

# UPPER DEVONIAN GONIATITE SUCCESSION OF WESTERN AUSTRALIA.

CURT TEICHERT.

ABSTRACT. The Upper Devonian Goniatite beds of the Kimberley District, in the northern part of Western Australia, comprise equivalents of Oberdevonstufe, I, II, and III. The fauna of these beds is very similar to that of the strata in the European standard sections of these stages. Among the important fossils are the lamellibranch *Buchiola*, the trilobites, *Scutellum* and *Cyrtosymbole*, the goniatites, *Manticoceras*, *Beloceras*, *Cheiloceras*, *Tornoceras*, *Sporadoceras*, *Dimeroceras*, *Pseudoclymenia*, and the clymeniid *Platyclymenia*.

REVIEWING the world-wide distribution of Upper Devonian goniatites, A. K. Miller, in his recent monograph on the American representatives of this group (1938, p. 4), justly deplored the fact that "the Devonian ammonoids of Australia have received less attention than they seem to merit." As a matter of fact, prior to Delépine's description, in 1935, of a few species of Upper Devonian goniatites from the Kimberley District of Western Australia, no accurate information on Devonian forms from Australia had been available at all.

The Kimberley District of Western Australia is the only part of Australia, where a goniatite facies is developed in any portion of the Devonian. It is, therefore, the only place on this continent where Devonian strata can be correlated in much detail with strata of corresponding age elsewhere. Fortunately, new information has been obtained in recent years which increases our knowledge of the Upper Devonian succession in this area and which throws new light on the Upper Devonian history of this part of the world.

The Upper Devonian has its main distribution in the neighbourhood of Mt. Pierre (approximately  $125^{\circ} 50'$  long.,  $18^{\circ} 17'$  S. lat.) and extends from there probably as a more or less continuous belt in a southeasterly direction along the northeastern side of the Rough Range and still farther south along unnamed ranges which are a continuation of Rough Range (Wade 1936). Owing to the remoteness of the region from any centers of research, no detailed investigations of the extent and succession of these strata have ever been carried out, nor are any further additions to our knowledge likely to be made in the near future.

The discovery of the Devonian strata at Mt. Pierre is due to E. T. Hardmann, one of the pioneers in Western Australian geology. Hardmann's finds of a few fragmentary goniatites were described by A. H. Foord in 1890, but the fossils were too poorly preserved to allow of any close comparison with faunas outside Australia. Some time later, in 1901, Gürich ventured the guess that these fragmentary specimens might represent some early Upper Devonian species. No further additions to our knowledge were, however, made until in recent years, when additional collections and some stratigraphical observations were made by Prof. E. de C. Clarke in 1927, by Dr. Arthur Wade in 1924 and in 1934 and finally by myself in 1939. The only published record so far is the description of a small goniatite fauna of Fammenian age, mainly from Professor Clarke's collections, by Delépine in 1935, and the listing of *Beloceras multilobatum* by Wade in 1938.

My own field investigations, limited as they were to one day, as well as the study of collections brought home by Doctor Wade have revealed the presence of a fair number of hitherto unrecorded goniatite species in the Upper Devonian of the Kimberley District and on the basis of the stratigraphical information obtained, however incomplete it may be, it is now possible to describe the main outlines of the goniatite succession and to demonstrate the close relationships between the development of the faunas in this area and those of certain type localities of the Upper Devonian in Europe. Owing to the fact that only a small part of the widely scattered literature on this subject is available in Western Australian libraries, it will not be possible to complete the description of this new fauna in the immediate future. The salient facts are, therefore, given here in advance and further details must be left to the fuller publication.

As is well known, goniatites afford the best means for detailed zoning and correlation of Devonian deposits and it will be seen that the West Kimberley goniatite succession provides another excellent example of the usefulness of this group in this respect, even in a case where huge geographical distances are involved in the task of correlation.

There are a few places known in Europe where the entire Upper Devonian is represented by goniatite-bearing strata. The most complete and best known of these sections are in

Germany and it may be well to recall that the following divisions of this goniatite facies are now recognized there:

Oberdevonstufe VI = *Gattendorfia* stage (considered by some authors to be Lower Carboniferous)

Oberdevonstufe V = *Wocklumeria* stage

Oberdevonstufe IV = *Laevigites-Gonioclymenia* stage

Oberdevonstufe III = *Prolobites-Platyclymenia* stage

Oberdevonstufe II = *Cheiloceras* stage

Oberdevonstufe I = *Manticoceras* stage

These stages are again subdivided into zones designated by the addition of Greek letters to the Roman number (I $\alpha$ , I $\beta$  etc.). On the other hand, Belgian and French authors often refer to the *Manticoceras* stage as Frasnian and to the rest of the Upper Devonian as Fammenian. In many areas all over Europe only some part of Upper Devonian time is represented by goniatite facies, the balance of the Upper Devonian being absent or represented by coral—or brachiopod-bearing strata, devoid of goniatites. For details of correlation it might be useful to refer to Schindewolf's treatise on Upper Devonian palaeogeography (1921).

As mentioned above, the presence in the Kimberley District of strata of Fammenian age, approximately equivalent to Oberdevonstufe III, was realized by Delépine in 1935, though my observations in 1939 have shown that some of Delépine's species, at least *Dimeroceras clarkei*, are restricted to strata which are equivalent to Oberdevonstufe II. Our present knowledge of the general succession of the Upper Devonian of Western Australia, as based on the sources mentioned above, can be summarized as follows:

|                       | Fauna           |   |
|-----------------------|-----------------|---|
| Crinoidal limestone   |                 |   |
| Upper Goniatite beds  | Goniatites:     | <i>Sporadoceras</i> n. sp.<br><i>Pseudoclymenia australis</i>   |
|                       | Clymeniids:     | <i>Platyclymenia</i> sp.  |
|                       | Nautiloids:     | <i>Wadeoceras australe</i>  |
| Middle Goniatite beds | Goniatites:     | <i>Dimeroceras clarkei</i><br><i>Imitoceras</i> n. sp.<br><i>Cheiloceras</i> spp.<br><i>Tornoceras</i> spp. |
|                       | Trilobites:     | <i>Cyrtosymbole</i> sp.   |
|                       | Lamellibranchs: | <i>Buchiola</i> cf. <i>retrostriata</i>   |
|                       | Goniatites:     | <i>Manticoceras</i> sp.   |
|                       |                 | <i>Beloceras multilobatum</i>   |
| Lower Goniatite beds  | Trilobites:     | <i>Scutellum</i> n. sp.   |

The boundaries between the different goniatite beds are not yet fixed nor is their thickness known, but it is known that the Upper Goniatite beds in the vicinity of Mt. Pierre are overlain by crinoidal limestone and that the Lower Goniatite beds at Bugle Gap, in the range that forms the southern continuation of Rough Range, overlie unconformably limestones with the stromatoporoid *Amphipora ramosa*. It is, furthermore, quite clear that the Lower, Middle and Upper Goniatite beds correspond to Oberdevonstufe I, II, and III respectively. In fact, the close similarities with corresponding faunas in Europe (and North America) are startling. The assemblage of fossils in the Lower Goniatite beds, all found in a few limestone specimens from Bugle Gap in the Wade collection, is one that could easily have been picked from about six feet of limestone near Adorf, in the Rhenish Schiefergebirge of Germany, one of the type localities of the *Manticoceras* stage in Europe. *Manticoceras* is restricted to the zone I $\beta$  and I $\gamma$ , now united into one zone "I( $\beta$ )- $\gamma$ " by Matern (1929), and to I $\delta$ . *Beloceras* is restricted to I( $\beta$ )- $\gamma$ . The trilobite *Scutellum* (*Goldius* = *Bronteus*), first met with in the Silurian, where it is comparatively plentiful, decreases in number of species during the Lower and Middle Devonian and survives with two or three species into the Upper Devonian, where it is confined to the *Manticoceras* stage (R. and E. Richter 1926). It is an interesting fact that this genus, although on the verge of extinction, has found its way to these distant waters. *Buchiola* is common in the Middle Devonian, but like *Scutellum* it is still a characteristic member of the *Manticoceras* assemblage in Europe and North America.

The fauna of the Middle Goniatite beds is not as strikingly characteristic as that of the lower beds, but it is nevertheless easily datable. *Cheiloceras* is restricted to Oberdevonstufe II; *Dimeroceras* has its main distribution in this stage; *Imitoceras* is not known from strata older than Oberdevonstufe II; and only *Tornoceras* has a longer time range. The trilobite *Cyrtosymbole* (*sensu stricto*) is restricted to Oberdevonstufe II and III, but is more abundant in II. *Wadeoceras* (Teichert 1939) is a member of the interesting group of actinosiphonate nautiloids or Cyrtoceroidea which was formerly not known to be represented outside North America and Europe. The Middle Goniatite beds also contain fish remains which have not yet been properly studied.

The Upper Goniatite beds carry a fauna which is characteristic of Oberdevonstufe III. *Sporadoceras* starts in II, has its main development in III, and survives with a few species into IV. *Pseudoclymenia* occurs in Oberdevonstufe II and III. *Platyclymenia*, however, the first clymeniid yet reported from Australia, is limited to Oberdevonstufe III and it is interesting to note that even this short-lived Upper Devonian group of cephalopods has found its way to Australia.

These facts may suffice to demonstrate that in the West Kimberley District of Western Australia we have a series of goniatite strata equivalent to the first three of the Oberdevonstufen in Germany. Whether it will be possible to carry the correlation down to the subzones, it is as yet too early to say.

It may be mentioned that there are, outside Western Australia, only five places in the world, where an equally complete succession of the first three of the Upper Devonian goniatite stages are known and all of these are far removed from Australia. They are Béni-Abbès in northern Africa (northwestern Sahara), Cabrières in the Montagne Noire, France, recently redescribed by R. Böhm (1935), the Upper Harz Mountain in Germany, the Lysa Gora in Poland and Verchne-Uralsk on the eastern slope of the Ural Mountains. In most of these places the faunal assemblages are richer in species than the Western Australian beds, but this might well be due to the small amount of investigation in this country.

Of particular interest is the discovery of the *Manticoceras* stage in Western Australia. This is the most wide-spread of all the Upper Devonian goniatite stages. It is well developed in the State of New York, it is wide-spread all over Europe from France and Devonshire to the Ural Mountains, it has been found in northern Africa, and it is also reported from Central Hunan in southern China (Sun 1935). This latter occurrence is the only link as yet known between the European and the Western Australian development of the Upper Devonian goniatite facies. The younger goniatite stages in Western Australia are still more isolated—no goniatites of any age younger than the *Manticoceras* stage have yet been found anywhere east of the Ural Mountains and goniatites indicating the presence of Oberdevonstufe II and III are only sparsely represented in North America. It is, however, reasonable to suppose that occurrences of this age will some time be discovered in southeastern Asia, because the contemporaneous gonia-

tite fauna must have arrived in Western Australia by way of the Devonian Tethys.

In conclusion, I wish to express my gratitude to Mr. L. M. Waterford and to Dr. R. T. Prideo for their valuable assistance in the field, and to Dr. Arthur Wade for important personal communications and discussions.

REFERENCES.

- Böhm, R.: Etudes sur les faunes du Dévonien supérieur et du Carbonifère inférieur de la Montagne Noire. 195 pp. 10 pls. Montpellier, 1935.
- Delépine, G.: Upper Devonian goniatites from Mount Pierre, Kimberley District, Western Australia. *Qu. Jour. Geol. Soc. London.* Vol. 91, pp. 208-215, 1935.
- Foord, A. H.: Description of fossils from the Kimberley District, Western Australia. *Geol. Mag.*, Dec. III, Vol. 7, pp. 2-20, 1890.
- Gürich, G.: Jura- und Devon-Fossilien von White Cliffs, Australien. *Neues Jahrb. f. Min., Geol., Pal., Beil.-Bd. 14.* pp. 484-518, 1901.
- Matern, H.: Die Gliederung der Adorf-Stufe. *Senckenbergiana*, Vol. 11, pp. 142-152, 1929.
- Miller, A. K.: Devonian Ammonoids of America. *Geol. Soc. Amer., Spec. Pap. No. 14*, 262 pp., 39 pls., 1938.
- Richter, R. and E.: Die Trilobiten des Oberdevons. *Abhandl. Preuss. Geol. Landesanst*, N. F. 99. 314 pp. 12 pls., 1926.
- Schindewolf, O. H.: Versuch einer Paläogeographie des europäischen Oberdevonmeeres. *Zeit. Deutsch. Geol. Ges.*, Vol. 73, pp. 137-223, 1921.
- Sun, Y. C.: On the occurrence of the Manticoceras fauna in Central Hunan. *Bull. Geol. Soc. China*, Vol. 15, pp. 249-252, 1935.
- Teichert, C.: Nautiloid Cephalopods from the Devonian of Western Australia. *Jour. Roy. Soc. West. Austr.*, Vol. 25, pp. 103-120, 2 pls., 1939.
- Wade, A.: The Geology of the West Kimberley District of Western Australia. Final Rep. on Concessions held by Freney Oil Co. Perth. 69 pp. [Printed privately for Freney Oil Co., Perth.] 1936.
- : The Geological Succession in the West Kimberley District of Western Australia. *Rep. Aust. U. Zeal. Assoc. Adv. Sci.*, Vol. 23 (Auckland Meeting), pp. 93-96, 1938.

UNIVERSITY OF WESTERN AUSTRALIA,  
CRAWLEY, WESTERN AUSTRALIA.