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RAJKO PAVLOVEC *

REMARKS ON THE GROUP NUMMULITES LAEVIGATUS S.L., WITH THE DESCRIPTION OF THE NEW SPECIES NUMMULITES HAGNI

(Pl. XLVII—L, 5 Figs.)

K poznavanju skupine Nummulites laevigatus s.l. z opisom nove vrste Nummulites hagni

(Pl. XLVII—L, 5 sl.)

A b s t r a c t: The author studied nummulites from the group *Nummulites laevigatus* s.l., which were divided in two separate groups *Nummulites laevigatus-brongniarti* and *Nummulites planulatus-puschi.* The revision of some nummulites of these groups was made. The new species *Nummulites hagni* from lower Lutetian beds in Turkey was described. *Nummulites hagni* is the transitional form between *Nummulites* aff. *praelaevigatus* from the profile in Campo and *Nummulites britannicus.*

INTRODUCTION

The large Foraminifera of the group *Nummulites laevigatus* s.l. are very abundant in various beds. Some of the species belonging to this group are characteristic for individual periods, and they are therefore of stratigraphical importance. In spite of this fact, the group has not been studied sufficiently. The *Nummulites laevigatus* (B r u g u i è r e) itself has been known since 1792. It is one of the most abundant representatives of the Lower Lutetian fauna in the Paris basin, and also elsewhere.

The reason for the hitherto unsufficient knowledge of various species of the group *Nummulites laevigatus* s.l. could be chiefly explained by the fact that mainly isolated species have been studied, and much less the phylogenetic lines. On the other hand, more clear and modern views of the evolution of the nummulitic species have been set up only recently. However, only the study of larger groups makes possible the correct establishment of individual species and their most correct classification.

THE GROUP *NUMMULITES LAEVIGATUS S.L.*

As one of the most significant characteristic of the group *Nummulites laevigatus* s.l., and particularly of the species *Nummulites laevigatus,* its extraordinary variability has been mentioned by numerous paleonto-

* Address: Dr Rajko Pavlovec Institut za paleontologijo SAZU, Novi trg 3, Ljubljana, Jugoslavija.

logists. Boussac (1911, 61) stated even that *Nummulites laevigatus* were the most variable species of all *Nummulites*. Variations of different parts of the test make difficult the determination, and involve, on the other hand, much vagueness and error in the study of the phylogenesis of this group. It is undoubtedly true that *Nummulites laevigatus* and several related species show a high variability, but it seems, however, that some paleontologists tend to exaggerate this property. As a consequence, different nummulites were attributed to the same species.

Investigators mention the high variability of different elements of the nummulitic test (cf. Nemkov, 1967, p. 149—150). The most variable are its shape, size, number and disposition of granules on the surface, and also the whorls and the chambers. Especially outstanding are the differences in the height of the whorls and in the shape of the chambers. Nemkov (1967, p. 150) stated that in the case of the marginal cord of medium thickness the chambers are rhomboidal, almost isometric. If the marginal cord is thinner, the whorls are higher, and the chambers of greater height than length. Such forms were named *Nummulites laevigatus laxispirus* by de la Harpe. In the case of the thick marginal cord, however, the length of the chamber exceeds their height. Such nummulites were called *Nummulites laevigatus paucicameratus* (de la Harpe and Rozlozsnik, 1926, p. 82). The enumerated differences are so easily observable that attention was paid to them, although there never was much discussion about different distinct species. Everybody was troubled by the fact that very frequently in the same place tests with high whorls and those with low ones occurred. So Blondeau (1965) inspected over 4500 specimens of the species *Nummulites laevigatus* (from Mont-Gauelon, Septimonts, Le Vivray and Ully-Saint-Georges in France) and carried out detailed biometric analyses. He compared them also with the tests from the Whitecliff-Bay, Isle of Wight. Blondeau concluded (p. 271) that tests with high and low whorls occur in France as well as in England. He demonstrated that all his measurements concerned the specimens between the two extreme forms; with other words, he found the transitions between the most deviating tests.

The present writer has the following objections to these conclusions. If one adopts the view that transitions between the tests with extremely low and extremely high whorls exist really, then *Nummulites laevigatus* represents the only species known up to date showing such extraordinary variability. The writer's opinion is, however, that a more correct solution was indicated by Schaub (Hottinger, Lehmann and Schaub, 1964), who stated (p. 632) that the species *Nummulites laevigatus* is not very homogeneous, as there are specimens with flat, large tests with somewhat turned up margins, and those with more regular lenticular tests. Although he drew attention, at the same time, to the significance of the height of the whorls, that is to the specimens with high and those with low whorls. In this, Schaub maintained his former idea (1951, p. 89), that in nummulites, the shape of the chambers and septa, the character of spira and the disposition of the columns are more important characteristics than the size and the shape of the test, or the shape of the axial section.

Schaub simply distinguished in the group *Nummulites laevigatus* two branches, the first one with low whorls, and the second one with high whorls. In the first one he placed with the *Nummulites laevigatus* proper also *N. tuberculatus* (Bruguière), *N. carpenteri* d'Archiac

et Haime, and finally, *N. brongniarti* d'Archiac et Haime. In the branch with high whorls there are *Nummulites planulatus* Lamarck, *N. aquitanicus* Benoist, *N. manfredi* Schaub, *N. britannicus* Hantken and *N. puschi* d'Archiac et Haime.

The establishment of two distinct phylogenetic lines of the group *Nummulites laevigatus* s.l. satisfies also the objection made by Boussac (1911), remarking that slightly different representatives of the species *N. laevigatus* descend from the same period.

With Schaub's views on the evolution of the group *Nummulites laevigatus* does not correspond the conception of Nemkov (1967, p. 36), who distinguished two distinct groups *Nummulites planulatus* and *N. brongniarti*. To the first one he assigned besides *N. planulatus* also *N. exilis* Douvillé and *N. nitidus* de la Harpe, and to the second one *N. aquitanicus, N. laevigatus* and *N. brongniarti*. In this ascribing of different species in groups most objections arises from the fact that Nemkov placed the species *Nummulites planulatus* Lamarck which displays high, rapidly evolving whorls, into the same group as *N. laevigatus* proper which has low whorls and long chambers. Therefore Schaub's interpretation is undoubtedly more acceptable, although it might undergo some modifications and extensions.

In Schaub's separation of the group *Nummulites laevigatus* into two branches it is particularly important that all forms, placed into one of them differ clearly from those in the other branch. The two branches have neither a direct common origin. The final forms *(Nummulites brongniarti* in the branch with low whorls, and *N. puschi* in the branch with high whorls) are very different. Therefore, the author's opinion is that both branches could not be considered as „sub-groups" of a large group, but that there are two entirely distinct groups having possibly their common ancestor somewhere in the Middle or Early Ilerdian. For the group of nummulites with low whorls and long chambers (Hottinger, Lehmann and Schaub, 1964, p. 633, pl. 1), I propose the name: the group *Nummulites laevigatus — brongniarti,* and for the second one comprising nummulites with higher whorls and high chambers (Hottinger, Lehmann and Schaub, 1964, p. 635, pl. 2), the name *Nummulites planulatus — puschi.* Both groups belong to the subgenus *Nummulites* in the Nemkov's sense (1967).

The writer has based this discussion of the group *Nummulites laevigatus* s.l. on morphological characteristics of different species only. In the following some light will be directed on the physiological side of the problem.

The growth of the nummulitic test depended on the quantity of the protoplasm. It was influenced by the environmental conditions, as the temperature of the water, its salinity, depth and others. Undoubtedly it was not by accident that precisely in Lutetian the largest nummulites occurred; very favourable conditions prevailed then particularly the high temperature of water. In those times the largest nummulites lived, as for example *Nummulites millecaput* Boubée. It seems that the quantity of the protoplasm was large too, in spite of numerous whorls (Nemkov, 1960, p. 57, wrote of nummulites with 10.000 chambers!). Therefore double whorls occurred, to establish the equilibrium between the quantity of the protoplasm and the test (cf. Kecskeméti, 1962, p. 76). A similar explanation is valid also for the anomalies in the species *Operculina exiliformis* Pavlovec (Pavlovec, 1966, p. 272). The abnormally

lowered whorl in this operculina originated at the time, when the volume of the rapidly growing whorl exceeded the growth of the protoplasm.

Transferring this discussion to the groups *Nummulites laevigatus-brongniarti* and *N. planulatus — puschi,* we come to the following conclusions. If all tests of *Nummulites „laevigatus"* — these with high whorls as well as those with low ones — belong to the same species, there should have been an external cause of different reactions of the protoplasm. First of all the temperature of water, differences in salinity etc. must be taken in consideration. But this was not the case, as tests with low and with high whorls occur almost regularly together, in the same place and in the same layer, in France, England, Istria, Georgia and elsewhere. Therefore, the different height of the whorls could be explained only by the processus in the protoplasm, which were entirely normal for one and the other form of nummulites. Consequently also this physiological discussion confirms the justification of two distinct phylogenetic lines of *Nummulites laevigatus — brongniarti* and *N. planulatus — puschi.*

THE GROUP *NUMMULITES PLANULATUS — PUSCHI* IN THE UPPER CUISIAN AND IN THE LOWER LUTETIAN

After having discussed the general views on the development of the group *Nummulites laevigatus* s.l., us go over to the Upper Cuisian and Lower Lutetian forms of the group *Nummulites planulatus — puschi.* Thanks to Schaub (Hottinger, Lehmann and Schaub, 1964; Schaub, 1966), also among those nummulites the situation became more clear, although in the course of future investigations undoubtedly many new forms will be found.

In the upper Cuisian beds of the Campo profile in Northern Spain, Schaub (1966) found the species *Nummulites manfredi* Schaub and *N.* aff. *praelaevigatus* Schaub. Somewhat younger is the nummulite from Bracklesham in England, for which Schaub (Hottinger, Lehmann and Schaub, 1964, p. 634; Schaub, 1966, p. 374) assumed the Hantken's name *Nummulites britannicus.*

All these nummulites are very similar. *Nummulites manfredi* and *N.* aff. *praelaevigatus* have very thin tests, and *N. britannicus* a somewhat thicker one. *Nummulites manfredi* is smaller than *N. britannicus.* But above all the three forms differ in their equatorial sections. In *N. manfredi* three parts can be distinguished: 4 to 7 internal whorls are disposed similarly as in the species *N. planulatus.* The middle whorls are much higher, but they are not augmented much. The external whorls are less regular and ordinarily even somewhat lowered. Likewise, also the shape of the chambers is changing. Inner whorls have high chambers, the middle ones somewhat longer ones, although still higher than longer, and in the external whorls the chambers tend to be isometric.

Nummulites britannicus displays more regular whorls and chambers than *Nummulites manfredi.* Still more regular and lower whorls are present in *Nummulites* aff. *praelaevigatus.* Chambers are longer, and in the external whorls longer than higher.

Schaub (1966, p. 375) mentioned that *Nummulites* aff. *praelaevigatus* from Campo can be distinguished from *N. praelaevigatus* already by its size. Also it can not be associated with *N. manfredi.* Therefore, I am convinced that we have to deal with a new species.

In the literature, numerous representatives of the *Nummulites „laevigatus"* were described, and many of them could be attributed, undoubtedly, to the group *Nummulites planulatus — puschi.* It is well known (cf. Schaub, 1966, p. 374) that *Nummulites laevigatus* var. *laxispira* (De la Harpe — Rozlozsnik, 1926, p. 82) is in fact *N. britannicus.* Also Boussac's (1911) *N. laevigatus* from Bracklesham (pl. 2, fig. 16 and 18) belongs to *N. britannicus.* The same holds also for Blondeau's (1965) specimens from Whitecliff-Bay on the Isle of Wight, England. I am further convinced, that also several nummulites from France are not the proper *N. laevigatus* (pl. 4, fig. 3, 5), although it is not easy to decide to what species they belong.

The forms with high whorls can be found also among some nummulites from the Soviet Union (Nemkov, 1967). Anyhow, the specimens on pl. 13, fig 10 and 11 are not *Nummulites laevigatus.* Unfortunately, in their equatorial sections the central part is not clear enough to enable the observation of the disposal of whorls. However it is clear that the whorls are too high for *N. laevigatus,* and the chambers too short. The same holds also for the specimen on fig. 5, which represents the form *B,* and not A. Judging upon the internal whorls of the *planulatus* type, and upon the high middle whorls, this specimen resembles to a high degree the species *Nummulites manfredi.* It displays, however, longer chambers than the Schaub's species.

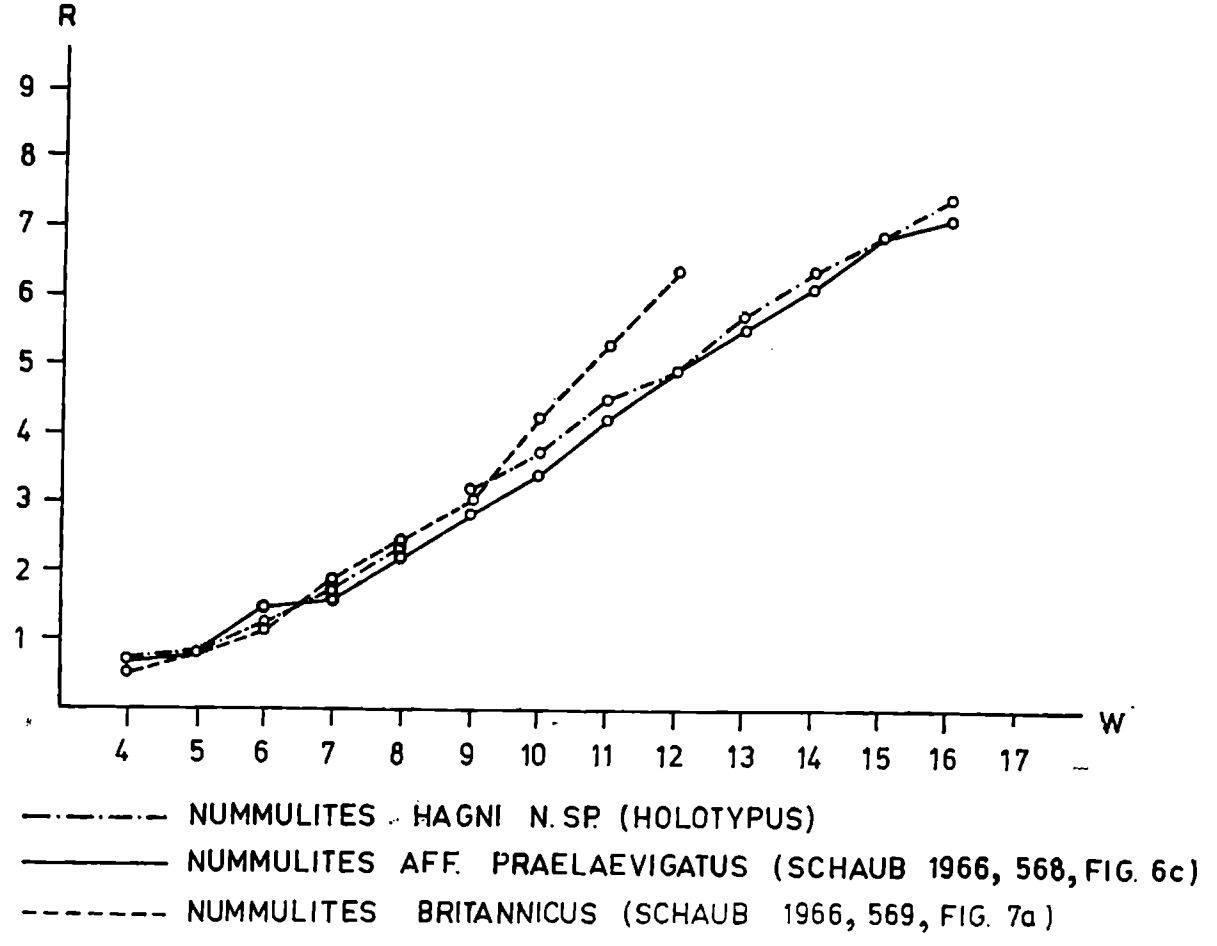

Fig. 1. Diagram of the whorls course $\left(\frac{W}{R}\right)$ of some species of the group *Nummulites planulatus — puschi.* W — number of whorls; R — radius

Also the Bulgarian specimens of *Nummulites laevigatus* (Belmustakov, 1959, pl. 8, fig. 17, pl. 9, fig. 1—2) are not proper representatives of this species. Uummulites on the plate 8, fig. 17, has the characteristics of the species *N. manfredi,* whereas that on the plate 9, fig. 2 is difficult to classify. The Bulgarian nummulites belong among the smaller specimens of this species.

Let us consider also the Friulian representatives of the species *Nummulites laevigatus,* described by Dainelli (1915). In shape and regular whorls some of them resemble very much the specimens from Campo which Schaub described as *N.* aff. *praelaevigatus.* The septa of the Friulian nummulite are more bent. Undoubtedly the Dainelli's specimens are not proper *Nummulites laevigatus,* and almost certainly they belong to several species.

The writer has examined also several nummulites from Turkey; they resemble much the mentioned species from the group *Nummulites planulatus — puschi,* although they can be distinguished from them by several characteristics. The septa are bent more than in *Nummulites manfredi,* the whorls are more regular, but lower than in the species *N. britannicus.* The tests are larger than in *N.* aff. *praelaevigatus.* Therefore the author describes these nummulites in the following chapter as a new species *Nummulites hagni.*

Similar characteristics as *Nummulites hagni* are shown also by the specimens from Sorde-l'Abbaye in Southern France, called by Schaub (1963, p. 184, pl. 2, fig. 3—5) *Nummulites* aff. *laevigatus.* The two specimens from the Soviet Union, shown by Nemkov (1967) on pl. 13, fig. 10—11, resemble less the species *Nummulites hagni.*

In consequence of this discussion, the following synonymics can be erected, lacking, however, perfection.

a) *Nummulites manfredi* Schaub:

Nummulites laevigatus Bruguière — Belmustakov, 1959, pl. 8, fig. 17, ? pl. 9, fig. 2.

Nummulites nov. sp., Rosazzo — Hottinger, Lehmann and Schaub, 1964, p. 634, pl. 2.

Nummulites manfredi nov. sp. — Schaub, 1966, p. 371—375, fig. 6a—b, 9, pl. 4, fig. 11—14, pl. 5, fig. 1—4, pl. 6, fig. 1—3.

cf. — *Nummulites laevigatus* (Bruguière) — Nemkov, 1967, pl. 13, fig. 5.

b) *Nummulites britannicus* Hantken

Nummulites laevigatus Bruguière — Boussac, 1911, p. 63, pl. 2, fig. 16—18.

Nummulina laevigata var. *laxispira* n. var. — De la Harpe — Rozlozsnik, 1926, p. 82.

Nummulites „britannicus" Hantken — Hottinger, Lehmann and Schaub, 1964, p. 634, pl. 2.

Nummulites laevigatus Bruguière — Blondeau, 1965, pl. 4, fig. 1.

c) *Nummulites* aff. *praelaevigatus* Schaub (= new species?)

Nummulites aff. *praelaevigatus* Schaub — Schaub, 1966, p. 375, fig. 6c—d, pl. 6, fig. 4—8.

cf. — *Nummulites laevigatus* Bruguière — Dainelli, 1915, p. 179—183 partim, pl. 20, fig. 1—5, ? 11—13.

d) *Nummulites hagni* n.sp.

Nummulites aff. *laevigatus* (Bruguière) — Schaub, 1963, p. 984, pl. 2, fig. 3—5.

? — *Nummulites laevigatus* (Bruguière, 1792) — Nemkov, 1967, pl. 13, fig. 10—11.

The strattigraphic position of the mentioned species is the following: *Nummulites manfredi* and *N.* aff. *praelaevigatus* are from the Upper Cuisian, *N. britannicus* and *N. hagni* are from the Lower Lutetian.

Nummulites hagni n. sp.

(Pl. XLVII—L, Text-figs. 2—4, 5 d—g)

H o l o t y p u s: the forms B, inv. no. 2716 (TR-20) in the collection of the Institute of Paleontology SAZU, Ljubljana.

P a r a t y p i: forms B, some specimens in the same collection as the holotype, the rest in the collection of the Bayerische Staatssammlung für Paläontologie und historische Geologie in Munich (the form A has not been found).

L o c u s t y p i c u s: Turhal, at the entrance to the adit of the antimony mine about 5 km northeast of the town, appr. 100 m to the west of the road Turhal — Dazmana (more details in the text, p. 260).

S t r a t u m t y p i c u m: Lower Lutetian.

D i a g n o s i s: The new species resembles in the disposition of the whorls the species *Nummulites* aff. *praelaevigatus* S c h a u b from Campo (S c h a u b, 1966, p. 375, fig. 6c, pl. 6, fig. 4) and in the shape of chambers and septa the species *Nummulites britannicus* H a n t k e n.

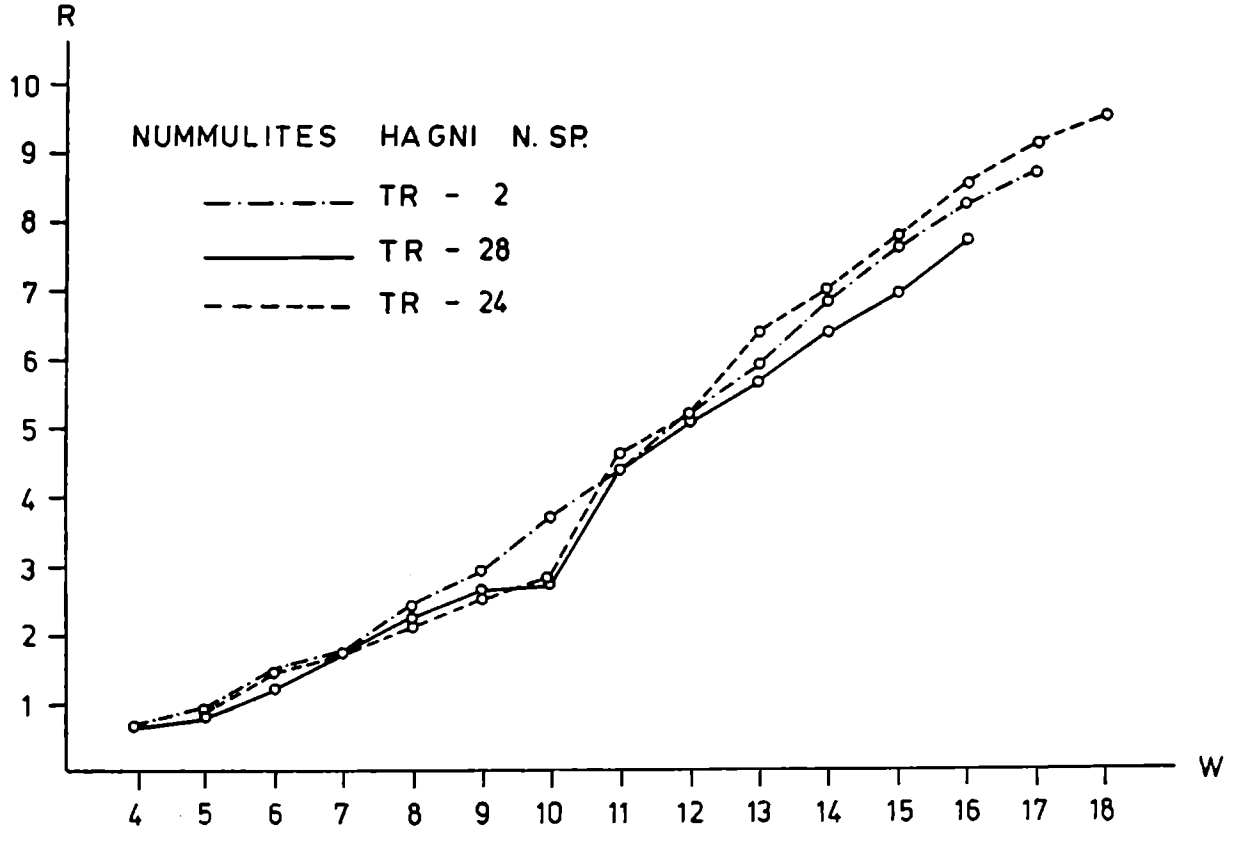

Fig. 2. Diagram of the whorls course $\left(\frac{W}{R}\right)$ of the new species *Nummulites hagni*.

TR-2 (No. 2717) — the test with the regular whorls; TR-24 (No. 2722) and TR-28 (No. 2723) — the test with something more irregular whorls; W — number of whorls; R — radius

Derivatio nominis: after dr. Herbert Hagn, professor at the Munich University.

Description: The shape and the surface of the test: The test is very thin, often slightly undulated, gradually increasing in thickness towards the center. Usually it is distinctly thickened in the central part, conforming with the observations of Schaub (1966, p. 372) on the tests of the species *Nummulites manfredi*. The outer rim of the test is rather sharp. D [1] = 2,7 to 4,2 mm.

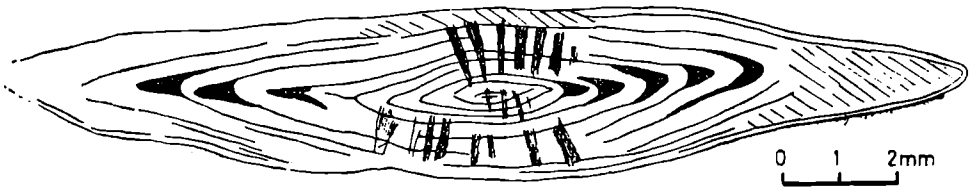

Fig. 3. *Nummulites hagni* n. sp., B-form, Lower Lutetian, Turhal in Turkey. No. 1260/1 — axial section

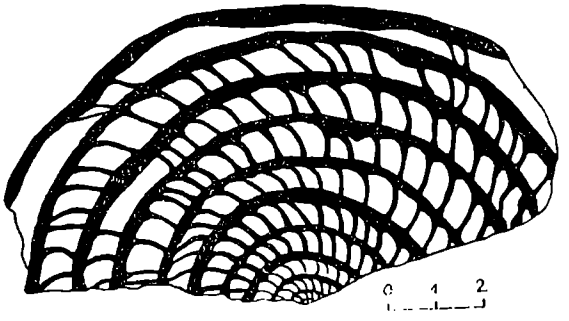

Fig. 4. *Nummulites hagni* n. sp., B-form, Lower Lutetian, Turhal in Turkey. No. 1247/2 — part of equatorial section

On the surface, undulated or sickle-shaped septal lines are observable, and between them not very frequent granulae. Also the „trabecules transverses" are seen.

The axial section: The whorls are compressed one to the other. In the central part, strong columns are frequent, becoming more rare towards the periphery. No columns are present in the external whorls.

The equatorial section: In the inner whorls, there are still some characteristics of the planulatus type to be seen, although less expressive as e.g. in the species *Nummulites manfredi* or *N.* aff. *praelaevigatus* from Campo. The whorls are more regularly elevating as in the species *N. manfredi*, but less than in *N. britannicus*. External whorls are somewhat lowering. Larger specimens display 16 to 18 whorls.

The chambers in the inner whorls are much higher than long. In the middle whorls they elongate, although the height still predominates over the length. Towards the external whorls the chambers become longer, and they approach isometric shape. Chambers with length exceeding their height can often seen. The roof of the chambers is slightly bent.

A foot is present at the base of a septum. The septa are slightly bent

[1] All designations in the description are made conformingly to the proposition made by De Zanche, Pavlovec and Proto Decima, 1967, p. 217—221 (in the abstract, p. 245—247).

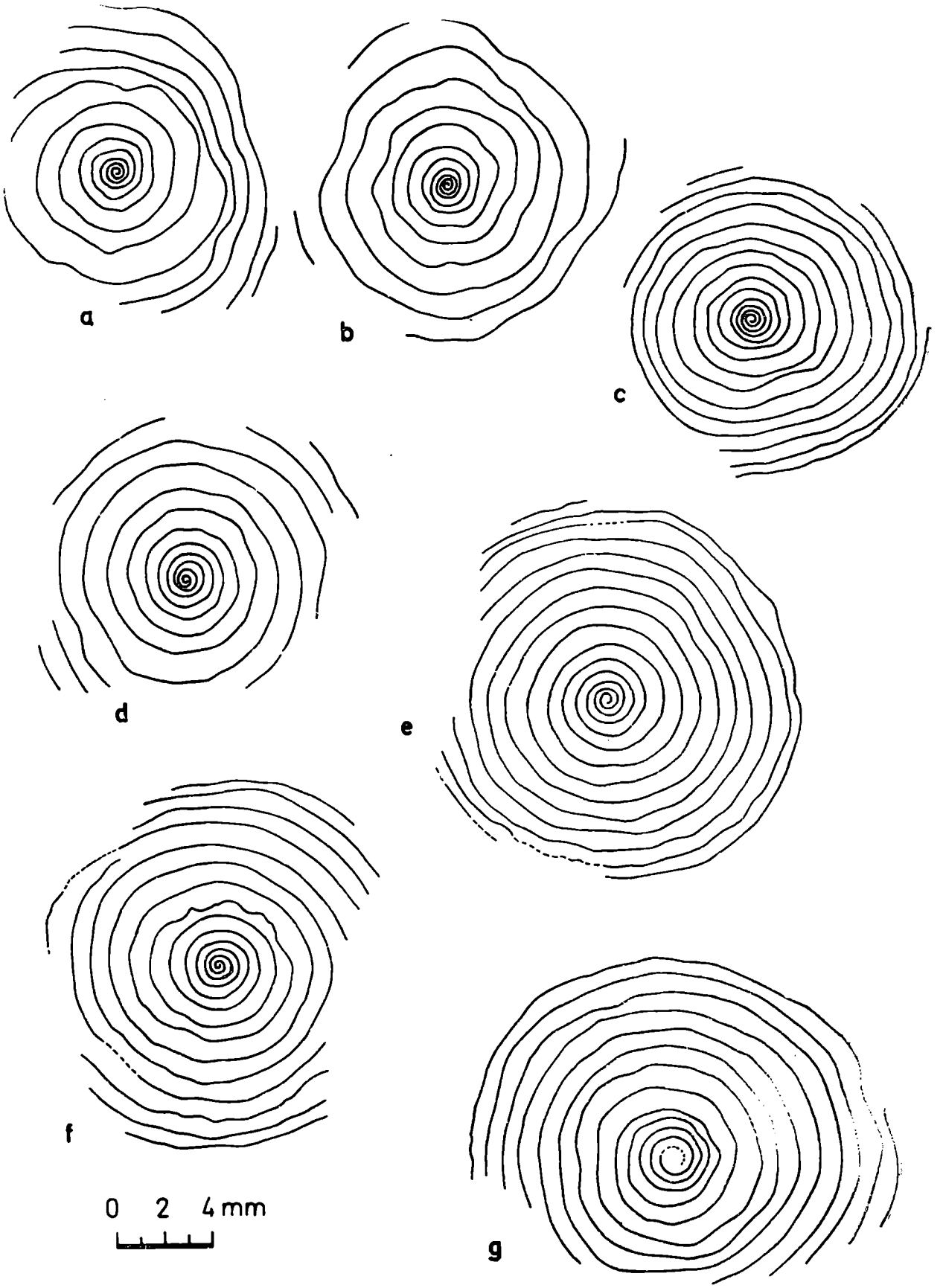

Fig. 5. The disposition of the whorls in some tests of the group *Nummulites planulatus — puschi*, B-forms. a — *Nummulites manfredi* Schaub (Schaub, 1966, fig. 6a); b — *Nummulites britannicus* Hantken (Schaub, 1966, fig. 7a); c — *Nummulites* aff. *praelaevigatus* Schaub (Schaub, 1966, fig. 6c); d — *Nummulites hagni* n. sp. (TR-4, No. 2721) — test with relative high whorls, similar to the species *N. britannicus*; e — *Nummulites hagni* n. sp. (TR-20, No. 2716) — holotypus; f — *Nummulites hagni* n. sp. (TR-8, No. 2720); g — *Nummulites hagni* n. sp. (TR-24, No. 2722)

in the inner whorls; towards the external ones they incline successively more and more, so that they are already strongly inclined in the last whorls.

Comparison: *Nummulites hagni* resembles the species. *N. manfredi, N. britannicus,* and *N.* aff. *praelaevigatus* from Campo. In the disposal of the whorls it is approaching the species *N.* aff. *praelaevigatus.* However, several specimens have been found displaying much more irregularly disposed whorls, approaching in that the species *N. britannicus.* Nevertheless, in *N. hagni* the disposal of whorls, described by Schaub (1966, p. 373) for the species *N. manfredi,* is not observable.

In its size *Nummulites hagni* corresponds to *N. britannicus.* The specimens from Turhal have *Dm* from 16,2 to 20,5 mm, whereas in *N. britannicus Dm* is from 12 to 24 mm (Schaub, 1966, p. 374). *Nummulites manfredi* is smaller (*Dm* from 10 to 17 mm; Schaub, 1966, p. 374).

The chambers of *Nummulites hagni* are as rule shorter than in *Nummulites* aff. *praelaevigatus,* and somewhat longer than in *N. britannicus.* As the whorls are lower than in *N. britannicus,* the impression of denser septa is observable in *N. hagni.*

All this leads to the conclusion that *Nummulites hagni* resembles in part the species *N.* aff. *praelaevigatus* from Campo, and partly the species *N. britannicus. Nummulites* aff. *praelaevigatus* is an Upper Cuisian form, and *N. britannicus* a Lower Lutetian one. Of all the mentioned species *Nummulites manfredi* from the Upper Cuisian displays the most of characteristics of the whorls of the planulatus-aquitanicus type. Therefore in the opinion of the writer they all could not originate directly from each other. In his opinion, the development passes in the following direction: *Nummulites praelaevigatus — N.* aff. *praelaevigatus* from Campo — *N. hagni — N. britannicus. Numulites manfredi* takes part of a distinct branch, perhaps originating from *N. aquitanicus,* or from other forms, as for example *N.* aff. *planulatus* from Campo (Schaub, 1966, p. 368, fig. 6e).

Material: The geologist dr. Rudolf Höll from Munich collected in Turkey several years ago some Palaeogene fossils which are now conserved in the Bayerische Staatssammlung für Paläontologie und historische Geologie in Munich. The author inspected the material for the first time in 1963 as the scholar of the Alexander von Humboldt Institution, when working in the Institut für Paläontologie und historische Geologie in Munich with prof. dr. Herbert Hagn (Director prof. dr. Richard Dehm). To all these geologists I owe my gratitude for the kind authorization of the publication, for their precious advices, as well as for all their aid to my work.

During a visit to the Naturhistorisches Museum in Basel I discussed the nummulites collected by dr. R. Höll in Turkey, also with prof. dr Hans Schaub, to whom I want also to express my sincere thanks for his precious suggestions.

I have completed my studies of these nummulites in the Institute of Paleontology at the Slovene Academy of Sciences and Arts in Ljubljana, where a part of the material is deposited.

Data on the finding place:

Among the material from Turkey, there were foraminifers, molluscs and corals. It was collected near Turhal, at the entrance of an addit of a small antimony mine some 5 km NE from Turhal, approximately 100 meters westwards of the road Turhal — Dazmana, at the altitude of

ca. 1000 m above sea level (these and the following data concerning the finding place originate from a letter by dr R. H ö l l of 10th July, 1968). Turhal lies approximately 280 km ENE of Ankara, about in the middle between the towns Samsun at the Black Sea and Sivas at the Kizilirmak river.

The Eocene beds are transgreding over Permian shales and diabases. They are preserved only in small remainders which at Dazmana reach c. 30 m in thickness. In the base conglomerate, thick up to 50 cm, predominate diabase, quartz and limestone pebbles, and fragments of the shales. In this layer, the following fauna was determined by the writer: *Stylocoenia taurinensis* (M i c h e l i n), *Discocyclina* div. sp., *Nummulites partschi* de la H a r p e and *N.* cf. *burdigalensis* de la H a r p e.

Although the enumerated fauna is not sufficiently characteristic for a more detailed age determination, it could be nevertheless attributed to the Eocene. The nummulites from the basal conglomerate suggest the Lower Eocene, whereas the species *Stylocoenia taurinensis* was found most frequently in the somewhat younger beds. Therefore the conclusion could be suggested that the fauna in the basal conglomerates has been redeposited.

The basal conglomerates are overlain by sandy marls and sands with some intercalations containing hard limestone nodules. In these beds the fossils are abundant. Among then I determined *Stylophora* cf. *conferta* R e u s s, *Turritella imbricataria* L a m a r c k and *Clavilithes* sp., resembling the species *C. macrospira* C o s s m a n n. Besides this fauna, also numerous tests of *Nummulites hagni* n. sp. have been found.

The macrofauna from the beds overlying the basal conglomerate is of Middle Eocene age.

A g e: Unfortunately, for the beds with *Nummulites hagni* we do not dispose with more detailed data on the overlying and the underlying strata. The conglomerate underlying the layer with the new species contains macrofauna indicating Lutetian age. The Lutetian fauna occurs also in the bed with *Nummulites hagni.* In consequence of the preceding discussion, *Nummulites hagni* is younger than *N.* aff. *praelaevigatus* from Campo, found in Upper Cuisian. Following,*Nummulites hagni* represents the lower part of Lutetian. This age is supported also by the S c h a u b ' s (1963, p. 984) *Nummulites* aff. *laevigatus* from the series of Sorde-l'Abbaye, which the author attributes to the species *N. hagni.* It was namely found in the Lower Lutetian beds, in the zone with the species *Nummulites gallensis* H e i m, thus just on the base of the Lutetian.

Inštitut za paleontologijo SAZU
Novi trg 3, Ljubljana, Jugoslavija

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POVZETEK

Vrsto *Nummulites laevigatus* so imeli za obliko z izredno spreminjajočimi se elementi hišice. Boussac (1911) jo je označil kot najbolj variabilnega numulita sploh. Razlike se kažejo predvsem v višini zavojev in obliki kamric. Zato so vrsti *Nummulites laevigatus* prištevali numulite z enakimi ali vsaj zelo podobnimi površinami in oblikami hišic, ki pa imajo bodisi nizke, bodisi visoke zavoje in razlicne oblike kamric.

Po podrobnejšem preučevanju skupine *Nummulites laevigatus* s.l. je prišel Schaub (Hottinger, Lehmann in Schaub, 1964) do prepričanja, da sta se razvijali dve samostojni veji. Vendar so po mojem mnenju razlike med obema vejama tako velike, da obeh vej ni mogoče imeti za eno samo skupino *Nummulites laevigatus*, ampak za dve samostojni skupini. Zanju predlagam imeni: skupina *Nummulites laevigatus* — *brongniarti* (za hišice z nizkimi zavoji in sorazmerno dolgimi kamricami) in skupina *Nummulites planulatus* — *puschi* (za hišice z visokimi zavoji in sorazmerno visokimi kamricami). Obe skupini spadata v podrod *Nummulites* (v smislu Nemkova, 1967).

Da numulitov z nizkimi in numulitov z visokimi zavoji ni mogoče združevati, dokazujejo tako morfološke razlike, kakor tudi fiziološko delovanje protoplazme. Na rast hišice je vplivala množina protoplazme, ta pa je bila odvisna od zunanjih faktorjev (temperature in najbrž tudi drugih značilnosti morske vode). Numulite z visokimi in numulite z nizkimi zavoji najdemo v številnih nahajališčih od Francije do Kavkaza v istih plasteh, torej so imeli eni in drugi enake življenjske pogoje. Zato zunanji vplivi niso povzročili različne rasti, ampak je bila rast hišice

v teh primerih odvisna od fiziološkega delovanja, značilnega za posamezne vrste.

Podrobneje sem raziskoval nekatere zgornjecuisijske in spodnjelutecijske vrste iz skupine *Nummulites planulatus — puschi*. Te so *Nummulites manfredi, N.* aff. *praelaevigatus* iz Campa (S c h a u b, 1966) in *N. britannicus*. Med seboj se ločijo deloma po velikosti hišic, še bolj pa po različnem poteku zavojev in obliki kamric. *Nummulites manfredi* ima notranje zavoje še podobne kot so pri vrsti *N.planulatus*. Srednji zavoji so mnogo višji, toda ne naraščajo mnogo. Zunanji zavoji so nepravilnejši in se večinoma celo nekoliko znižajo. Zavoji pri *Nummulites britannicus* potekajo pravilneje kot pri *N. manfredi*, enakomernejše pa so tudi kamrice. *Nummulites* aff. *praelaevigatus* ima še pravilneje potekajoče in predvsem nižje zavoje kot obe omenjeni vrsti, daljše pa so tudi kamrice. Prepričan sem, da je *Nummulites* aff. *praelaevigatus* iz Campa nova vrsta.

Narejena je bila delna revizija nekaterih numulitov, opisanih kot *Nummulites laevigatus*.

Preučeval sem tudi numulite, ki jih je iz bližine Turhala v Mali Aziji (Turčija) prinesel dr. R. H ö l l iz Münchna. Po poteku zavojev so mnogi med njimi podobni vrsti *Nummulites* aff. *praelaevigatus* iz Campa, nekateri pa se po precej nepravilnih zavojih približujejo vrsti *Nummulites britannicus*. Kamrice pri numulitih iz Turčije so krajše kot pri *Nummulites* aff. *praelaevigatus*, toda na splošno nekoliko daljše kot pri *N. britannicus*. Zaradi teh razlik opisujem numulite iz Turčije kot novo vrsto *Nummulites hagni*.

Ker je *Nummulites hagni* deloma podoben obliki *N.* aff. *praelaevigatus* iz Campa, deloma pa *N. britannicus*, ga imam za prehodno vrsto med tema numulitoma. *Nummulites britannicus* je spodnjelutecijski, *N.* aff. *praelaevigatus* pa zgornjecuisijski. *Nummulites hagni* kot prehodna oblika med obema je torej lahko iz najvišjega cuisija ali iz najstarejšega lutecija. Ker pa prištevam vrsti *Nummulites hagni* tudi obliko, opisano kot *N.* aff. *laevigatus* iz spodnjelutecijskih plasti v profilu Sorde-l'Abbaye (S c h a u b, 1963), spada *N. hagni* med spodnjelutecijsko favno. Skromna makrofavna, ki spremlja numulite iz Turhala, potrjuje srednjeeocensko starost.

EXPLANATION OF PLATES

Plate XLVII—L

Nummulites hagni n. sp., B-forms, Lower Lutetian. Turhal in Turkey.

Plate XLVII

Fig. 1. Holotypus, No. 2716 (TR-20)
Fig. 2. No. 2717 (TR-2)

Plate XLVIII

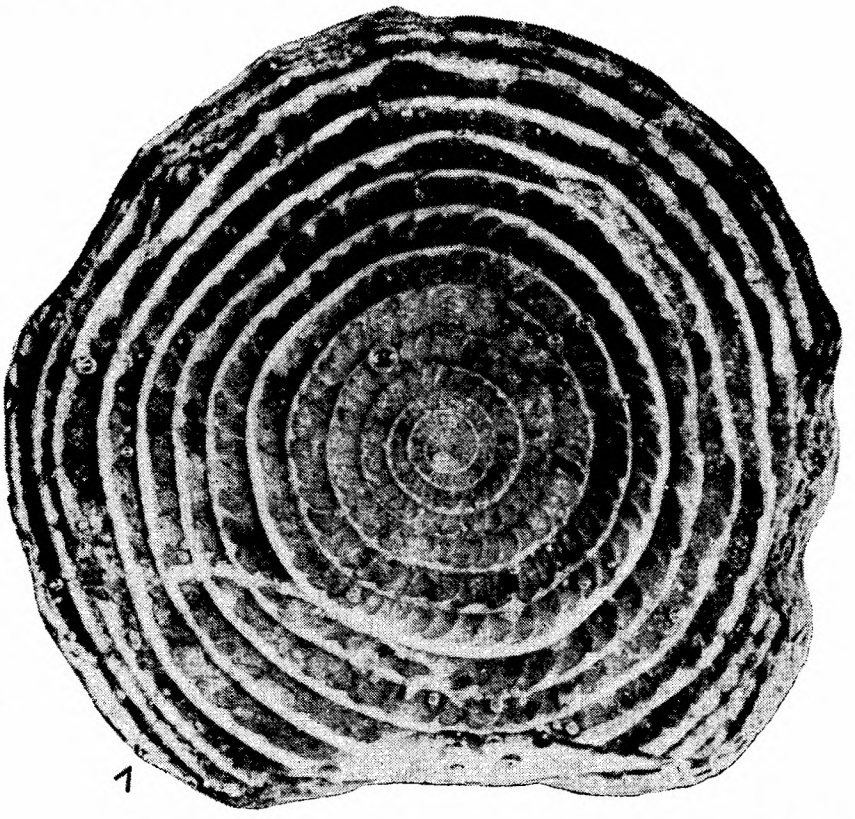
Fig. 1. No. 2718 (TR-16)
Fig. 2. No. 2719 (TR-9) — surface and septal filements

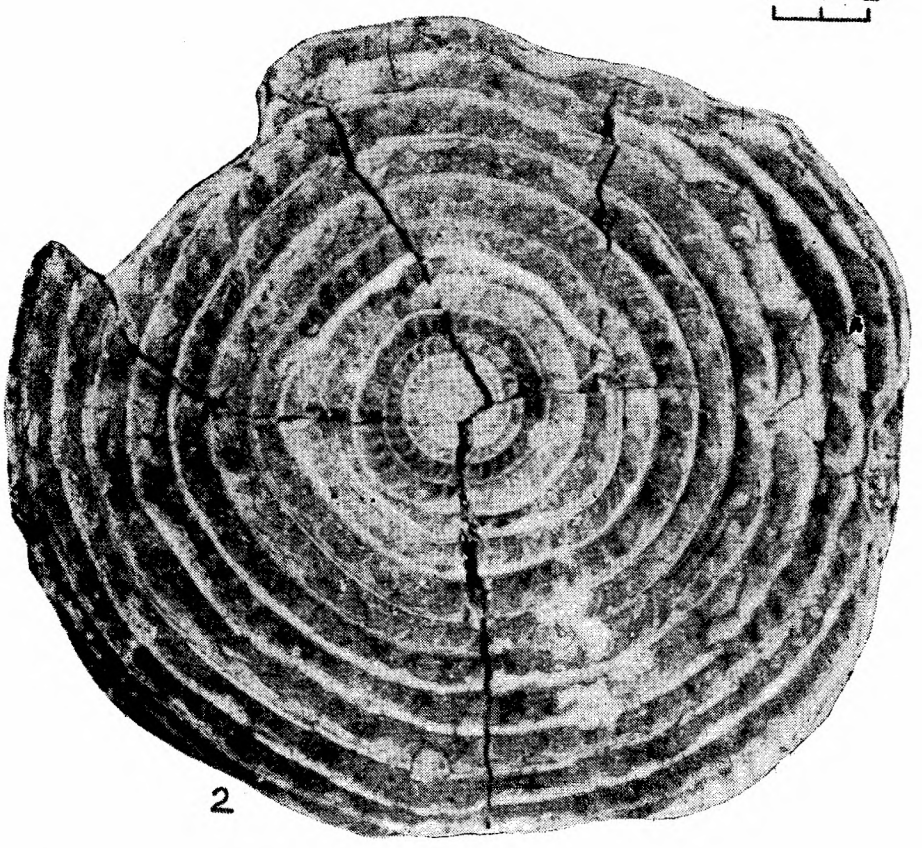
Plate XLIX

Fig. 1. No. 2720 (TR-8)
Fig. 2. No. 2721 (TR-4)

Plate L

Fig. 1. No. 1247/1
Fig. 2. No. 1247/2





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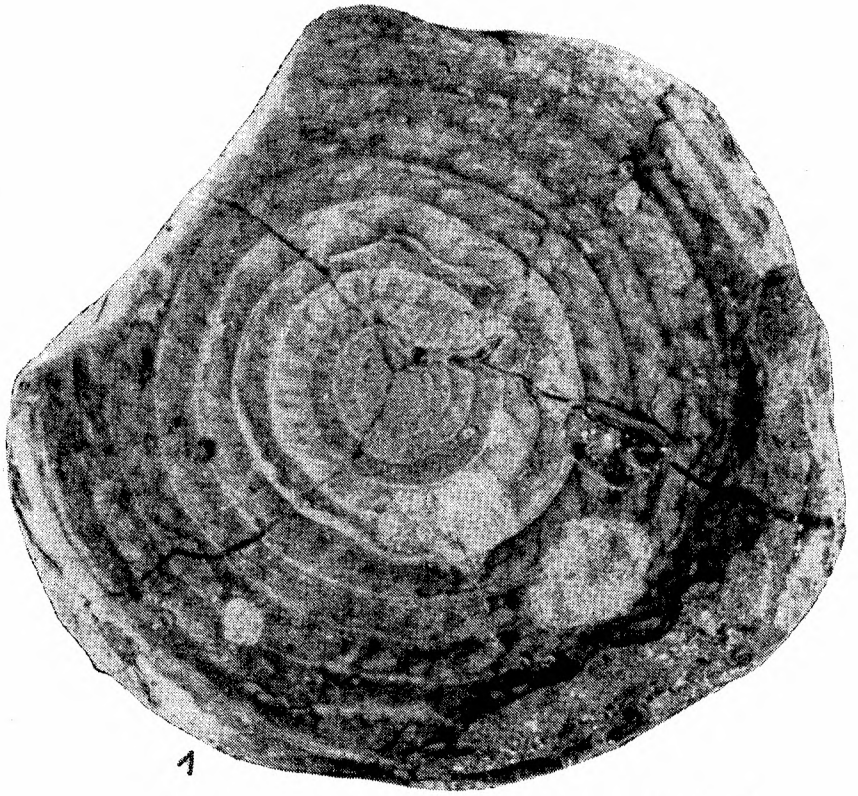

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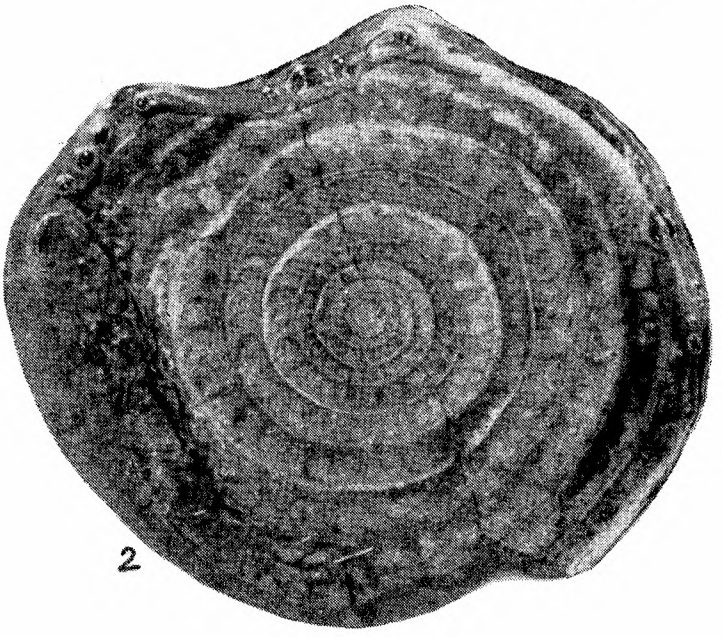

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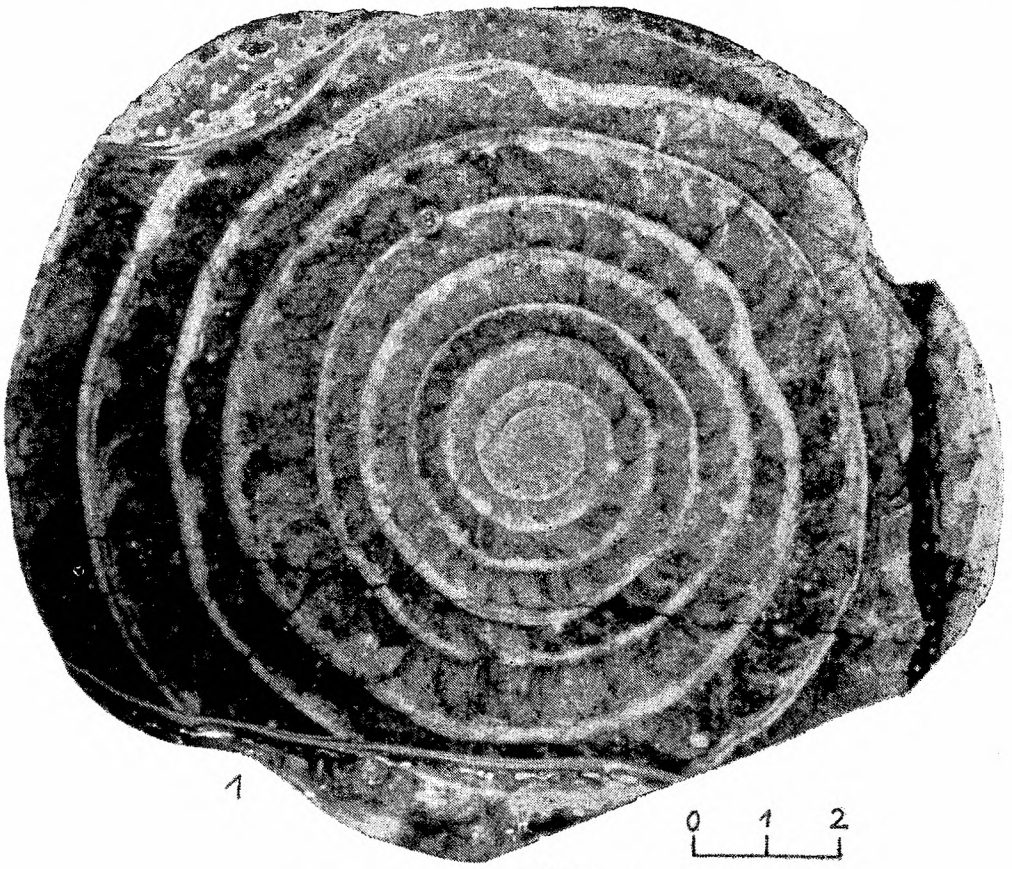

R. Pavlovec