

The latest Permian calcareous algae of the Changxingian from the lower Yangtze region, East China, and the establishment of a new algal province: the *Pyrulites* Province

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Although the latest Permian calcareous algae are widespread and well documented in South China, there have been only scattered records from East China. Here we reported a latest Permian calcareous algal flora from the Changxing Formation of the lower Yangtze region, East China. The flora was collected from two sections in southern Jiangsu (Wuxi and Suzhou) and two sections in northwest Zhejiang (Huzhou and Changxing). The algal flora comprises five genera and 8 species, including a new species, all assignable to Gymnociodiaceae (*Gymnocodium bellerophontis*, *G. exile*, *G. sp.*, *Permocalculus fragilis*, *P. tellenus* and *Pyrulites sinicus*) and Dasycladales (*Macroporella changxingensis* sp. nov., *Mizzia* sp.). Two common microproblematica genera *Pseudovermiporella* and *Tubiphytes* are also identified here. The algal flora shows close Tethyan affinities and is comparable in general terms to other Late Permian algal floras known from the Tethys Realm and particularly it is similar to the eastern Tethyan floras from South China, which is characterized by the dominance, both in species diversity and in abundance of Gymnociodiaceae algae. Compared to the calcareous algal flora of Middle Permian age the Changxingian flora shows low diversity and none of species continue over the Permian-Triassic boundary. The discovery of calcareous algae from the Changxing Formation at Meishan section, Changxing, northwestern Zhejiang is particularly interesting since this section is the global stratotype section for the Changxingian Stage and for the Permian-Triassic boundary (GSSP) (Yin, 1996). The Changxing Formation at this locality is composed of shallow marine carbonates with carbonate tempestites and turbidites representing an intra shelf slope and basin facies with anoxia/dysaerobic environment conditions. Although the algal assemblage is similar in general aspects to the assemblages of the Huzhou, Wuxi and Suzhou sections to the east and northeast, these three sections represent shallow platform/reef limestone facies. Further, the fossil algae from the Meishan section are usually fragmentary and few in number indicating allochthonous preservation and it is believed that most of the fossils were transported from east and northeast.

It is interesting to note that a well known Permian microproblematica genus, *Pseudovermiporella*, was discovered both from Meishan section and from Xishan section, Suzhou. There is no consensus regarding the systematic affinity of this fossil. It has been established as a dasyclad alga by Elliott (1958) and referred by Korde (1965) to red algae. The other authors suggested that *Pseudovermiporella* is a benthic attached foraminifera (Henbest, 1963; Vachard, 1980, etc.). The abundant occurrence of the genus in the carbonate sequence of the Meishan section, which is deposited in a sedimentary environment unfavourable for shallow marine calcareous algae may support a foraminiferal affinity of *Pseudovermiporella*.

The discovery of the distinctive genus *Pyrulites* Mu in the lower Yangtze region is of interest both stratigraphically and palaeobiogeographically. This genus was established as a subgenus of *Permocalculus* on the basis of *Permocalculus (Pyrulites) sinicus* Mu (1981)

from the Changxing Formation in western Guizhou, southwest China. It has previously been reported from many localities in the Yangtze platform of South China (e.g. Guizhou, Guangxi, Sichuan, Shaanxi, Hubei, Hunan and Jiangxi). The discovery of *Pyrulites* from the lower Yangtze region has further extended its geographical range and its occurrence in southern Jiangsu is currently the easternmost record of the genus. Stratigraphically the genus first appeared in the lower Upper Permian Longtan Formation, reached its maximum development and distribution in the uppermost Permian Changxing Formation and became extinct by the end of the Permian, immediately below the Permian-Triassic boundary. In view of the short stratigraphical range of genus, its widespread geographical distribution and its distinctive morphology that make it easily recognizable in the field. It has been regarded as an index fossil and the *Pyrulites* zone was established for the Changxingian (Mu, 1981). The widespread occurrence of *Pyrulites* in the latest Permian calcareous algal flora of South China together with the absence of the genus in the Tethyan Realm outside South China demarcate a distinctive calcareous algal province in the eastern part of the Tethyan Realm that is here named the *Pyrulites* Province. The *Pyrulites* Province represents one of the latest Permian calcareous algal floral province in the world. Palaeobiogeographically, the range of the *Pyrulites* Province corresponds approximately to the Cathaysian (Faunal) Province (Fang, 1984; Shen and Shi, 2000) but is somewhat narrower.

References

- Elliott G. F. 1958: Fossil micropaleontology from the Middle East. *Micropaleontology* 4: 419-428.
- Fang Z. 1984: A preliminary study of the Cathaysian Faunal Province. *Acta Palaeontologica Sinica* 24(3): 344-349 (in Chinese with English abstract).
- Henbest L.G. 1963: Biology, mineralogy and diagenesis of some typical Late Paleozoic sedentary foraminifers and algal-foraminiferal colonies. *Cushman Foundation Foramin. Res., Spec. Publ.* 6: 1-44.
- Mu X. 1981: Upper Permian calcareous algae from western Guizhou. *Acta Palaeontologica Sinica*, 20(1): 33-49. (in Chinese with English abstract).
- Shen S. & Shi G. R. 2000: Wuchiapingian (Early Lopingian, Permian) global brachiopod palaeobiogeography: quantitative approach. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 162: 299-318.
- Vachard D. 1980: Tethys Gondwana au Paleozoic superieur: les donnees Africaines: biostratigraphie, micropaleontologie, paleogeographie. *Doc. Trav. IGAL*, 2, 463 pp.