimjus formations) corresponds to uppermost horizons of the upper Norian, and the formation top is at the level of the Norian–Rhaetian boundary.

On the other hand, if the Rhaetian lower boundary is, according to alternative viewpoints, at the *Sagenites reticulatus* Zone top and basal level of the *Cochloceras suessi* (Kozur, 2003) or *Choristoceras haueri* (Krystyn, 1990) zones, then its position in the South-East Pamirs would be considerably higher, i.e., at the base of the Chichkautek Formation overlying with angular unconformity the older deposits. In this situation, the Zorkaradjilga Formation (= Kamarutek and Igrimjus formations) could be attributed to upper part of the upper Norian. Following in contrast the idea of Tollmann (1978) who defined the Rhaetian lower boundary at the base of the *Cochloceras suessi* Zone we should correlate the Zorkaradjilga and underlying Naizatash Formation with the lower Rhaetian.

In the South-East Pamirs, specimens of *Kaeveria fluegeli* have been found exactly in sediments of the Zorkaradjilga Formation exposed in the right wall of the Kunteisai River valley and in its stratotype area (upper reaches of the eponymous river). Deposits of the formation overlie here with local scouring either massive limestones of the Shaimak Formation, or sediments of the Naizatash Formation, being overlain in turn, also with scouring, by rocks of the Pordjilga Formation. Interval of the Zorkaradjilga section, where *Kaeveria fluegeli* specimens have been found, is described below (Figs. 2, 3a).

Section no. 2, Zorkaradjilga (Exposure 2)

Shaimak Formation (upper part). Bed no. 14589. Limestone, light gray, coarsely layered, pelitomorphic, with white calcite veinlets; samples 14589/1-20; bed thickness is 15.0 m.

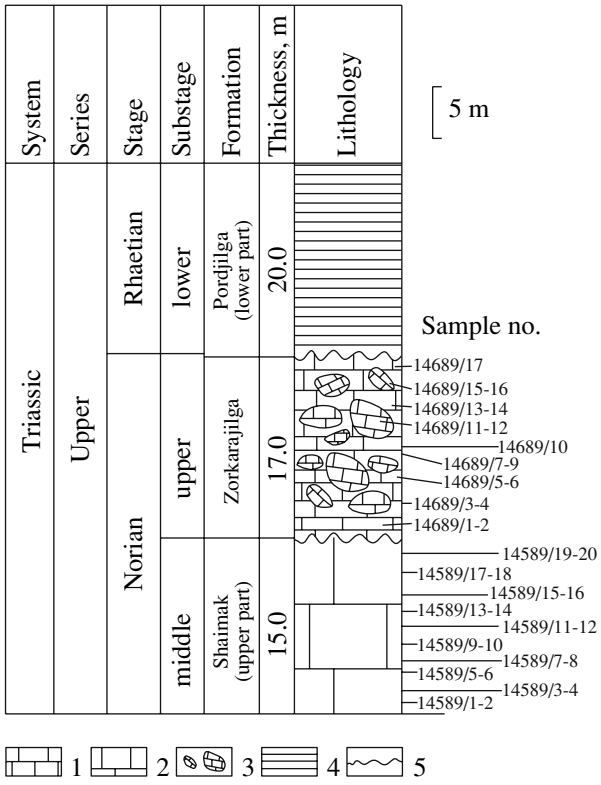

Fig. 2. Lithostratigraphy of the Zorkarajilga Formation (section no. 2, Exposure 2): (1) calcareous matrix, (2) massive limestone, (3) limestone boulders and clasts, (4) argillite, (5) erosion surface.

Zorkaradjilga Formation. Bed no. 14689. Limestone, brownish gray, coarsely layered, algal, fine-clastic and locally rudaceous in the upper part; brownish tint on the surface of clasts is a result of limonite incrustation. Within a series of outcrops, deposits of the formation are wedging out in places; samples 14689/1-15; bed thickness is 17.0 m.

Being confined to middle part of the formation (samples 14689/5-9), *Kaeveria fluegeli* specimens occur in the light gray cryptocrystalline calcareous matrix cementing limestone clasts and boulders.

Pordjilga Formation. Argillite, shale, and aleurolite interlayering; nearly black to dark gray sediments enclose in middle part a clay interlayer (2.0 m thick) and two coal seams (0.7 and 1.5 m thick); in upper part there is a member of fine-grained sandstones (5.0 m thick) bearing bivalve remains; total thickness is 100.0 m.

DISCUSSION AND CONCLUSION

Species *Kaeveria fluegeli* is known from the Norian–Rhaetian limestones of the Taurus in southern Turkey (Zaninetti et al., 1982) and from the Argolis Peninsula and Hydra Island of southern Greece (Senowbari-Daryan et al., 1996). In Oman, these species are confined to facies of clastic limestones of the Norian–Rhaetian Jabal Kawr Formation (Bernecker, 1996, 2005). In the Southern Apennines, this species is characteristic exclusively of the slope clastic facies (clastic dolomites) of the Monti del Maddalena unit (= Dachstein-type reef) of the Norian–Rhaetian age (Iannace and Zamparelli, 2002). It occurs as well in the Norian and Rhaetian of the Northern Alps in Gosau area (Riedel, 1988; Bernecker, 2005) and in the Rhaetian limestones of Papua New Guinea (Kristan-Tollmann, 1990) (Figs. 3b and 3c).

In the South-East Pamirs, as in the other regions of the world, species *Kaeveria fluegeli* are strictly confined to clastic facies and characterize paleoecologic niches, which existed on slopes of reefs and carbonate platforms (Dachstein facies). Facies of this kind accumulated on slopes of both the isolated carbonate platform separated by black-shale depressions (e.g., in the Southern Apennines) and the vast carbonate platforms adjacent to continent (Oman, the Northern Calcareous Alps).

In the South-East Pamirs, species *Kaeveria fluegeli* were found, as is mentioned above, in deposits of the *Sagenites quinquepunctatus* Zone of the upper Norian that is important for careful consideration of their stratigraphic range in the other regions and coordination with the Upper Triassic zonal scale. Nothing excludes a possibility that stratigraphic position of the species under consideration in the other regions is close to that in the South-East Pamirs. On the other hand, it is necessary to admit that *Kaeveria fluegeli* appeared earlier (in the Norian) on the west (Alps) and south of the Tethys (Oman) than in the easterly regions, as the occurrence level of this taxon corresponds to the upper Norian in the South-East Pamirs and to the Rhaetian in New Guinea (or probably to the upper Norian depending on the alternative position of the Norian–Rhaetian boundary). As for the problem of positioning the *Sagenites quinquepunctatus* Zone in the upper Norian or lower Rhaetian, the solution depends on criteria used to define the boundary between the Norian and Rhaetian stages (Tollmann, 1978; Dagys and Dagys, 1994; Krystyn, 1990; Kozur, 2003).

The above review shows that species *Kaeveria fluegeli* appear to be very characteristic of the southern (Peri-Gondwanan) margin of the Tethys (the Southern Apennines, southern Turkey, southern Greece, Oman), whereas in the northern margin they have been found only in the Northern Calcareous Alps, i.e., close to western closure of the Tethys.

It is remarkable that in the southern (Peri-Gondwanan) shelf of the Tethys, the species under consideration coexisted with foraminifers of genera *Siphonofera, Costifera*, and *Siculocosta* whose distribution area delineate the southern (sephardian) paleobiogeographic province of the Tethys. On the other hand, the aforementioned genera of the sephardian province are unknown in the South-East Pamirs and Northern Cal-

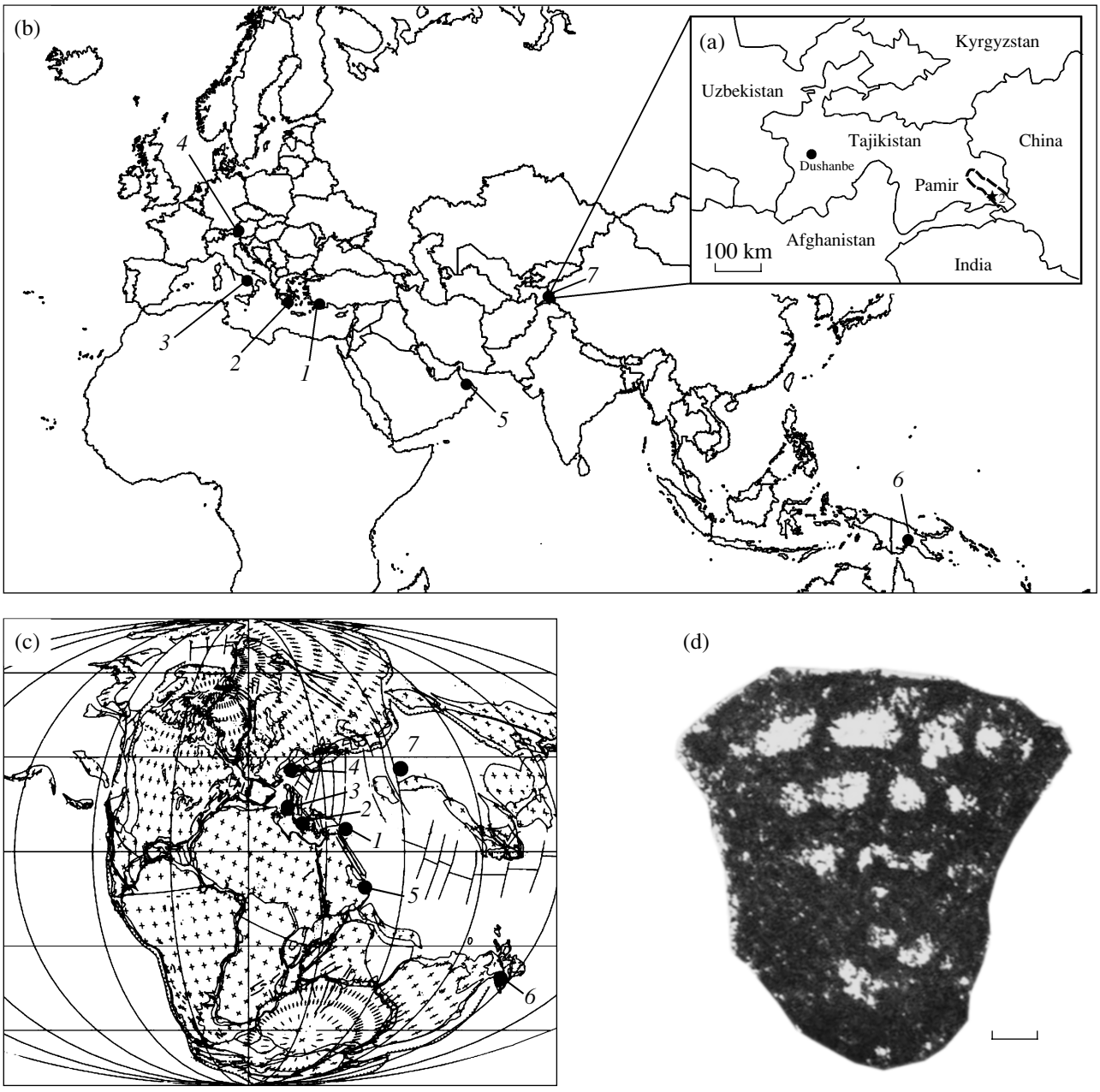

Fig. 3. Species *Kaeveria fluegeli* (Zaninetti, Altiner, Dager et Ducret, 1982) and its localities in the South-East Pamirs (a, Zorkarajilga section, Exposure 2) and in other regions of the world shown in the present-day geographic scheme (b) and (c) in paleotectonic map after (Golonka, 2007): (*1*) the Taurus, southern Turkey (Zaninetti et al., 1982), (*2*) Argolis Peninsula and Hydra Island, southern Greece (Senowbari-Daryan et al., 1996), (*3*) Southern Apennines, Italy (Iannace and Zamparelli, 2002), (*4*) Northern Calcareous Alps, Austria (Bernecker, 2005), (*5*) Oman (Bernecker, 2005), (*6*) New Guinea (Kristan-Tollmann, 1990), (*7*) South-East Pamirs (this work). Shown in Fig 3d is specimen of *Kaeveria fluegeli* (Zaninetti, Altiner, Dager et Ducret, 1982), hypotype no. 65/170 from the South-East Pamirs, Zorkarajilga section, Sample 14689/5, Zorkarajilga Formation, upper part of the upper Norian, the *Sagenites quinquepunctatus* Zone (scale bar 100 μm).

careous Alps, although species *Kaeveria fluegeli* have been found nevertheless in the these regions. It is possible to assume in this connection that the South-East Pamirs and Northern Calcareous Alps were in the same paleolatitudes during the late Norian not far away from the Peri-Gondwanan margin, i.e., from the southern (sephardian) province of the Tethys.

Two main variants of the Tethys paleoreconstruction for the Late Triassic time have been suggested in works by Golonka (2007) and by Stampfli and Borel (2002). The South-East Pamirs has not been shown in both paleotectonic maps. As this region is situated at present northward of the territories, which corresponded to separate microcontinents in the Late Triassic (central Iran,

Lut, southern Afghanistan, Quantang), and southward of the Eurasia margin, these structural areas should constrain in general the paleotectonic position of the South-East Pamirs.

Analyzing distribution areas of *Kaeveria fluegeli*, we can figure out more precisely the geographic position of the study region in the Late Triassic. In the paleotectonic map reconstructed by Golonka (2007), the *Kaeveria fluegeli* localities are unknown above the latitude of 25° N on the north and extend southward to the extreme latitude of New Guinea (45° S). In such a situation of very asymmetric latitudinal distribution of the species, we can admit former existence of a wide warm belt on the south and comparatively narrow warm belt on the north. Seeking for the South-East Pamirs position in the map under consideration (Golonka, 2007), we can place this region either at the latitude of the Northern Alps (25° N), thus admitting the asymmetry of climatic belts, or further northward (up to 45° N) when assuming the bipolar distribution of the species and the symmetry of climatic belts.

In the map reconstructed by Stampfli and Borel (2002), the southern distribution limit of *Kaeveria fluegeli* is constrained by the latitude of 25° S (New Guinea), and the South-East Pamirs should be close in this case to the latitude of 45 to 50° N. Hence, we observe again the very asymmetric distribution of *Kaeveria fluegeli* and should admit, therefore, the asymmetry of climatic belts in the late Norian with a broad warm belt extended northward in the Northern Hemisphere and a narrow warm belt in the Southern Hemisphere. An alternative possibility is to assume influence of a powerful warm current along northern margin of the Tethys that favored migration of warm-water faunal groups into high latitudes of the Northern Hemisphere.

Consequently, none of the considered paleotectonic reconstructions is satisfying completely the bipolar distribution models suggested for certain warm-water benthic faunas, e.g., for the foraminifers of the *Kaeveria fluegeli* group. At best, the equator position must be changed in both paleotectonic maps considered above. The paleotectonic scheme by Golonka (2007) is more appropriate, in my opinion, for reconstructing the bipolar climatic and paleobiogeographic zoning, being accepted therefore in this work (Fig. 3c).

Thus, the *Kaeveria fluegeli* stratigraphic range in the South-East Pamirs is established with a high precision, because this taxon of foraminifers is strictly confined here to upper part of the *Sagenites quinquepunctatus* Zone of the upper Norian (or of the lower Rhaetian according to alternative stratigraphic standards). In this region, this taxon is one of the characteristic species from the designated stratigraphic interval and can be used as a zonal index species in the future. The *Kaeveria fluegeli* species found in the South-East Pamirs evidence that dispersal of benthic fauna in carbonate shelves of the Tethys was in progress from the west to the east during the comparatively long time span. The species originated in and populated first the western and southwestern parts of the Tethys in the Norian (the Alps and Oman), then penetrated into the South-East Pamirs in the late Norian and reached the eastern margin of the Tethys (Papua New Guinea) in the Rhaetian. As the species *Kaeveria fluegeli* is of a great stratigraphic and paleogeographic significance, it seems reasonable to present below a brief paleontological description of this taxon.

PALEONTOLOGICAL DESCRIPTION

FAMILY Ataxophragmiidae Schwager, 1877

SUBFAMILY Pernerininae Loeblich et Tappan, 1984

Genus *Kaeveria* Senowbari-Daryan, 1984

Kaeveria Senowbari-Daryan, 1984: Senowbari-Daryan, 1984, p. 87; Loeblich, Tappan, 1987, p. 142, Pl. 828, figs. 9–11.

Type species: *Paleolituonella fluegeli* Zaninetti, Altiner, Dager et Ducret, 1982: Zaninetti et al., 1982, p. 107; Upper Triassic (Norian–Rhaetian), southern Turkey (the Taurus).

Diagnosis. Almost conical test coiled into trochospiral and undivided internally at the early stage; at the late stage it is biserial, evolute, having low wide chambers with internal radial septae dividing them into segments, agglutinated walls, and simple terminal aperture.

Species composition: *Kaeveria fluegeli* (Zaninetti, Altiner, Dager et Ducret, 1982), *Kaeveria* (?), *Kaeveria* sp.

Distribution and age. Species *Kaeveria fluegeli* occur in the Upper Triassic (Norian–Rhaetian) of southern Turkey, Italy, Greece, Papua New Guinea, Australia, and the South-East Pamirs. The other representatives of the genus (*Kaeveria* sp.) occur in lower dolomites of the Rhaetian Mentese Formation of the Taurus, southern Turkey (*Senel et al.,* 1996), whereas *Kaeveria* (?) is known from the Norian–Rhaetian limestones of the Wombat Plateau in Ceram (Martini et al., 2004). Stratigraphic range of the genus *Kaeveria* is constrained by the Norian–Rhaetian according to the common viewpoint (Loeblich and Tappan, 1987; Márquez, 2005), although some researchers argued for the genus occurrence in the Carnian (Bernecker, 1996).

Kaeveria fluegeli (Zaninetti, Altiner, Dager et Ducret, 1982)

Fig. 3d

"Lituosepta" sp.: Dullo, 1980, Pl.12, fig. 2.

Pseudolituonella fluegeli Zaninetti, Altiner, Dager et Ducret, 1982: p. 106.

Paleolituonella fluegeli Zaninetti, Altiner, Dager et Ducret, 1982: p.107-108, Pl. 8, figs. 1–2, 4–5; Kristan-Tollmann, 1990, Pl. 3, figs.4, 5.

Kaeveria fluegeli (Zaninetti, Altiner, Dager et Ducret): Senowbari-Daryan, 1984, p. 87, Pl. 1, figs. 1–2, 5–7, 9–11, Pl. 2, fig. 9; 2005, p. 9-10, fig. 1/3; Bernecker, 1996, p. 67, Pl. 17, figs. 9, 10.

Diagnosis. Conical test, low trochospiral at the early stage and evolute at the late stage; the early subglobose trochospiral part includes 5 to 7 undivided spheroidal chambers with slightly enlarging dimensions and corresponds to one third of the test length. Evolute part con-

sists of 3–4 low and wide, slightly trapezoidal chambers arching a little toward aperture, insignificantly growing in size, and subdivided by septae into secondary smaller chambers. Aperture is invisible; thick wall is of agglutinated type.

Dimensions. Hypotype no. 65/170 is 0.7 mm high and up to 0.7 mm wide in evolute part; diameter of the latter is 0.3 mm.

Material: 8 variably preserved tests.

Distribution and age. The species is known from the Norian–Rhaetian deposits of the Taurus, southern Turkey (Zaninetti et al., 1982), of the Argolis Peninsula and Hydra Island, southern Greece (Senowbari-Daryan et al., 1996), of Oman (Bernecker, 1996, 2005) and the southern Apennines, Italy (Iannace and Zamparelli, 2002); it is found also in the upper Norian (or lower Rhaetian) of the South-East Pamirs (this work) and in the Norian of the Northern Calcareous Alps, Gosau area (Dullo, 1980; Bernecker, 2005).

ACKNOWLEDGMENTS

The work was supported by the Russian Foundation for Basic Research, project nos. 05-05-64949 and 06-05-65201.

Reviewer V.Ya. Vuks

REFERENCES

1. *Atlas of Triassic Invertebrates from the Pamirs*, Ed. by A. Yu. Rozanov and A. A. Shevyrev (Nauka, Moscow, 2001) [in Russian].
2. M. Bernecker, "Upper Triassic Reefs of the Oman Mountains: Data from the South Tethyan Margin," Facies **34**, 41–76 (1996).
3. M. Bernecker, "Late Triassic Reefs from the Northwest and South Tethys: Distribution, Setting, and Biotic Composition," Facies **51** (1–4), 442–453 (2005).
4. A. S. Dagys and A. A. Dagys, "Global Correlation of the Terminal Triassic," Mem. Geol. (Lausanne) **22**, 25–34 (1994).
5. V. I. Dronov and E. Ya. Leven, "To the Problem of Geology of the Southeast Pamirs," Sov. Geol., No. 11, 21–36 (1960) [in Russian].
6. W. C. Dullo, "Paleontology, Facies and Geochemistry of the Dachstein Limestones (Upper Triassic) in the Southwestern Gesause Maintain, Styria, Austria," Facies **2**, 55–122 (1980).
7. J. Golonka, "Late Triassic and Early Jurassic Palaeogeography of the World," Palaeogeogr., Palaeoclimatol., Palaeoecol. **244**, 297–307 (2007).
8. A. Iannace and V. Zamparelli, "Upper Triassic Platform Margin Biofacies and the Paleogeography of Southern Apennines," Palaeogeogr., Palaeoclimatol., Palaeoecol. **179**, 1–18 (2002).
9. H. W. Kozur, "Integrated Ammonoid, Conodont and Radiolarian Zonation of the Triassic and Some Remarks to Stage/Substage Subdivision and the Numeric Age of the Triassic Stages," Albertiana **28**, 57–74 (2003).
10. E. Kristan-Tollmann, "Rhat-Foraminiferen aus dem Kuta-Kalk des Gurumugl-Riffes in Zentral-Papua/Neuguinea," Mitt. Osterr. Geol. Ges. **82**, 211–289 (1990).
11. L. Krystyn, "Rhaetian Stage – Chronostratigraphy, Subdivisions and Their International Correlation," Albertiana **9**, 15–24 (1990).
12. A. R. Loeblich and H. Tappan, *Foraminiferal Genera and Their Classification* (Van Nostrand Reinold Company, New York, 1987–1988).
13. L. Márquez, "Foraminiferal Fauna Recovered after the Late Permian Extinctions in Iberia and the Westernmost Tethys Area," Palaeogeogr., Palaeoclimatol., Palaeoecol. **229**, 137–157 (2005).
14. R. Martini, L. Zaninetti, B. Lathuilliere, et al., "Upper Triassic Carbonate Deposits of Ceram (Indonesia): Palaeogeographic and Geodynamic Implications," Palaeogeogr., Palaeoclimatol., Palaeoecol. **206**, 75–102 (2004).
15. P. Riedel, "Facies and Development of the "Wilde Kirche" Reef Complex (Rhaetian, Upper Triassic, Karwendelgegebirge, Austria), Facies **18**, 205–218 (1988).
16. M. Şenel, I. Gedik, H. Dalkiliç, et al., "Isparta Büklümü Dogusunda, Onokton mo Allokton Birimleren stratigrafisi (Bati Toroslar)," MTA Dergisi. **118**, 111–160 (1996).
17. B. Senowbari-Daryan, "Ataxopharagmiidae (Foraminifera) aus den obertriadischen Riffkalken von Sizilien," Munster Forsch. Geol. Palaont. **61**, 83–99 (1984).
18. B. Senowbari-Daryan, "Fossil Names Dedicated to Erik Flugel," Facies **51**, Nos. 1–4, 3–11 (2005).
19. B. Senowbari-Daryan, D. Matarangas, and M. Vartis-Matarangas, "Norian-Rhaetian Reefs in Argolis Peninsula, Greece," Facies. **34** (1), 77–82 (1996).
20. G. M. Stampfli and G. D. Borel, "A Plate Tectonic Model for the Paleozoic and Mesozoic Constrained by Dynamic Plate Boundaries and Restored Synthetic Oceanic Isochrones," Earth Planet. Sci. Lett. **196**, 17–33 (2002).
21. A. Tollmann Bemerkungen zur Frage der Berechtigung der rhatishen Stufe, Schrift. Erdwiss. Komm. Osterr. Acad. Wiss. **4**, 175–177 (1978).
22. L. Zaninetti, D. Altiner, Z. Dager, and B. Ducret, "Les Milioliporidae (Foraminferes) dans le Trias Superieur a facies recifal du Taurus, Turquie. II: Microfaunes associess," Rev. Paleobiologie **1** (2), 105–139 (1982).