

CLASSIFICATION AND CORRELATION OF PALÆOZOIC COAL-BEARING FORMATIONS IN NORTH CHINA

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HISTORICAL

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During his epoch-making exploration in China, von Richthofen¹ divided the Palæozoic coal-bearing series in Shansi into 3 subdivisions:

C. Supracol Sandstone

B. Productive measures

A. Taiyang series.

The marine fossils collected by him from the Po Shan coal field of Shantung were later on studied by Frech² who considered them to be Viséen in age. He recorded the following species:

Spirifer bisulcatus Sowerby

Spirifer duplicicostatus Phillips

Martinia glabra (Martin)

Orthis crenistria Phillips

Productus semireticulatus Martin

Productus punctatus Sowerby

Productus humboldti d'Orbigny

Productus sublaevis de Koninck

Productus longispinus Sowerby

Productus granulatus Phillips

Bellerophon hiulcus Sowerby

Loxonema walciodorensis de Koninck

Macrocheilus cf. intermedius de Koninck

Phymatifer pugilis Phillips

Naticopsis cf. globulina de Koninck

From Hei Shan, he reported the following species:

Spirifer duplicicostatus Phillips

1. Richthofen, F. v. China, Vol. II, pp. 406, 411.

2. Richthofen, F. v. China, Vol. V, p. 64.

Spirifer bisulcatus Sowerby

Orthothetes crenistria Phillips

Productus giganteus Martin

Productus semireticulatus Martin

Productus humboldti d'Orbigny

Productus longispinus Sowerby

Macrocheilus cf. intermedius de Koninck.

Several years later, Bailly Willis and Eliot Blackwelder³ made their Geological reconnaissance in China. They contributed much to the Cambrian stratigraphy and physiography of N. China, but little was done to the Upper Palaeozoic. They classed the Palaeozoic coal-bearing formation in Shansi collectively under the designation *Shansi system* in which were included all the marine intercalations at the base and the coal measures in the upper part. Several assemblages of fossils were collected in Shansi and Shantung, but they were all too fragmentary for a precise identification. Based upon the presence of *Squamularia cf. perplexa* and the extensive occurrence of productive coal measures, Girty⁴ compared the Shansi system with the Pennsylvanian of N. America.

Douvillé, on the other hand, after an examination of several species of brachiopods obtained from the marine limestones of the Shansi system arrived at no definite result as to its age.

Both Yabe⁵ and Hayasaka doubted the correctness⁶ of some of Frech's identifications of the fauna from the Poshan series of Shantung and seemed rather inclined to compare the Shansi system with the Upper Carboniferous.

3. Research in China, Vol. I, p.

4. Girty, G. H. A report on Upper Palaeozoic Fossils collected in China in 1903-04; Research in China, Vol. III, pp. 297-303.

5. Yabe, H. Is Lower Carb. really developed in Shantung, China?, Jour. Geol. Soc. Tokyo, Vol. XXIII, No. 274.

6. As is shown by an extensive study of the Carboniferous fossils from various parts of N. China and an actual examination of the material from Po shan, Y. T. Chao further suggests that most, if not all, of Frech's identifications are unreliable. *Productus giganteus*, *P. humboldti*, *P. sulcatus* and *P. granulatus* are entirely absent from the Taiyuan series of N. China; *Spirifer bisulcatus* Frech has been made a new species *Spirifer taiyuanensis* closely related with *Sp. fritschii* Schellwien and *supramosquensis* Nikitin; while the identification of *Productus longispinus* and *Spirifer duplicatatus* is not quite free from doubt. The various mollusks also need a thorough revision.

Hayasaka⁷ himself made a small collection from the Po-shan coal field among which he listed the following:

Productus semireticulatus var. *humosanus* Girty.

Productus cf. *aculeatus* Schellwien

Marginifera typica var. *septentrionalis* Tschernyschew.

From the Hon Kei Ho coal field⁸ of Manchuria, he also obtained an Upper Carboniferous fauna which contains the following species:

Marginifera timanica Tschernyschew

Camarophoria cf. *mutabilis* Tschernyschew

Dielasma cf. *plica* Kutorga

Spirifer jigulensis Stuckenberg

Spirifer tschernyschewi Stuckenberg

Spirifer nikitini Tschernyschew

Spirifer supramosquensis Nikitin

Spirifer wynnei Waagen

Squamularia cf. *perplexa* M. Chesney

Martinia semiplana Waagen

Martiniopsis baschkirica Tschernyschew

In the same paper, he further noted the occurrence of *Spirifer nikitini* from Yen Tai and *Spirifer wynnei* together with *Arachnastraea manchurica* from Niu Hsin Tai, both being situated in the vicinity of the Pen Hsi Hu coal field of S. Manchuria. After a consideration of the stratigraphical relations between the different coal fields in S. Manchuria and Korea and a study of their contained fossils, he arrived at the conclusion that all the marine beds underlying the coal-bearing series represent the Schwaigerina stage of the Upper Carboniferous.

From Teng-tzang-sebing (Yang Hu Kou), Shan Tan Hsien, Kansu, Béla Széchenyi made an extensive collection of marine fossils which were described by von Lóczy.⁹ He recognized two different kinds of rocks among them and expressed the opinion that they represented most probably two

7. Hayasaka, T. Palaeozoic Brach. from Japan, Korea and China, Pt. I, Middle and South China, P. 18.

8. Hayasaka, T. Palaeoz. Brach. from Japan, Korea and China; Pt. 2, Upper Carb. Brach. from the Hon-Kei-Ho Coal Mines, Manchuria.

9. Lóczy, L. V. Wissenschaftl. Ergebn. d. Reise d. Grafen Béla Széchenyi in Ostasien III, p. 41.

horizons, one being Moscovian while the other is Gschellian. The following is the combined list of species as recognized by Lóczy:

- Productus semireticulatus* Martin
- Productus punctatus* Martin var. *elegans* M'Coy
- Productus scabriculus* Martin
- Productus aculeatus* Martin
- Productus* cf. *undatus* DeFrance
- Productus* cf. *lineatus* Waagen
- Marginifera longispina* Sowerby
- Chonetes pseudovariolata* Nikitin
- Chonetes* cf. *uralica* Möller var. *pygmæa* Lóczy
- Chonetes flemingi* Norwood et Pratten var. *gobica* Lóczy
- Chonetes* cf. *polita* M'Coy
- Chonetella dubia* Lóczy
- Enteleutes lamarcki* Fischer
- Orthothetes crenistria* Phillips
- Spirifer mosquensis* Fischer
- Spirifer strangwaysi* de Verneuil
- Reticularia lineata* Martin
- Athyris* cf. *royssii* l'Eveille
- Eumetria* cf. *grandicosta* Davidson
- Dielasma reticularis* de Koninck

From Sin Ho Yi in the same district, Futterer made another collection which was studied by Schellwien¹⁰ and was believed to be of Gschellian age:

- Gastrioceras? kayseri* Lóczy
- Pleurotomaria lóczyi* Schellwien
- Lingula* aff. *atra* Herrick
- Derbyia* aff. *waageni* Schellwien
- Chonetes pseudovariolata* Nikitin
- Productus cancriniformis* Tschernyschew
- Productus semireticulatus* Martin

10. Schellwien, E. Paläozoische und triadische Fossilien aus Ostasien; Futterer's durch Asien, Vol. III, p. 127.

Productus semireticulatus var. *bathykolpos* Schellwien
Productus (Marginifera) longispinus var. *lobatus* Sow
Productus (Marginifera) pusillus Schellwien
Spirifer (Reticularia) lineatus Martin
Spirifer (Ambocoelia) aff. *planoconvexus* Shun
Retzia (Hustedia) grandicostata (Dav.) Waagen
Rhynchonella (Uncinulus) timorensis Beyr.
Terebratula (Dielasma?) nov. sp.

All the above conclusions are based upon scattered material obtained from various parts of North China. Hence, it is no wonder that very little has been known about the relation between the Palaeozoic coal series in the different provinces and its detailed stratigraphy. In recent years, the Geological Survey carried on a systematic study of the Palaeozoic coal series in N. China and extensive collections of fossils were brought back from successive horizons. A preliminary examination of these fossils leads Prof. A. W. Grabau¹¹ to think that there exists two distinct divisions in the coal series of Shansi, namely a lower believed to be of late Lower Carboniferous age, and an upper of Permo-Carboniferous age, that the two series are separated by a great hiatus and disconformity and that all the marine beds of the coal series in N. China are essentially alike and mark a transgression from the west, i. e. Kansu. The lower division which contains all the principal marine limestones was named by him the Taiyuan series, while the Shansi series of Willis and Blackwelder was restricted only to the upper division which is composed principally of productive coal seams.

In the course of his study of some leading brachiopods from the Taiyuan series, Y. T. Chao¹² on the other hand arrived at a different conclusion. He separated the Taiyuan series, as a whole, into two fossiliferous zones—an upper, the zone of *Spirifer taiyuanensis* and a lower, the zone of *Spirifer mosquensis*. The zone of *Spirifer taiyuanensis* is extensively developed in nearly every part of N. China and contains most of the marine limestones. It is characterized by *Spirifer taiyuanensis*, *Productus*

11. Grabau, A. W. Stratigraphy of China Pt. I, pp. 236-243 and pp. 455-464.

Wong, W. H. & Grabau, A. W. Carboniferous Formations of China; Congrès Géol. Internationale, XIIIe Session.

12. Chao, Y. Y. Age of Taiyuan Series; Bull. Geol. Soc. China, Vol. VI, p. 221-250 pts. D-III.

gratiosus var. *occidentalis*, *Pr. juresanensis*, *Pr. echidniformis*, *Marginitifera pusilla*, etc. and is believed to be of Uralian age, most probably Gschellian. The zone of *Spirifer mosquensis*, on the other hand, is only found at the basal part of the Taiyuan series in Kansu, Shansi, N. Chihli and Shantung, but is well developed in the Pen Hsi Hu coal field of South Manchuria where the zone of *Spirifer taiyuanensis* is entirely absent. This lower zone is characterized by many typical Moscovian species, such as *Spirifer mosquensis* Fisch., *Sp. strangwaysi* Verneuil, *Enteleles lamarki* Fisch. etc. It is, however, worthy of note that even in this zone there have appeared some Uralian species. This mingling of faunas leads him to suggest that the zone of *Spirifer mosquensis* in N. China represents upper Moscovian or else forms a connecting link between the Moscovian and Uralian.

The study of the plant fossils by Newberry, Schenk, Zeiller, Yokoyama, Mathieu and others has also led to valuable results. It is, however, to be noted that plant fossils are abundantly found in strata practically always in association with coal seams. Hence the age of the flora is to be attributed to the Shansi series as defined by Prof. Grabau. In spite of the slightly conflicting ideas held by some of the palaeobotanists, it seems unquestionable that it belongs to Permo-Carboniferous. Thus the conclusion regarding the age of the Shansi series furnished by the plant fossils coincides to a remarkable degree with that indicated by the animal remains.

Summarizing the different classifications and correlations of the Palaeozoic coal series of N. China formerly introduced, we get the following variation from the time of Richthofen down to the present time.

| Richthofen | Willis, Blackwelder | Grabau | Chao |
|--------------------------|-------------------------------|--|---|
| Frech | Girty | | |
| Supra coal sandstone | Shansi System (Pennsylvanian) | Shansi series (Permo-Carb.) | Zone of <i>Spirifer taiyuanensis</i> (Gschellian) |
| Productive measures | | Taiyuan series (Post-Viséan Dinantion) | |
| Late Lower Carboniferous | | | Zone of <i>Spirifer mosquensis</i> (Moscovian) |