Stratigraphy of the Triassic Deposits of the Soviet Carpathians and the Significance of Radiolarians*

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With one figure and 2 plates

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It is well known that the Triassic deposits in the northern Carpathians were for the first time recognized by F. HAUER in 1859. In 1932–1934, D. N. ANDRUSOV suggested the best confirmed stratigraphic scheme of the Triassic for the Rakhov region. He determined the age of red shales, sandstones and basic volcanogenic rocks as Lower Triassic and that of dolomites and limestones as Middle Triassic; lenses of limestones in the so called Stony Stream were placed by him into the Upper Triassic.

D. N. ANDRUSOV'S scheme served as a basis of all subsequent works by Soviet geologists. The most outstanding ones among them were those carried out by V I. SLAVIN, V. N. ZHIVLJUK, N. S. RASTOCHINSKAYA, I. D. GOFSHTEIN, JA. O. KULCHITSKIY, S. S. KRUGLOV.

On the territory of the Ukrainian Carpathians the Triassic deposits outcrop into the day-surface in Chivcha and Delovets areas of the Marmarosh crystalline massif (zone) and also in the Ugolki basin in the belt of Marmarosh cliffs. They outcrop as small isolated patches occurring in different horizons of older rocks.

Besides, fragmentary outcrops of grey bedded dolomites, presumably of Triassic age, were recognized in flysch formations of Cretaceous and Paleogene age. There they form separate olistolites in olistostrome horizons or tectonic detached masses in frontal parts of some imbricate structures (the Rakhov zone, headwaters of Black Cheremosh).

Deep drilling has shown that in the basement of the Trans-Carpathian inner depression, the Triassic rocks are overlain by the Neogene molasse in the Nevitsky, Zaluzha, Nowoe Selo, Beregova and Sokirnitsy areas.

In the zone of the Pieniny cliffs D. N. ANDRUSOV distinguished Triassic sandstones and gritstones containing no fossil remains.

The Triassic section is characterized by a predominance of dolomites and limestones; the calcareous conglomerate breccia, quartz conglomerates, variegated sandstones, siltstones, jaspers and other rock types are found in very subordinate amounts.

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Scheme of the Stratigraphy of Triassic Deposits of the Ukrainian (Soviet) Carpathians

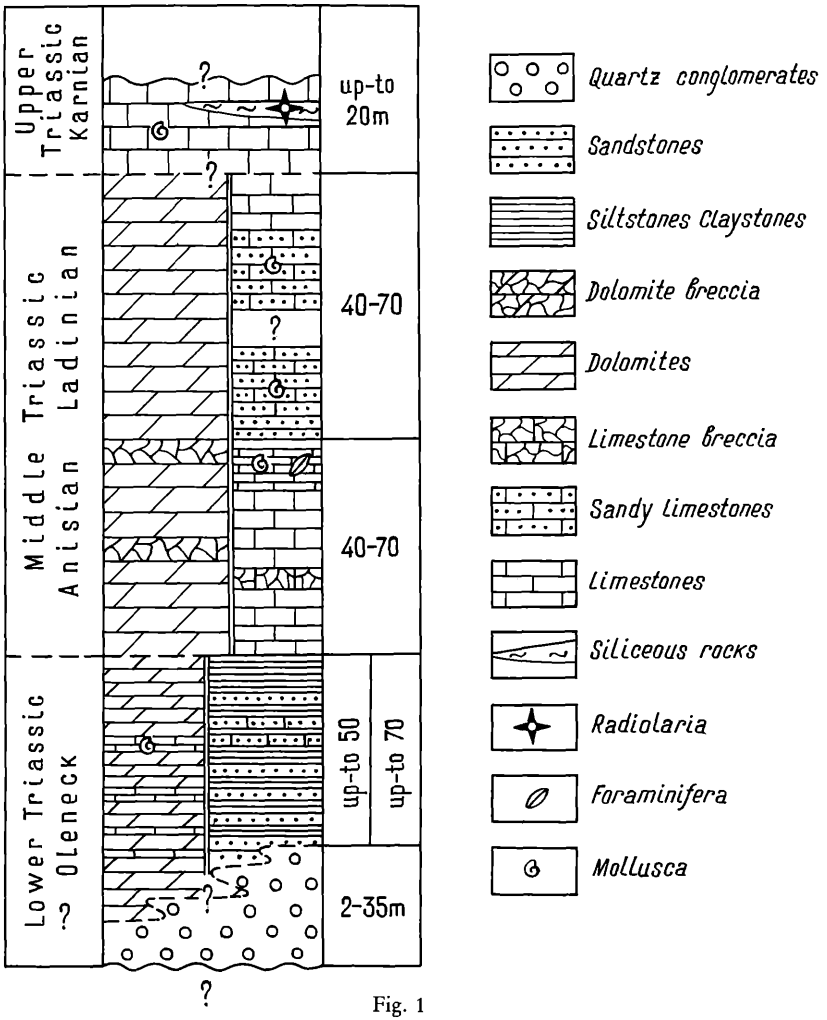

Fig. 1

According to rare findings of macro- and microfauna, nearly all stages of the Triassic system are recognized. Only the lowermost part of the Lower Triassic and the Norian stage contain no fossils.

Within the Marmarosh crystalline massif one usually observes at the base of the Triassic section a basal horizon of quartz conglomerates with a thickness of 2–7 to 20–35 m (Wide Stream). In one case it is overlain by a variegated sequence of sandstones, siltstones, claystones and thin bedded dark – gray sandy limestones up to 70 m thick (the Wide Stream area). In the other case the basal horizon is overlain by dark – gray dolomites and

almost black dolomitized limestones with a thickness of 40–50 m. On the Cherny Div mountain and Preluchny ridge the latter contain some pelecypod fauna (*Myophoria costata* ZENK., *M.* ex gr. *laevigata* ZIET. u. *Gervilleia modiola* FRECH.), which testifies Oleneck age of the enclosing rocks.

The Middle Triassic deposits (Anisian and Ladinian stages) are represented by two types of geological sections – the dolomites and the limestones. Dolomite facies occurs in a wider area represented by gray and brown massive dolomites and dolomite breccia without any fauna.

The limestones of the Middle Triassic lie conformably on the Campil deposits, gradually passing into the latter. These are light grey and grey, rarely rose, red and green bedded limestones (dark grey close to the top) with the fauna of molluscs and foraminifera.

The limestones and breccia of Anisian age contain molluscs: *Entolium discites* SCHL., *Lima* ex gr. *costata* GOLDF., *Rhynchonella* cf. *mentzeli* BUCH, *Aequipecten* sp. and foraminifers (determined by N. A. EFIMOVA): *Frondicularia* ex gr. *reliqua* GERQUE, *Dentalina* ex gr. *communis* ORB., *Ammobaculites* sp.

The thickness of Anisian deposits varies from 40 to 70 m.

The limestone type of the Ladinian section begins with the layer of grey quartzites overlain by brown and grey sandy limestones (10 m). They contain molluscs: *Myophoria* aff. *curvirostris* SCHL., *Entolium* cf. *discites* SCHL., *Gryphaea* sp., *Aviculopecten* sp. These rocks are transgressively overlain by sandy, frequently pseudo-oolite limestones (40–60 m) with corals: *Procyclolites* aff. *dichotoma* KB. and *Pr.* aff. *mojsvari* VOLTZ.

The Upper Triassic deposits (Carnian stage) were recognized in the vicinity of the Rakhov city (Rudarny area) and in the upper course of the White Cheremosh River (Chichva area).

Within the Rakhov crystalline massif grey and brown limestones (20 m) contain: *Pecten* cf. *tetuichensis* KIPAR., *Aviculopecten* aff. *wissmani* MÜNST., *Waldheimia* ex gr. *edlingeri* ASSM., *Worthenia tornquisti* ASSM.

In the Chichva area (the Deep Stream) the variegated (grey, rose, red, cream and white) limestones (up to 20 m) with lenses of siliceous rocks are dated as Carnian. They contain *Halobia moluccana* WANNER, while the siliceous rocks contain radiolarians.

Probably it is precisely this part of the section to which the variegated jasper-like rocks from the alluvium of the Moskatynu Stream (the left tributary of the Perkalaba stream) belong to. Abundant radiolarians of good preservation have been found in thin sections of these rocks: *Cenosphaera* sp., *Acanthosphaera* sp., *Carposphaera* sp., *Acanthocircus* sp., *Archaeospongoprunum japonicum* NAKASEKO et NISHIMURA, *A. compactum* NAKASEKO et NISHIMURA, *A. helicatum* NAKASEKO et

NISHIMURA, *A. tenue* NAKASEKO et NISHIMURA, *Capnuchosphaera* cf. *theloides* DE WEVER, *Tripocyclia* cf. *acythus* DE WEVER, *Trilonche* sp., *Plafkerium hindei* PESSAGNO, *Staurodoras variabilis* NAKASEKO et NISHIMURA, *Cryptamphorella* sp., *Veharaia* cf. *elegans* NAKASEKO et NISHIMURA etc. (see plate I).

The representatives of the *Spumellaria* order are predominant in this radiolarian complex. They are mainly represented by large skeletons of spherical, quadrangular, ellipsoid and round-triangular form with two, three, four or numerous radial spines. Skeletons of *Archaeospongoprunum* occur very often. These are spongy, very large forms with two polar spines, orientated in opposite directions, occasionally twisted in a spiral. *Plafkerium*, *Tripocyclia*, *Trilonche* occur less frequently. Skeletons of *Capnuchosphaera* and representatives of the *Nassellaria* order are very scarce. Among the latter the skeletons of two genera are found: *Cryptamphorella* and *Veharaia* (see plate II).

The above radiolarian-associations occur within a wide geographical range and are stratigraphically confined to the Upper Triassic deposits. Thus, the numerous species belonging to *Archaeospongoprunum* and also *Staurodoras variabilis* and *Veharaia elegans* are reported from the Upper Triassic deposits of Sicily, Greece, Turkey, Japan, whereas *Plafkerium hindei* is reported by E. PESSAGNO from the Upper Triassic deposits *(Pantanellium silberlingi* zone) of California and British Columbia.

Thus, the assoziation of the Triassic radiolarians of the Ukrainian Carpathians can be correlated with the contemporaneous complexes of the Mediterranean region, Japan and California.

In conclusion, the authors would like to emphasize that adequate attention is to be paid to the possibility of wider use of radiolarians for studying the Triassic stratigraphy of the Mediterranean belt, particularly when dealing with fragmentary sections.

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Plate I

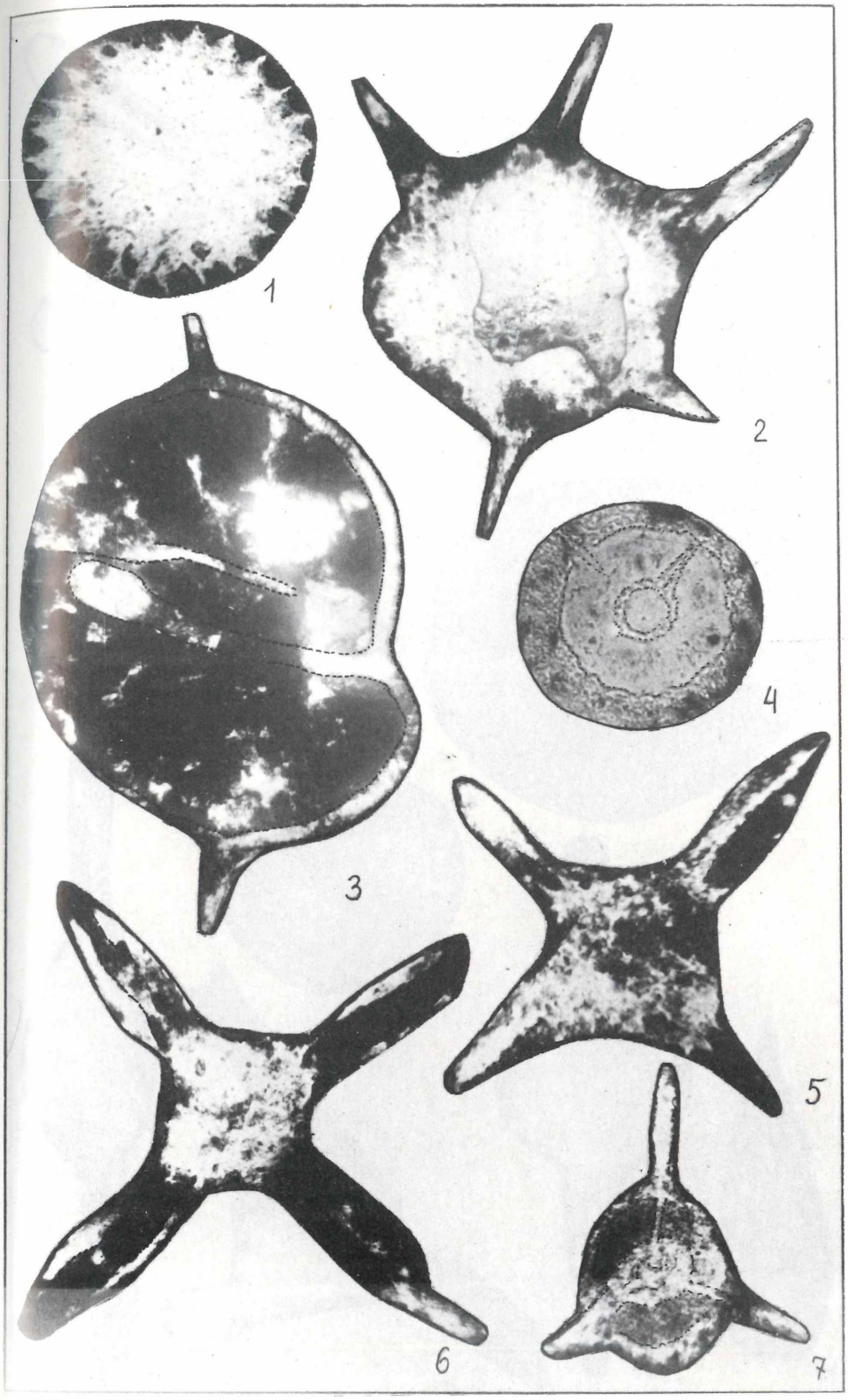

Plate II

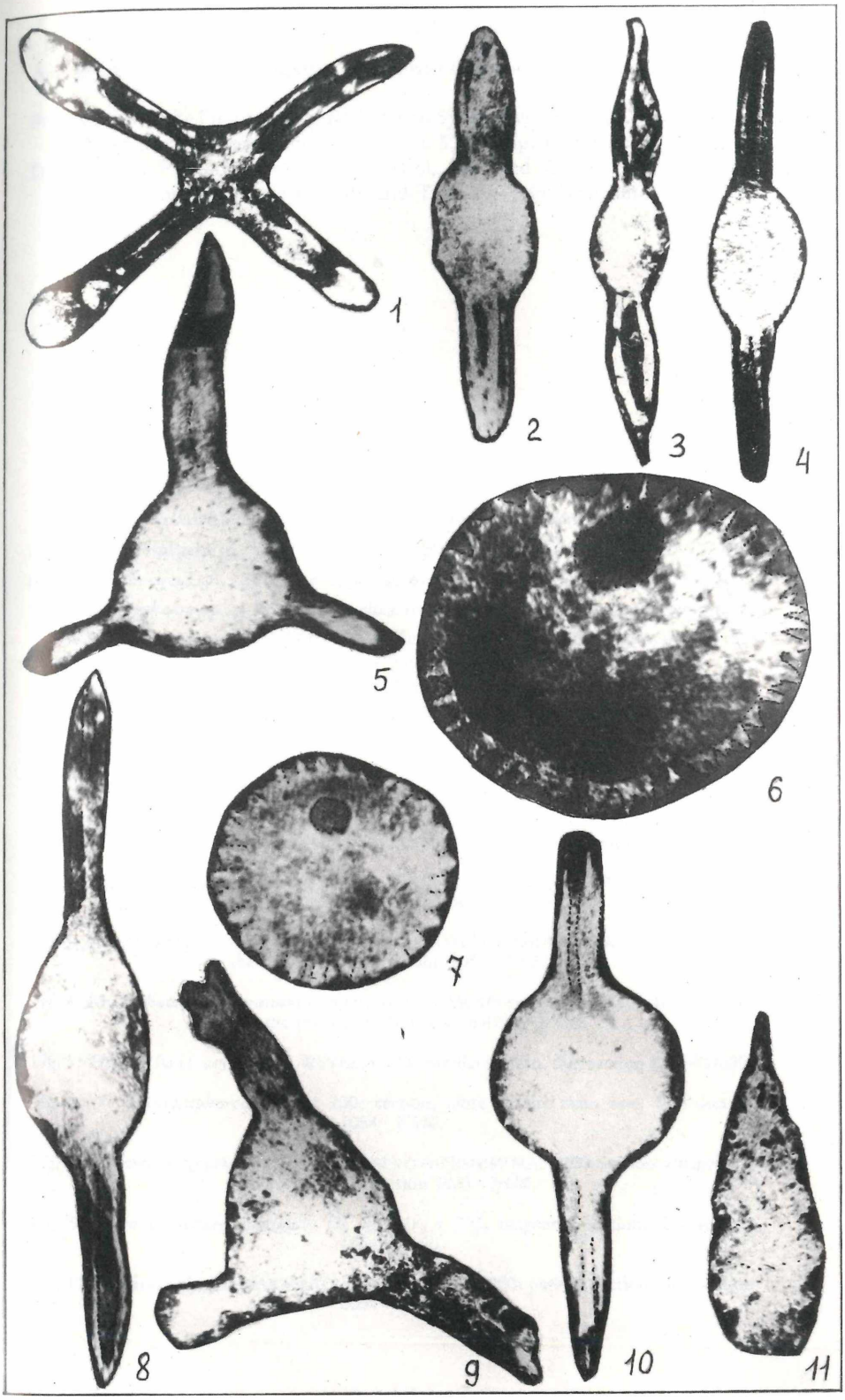

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Plate I

Fig. 1: *Cenosphaera* sp., x 200; parallel section, thin section 1054–2/600.

Fig. 2: *Acanthosphaera* sp., x 200; longitudinal-oblique section, thin section 1054–1/600.

Fig. 3: *Acanthocircus* sp., x 200; outer appearance of the skeleton, thin section 1054–2/600.

Fig. 4: *Carposphaera* sp., x 100; section, close to the main one, thin section 1054–2/600.

Fig. 5: *Staurodoras variabilis* NAKASEKO et NISHIMURA, x 200; outer appearance of the skeleton, thin section 1054–1/600.

Fig. 6: *Plafkerium hindei* PESSAGNO, x 200; main section, thin section 1054–2/600.

Fig. 7: *Trilonche* sp., x 200; main section, thin section 1054–2/600.

Plate II

Fig. 1: *Tetratrabs?* sp., x 100; section, close to the main one, thin section 1054–1/600.

Fig. 2: *Archaeospongoprunum japonicum* NAKASEKO et NISHIMURA, x 100; outer appearance of the skeleton, thin section 1054–2/600.

Fig. 3: *Archaeospongoprunum helicatum* NAKASEKO et NISHIMURA, x 100; section, close to the main one, thin section 1054–1/600.

Fig. 4, 10: *Archaeospongoprunum compactum* NAKASEKO et NISHIMURA, x 100; section, close to the main one, thin section 1054–2/600.

Fig. 5: *Tripocyclia* cf. *acythus* DE WEVER, x 200; parallel section, thin section 1054–1/600.

Fig. 6, 7: *Cryptamphorella* sp., x 200; section, close to the main one, thin section 1054–2/600.

Fig. 8: *Archaeospongoprunum tenue* NAKASEKO et NISHIMURA, x 200; section, close to the main one, thin section 1053–2/600.

Fig. 9: *Capnuchosphaera theloides* DE WEVER, x 200; tangential section, thin section 1054–1/600.

Fig. 11: *Veharaia elegans* NAKASEKO et NISHIMURA, x 200; parallel section, thin section 1054–1/600.