The microstructure concept – Coral research in the conflict of controversial opinions

KLEMENS OEKENTORP

OEKENTORP, K. 2007. The microstructure concept – Coral research in the conflict of controversial opinions. *Bulletin of Geosciences 82(1),* 95–97. Czech Geological Survey, Prague. ISSN 1214-1119. Manuscript received March 19, 2007; issued March 30, 2007. • DOI 10.3140/bull.geosci.2007.01.95.

Klemens Oekentorp, Westfälische Wilhelms-Universität, Geologisch-Paläontologisches Institut und Museum, Forschungsstelle für Korallenpaläozoologie, Pferdegasse 3, D-48 143 Münster; oekento@uni-muenster.de; oekento@t-online.de

'*Cogito, ergo sum.*' This famous remark is attributed to René Descartes, a French universal scientist and mathematician, also dubbed as the first modern philosopher. This sentence should express that everything he believed he recognized clearly is accepted to be true – given that it is also plausible. His instrument to treat philosophical questions was the permanent doubt – the 'Cartesian doubt' – with one exception: the proposition that he existed.

Science is generally confined to the old-established natural sciences. A more modern approach includes the perceptions of different domains in their whole as well as rational assessment. In modern sense, science is also based on theoretical doubts and on research. The latter one is, in its widest sense, 'the trained observation and inquiry directed upon any department of knowledge with a view to the discovery of new information' (Chambers's Encyclopaedia 1969).

To bring science forward, an exchange of ideas and results is essential. Mostly, publications are the gateway towards the spread of one's own findings (not always are they read or taken into consideration). Meetings or symposia are also useful to communicate and discuss existing differences and problems, to clear contrary opinions. But the best way should be to exchange special minds personally and by visits. This sounds like a good idea, but sometimes reality may be quite different. The most important point in this context seems to be the readiness to cooperate and to esteem each other. Thus, different opinions must be checked repetitively or in different ways to prove one's case. 'Observation' exclusively applied would contradict the above mentioned requirement of research and science in general. Then, spreading the ideas beyond the Descartes' statement could be interpreted as '*video, ergo est*'.

This 'preamble' wants to call attention to general problems in science and research. Explicitly, it should also help us to address the situation concerning the investigation of Palaeozoic corals and specifically the opinions on the morphogenesis of the skeleton and its microstructures. The skeleton of corals, in modern as well as in fossil corals, consists of $CaCO_3$. The aragonitic modification characterizes extant as well as Mesozoic and Tertiary Scleractinia. The Palaeozoic rugose corals and the Tabulata produced calcitic skeletons. The basic element of the fine skeletal structure 'is considered to have exuded ...in needles ('fibres') according to the laws of spherulitic crystallization and in right angles to the secreting ectodermal surface'. This statement has been confirmed manifold (Ogilvie 1897, Hill 1956, p. 250, Goreau 1961, Wainright 1964, Vahl 1965, Schouppé & Stacul 1966, Oekentorp 1972, *etc*.).

Additional different microelements have been described, too, which do not correspond to the widely accepted fibrous structures. For the first time, Hill (1935, 1956) argued that special structures in Palaeozoic corals may result from diagenesis. As an example, she focussed to the 'holacanth trabeculae' in rugose corals. Her assumption could be proved by the author studying Pleistocene Scleractinia (Oekentorp 1993). Also Kato (1963) described and classified diagenetic microstructures in rugose corals. A detailed investigation lasting more than thirty years, including different methods and modern techniques, considering the huge amount of publications on reef sedimentology and carbonate diagenesis, demonstrated that those structures are the result of diagenetic processes, following mineralogical realities. These connections have been published at many occasions, and condensed in 'Review on diagenetic microstructures in fossil corals – a controversial discussion' (Oekentorp 2001; with a representative reference list). In summary, it can be stated that 'Microstructures occurring in Palaeozoic corals which do not correspond to fibrous or trabecular structures can easily be explained as diagenetic changes on the basis of crystallographic regularities'. Assuming that the same diagenetic processes affected skeletal carbonate and surrounding sediments, all microstructures considered here clearly speak for themselves. Regular re-formations, developed in the course of diagenesis, are subject to mineralogical regularities. Regarding the formation of skeletal structure, as in recent corals and in the major part of Palaeozoic forms, these microstructures cannot also be explained morphogenetically. The identification of diagenetic structures is essential for any taxonomic evaluation, and requires the scientific interpretation of observed facts, including the results of abundant and detailed sedimentological investigation. [Otherwise, '*video, ergo est*' is not a scientific argument in this context!] Normally these statements deserve no authorship, but the facts about this have been long neglected in the past' (Oekentorp 2001, p. 207). And the application of such 'postmortem' structures for systematic purposes would *eo ipso* be invalid!

In contrast to this, all the unusual microstructures not corresponding to the mode of formation known in recent Scleractinia as well as in the majority of the Palaeozoic Rugosa were declared to be primary and used as a criterion for systematics. Contradicting the content of the last chapter, it has been stated: 'In the absence of a convincing demonstration that the morphology, polarity and disposition of the lamellae (and microlamellae) in relation to the dark middle line are no more the result of diagenetic processes, it seems appropriate to accept the validity of the genus *Praemichelinia*, just as defined by Lafuste & Plusquellec (1985)' (Fernández-Martínez & Plusquellec 2006, p. 47). 'Microlamellae' were described as tiny calcitic elements to be found in the skeleton arranged parallel or oblique to the polyp surface. As already stated, they do not correspond to the well known orientation of fibres perpendicular to the soft tissue.

Jean Lafuste, who established the investigation of microstructures using ultra thin sections, has introduced the term 'microlamellae' or French 'microlamelles' for the first time in France. Meanwhile, many types and varieties were observed and described by him and other French colleagues – 'French school' and affiliated Spanish coral specialists: for example, 'microlamelles' (Lafuste 1959), 'm. en lunules' and 'm. cupolaires' (Lafuste 1983), 'm. showing phylogenetic increase of size' (Plusquellec & Tourneur 1998), 'microlamelles coexistant avec des éléments atypiques qui peuvent être décrits comme des lamelles courtes' (Plusquellec *et al.* 2004) and others (listed in Oekentorp 2001). The peculiar differences in shape and measurement were used for systematic purposes.

Indeed, Lafuste has taken in consideration the possibility of diagenetic formation of the so-called 'microlamellaire' structure, but excluded this interpretation because of the existence of fibrous trabeculae-like structures (*i.e.* spines) not traversed by 'microlamellae'. However, these can be explained as alien elements which worked as an abutment by their special arrangement. Such phenomena can be observed very often in diagenetically influenced microstructures (Oekentorp 1972, p. 58, fig. 6). Moreover, similar phenomena are widespread with recrystallization of many carbonate crystal aggregates and also particularly well developed with simple shear, tectonically (or experimentally) induced deformations.

But, the deficiency of this deduction by the French colleagues ('Lafuste school') consists in the method: the ultra thin sections ('lames pétrographiques' à 30 μm) as well as 'emprentes à l'acétate' are only tools, in this special case very useful to observe microstructures. Nevertheless, the results based on observation must be interpreted using all the existing knowledge in sedimentology, mineralogy, diagenesis *etc*. Unfortunately, this so-called 'physiological' or 'histological' mode of formation of the 'microlamellae', so unusual in corals, has never been discussed in detail, and any comparison with common secondary microstructures is typically absent in their papers. Moreover, publications with controversial interpretations have been neither critically argued nor cited. Instead, these secondary microstructures were used directly for systematic and phylogenetic purposes.

The above discussion of the microstructure concept of the French School was initiated by the paper by Fernández & Plusquellec (2006) and by May (2006) as well. Especially, the discussion of the status of *Michelinia* De Koninck, 1841 and *Praemichelinia* Lafuste & Plusquellec, 1980 gave raise to this critical comment: 'In the absence of a convincing demonstration that the morphology, polarity and disposition of the lamellae (and microlamellae) in relation to the median dark line are no more the result of diagenetic processes, it seems appropriate to accept the validity of the genus *Praemichelinia*, just as defined by Lafuste & Plusquellec (1985).'

Generally, I am very familiar with the problem of diagenetic microstructure, also involving micheliniids (Oekentorp 2001; Oekentorp & Schröder 2001). The collection of the Forschungsstelle für Korallenpaläozoologie houses a huge number of micheliniid corals from the sections on the coast of Asturia, collected by F. Radig in 1950s. This material has been sectioned but not yet described. Only some sections have been used for different papers on microstructures (*e.g.*, Oekentorp 1972, fig. 6; pl. 5, fig. 3; Oekentorp 2001, figs 32, 33). For instance, fig. 3 in Oekentorp (1972) shows a longitudinal section with distinct lamellae arranged opposite to growth direction. Moreover, in the upper part, these lamellae cross the dark middle line. Additional scanning micrographs of a wall of *Procteria* (Lower Devonian, Ferroñes Marls, Asturias) show coarse distinct rhombohedra consisting of 'lamellae' arranged in different directions (Oekentorp 2001, figs 32, 33). These 'lamellae' are staples of smaller rhombohedra caused by twinning. These and similar arguments, backed up by relevant data, are really numerous, and managers tend to neglect them.

Therefore, Andreas May is right to revise the status of *Praemichelinia* and to assign it to *Michelinia* as a younger synonym, as Oekentorp & Schröder (2001) already did before. Birenheide (1985, p. 97) also considered *Praemichelinia* a younger synonym of *Michelina* but was not sure how to interpret the true nature of the spines, *i.e.* whether they are of primary or secondary preservation.

May's scientific studies on tabulate corals are well accepted. The propriety of the discussion in his paper ('Micheliniidae and Cleistoporidae') may be criticized in several particular cases, but this does not disturb his basic interpretation of diagenetic microstructures.

Epilogue: Unfortunately, Jean Lafuste renounced the continuation of his studies on the above discussed special microstructures towards their interpretation as diagenetic ones. He followed the other direction stumbling over the spines in the walls of favositids. Otherwise he would have solved many problems in coral research. It is very regrettable that his excellent microstructural techniques and methods are so frequently used 'only biologically', *i.e.* without a full understanding of diagenetic carbonate fabrics in fossil coral skeletons.

References

BIRENHEIDE, R. 1985. Chaetetida und tabulate Korallen des Devon. *Leitfossilien 3*, 1–249.

FERNÁNDEZ-MARTÍNEZ, E. & PLUSQUELLEC, Y. 2006. A new species of *Praemichelinia* (Tabulata) from the Emsian (Lower Devonian) of Colle (Cantabrian Mountains, NW Spain) and the occurrence of solenia-like pores in the genus. *Revista Española de Paleontología 21(1)*, 43–59.

HILL, D. 1935. British terminology for rugose corals. *Geological Magazine 72(11)*, 481–519.

HILL, D. 1936. The British Silurian rugose corals with acanthine septa. *Philosophical Transactions of the Royal Society of London B 226*, 189–217.

HILL, D. 1956. Rugosa, F233–F444, figs 165–357. *In* MOORE, R.C. (ed.) *Treatise on Invertebrate Paleontology. Part F. Coelenterata*. Lawrence, Kansas.

KATO, M. 1963. Fine skeletal structures in rugosa. *Journal of the Faculty of Science Hokkaido University (IV, Geology and Mineralogy) 11(2)*, 571–630.

LAFUSTE, J. 1959a. Murailles à parois lamellaires certains Tabules. *Comptes rendus hebdomadaires de l'Académie de Science Paris 248-D*, 2373–2375.

LAFUSTE, J. & PLUSQUELLEC, Y. 1980. Les Polypiers – Tabulata, 143–173. *In* PLUSQUELLEC, Y. (ed.) *Les schistes et calcaires de l'Armorique (Devonien inférieur, Massif Armoricain). Mémoires de la Société géologique et minéralogique de Bretagne 23*.

LAFUSTE, J. & PLUSQUELLEC, Y. 1985. Structure et microstructure de quelques Micheliniidae et Michelinopmorphes (Tabulata paléozoïques). *Bulletin du Muséum national d'histoire naturelle (série 4) 7 C(1)*, 13–55.

GOREAU, T. 1961. Wachstum und Kalkanlagerung bei Riffkorallen. *Endeavour 20(77)*, 32–39.

MAY, A. 2006. Micheliniidae and Cleistoporidae (Anthozoa, Tabulata) from the Devonian of Spain. *Bulletin of Geosciences 81(3)*, 163–172.

OEKENTORP, K. 1972. Sekundästrukturen bei paläozoischen Korallen. *Münstersche Forschungen zur Geologie und Paläontologie 44*, 35–108.

OEKENTORP, K. 1993. Frühdiagenese bei Galaxea und Goniastrea (Scleractinia) aus dem Jungpleistozän der südlichen Sinai-Halbinsel (Ägypten). *Sonderveröffentlichung aus dem Geologischen Institut der Universität zu Köln 70*, 349–368.

OEKENTORP, K. 2001. Review on diagenetic microstructures in fossil corals – a controversial discussion. *Bulletin Tohoku University Museum 1*, 193–209.

OEKENTORP, K. & SCHRÖDER, S. 2001. Korallen (Rugosa; Tabulata) aus dem Paläozoikum des SW Sultan Dağ, Türkei, 369–381. *In* WEISS, R.H. (ed.) *Contributions to Geology and Palaeontology of Gondwana in Honour of Helmut Wopfner*. Cologne.

OGILVIE, M.M. 1897. Microscopic and systematic study of Madreporarian types of corals. *Philosophical Transactions of the Royal Society of London (B) 187(1896)*, 83–345.

SCHOUPPÉ, A. VON & STACUL, P. 1966. Morphogenese und Bau des Skelettes der Pterocorallia. *Palaeontographica Supplement 11*, 1–186.

PLUSQUELLEC, Y., FERNÁNDEZ-MARTÍNEZ, E., MISTIAEN, B. & TOURNEUR, F. 2004. Révision de *Crenulipora difformis* Le Maître, 1956 (Tabulata, Dévonien du Nord Gondwana): morphology, structure et microstructure. *Revue de Paléontologie 23(1),* 181–208.

PLUSQUELLEC, Y. & TOURNEUR, F. 1998. Persistance de Favositides microlamellaires (Cnidaria, Tabulata) dans le Dévonien. *Comptes Rendus de Académie de Science Paris, Sciences de la terre et des planètes 326*, 283–289.

VAHL, J. 1966. Sublichtmikroskopische Untersuchungen der kristallinen Grundbauelemente und der Matrixbeziehungen zwischen Weichkörper und Hartteil an *Caryophyllia*, Lamarck 1801. *Zeitschrift für Morphologie und Ökologie der Tiere 56*, 21–38.

WAINRIGHT, S.A. 1964. Studies of the mineral phase of coral skeleton. *Experimental Cell Research 34*, 213–230.