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THE NANBIANCUN ALGAL MICROFLORA : A STUDY OF THE DEVONIAN-CARBONIFEROUS BOUNDARY IN CHINA

by

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(1 figure)

RÉSUMÉ.- La microflore algaire au voisinage du contact *praesulcata-sulcata* à Nanbiancun, Chine, est peu diversifiée et terne. Elle ne suggère ni modification majeure de faciès, ni transgression importante, ni variation de température à la limite conventionnelle Dévonien-Carbonifère.

ABSTRACT.- The algal microflora at the *praesulcata-sulcata* level in Nanbiancun, China, is undiversified and monotonous. It suggests no major facies change, no important transgression and no temperature variation at the Devonian-Carboniferous boundary.

INTRODUCTION

During the long search for a Devonian-Carboniferous (D/C) reference succession, numerous localities were investigated by a Working Group organized under the leadership of E. Paproth. After a preliminary choice of a boundary at the conodont *praesulcata-sulcata* level in Washington, May 1979, it soon became evident that sections with suitable sedimentary records were not common. Many proposed sequences had to be dismissed as they contained hiatus, condensation, abrupt facies change or showed dominance of a single fossil group with exclusion of the others. Refer for instance to "Devonian-Carboniferous boundary" a volume printed as Courier of the Forschungsinstitut Senckenberg, vol. 67, 1984 and the special volume "Aachen 1986" in the Annales de la Société Géologique de Belgique, t. 109, 1986 (respectively edited by Paproth & Streel 1984 and Bless & Streel, 1986).

After a decade of screening, the number of possible reference sections was reduced to very few. This article is a discussion on stratigraphic results derived from the study of algae of the Nanbiancun section, Guilin, South China, one of the strongest candidate for a global stratotype and point (Yu *et al.*, 1987).

Nanbiancun is well exposed, easily accessible, and its perennity is guaranteed. The limestone sedimentation is apparently "continuous", with many faunal and floral elements from superficial to deeper water facies. It had been carefully investigated by a team of Chinese geologists. The results of their work were published in a Symposium edited by Yu (1988) with data on the sedimentation patterns, geophysical data and the systematic description of fourteen fossil groups : algae, ammonoids, bivalves, blastoids, brachiopods, bryozoans, conodonts, corals, fishes, foraminifers, gastropods, ostracods and trilobites. Few stratigraphic sections in the world, encompassing only a few meters, have yielded such an array of fauna and flora.

The carbonate sequence, first reported to an undivided Rongxian Formation (Anonymous, 1987) was split into the Yongshien, Nanbiancun and Chuanbutou formations (Li *et al.* , *in* Yu, 1988) (see Fig. I). The D/C contact was placed at the bed 55/bed 56 level. More recently, Gong *et al.*, 1991

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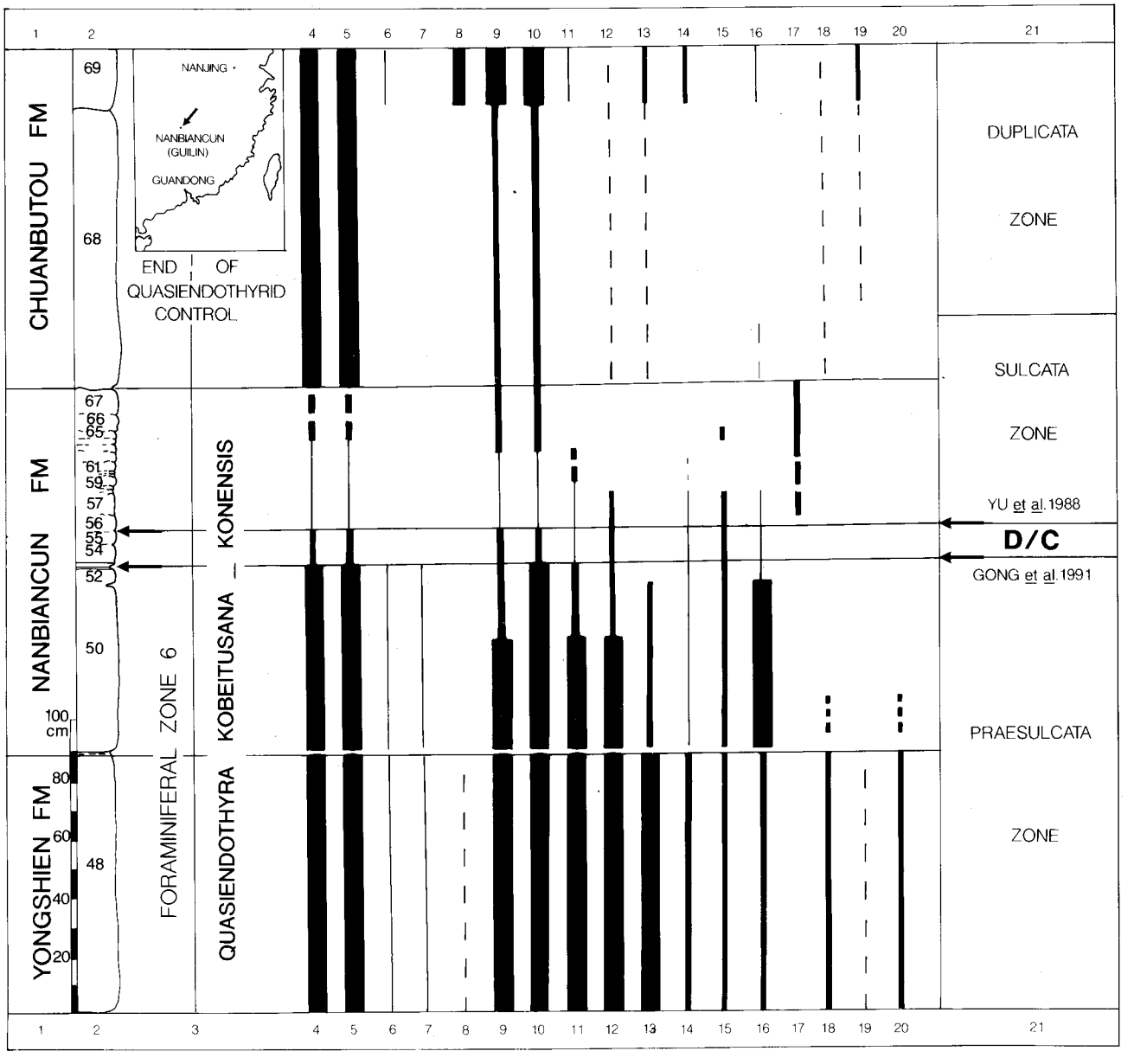

Figure 1. Stratigraphic log of the Nanbiancun section at the vicinity of the D/C boundary beds
1. Formations. 2. Lithologic column with numbers used in Yu, 1988, p. 59. Scale in centimeters. (The entire log is about 3 meters thick) 3. Observed extension of the *Quasiendothyra* Zone 6. 4. Floated algal kysts - Calcisphaeridae. 5. Floated algal kysts - Parathuramminidae 6-8 Questionable *in situ* microfossils: 6. *Renalcis*. 7. *Uralinella*. 8. *Bisphaera*. 9-19 Reworked microfossils (tempestites.): 9. Calcisphaeridae. 10. Parathuramminidae. 11. *Renalcis*. 12. *Wetheredella*. 13. *Palaeomicrocodium*. *14. Girvan*ella. 15. *Sphaeroporel*la. 16. *Uralinel*la. 17. *Parachaetetes* and *Pseudochaetetes*. 18. *Aphralysia*. 19. *Bisphaera*. 20. New genus. 21. Conodont Zones and positions of the Devonian-Carboniferous (D/C) boundary proposed by Yu *et al.* 1988 and Gong *et al.*, 1991.

lowered the first occurrence of the *sulcata*- Zone by a dozen centimeters (52/53 level). The purpose of this note is not to discuss the conodont boundary, but to concentrate on stratigraphic results derived from the floral sequence.

CALCAREOUS MICROFOSSILS (ALGAE AND FORAMINIFERS)

Mu and Zhang (*in* Yu, 1988) illustrate the algae and microproblematica and report a rich *Renalcis* (*Chabakovia-Shuguria-Izhella*) microflora, from the top of the Yongshien Formation, associated with *Palaeomicrocodium*. The Nanbiancun Formation displays a slightly impoverished assemblage, while the Chuanbutou Formation is similar to the Youngshien carbonates and yields abundant Calcisphaeridae.

Wang (*in* Yu, 1988) reports from the same beds, many unilocular "foraminifers" notably *Calcisphaera* and *Archaesphaera*. He thus follows the Russian usage that considers calcispheres as

protozoans, while they are probably algal kysts (Armstrong & Mamet, 1977). He correlates the Nanbiancun assemblage with the "Unilocular Zone" between the *Quasiendothyra* and *Chernyshinella* complexes. Oddly, Wang does not report the presence of plurilocular foraminifers. These are indeed quite scarce, especially if one compares with the prolific *Quasiendothyra* fauna observed in the close-by Etoucun Formation (Anonymous, 1987, Conil *et al.*, 1988). However, scarce and mud-filled reworked Endothyridae and Tournayellidae are present in the Yongshien, Nanbiancun and at the base of the Chuanbutou formations. The association *Latiendothyra, Quasiendothyra communis, Quasiendothyra konensis, Septabrunsiina, Septaglomospiranella, Septatournayella,* indicates Zone 6, the acme of the *Quasiendothyra* lineage. The last beds of the Nanbiancun Formation in the *sulcata-* Zone are very poor and the foraminiferal stratigraphic control is lost at the base of the *duplicat*a Zone.

MATERIAL. SEDIMENTATION

Dr. E. Paproth, Head of the Working Group, had the opportunity to visit the section two times, notably during the IIth International Congress on Carboniferous Stratigraphy and Geology held in Beijing (1987) . W. Ziegler, R. Conil, M. Streel and many Carboniferous stratigraphers became familiar with the section.

The author had the opportunity to collect twice, the first time with M. Legrand-Blain, E. Paproth, G. Sevastopulo and Cheng-Yuang Wang (24th of August, 1987) and the second, (September 7th, 1987) with the participants of the Guangxi Excursion Six of the Carboniferous Congress.

Ninety-seven samples spread on three meters were collected on both sides of the boundary beds in rather pure limestone facies. One hundred fifty thin-sections were cut from the samples and form the basis of this study. By order of decreasing importance, the rocks are brachiopod-echinid grainstones with exotics, echinid grainstones with exotics, brachiopod- echinid-bryozoan grainstones-packstones with exotics, pelloid-fossil grainstones with exotics, echinoderm grainstones with floated calcispheres and a few pelloid-grainstones/packstones. Most of the fossils are reworked bioclasts. The only elements which show little trace of reworking are the crinoids which are often fresh and show no bacterial micritic pitting. Bryozoans are reduced to hash and their zoecia are mud-filled. Thus the sedimentation level fluctuated within the Paleozoic crinoidal meadows, below the crinoidal-bryozoan meadows (Armstrong& Mamet, 1977).

The most obvious characteristic is the presence of exotics which, in the Yongshien Formation, form the vast majority of the carbonate elements. They are less abundant in the Nanbiancun Formation, but omnipresent in the overlying Chuanbutou Formation. They are reworked from a nearby lagoon or shallow ramp and are clearly allochtonous.

The mechanically-reworked flora is composed of free algal kysts, notably *Archaesphaera-Calcisphaera-Parathurammina-Vicinesphaera* which floated at the surface of the sea and slowly descended into the crinoidal meadows. These free kysts are dominant features in the Yongshien Formation, are scarcer in the Nanbiancun Formation, and become again omnipresent in the overlying Chuanbutou Formation.

MICROFLORAL ASSEMBLAGES

Four microflora are recognized in the reworked blocks of the Yongshien and Nanbiancun formation.

1. *Renalcis* bafflestone, usually with mud matrix. Mu interprets the morphs *Chabakovia-Izhella-Shuguria-Renalcis* as independent constructions. (Mu and Zhang, 1988) . In the Frasnian-Famennian mud-mounds and bafflestones the four growth forms are always associated (Mamet & Roux 1983, Mamet & Boulvain, 1992) . Nanbiancun, no exception, supports the hypothesis that the four taxa are four growth forms of bacterial colonies.

2. *Renalcis* bafflestone associated with encrusting *Wetheredella-Sphaeroporella* bindstone in mud matrix.

3. Complex *Renalcis-Wetheredella-Sphaerocodium-Sphaeroporella* bafflestone-bindstone.

4. Highly complex *Renalcis-Wetheredella-Sphaeroporella-Sphaerocodium-Aphralysia-* new genus bafflestone-bindstone.

The four microflora are always associated with numerous calcispheres, parathuramminids and uralinellids. This indicates calm, protected or very shallow water environments, although the paucity of tubular cyanobacteria *(Girvanella)* is striking.

It is therefore tempting to link the origin of the reworked blocks with the contemporaneous Etoucun lagoon which is exposed a few miles south of Nanbiancun. That restricted facies is also dominated

by floods of calcispheres, but *Renalcis* is scarce and these is a conspicuous absence of complex baffle-stones. Thus an Etoucun - type lagoon cannot be the source of the exotics. On the other hand, the Yishan type of condensed lagoon is characterized by abundant and complex associations of *Renalcis-Shaeroporella-Wetheredella-* and it is from this type of facies that the Nanbiancun exotics must originate.

The flora of the base of the Nanbiancun is very similar to that of the underlying strata. The centimetric shale that separates the two formations was interpreted by Huang *et al. in* Yu 1988 as a major transgressive "global eustatic rise at the D/C boundary". This transgression is not substantiated by the flora observed on both sides of the shale. Reworked and *in situ* elements are exactly the same.

In the middle part of the Nanbiancun Formation, below and at the Gong *et al.* and Yu *et al.* D/C contacts, both the quantity of shallow elements and the "snow" of calcispheres diminish. As the two phenomena occur at the same pace, they are not the result of a rapid transgression. The only obvious floral change is the presence of minute solenoporid fragments *(Parachaetetes, Pseudochaetetes)* observed in the *sulcata-* Zone. Again, these fragments are reworked, this time from the open marine ramp.

The base of the Chuanbutou Formation witnesses conditions more or less similar to those of the Yongshien. Floated and reworked calcispheres are more and more abundant, while the coccoid constructions (*Renalcis*) are quite reduced in number and size. *Bisphaera* which was an insignificant contributor, suddenly becomes very abundant at the top of the measured section.

COMPARISON WITH THE D/C BOUNDARY FLORA OF LA SERRE, MONTAGNE NOIRE

The La Serre section in Southern France was, like Nanbiancun, one of the few suitable candidates for a reference section. After long debate, it was finally selected as the best possible reference point (Courtmacsherry, May 25th 1988). It is thus interesting to compare the report of Vachard (1988) with what is known from Nanbiancun.

Vachard notes that lithoclasts are present in the La Serre D/C succession. The level of erosion is much greater than in Nanbiancun as Frasnian and Famennian "griottes" fragments are recognized in the clasts.

Algae are scarce with poor representation of *Aphralysia, Girvanella, Sphaeroporella, Issinella,* kamaenids and solenoporids. The erection of a new *Hedstroemia koninckoporoides* n. sp. is due to a confusion with a micritized bryozoan. Thus the microflora seems to be even less diversified that its Chinese counterpart. On the other hand La Serre has some *Menselina,* a genus not known at Nanbiancun, but common in the Late Famennian Zhewang Formation (Baihupo section, near Dushan, Guyang).

Flajs and Feist (1988) and Feist in Perret, 1990, fig. II, indicate little bathymetric variation at the D/C boundary within their "calcoolitic unit". There are however, just as in Nanbiancun, extensive indications of faunal and floral reworking. In addition, the entrance of ammonoids at the base of the Carboniferous suggests open marine conditions.

CONCLUSIONS

1. The algal microflora observed in the Nanbiancun succession is essentially allochtonous. Calcispheres formed a "snow" that gently settled on the carbonate ramp at the level of the crinoid meadows. The *in situ* algal constructions are limited.

   The reworked flora is quite undiversified, as is the flora of the nearby lagoon of Etoucun and the condensed section at Yishan. No representative of Dasycladales or Udoteaceae are encountered. Absent are *Asphaltina, Asphaltinella, Bevocastria, Garwoodia, Issinella, Ortonella, Proninella, Pseudokamaena* that are common from the Upper Devonian to the Lower Carboniferous. There are few Palaeosiphonocladales.

   This paucity can be explained by two facts : in situ sedimentation is at the base of the photic zone and tempestites gouged the superficial levels leaving unrecorded the middle and upper part of the ramp. In addition, no solid bioconstructions ("reefs") are observed.

2. There is no important floral change to support the existence of a major transgression between the Nanbiancun and Yongshien formations.

3. There is less reworking around the D/C boundary, but no evidence of major breaks in sedimentation or flora and, by inference, in climate and bathymetry.

4. In most of the Tethys, the *Renalcis-Sphaerocodium* flora is drastically reduced in Famennian time. In Southern China, that assemblage slowly peters out slightly later through the Devonian-Carboniferous transition.

5. Transgressive-regressive sequences (sequence-stratigraphy) have been enthusiastically endorsed for global correlations (see the symposiums on sea-levels changes edited by Ross and Haman, 1987 and by Ross and Ross, 1988). The *praesulcata/sulcata* level at Nanbiancun (and probably La Serre) indicates only fourth to third order fluctuations (Ross and Ross, 1991) which can be caused by local subsidences as well as by eustatism (Emery and Aubrey, 1991).

6. The obvious drawback of the Nanbiancun sequence is the importance of the reworking and in particular the necessity to separate in situ and transported material. This applies not only to the microflora, but also to the rest of the microfossils.

BIBLIOGRAPHY

ANONYMOUS, 1987.- Carboniferous carbonates in Guangxi. 11th International Congress Carboniferous Stratigraphy and Geology, Beijing 1987, *Guidebook* 6, p. 1-28.

ARMSTRONG, A.K. & MAMET, B., 1977.- Carboniferous Microfacies, Microfossils and Corals, Lisburne Group, Arctic Alaska. U.S. Geological Survey, *Prof. Paper* 849, 220 pp, 39 pls.

BLESS, M.J.M. & STREEL, M. (eds.), 1986.- Late Devonian events around the Old Red Continent. *Ann. Soc. géol. Belg.*, 109 (1) : 323pp.

CONIL, R. , DE PUTTER, TH., HOU, HONG-FE, WEI, JIA-YONG & WU, XIANG-HE, 1988.- Contribution à l'étude des Foraminifères du Strunien et du Dinantien de la Chine sud-orientale. *Bull. Soc. belge Géol.*, 97 (1) : 47-62.

EMERY, K.O. & AUBREY, D.G. , 1991. Sea levels, land levels and tide gauges. Springer-Verlag, 237 pp.

FEIST, R. 1990.- Première journée. Montagne-Noire in Perret, M. F.(ed.), Field meeting in France and Spain. Guidebook Palaeontological Association, Carboniferous Group, p.1-1-12.

FLAJS, G. & FEIST, R. 1988. Index conodonts, trilobites and environment of the Devonian-Carboniferous Boundary beds at La Serre (Montagne Noire, France). *Courier Forschungs-Institut Senckenberg* , 100 : 53-107, 11 pl.

GONG, XING-BAO, HUANG, HAN-DUO, ZHANG, MEI-LIANG & HUANG, OING-DA, 1991.- The stratigraphic classification and correlation of carbonate rocks of Upper Devonian and Lower Carboniferous in Guilin karst region. *Guangxi Science and Technology Publishing House*, 101 pp.

HUANG, ZHI-CHENG, ZHU, SI-ZHAO & ZHANG, YUE-E, 1988.- Microfacies analysis and sedimentary environment interpretation in Yu, Chang-min, ed. Devonian-Carboniferous Boundary in Nanbiancun, Guilin, China-Aspects and Records. *Science Press,* Beijing : 37-57.

LI, ZHENG-LIANG, LU, HONG-JIN & YU, CHANG-MIN, 1988.- Description of the Devonian-Carboniferous boundary sections in Yu, Chang-min, ed., Devonian-Carboniferous Boundary in Nanbiancun, Guilin, China-Aspects and Records. *Science Press*, Beijing : 19-36.

MAMET, B. & ROUX, A.,1983.- Algues dévono-carbonifères de l'Australie. Revue de Micropaléontologie, 26 (2) : 63-130, 16 pls.

MAMET, B. & BOULVAIN, F., 1992.- Microflore des monticules frasniens "F2j" de Belgique. *Revue de Micropaléontologie,* 35 (4) : 283-302.

MU, XI-NAN & ZHANG, YUE-E, 1988.- Calcareous algae and microproblematica in Yu, Chang-min, ed., Devonian-Carboniferous boundary in Nanbiancun, Guilin, China - Aspects and Records. *Science Press,* Beijing : 149-158, 4 pls.

PAPROTH, E. & STREEL, M. (ed.), 1984.- The Devonian-Carboniferous Boundary. *Courier Forschungsinstitut Senckenberg,* 67, 288 pp.

ROSS, C.A. & HAMAN, DREW, 1987. Timing and depositional history of eustatic sequences. Constraints on seismic stratigraphy. *Cushman Foundation Foraminiferal Research, Special Publication* no 24, 288 p.

ROSS, C.A. & ROSS, JUNE, 1988.- Late Paleozoic transgressive-regressive deposition in Wilgus Ch.K. *et al.*, ed., Sea-level changes; an integrated a approach. *Society of Economic Paleontologists and Mineralogists, Special Publication* 42 : 227-247.

ROSS, C.A. & ROSS, JUNE, 1991. Patterns in Late Paleozoic sea-level fluctuations and depositional sequences (abst). *Geological Society America,* Abstracts with Program, San Diego, p. A 29.

VACHARD, D., 1988.- Calcareous microfossils (Algae, Pseudo-Algae and Foraminifera) from La Serre, Montagne Noire, France. *Courier Forschungsinstitut Senckenberg,* 100 : 137-147, 3 pls .

WANG, KE-LIANG, 1988.- Foraminifera *in* Yu, Chang-min, (eds.), Devonian-Carboniferous Boundary in Nanbiancun, Guilin, China - Aspects and Records. *Science Press,* Beijing : 159-164, 1 pl.

YU, CHANG-MIN, WANG, CHENG-YUAN, RUAN, YI-PING, YIN, BAO'AN, LI, ZHEN-LIANG & WEI, WEI-LIE, 1987.- A desirable section for the Devonian-Carboniferous boundary stratotype in Guilin, Guanxi, South China. *Scientia Sinica,* 30 (7) : 751-764.

YU, CHANG-MIN (ed.), 1988.- Devonian-Carboniferous Boundary in Nanbiancun, Guilin, China - Aspects and Records. *Science Press,* Beijing, 379 , 87 pls.