LJUBO BABIĆ

SPHAEROCODIUM OR ONKOIDS FROM THE UPPER TRIASSIC DOLOMITE OF WESTERN YUGOSLAVIA?

With 1 text-figure and 1 plate

Coated grains named by many authors *Sphaerocodium bornemanni* Rothpletz are described in detail. These grains do not show the main quality of the species and genus: a filamentous structure.

In the last two decades *Sphaerocodium bornemanni* has been reported from numerous Upper Triassic localities of western Yugoslavia. Most of them have been mentioned by Herak (1952, 1957), Gušić, Jelaska & Nenadović (1965) and Buser (1966), who have been mainly dealing with its stratigraphic position, leaving aside an examination of structural details. A number of these localities have been re-examined by the present author and some new ones have been added (fig. 1). Specimens deriving from different places have been studied, compared with one another and with the descriptions of *Sphaerocodium bornemanni* Rothpletz.

In the field, the bodies in question appear spheroidal, ellipsoidal, grumous or reniform. The largest individuals have the smallest diameter up to 10 mm and the biggest up to 15 mm. The average values are 4 and 5 mm respectively. On a fresh and smooth fracture a number of nearly concentric layers is usually seen while weathered specimens display a few thicker and outstanding layers. Layer surfaces can be smooth or slightly corrugated.

The individuals differ from each other in some characters of both their cores and coatings, but different characters come up also in the same locality and even in one thin section.

CORES

Two main types of cores are recognized.

(1) The first type of cores (diameters 0,48–2,7 mm) is of a composite structure (pl. 1, figs. 1, 2, 5) comprising several kinds of particles sited in abundant clear or grey crystalline dolomite (crystals 0,02–0,1 mm). These particles are: (A) spheroidal coated grains (0,06–1 mm) with one

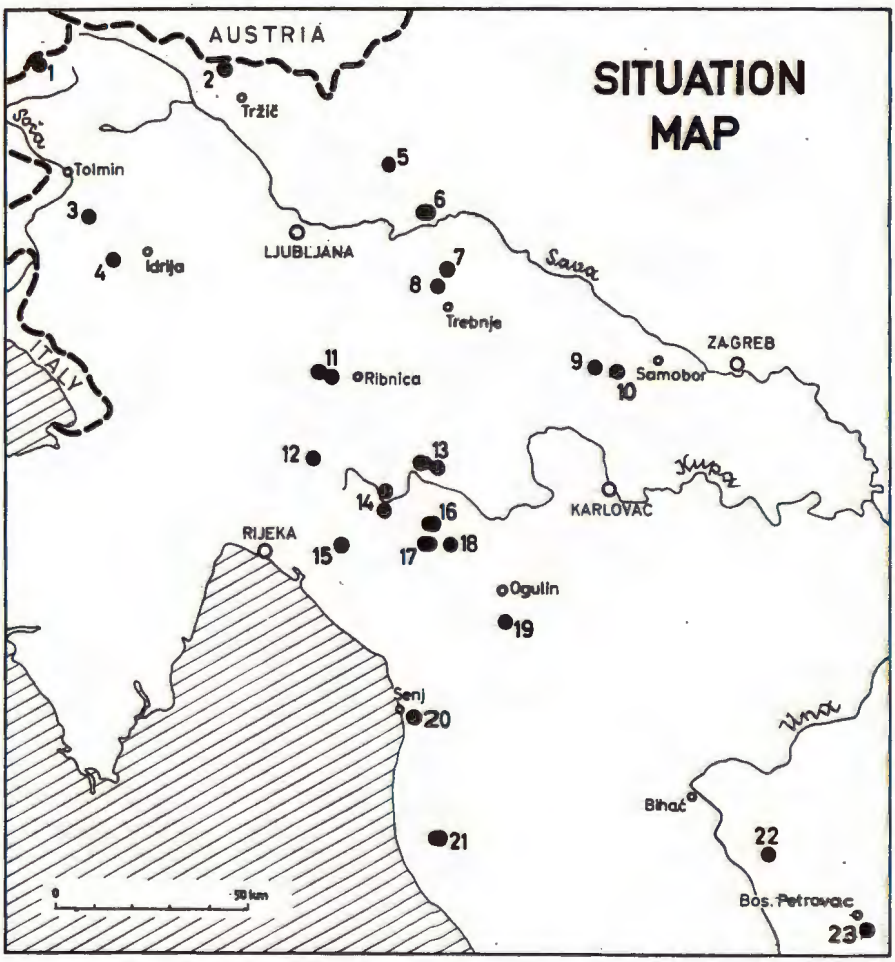

Fig. — Sl. 1.

1 Strmec (Julian Alps)
2 Ljubelj (Karawanken)
3 Podčepovan
4 Krekovšče (ESE of Idrija)
5 Češnjice (Menina)
6 Šent Lambert (ESE of Zagorje)
7 Dole (N of Trebnje)
8 Čatež (NNW of Trebnje)
9 Budinjak
10 Draganoš
11 Travna Gora and Sodražica (W of Ribnica)
12 Sokolanske Stene (E of Tršće)
13 Knežja Lipa
14 Lešnica and Kuželjska Stena
15 Špičunak
16 S of Brod Moravice
17 Ravna Gora
18 Vrbovsko
19 Veljun (S of Ogulin)
20 Senjska Draga
21 Štirovača (Velebit)
22 Lipa (SE of Bihać)
23 Bukovačko Brdo (SE of Bosanski Petrovac)

or two concentric envelopes; details of their structure are obliterated by diagenetic changes and only thin dark rings, and sometimes a minute dark nucleus is seen in the crystalline mass; (B) fragments (0,03–1,1 mm) of previously formed coated grains (or crusts); they can be slightly rounded and coated: small complete onkoids (0,3–1,14 mm) can be also found; (C) dark micritic grains (0,015–0,12 mm) of an undefined origin, a part of them being rounded to different degrees; (D) grains with an only discernible angular or rounded shape (0,04–0,38 mm) defined by minor (or rarely larger) crystal sizes of the grain interior in relation to the surroundings, and sometimes with a thin dark rim. (C) and (D) particles are more frequent. The crystalline matrix (»cement«) surrounding the described particle types (A, B, C, D) was originated by recrystallization (and dolomitization) with crystal growth. A part of the primarily present particles and mud were completely destroyed, thus generating a secondary »cement«-supported structure.

(2) The second main type of cores seems to be somewhat more frequent being represented by a single fragment (0,2–2,6 mm) of a previously formed coated grain or crust. Some of these cores display twice repeated breaking and coating.

Other types of cores are rare. Some of them are represented by a finely crystalline mass resulting from the complete destruction of the primary core structure. Some others are probably minute coating fragments, but they could not be identified with certainty.

Broken shells of gastropods or pelecypods (mentioned by many authors as cores) have not been identified. They seem to play a role of the core only in the calcareous Upper Triassic.

ENVELOPES

For our purpose, that is a comparison with *Sphaerocodium*, the coating structure is more interesting than the core.

The number of envelopes varies from one to about ten and the total thickness of coating from 0,09 to 3 mm. Single envelopes are from 0,01 to 0,4 mm thick but the thickness of one and the same envelope can greatly vary over the grain. In some cases it can be doubled or tripled, and in others an envelope or series of envelopes can wedge out successively or abruptly. A number of envelopes seem to cover only about a half or three quarters of the previous grain surface. Envelopes may be minutely and irregularly crinkled and corrugated or wavily curved (pl. 1, figs. 1–6). Such uneven surfaces are more often near the core.

The envelopes are composed of (1) finely crystalline dolomite (crystals 0,01–0,06 mm) without a radial arrangement, or (2) dark micritic dolomite. Both types of envelopes usually occur together. It must be emphasized that no kind of filaments or similar organic structure is found.

Sometimes particles are scattered in crystalline envelopes (pl. 1, fig. 4) or only in a part of them; such a part may considerably thicken forming a »lens«. The mentioned particles are found to be the same as those occurring in the »first type« of cores described above. In this way the general aspect of such a layer or of a part of it (containing particles) and the mentioned type of cores display a close similarity. The material taken for their building was approximately the same.

The intensity of diagenetic crystal growth varies irregularly from one envelope to another; some envelopes with relatively large crystals neighbour very finely crystalline ones. In many cases only ghosts of one or several envelopes (usually external) are present.

NAME

According to the above descriptions it is clear that we are dealing with coated grains. A more precise identification and terming of the primary grain structures is also possible, but not in the case of every grain. Irregularities in envelope thickness and general shape, corrugations, and the presence of diverse particles correspond to the term onkoid according to Ar. Heim (1916) and to the terminologic synthesis made by E. Flügel & Kirchmayer (1962). Envelopes with the mentioned characters originated with assistance of algal film (on the older envelope surface) trapping minute particles and mud respectively. But the physico-chemical factor must be also kept in mind as the possible contributor to such accretion. The terms »algal pellet«, »algal lump«, and »algal ball« are also used by many authors, but not always in the precisely same sense. Pia (1927) classified such forms paleontologically in the group of *Spongiostromata*, undergroup *Onkolithi*, and emphasized the artificial character of this classification comprising the forms without any clear organic structure.

However, onkoid characters are clearly seen only in about one third of the coated grains and could be reconstructed or supposed to have been existing in another third. It is questionable whether other coated grains had the onkoid or perhaps ooid structure before the diagenetic reorganisation.

COMPARISON WITH SPHAEROCODIUM BORNEMANNI

Two main structural characters of the species *Sphaerocodium bornemanni* Rothpletz and genus *Sphaerocodium* Rothpletz will be mentioned here: (1) a ball-like body with concentric envelopes and (2) branching tubular filaments (Rothpletz, 1890, 1891). The second character was analysed by Wood (1948) who emended Rothpletz's

descriptions. Branching tubular filaments are also the main structural element of the redescribed genus with two new species according to Wray (1967). The same is true for a species of the same genus redescribed by E. Flügel & Wolf (1969).

Consequently, a ball-like shape and a concentric frame without filamentous structure cannot be named *Sphaerocodium* or *Sphaerocodium bornemanni*. Following the first and other descriptions they may be considered as unknown from the Yugoslav Triassic up to now. Future findings of *Sphaerocodium* are not impossible, but they seem to be more probable in calcareous Triassic rocks. On the other hand coated grains (mainly onkoids as we have seen) concentrated in several horizons (layers thick from some cm to some dm) are really a characteristic feature in the usually unfossiliferous Upper Triassic dolomite sequences of western Yugoslavia (Herak, 1952, 1957; Gušić, Jelaska & Nenadović 1956; Buser, 1966).

It is favourable to mentione here some other data concerning the same problem. Ogilvie Gordon (1927) described *Sphaerocodium bornemanni* with nearly the same words as Rothpletz (1890, 1891) had done, but the figures (pl. 11: figs. 15, 16a, 16b) do not show a clear organic structure. Other example is given by E. Flügel (1959), who considers *Stromactinia* Vinassa de Regny synonymous with *Sphaerocodium bornemanni* Rothpletz and describes half-spheroidal bodies (up to 10 mm) with concentric wavy layers without filaments or tubes. For the reasons explained above it does not seem probable that the material of these two descriptions represents *Sphaerocodium*.

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Department of Geology and Paleontology
Faculty of Science,
Zagreb, Socijalističke revolucije 8

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LJ. BABIĆ

SPHAEROCODIUM ILI ONKOIDI IZ GORNJOTRIJASKOG DOLOMITA ZAPADNOG DIJELA JUGOSLAVIJE?

U zadnjih dvadesetak godina publicirana su mnoga nalazišta alge *Sphaerocodium bornemanni* iz gornjeg trijasa zapadnog dijela Jugoslavije. Najvećim su dijelom spominjana u radovima Heraka (1952, 1957), Gušića, Jelaske i Nenadovića (1965), te Busera (1966), koji su međutim uglavnom raspravljali o njegovom stratigrafskom položaju a manje se bavili istraživanjem detalja građe. Pretežni dio ovih lokaliteta je ponovo istražen, a dodani su i neki novi (sl. 1). Primjerci koji potiču sa različitih lokaliteta su detaljno ispitivani, međusobno uspoređeni i uspoređeni sa opisima vrste *Sphaerocodium bornemanni* Rothpletz.

Ispitivani oblici su sferoidna, elipsoidna, grudasta ili bubrežasta tijela, među kojima najveći individui imaju najmanji promjer do 10 mm, a najveći do 15 mm;

prosječne vrijednosti su 4, odnosno 6 mm. Na svježem i glatkom odlomu obično se vide brojni gotovo koncentrični slojevi dok se na trošenim primjercima vidi manji broj ali izrazitih slojeva. Površina slojeva može biti glatka ili slabo neravna.

Primjerci se međusobno razlikuju po osobinama jezgre i omotača, ali različite varijante građe dolaze na istom nalazištu pa čak i u istom izbrusku.

Jezgre

Razlikuju se dva glavna tipa jezgri.

(1) Prvi tip jezgri (promjer 0,48–2,7 mm) je složene građe (tab. 1, sl. 1, 2, 5) i sastoji se od nekoliko vrsta čestica smještenih u obilnom i bistrom do sivom kristaliničnom dolomitu (kristali 0,02–0,1 mm). Čestice su: (A) Sferoidalna omotana zrna (= coated grains) (0,06–1 mm) s jednom do dvije koncentrične ovojnice; dijagenetske promjene izbrisale su strukturne detalje, pa se u kristaliničnoj masi vide samo tanki tamni prsteni i katkada sitan tamni nukleus; (B) Fragmenti (0,08–1,1 mm) ranije stvorenih omotanih zrna (ili kora); mogu biti slabo zaobljeni i s tankim omotačem; katkada dolaze i sitni cijeli onkoidi (0,3–1,14 mm); (C) Tamna mikritska zrna (0,015–0,12 mm) nepoznatog porijekla od kojih neka mogu biti do različitog stupnja zaobljena; (D) Zrna uglatih ili zaobljenih obrisa (0,04–0,38 mm) vidljiva samo po manjoj (rijetko većoj) veličini kristala u usporedbi prema okolini i rjeđe po tankom tamnom rubu. Partikule tipova (C) i (D) su češće od prva dva tipa. Kristalinični agregat koji okružuje spomenute partikule, nastao je rekristalizacijom (i dolomitizacijom), odnosno povećanjem veličine kristala iz jednog dijela prvotnih čestica i mulja koji su sasvim izbrisani, pa su sekundarno nastale strukture sa zrnima utopljenim u kristaliničnom »cementu«.

(2) Drugi glavni tip jezgri izgleda da je nešto češći a predstavljen je pojedinim fragmentom (0,2–2,6 mm) starijeg omotanog zrna ili kore. Poneki takav fragment odnosno jezgra pokazuje ponovljeno lomljenje i omatanje.

Ostali tipovi jezgre su rijetki. Neke su pretstavljene sitno kristaliničnom masom kao rezultatom posvemašnjeg uništenja primarne strukture jezgre. Neke druge su vjerojatno sitni fragmenti omotača.

Fragmentirani skeleti puževa ili školjkaša (spominjani kao jezgre od mnogih autora) nisu prepoznati; čini se da oni mogu pretstavljati jezgre samo u vapnenačkom gornjem trijasu.

Ovojnice

S obzirom na usporedbu sa algom *Sphaerocodium*, građa omotača je zanimljivija od jezgri.

Broj ovojnica varira od jedne do deset, a ukupna debljina omotača od 0,09 do 3 mm. Debljina pojedine ovojnice je od 0,01 do 0,4 mm, ali debljina jedne te iste ovojnice može znatno varirati. U pojedinim slučajevima ona se može udvostručiti ili utrostručiti, ili pak ovojnica ili niz ovojnica postepeno ili naglo isklinjava. Izgleda da veći dio ovojnica pokriva samo oko polovinu ili tri četvrtine prethodne površine zrna. Ovojnice mogu biti sitno i nepravilno kovrčane i naborane ili valovito savijene (tab. 1, sl. 1–6). Takve neravnine su češće bliže jezgri.

Ovojnice su izgrađene od (1) sitno kristaliničnog dolomita (kristali 0,01–0,06 mm) bez radijalnog rasporeda, ili (2) od tamnog mikritskog dolomita. Ove dvije vrste obično dolaze zajedno. Potrebno je naglasiti da u omotaču nisu nađeni filamenti niti ikakve slične organske strukture.

U kristaliničnim ovojnicama ili samo jednom njihovom dijelu katkada su raspršene partikule (tab. 1, sl. 4) za koje je ustanovljeno da su jednake onima koje učestvuju u građi »prvog tipa« jezgri, pa su tamo i opisane. Taj dio ovojnica može jako odebljati tvoreći »leću«. Opći izgled ovojnice ili njenog dijela (koji sadrži partikule) i spomenutog tipa jezgri, vrlo je sličan, a materijal od kojeg su građeni bio je približno isti.

Intenzitet dijagenetskog brisanja, odnosno rasta kristala nepravilno varira od jedne ovojnice do druge; neke su sa relativno velikim kristalima uz druge sa sitno kristaliničnom strukturom. U mnogim slučajevima postoje samo obrisi jedne ili nekoliko ovojnica (obično vanjskih).

Ime

Navedeni opisi jasno pokazuju da se radi o omotanim zrnima (coated grains) bez ikakvog traga organske strukture. Moguće je i preciznije prepoznavanje i imenovanje prvotne strukture zrna ali ne za svako pojedino zrno. Pri tome nas zanima samo omotač. Variranje debljine i općeg oblika ovojnica, kovrčanje i boranje, te učešće raznih vrsta čestica u građi, odgovara nazivu onkoid (prema Ar. Heim, 1916. i terminološkoj sintezi E. Flügel & Kirchmayer, 1962). Ovojnice sa spomenutim osobinama nastale su uz pomoć algalnog filma (na površini starije ovojnice), na koji su se hvatale sitne čestice, odnosno mulj. Treba dodati da i fizičko-kemijski faktor treba imati u vidu kao mogućeg učesnika u procesu. Nazivi »algalna lopta«, »gruda« ili »kuglica« (algal ball, lump ili pellet) također upotrebljavaju mnogi autori ali ne uvijek u točno istom smislu. Pia (1927) je paleontološki klasificirao ovakve forme u grupu *Spongiostromata*, podgrupu *Onkolithi*, i naglasio je umjetni značaj takve klasifikacije, koja obuhvaća forme bez ikakve jasne organske strukture.

Međutim, onkoidne osobine se jasno vide samo na oko jednoj trećini omotanih zrna, a mogu se rekonstruirati ili pretpostaviti na drugoj trećini. Pitanje je da li su ostala zrna imala onkoidnu ili možda ooidnu građu prije dijagenetske reorganizacije.

Usporedba sa *Sphaerocodium bornemanni*

Navesti ćemo dvije glavne osobine vrste *Sphaerocodium bornemanni* Rothpletz i roda *Sphaerocodium* Rothpletz: (1) okruglasta tijela s koncentričnim ovojima i (2) granate cjevaste niti (filamenti) (Rothpletz, 1890, 1891). Drugu osobinu je istraživao Wood (1948) popravivši izvorne opise. Wray (1967) je ponovo opisao rod sa dvije nove vrste, kod kojih su opet glavni strukturni element granati cjevasti filamenti. Isto vrijedi i za vrstu istog roda, koju su ponovo opisali E. Flügel & Wolf (1969).

Prema tome, sferoidni oblik i koncentrična građa bez filamenata ne može biti nazvana *Sphaerocodium* ili *Sphaerocodium bornemanni*. Sudeći prema originalnima i kasnijim opisima ovaj rod i vrsta mogu se za sada smatrati nepoznatim u dolomitnom gornjem trijasu Jugoslavije. Budući nalazi nisu nemogući, ali se čine vjerojatnijim u vapnenačkom trijasu. S druge strane, omotana zrna (kao što je objašnjeno uglavnom onkoidi) koncentrirana u pojedinim nivoima (slojevi debeli nekoliko cm do više dm), zbilja su osobita pojava u obično nefosilifernom gornjotrijaskom dolomitu zapadnog dijela Jugoslavije. (Herak, 1952, 1957; Gušić, Jelaska & Nenadović, 1965; Buser, 1966).

Ovdje je zgodno spomenuti i neke druge podatke u vezi s istim problemom. Ogilvie Gordon (1927) je opisala *Sphaerocodium bornemanni* gotovo istim riječima kao i Rothpletz (1890, 1891), ali slike (tab. 11: slike 15, 16a, 16b) ne pokazuju

jasnu organsku strukturu. Kod drugog primjera, E. Flügel (1959) je utvrdio da je *Stromactinia* Vinassa de Regny sinonim vrste *Sphaerocodium bornemanni* Rothpletz i opisao polusferoidna tijela (do 10 mm) s koncentričnim valovitim slojevima bez niti ili cijevi. Zbog istih razloga koji su gore navedeni nije vjerojatno da materijal za ova dva opisa predstavlja *Sphaerocodium*.

Ugodna mi je dužnost zahvaliti se svojem profesoru M. Heraku i kolegi I. Gušiću sa Geološko-paleontološkog zavoda Prirodoslovno-matematičkog fakulteta u Zagrebu, na korisnim savjetima i diskusiji.

Geološko-paleontološki zavod
Prirodoslovno-matematičkog fakulteta,
Zagreb, Socijalističke revolucije 8

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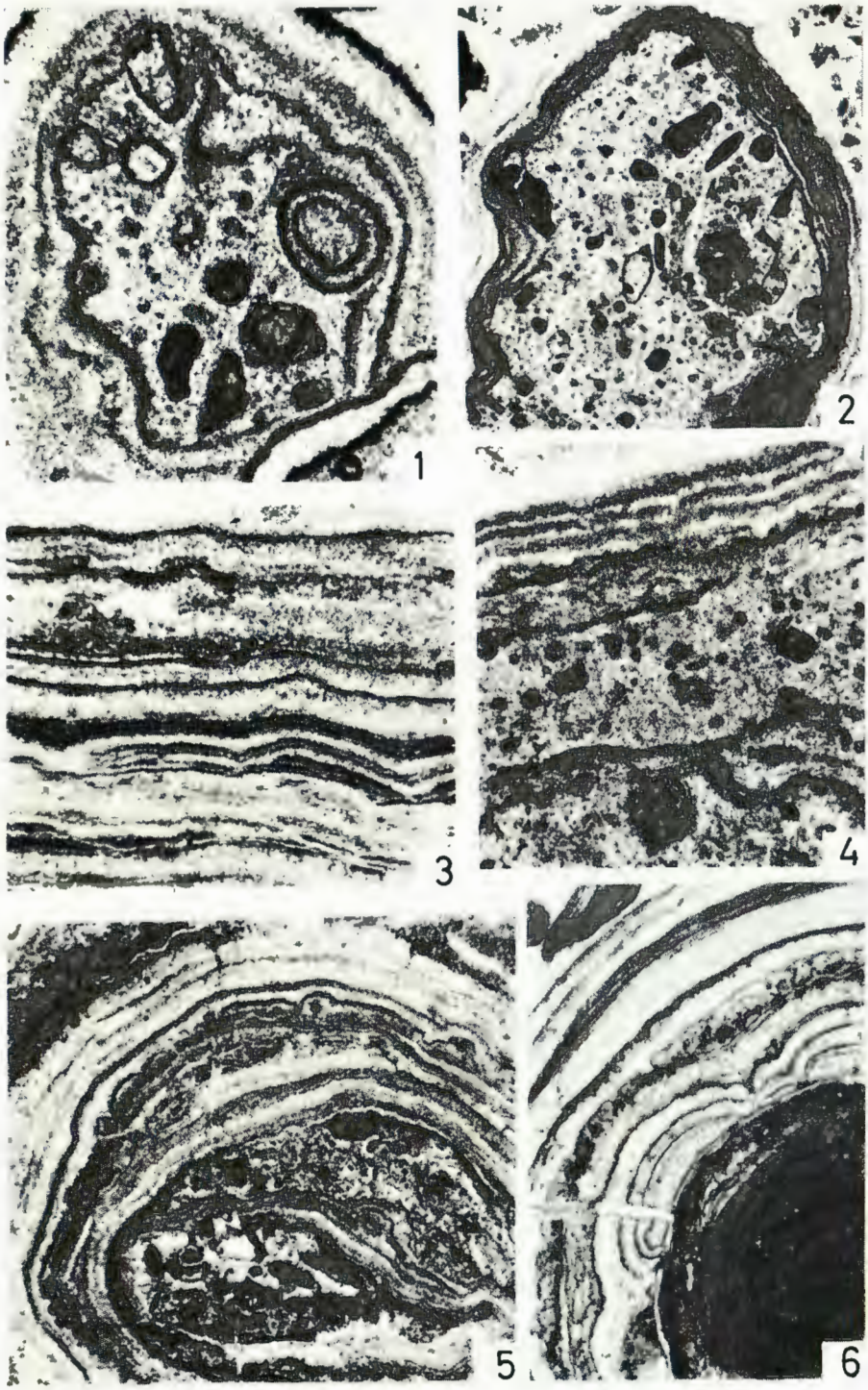
PLATE – TABLA I

1,2. The core with particles in the crystalline matrix; envelopes with corrugations.
Jezgra s partikulama u kristaliničnoj osnovi; ovojnice s naborima.
1. Loc. 16, 45×.
2. Loc. 23, 18×.

3. A detail of the coating with slightly curved envelopes.
Detalj omotača sa slabo savijenim ovojnicama.
Loc. 14, 45×.

4. The particles in the crystalline matrix as constituents of the envelopes.
Ovojnice izgrađene od partikula i kristalinične osnove.
Loc. 23, 50×.

5,6. General appearance of the onkoid coatings.
Opći izgled onkoidnih omotača.
5. Loc. 22, 18×.
6. Loc. 1, 18×.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