84. Ordovician Cephalopods in the Boreal Areas

By Teiichi KOBAYASHI, M. J. A.

(Communicated Nov. 12, 1987)

The Ordovician cephalopods of Siberia are so intimately related to those of Eastern Asia, particularly of the Hwangho basin with which they are considered to have constituted a large cephalopod province. In Central Siberia the Lower Ordovician Ustuiskey-Chunisky formation contains *Multicameroceras*, *Ellesmeroceras*, *Clarkoceras* and a few others which may be referred to the Wanwanian fauna, although *Multicameroceras* was recently found to be a late Upper Cambrian genus in China (Chen and Teichert, 1983).

The succeeding Krivolusky formation yields *Manchuroceras*, *Kotoceras*, *Kawasakiceras*, *Vaginoceras*, *Endoceras*, *Actinoceras*, *Armenoceras*, *Ormoceras*, *Sactoceras* and *Troedssonoceras* including *Kotoceras multiseptum*, *Actinoceras elongatum* and *Sactoceras yokoyamai* among which *Manchuroceras* is a solitary Wolungian relic genus (1987). All other cephalopods are closely allied to the Machiakou and other faunas, particularly the Chikunsan fauna of South Korea. The middle Caradocian Mangazeisky formation contains *Vaginoceras*, *Endoceras*, *Cyclendoceras* and *Spyroceras*. *Vaginoceras cylindricum* is a South Chinese species. Beside them *Richardsonoceras* is reported from an unnamed formation of Central Siberia.

In Eastern Siberia the oldest cephalopod-bearing is the Siensky formation. This and the Krivinsky formation yield *Kotoceras*, *Actinoceras*, *Ormoceras*, *Cyrtactinoceras*, *Discosoras*, *Michelinoceras*, *Spyroceras*, *Stereoplasmoceras*, *Tofangoceras* and so forth. Some of them are identified with the Koreo-Manchurian species. Therefore it is evident that this fauna belongs to the Toufangian probably inclusive of the Maruyaman member because *Armenoceras elegans* among them is possibly a *Polydesmia*.

Thus the Wanwanian fauna is distributed on the Siberian platform where *Manchuroceras*, typical of the Wolungian fauna also occurs. The Toufangian cephalopods flourished more in Eastern Siberia than Central Siberia. In view of the inclusion of Chinese and Korean species in these faunas Central and Eastern Siberia must be combined with Eastern Asia in the same large cephalopod province.

In Alaska *Ellesmeroceras bridgei* Flower, 1941 and *E. expansum* (Flower) reported from the Seward Peninsula are two upper Canadian species. Later Middle or Upper Canadian four new species of four new endoceroid genera and three Chazyian species of *Franklinoceras* and *Proteoceras* were added from the peninsula by Flower (1968). In the Canadian Rocky Mountains *Robsonoceras robsonense* (Walcott), *Walcottoceras monense* (Walcott) and *Clarkoceras* sp. besides three species of *Albertoceras* are known from the Mons formation in Alberta. The Sarbach formation which overlies the Mons unconformably yields *Protocycloceras* and *Catrapphiceras* (Ulrich *et al.* 1944). The Mons and Sarbach are probably early and late Canadian respectively. *Robsonoceras* sp. contained in the *Apatokephalus Peltura* faunule of the McKay group in British Columbia and this cephalopod is probably middle Canadian in age (1955).

Accompanied by *Caseoceras* (?) *holtedhali* (Foerste), *Ellesmeroceras schei* Foerste, 1921 was collected from the lower (?) Canadian limestone at Victoria Head on Bache Peninsula, Ellesmere Island. Poulsen (1927) described *Clarkoceras* from the lower Canadian Cape Clay formation and found *Orthoceras* limestone in the upper Canadian Nunatami formation in Northwest Greenland. Thus Canadian cephalopods have thrived in this part of the Ordovician Arctic sea. They may be more related to the Wanwanian than the Wolungian fauna of Eastern Asia.

The Ordovician sediments are wide spread from North Greenland to King William Land. There occur many early Ordovician cephalopods, but the Chazyan ones or the Maruyaman ones appear to be unrepresented. The Blackriverian and later ones recur. Various Ordovician fossils were described by Foerste, Troedsson, Teichert and others not only from these islands but also from the continental part of Canada. Of cephalopods *Armenoceras*, *Actinoceras* and *Kochoceras* are common genera to which *Calhounoceras*, *Lambeoceras*, *Gonioceras* and many others are associated. They are intimately related to the Toufangian fauna, especially to the Machiakou cephalopods among the Eastern Asiatic fauna. The late Ordovician submergence reached there to the inundation phase in the late Trentonian age (Teichert, 1937).

Little is known of the old basement rocks in the lowland of Western Siberia. It is, however, noteworthy that the Machiakou fauna is well represented in the Ural Mountains by more than ten species of *Actinoceras*, *Armenoceras*, *Sactoceras* and *Ormoceras* which were described by Miagkova (Ivanov and Miagkova, 1955) from the western slope of Central Urals. The Caradocian fossils procured from Khabasova at the northern terminus of the mountains are on the contrary related to the Baltic fauna closely (Kiaer, 1904). The *Ellesmereoceras*-bearing basal Ordovician appears on Waigatch Island.

On the east side of the North Atlantic Ocean not only *Actinoceras* and *Gonioceras*, but *Piloceras* and *Protocycloceras* also are reported from the eastern margin from Bear Island to Scotland through the Smøla Island, Norway. The boreal cephalopods were penetrable through the Caledonian axis in the Ordovician period, because there took place crustal movements repeatedly in the early Ordovician Trondheim phase, late Ordovician Ekne phase and later with the result the up-and-down movements of the barrier have taken place. *Nybyoceras* and *Ormoceras* have reached as far as Esthonia in the Lyckholm stage. Various actinoceroids contained in glacial boulders in Denmark are telling that the distribution of such boreal cephalopods was much wider in the Baltic region in the ice age (Teichert, 1930, 1934). Nevertheless the Middle Ordovician cephalopods of the Baltic region, *Lituities* particularly, indicate the cephalopod fauna is more allied to the Yangtze fauna than the Hwangho fauna.

References

- Balashov, Z. G. (1959): Some new species of Ordovician, Silurian and Devonian Nautiloids. *Foundation of Paleont.*, **3**, 37-46.
 — (1960): Nautiloids, New Species of Fossil Plants and Invertebrates, USSR. vol. 2, pp. 123-135, pls. 26-32.
 — (1962): Ordovician Nautiloids of the Siberian Platform. Leningrad Univ. Press.
 — (1964): Some Nautiloids, Endoceroids and Actinoceroids from Ordovician of northeast of the USSR. *Sci. Rep. Paleont. and Biostratigr.*, Sci. Inst. Aret. Nation. Geol. Comm. USSR, **6**.

- Barnes, C. R., Norford, B. S., and Skevington, D. (1981): The Ordovician system in Canada, correlation chart and explanatory notes. Intern. Union Geol. Sci. Publ., no. 6, 26 pp., 2 charts.
- Flower, R. H. (1941): Cephalopods from the Seward Peninsula of Alaska. Bull. Am. Paleont., **27**(102), 22 pp., 2 pls.
- (1968): Endoceroids from the Canadian of Alaska; A Chazyan cephalopod fauna from Alaska. State Bur. Mines Min. Inst., New Mexico, Mem. 21, pp. 13–23, pls. 4–5.
- Foerste, A. F. (1921): Notes on Arctic Ordovician and Silurian cephalopods, chiefly Boothia Felix-King William Land, Bache Peninsula and Bear Island. Denison Univ. Jour. Sci. Lab. Bull., **19**, 247–306.
- Holtedah, O. (1918): Notes on the Ordovician fossils from Bear Island collected during the Swedish Expedition of 1888 and 1889. Norsk. Geol. Tids., **5**, Hft. 1.
- Ivanov, A. I., and Myackeva, E. I. (1955): Description of the fauna of the western slope of Central Ural. Trudi Geol. Inst., **23**, 104 pp., 15 pls.
- Kobayashi, T. (1931): Ordovician Period. Geology and Palaeontology. Iwanami Lecture Series, 133 pp., 1 pl. (in Japanese).
- (1955): The Ordovician fossils from the McKay Group in British Columbia, Western Canada, with a note on the Early Ordovician palaeogeography. Jour. Fac. Sci. Univ. Tokyo, sec. 2, **9**(3), 355–493, 9 pls.
- (1960): The Ordovician of Korea and its relation to the other Ordovician territories. Rep. Intern. Geol. Congr., XXI Ses. Norden, 1960, Copenhagen, XXII. Ordovician and Silurian Stratigraphy and Correlation, pp. 34–43.
- (1969): The Ordovician of Eastern Asia and other parts of the Continent. Jour. Fac. Sci. Univ. Tokyo, sec. 2, **17**(2), 163–316.
- (1971): The Cambro-Ordovician faunal provinces and the interprovincial correlation. *ibid.*, sec. 2, **18**(1), 129–299.
- (1987a): Ordovician cephalopods in Hwangho basin, Eastern Asia. Proc. Japan Acad., **63B**, 235–238.
- (1987b): Ordovician cephalopods of Yangtze and neighbouring areas. *ibid.*, **63B**, 239–241.
- (1987c): On the *Manchuroceras* and *Piloceras* provinces in the Ordovician period. *ibid.*, 310–312.
- Nikiforova, N. J. (1955): Field Atlas of Ordovician and Silurian of Siberian Platform. 268 pp., 42 pls.
- Poulsen, C. (1927): The Cambrian, Ozarkian and Canadian faunas of Northwest Greenland. Jubilaemsekspektionen Nord om Grønland 1920–23, Nr. 2, pp. 237–343, 14–21 pls.
- (1930): Contributions to the stratigraphy of the Cambro-Ordovician of East Greenland. Meddles om Grønland, **74**, 299–316.
- (1937): On the Lower Ordovician faunas of East Greenland. *ibid.*, **119**(3), 1–72, 8 pls.
- (1946): Notes on Cambro-Ordovician fossils collected by the Oxford University Ellesmere Land Expedition 1934–5. Quart. J. Geol. Soc. London, **102**, 299–337, pls. 19–24.
- (1951): Position of the East Greenland Cambro-Ordovician in the palaeogeography of the North Atlantic Region. Medd. fra Dansk Geol. Forening, **12**, 2 pp.
- Shimansky, V. N., Balashov, Z. L., and Zhuravleva, F. A. (1962): Nautiloidea. Principles of Paleontology. 438 pp., 32 pls.
- Strand, T. (1933): The Upper Ordovician cephalopods of the Oslo area. Norsk. Geol. Tidsskr., **14**, 117 pp., 13 pls.
- Sweet, W. C. (1958): Middle Ordovician of Oslo region Norway. 10. Nautiloid Cephalopods. Norsk. Geol. Tidsskr., **38**, h. 1, 178 pp., 21 pls.
- Teichert, C. (1930): Die Cephalopoden-Fauna der Lyckholm-Stufe des Ostbaltikum. Palaeont. Zeitschr., **12**, 264–312.
- (1934a): Einige Actinoceroide Cephalopoden aus dänischen Diluvialgeschieben

- und aus der Gotlandium Skandnaviens. Dansk geol. Forning., **8**(4), 371–401, pls. 8–10.
- Teichert, C. (1934b): Untersuchungen an Actinoceroiden Cephalopoden aus Nordgrönland. Medd. om Grönland, **92**, Nr. 10, 5–48.
- (1937a): A new Ordovician fauna from Washington Land, North Greenland. *ibid.*, **119**, Nr. 1, 3–65, 1–7 pls.
- (1937b): Ordovician and Silurian faunas from arctic Canada. Report of the Fifth Thule Expedition 1921–24. vol. 1, no. 5, 169 pp., 1 geol. map, 24 pls.
- Troedsson, G. T. (1926, 1929): On the Middle and Upper Ordovician faunas of Northern Greenland, I. Part 1. 157 pp., 65 pls. in 2 vols. Part 2, 197 pp., 56 pls.
- (1937): On the Cambro-Ordovician Faunas of Western Quruq tagh, Eastern Tienshan. The Sino-Swedish Expedition, Publication 4, 74 pp., 10 pls.
- Ulrich, E. O. *et al.* (1944): Ozarkian and Canadian cephalopods, Part 3. Longicones and Summary. Geol. Soc. Am., Sp. Pap., no. 58, 226 pp., 68 pls.
- Zhulavleva, F. A. (1964): New Ordovician and Silurian Cephalopoda from the Siberian Platform. pp. 87–100, 2 pls.