LATE JURASSIC BRACHIOPODS FROM NORTH-EAST IRAN

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ABSTRACT. A brachiopod fauna from the Mozduran Formation of the Kopet-Dagh Basin in north-east Iran, near the border with Turkmenistan, is described. It is of Late Jurassic age and shows affinities with European forms, especially those of 'Boreal' type from Russia. There are no 'Tethyan' or 'Ethiopian' forms present.

THE Kopet-Dagh basin in north-east Iran is about 600 km long and about 200 km wide. It was established after mid Triassic orogenic movements, when the Iran and Turan plates had apparently joined (Berberian and King 1981). From mid Jurassic times onwards, the basin was invaded by a widespread Mesozoic epicontinental sea. It subsided and acquired a thick sequence (about 10 km) of almost continuous shallow marine to continental sediments ranging from Jurassic to Oligocene in age, with no major sedimentary breaks or volcanic activity. The basin started subsiding along major longitudinal faults during the Jurassic (Berberian and King 1981). Moussavi-Harami and Brenner (1992), however, suggested that much of the post-Jurassic subsidence in the eastern Kopet-Dagh basin was caused by sediment loading rather than tectonism. No important orogenic movements took place after early Jurassic times until the area was folded late in the Alpine Orogeny along south-east to north-west lines.

The study area is located to the north-east of Mashhad (Text-fig. 1) between latitudes 30° and 36° 10′ N and longitudes 60° 30′ and 61° E. The general stratigraphy of the Kopet-Dagh basin in this area comprises 15 different formations (Text-fig. 2) from mid Jurassic to Oligocene age (Afshar-Harb 1970; Kalantari 1987). The brachiopods described herein are from the Upper Jurassic Mozduran Formation, which is exposed in the Sarakhs area of north-east Iran. It conformably overlies fluvio-deltaic to shallow marine deposits of the Kashafrud Formation (Madani 1977) and is succeeded conformably by the Shurijeh fluvial siliciclastics (Moussavi-Harami 1986). Foraminiferal studies by Kalantari (1969) indicate that the Mozduran formation ranges in age from Callovian to Kimmeridgian. The brachiopods were collected from the upper part of the Mozduran section. At the time of formation the basin was situated probably at a palaeolatitude of about 20° N (Smith *et al.* 1981). The Mozduran carbonates consists of diverse skeletal and non-skeletal grains, with abundant red and blue-green algae, evaporites and early diagenetic dolomites. Petrographic and geochemical evidence indicates that the Mozduran Formation was deposited in a warm, tropical, shallow marine environment (Adabi and Rao 1991). The purpose of the paper is to describe this new brachiopod fauna and to examine its stratigraphical and biogeographical implications.

SYSTEMATIC PALAEONTOLOGY

Order TEREBRATULIDA Waagen, 1883
Superfamily TEREBRATULOIDEA Gray, 1840
Family TEREBRATULIDAE Gray, 1840
Subfamily LOBOIDOTHYRINAE Makridin, 1964

Genus MOESCHIA Boullier, 1976

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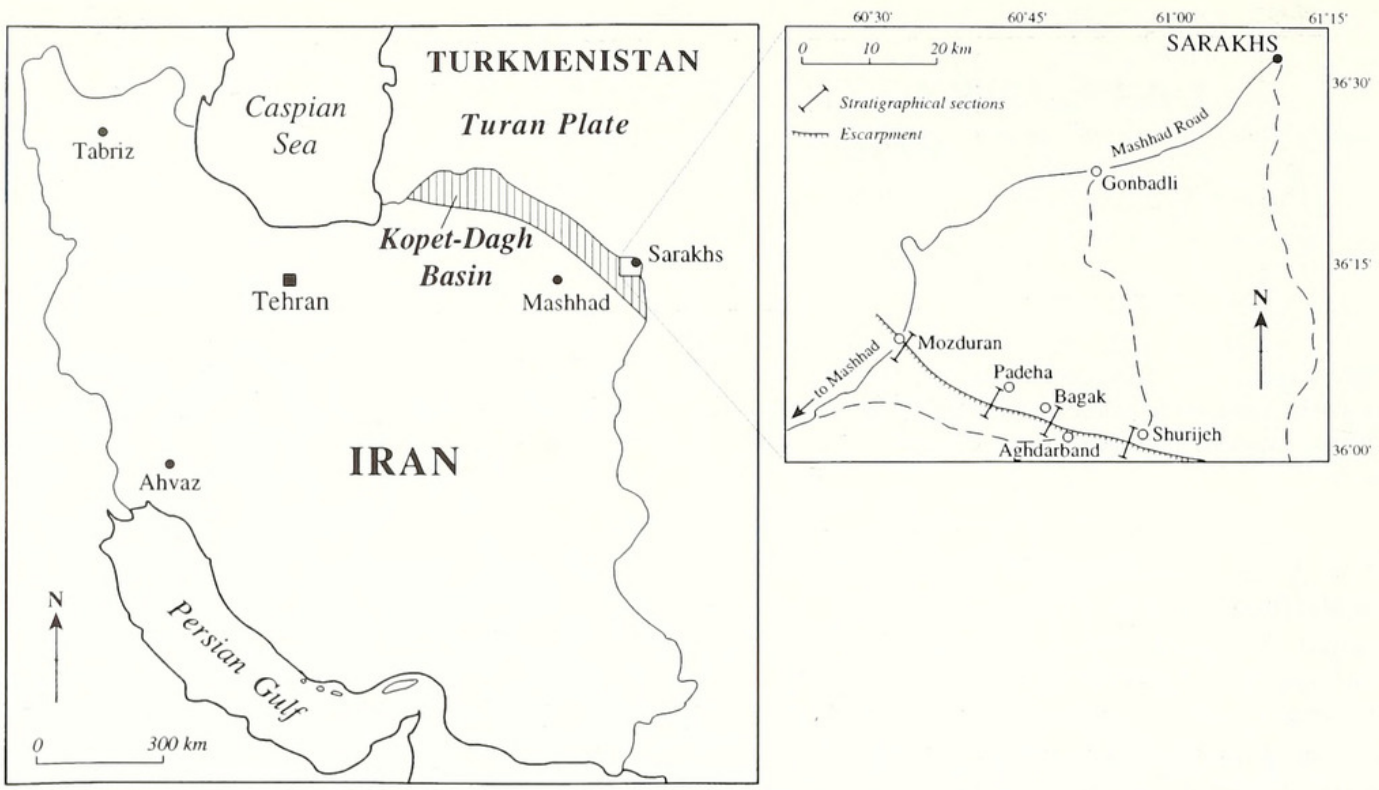


TEXT-FIG. 1. Location of sections in Kopet-Dagh Basin, north-eastern Iran.

Remarks. This genus is common in the Upper Jurassic of Europe. Besides the type species, *Terebratula alata* Rollet, Boullier (1976) also included *Loboidothyris zeiteni* (de Loriol). The latter was well known to one of us (DVA) and occurs commonly in the Kimmeridgian of the French Jura (Ager and Evamy 1963). It is found right across Europe to Poland (Barczyk 1969) and the Russian platform (Makridin 1964) and is closely related to the form described here.

Buckman (1918) originally described *Loboidothyris* from the Aalenian and Bajocian but Makridin (1960) recorded it in the Oxfordian of Russia, and Ksiazkiewicz (1974) recorded it doubtfully in Poland from as high as the Tithonian. Boullier (1976) described *Moeschia* species from the Upper Jurassic of France, and the Iranian form described below can be attributed to *M. subsella*.

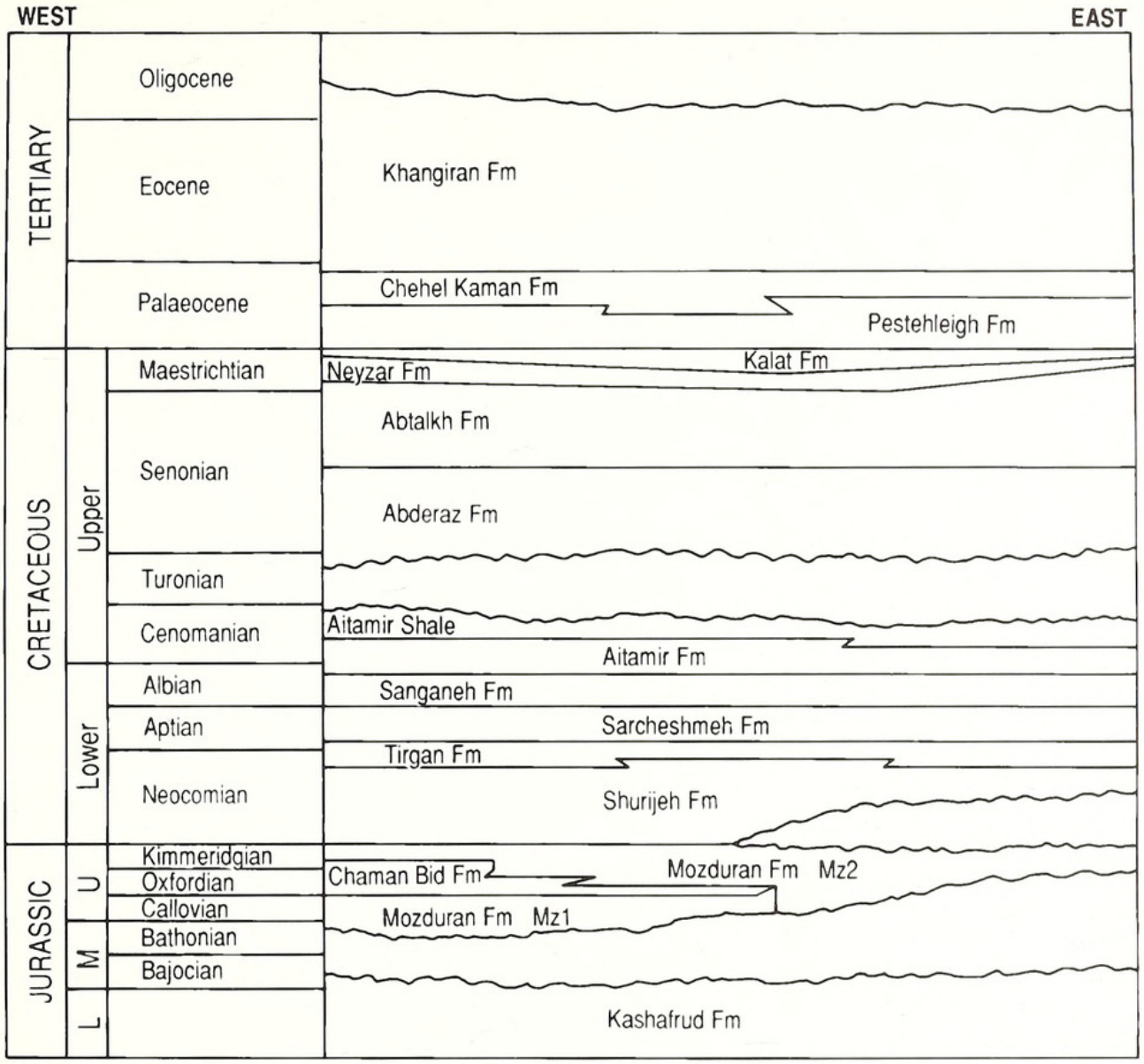
Moeschia subsella (Leymerie, 1846)

Plate 1, figures 1–4

Description. This is a small to medium-sized *Moeschia*, longitudinally oval in outline but with the characteristic truncated anterior margin. The largest specimen from Iran (albeit slightly damaged) is 41 mm long, 37 mm wide and 19 mm thick. The anterior commissure is uniplicate to gently biplicate, generally the latter. The beak is massive, erect and mesothyrid; the beak-ridges are rounded. The valves are biconvex of plano-convex. They are smooth with no discernible growth-lines. Makridin (1964) recorded this species from the Upper Oxfordian of the Russian platform, it is certainly close to *M. zieteni*, which ranges up through the Kimmeridgian to near the top of the Jurassic. There are 13 specimens in the Iranian collection which can be referred to *M. subsella*.

Genus URALELLA Makridin, 1960

Remarks. This is one of a group of very large terebratulids that characterize the uppermost Jurassic. Besides *Uralella*, it includes *Gigantothyris*, *Boreiothyris*, *Taimyrothyris*, *Siberiothyris*, *Juralina* and *Rouillieria*. Although particularly characteristic of the Russian Platform (extending into Poland), *Rouillieria* is also found as far west as Britain (Ager 1971) as a member of a typically Boreal assemblage. The accompanying rhynchonellids, such as *Torquirhynchia* and *Russirhynchia*, are also often of an unusually large size. All these forms are characteristic of the Boreal region.



TEXT-FIG. 2. Stratigraphical column for the Kopet-Dagh Basin, north-eastern Iran (after Afshar-Harb 1979).

Uralella gigantea Makridin, 1964

Plate 1, figure 5

Description. All members of this genus are large but, as the name implies, this species is even larger than the rest. The single specimen from Iran (Pl. 1, fig. 2) is the internal case of the pedicle valve and measures 67 mm long, 67 mm wide (though it is slightly broken and was probably a few millimetres wider) and about 21 mm deep for the single valve.

From Makridin's plates (1964, pls 18–19) *U. gigantea* appears to be equally biconvex, so the original depth of this specimen may have been about 42 mm. Makridin's specimens are up to 84 mm long, 80·5 mm wide and 35 mm deep. His smallest specimen (Makridin 1964, p. 257) is 35 mm long, 37 mm wide and 19·5 mm deep, but larger specimens appear to be the most common, and the small ones may be juveniles.

The surface of the Iranian specimen is smooth with faint growth-lines, like those from Russia. The ventral beak is broken, but appears to be strongly incurved. As it is an internal cast, no punctae are visible. Makridin (1964) figured serial sections and a reconstruction, which show a short smooth loop turned back in a posterior direction, with a short connecting band. The teeth are long and slender, inserted obliquely in the sockets. No cardinal process is shown, but in other species of *Uralella* this is known to be thick with rather few ridges.

Remarks. Makridin recorded this species from the Lower Volgian. It is not very common in Russia, and Makridin (1964, p. 256) recorded only five well-preserved shells and four internal casts. Dagys (1968, p. 100) recorded 17 small damaged shells from the northern Urals. From the name it may be presumed that the genus comes from the Urals, though Makridin does not seem to be specific on this point. Dagys, however, mentions Yatriya in the northern Urals and again gives the horizon as Lower Volgian.

Order RHYNCHONELLIDA Kuhn, 1949
Superfamily RHYNCHONELLOIDEA Gray, 1848
Family RHYNCHONELLIDAE Gray, 1848
Subfamily CYCLOTHYRIDINAE Makridin, 1955

Genus TORQUIRHYNCHIA Childs, 1969

Remarks. Large late Jurassic rhynchonellids, commonly attributed in the past to *Rhactorhynchia* or to *Septaliphoria*. Their most obvious feature is their strongly asymmetrical anterior commissure, from which the name is derived.

Torquirhynchia inconstans (J. Sowerby, 1816)

Plate 1, figures 6–8

Description. This is the best known member of the genus and is particularly common in the Kimmeridgian at its type locality in Dorset, southern England. It is a large globose form with marked asymmetry in the anterior commissure. The largest specimens range up to about 35 mm long, 34 mm wide and 32 mm deep. The Iranian specimens do not reach such dimensions, but are comparable in every way to the type material. The beak is massive, erect and submesothyrid with fairly sharp beak ridges. There are up to 20 simple, unbranched costae of the *tetrahedra* type (Ager 1956) on each valve. They are usually equally divided between the two lateral halves of the shell. The shells are dextrally or sinistrally skewed in almost exactly equal numbers. It has been suggested that this represents sexual dimorphism, but there is not real evidence of this (Ager 1969). It seems more likely that it is an adaptation to functioning either the right way up in rough water, or whilst resting on one of the broad planareas.

In the collection from Iran, 25 specimens appear to be attributable to this species, but it probably passes by insensible gradations into the following.

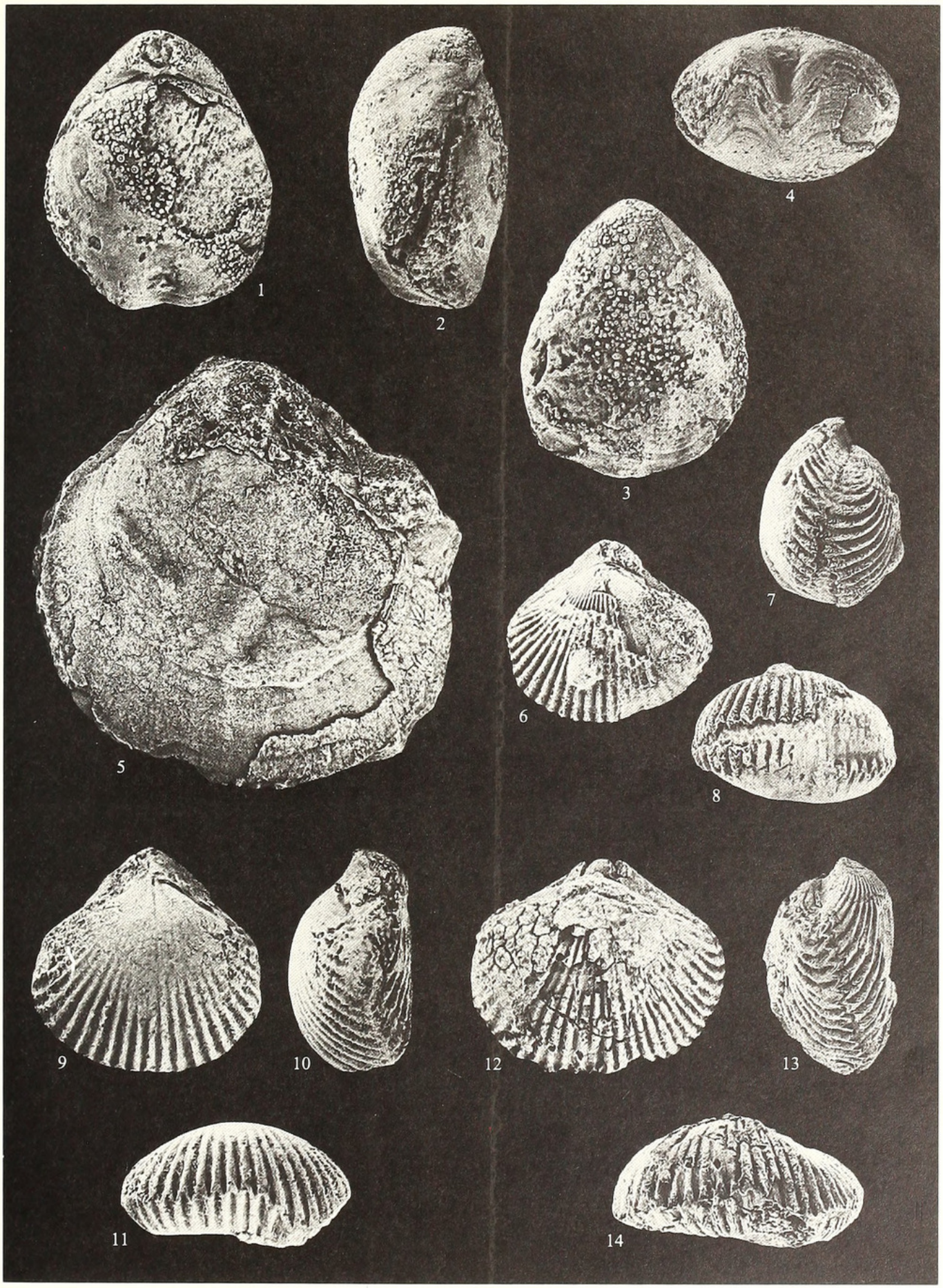
Torquirhynchia lehmanni (Makridin, 1964)

Plate 1, figures 9–11

Description. This is the most common brachiopod from the Mozduran Formation and 39 specimens belong here. The only apparent distinction from *Torquirhynchia inconstans* is the more depressed nature of the shells and the less marked nature of the asymmetry of the anterior commissure. An average specimen measures about 28 mm long, 32 mm wide and 17 mm deep, with the length to depth ratio much higher than in the type species.

EXPLANATION OF PLATE 1

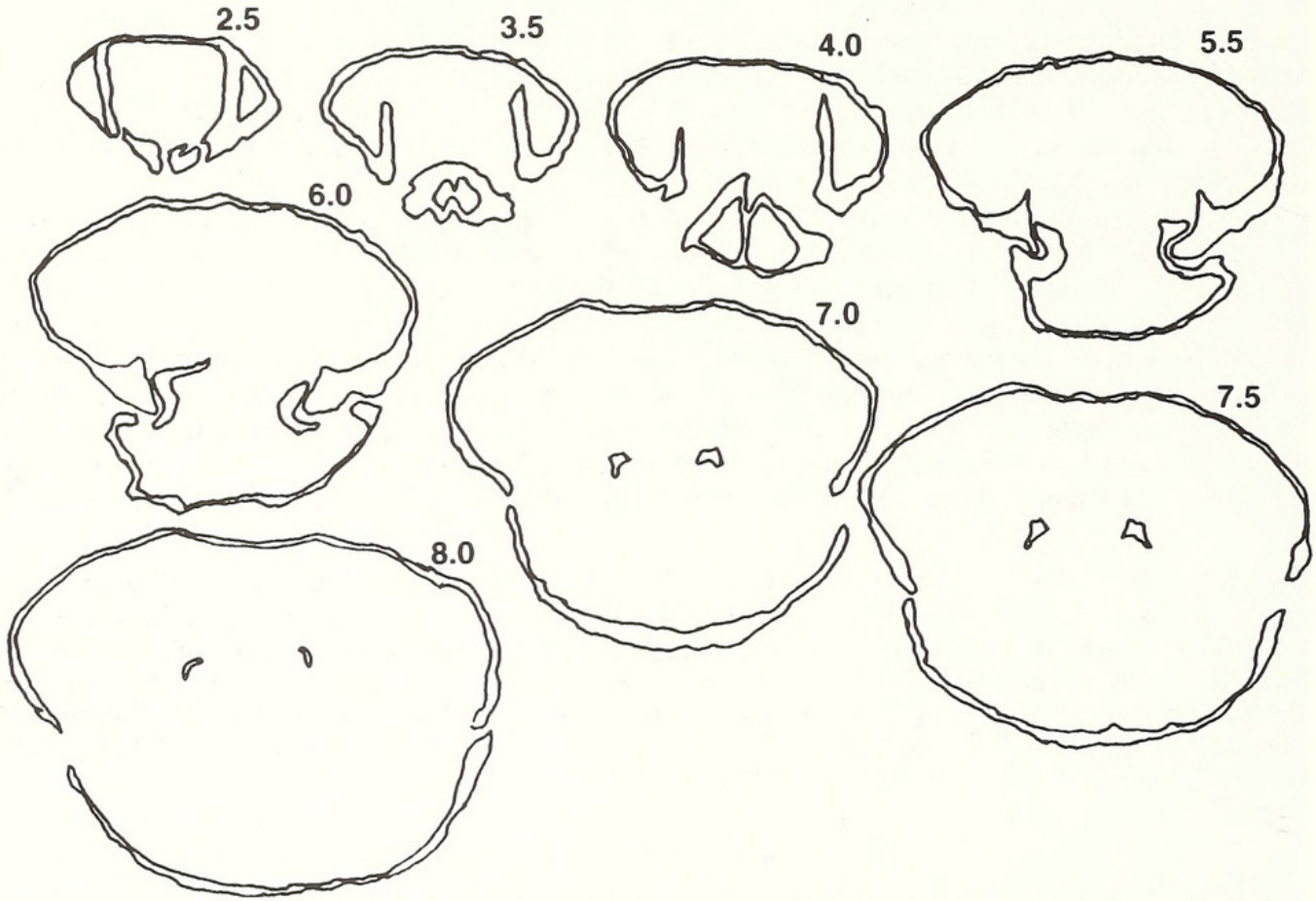
Figs 1–4. *Moeschia subsella* (Leymerie, 1846); UMGD 9601; dorsal, lateral, anterior and ventral views; × 1·5.
Fig. 5. *Uralella gigantea* Makridin, 1964; UMGD 9602; ventral view of internal cast of pedicle valve; × 1·0.
Figs 6–8. *Torquirhynchia inconstans* (J. Sowerby, 1816); UMGD 9603; dorsal, lateral and anterior views; × 1·5.
Figs 9–11. *Torquirhynchia lehmanni* (Makridin, 1964); UMGD 9604; dorsal, lateral and anterior views; × 1·5.
Figs 12–14. *Torquirhynchia speciosa* (Münster, 1839); UMGD 9605; dorsal, lateral and anterior views, × 1·0.
All anterior views have brachial valve uppermost. All specimens are from the Upper Jurassic, Mozduran Formation, upper part of Mozduran section, Sarakhs area, north-eastern Iran, and are housed in the Department of Geology, University of Mashhad, Iran.



ADABI and AGER, *Moeschia, Uralella, Torquirhynchia*

T. lehmanni was attributed by Makridin (1964, p. 109) to the closely related Upper Jurassic rhynchonellid genus *Septaliphoria*. Indeed it has been suggested (Ager *et al.* 1972, fig. 7) that *Torquirhynchia* is a direct early offshoot of *Septaliphoria*. Makridin (1964) figured the species from the Lower Volgian of the Russian Platform.

As the species is abundant in the Iranian collection, serial sections were made of one of the specimens to study its internal structures. These are illustrated in Text-figure 3. Points to note are the massive dental lamellae



TEXT-FIG. 3. Serial transverse sections of *Torquirhynchia lehmanni* (Makridin, 1964). The figures indicate the distance in millimetres from the posterior end of the shell. See text for discussion.

in sections 2·5 to 3·5, the clear if short septalium supported by a dorsal median septum in section 4·0, the massive teeth inserted obliquely into the sockets in sections 5·5 to 6·0 and the slightly concave crura seen in sections 7·0, 7·5 and 8·0. These last strengthen the case for including the genus in the Cyclothyridinae. The only unusual features are the very short dorsal median septum and the thinness of the shell. The massive teeth and dental lamellae suggest adaptation to a shallow water, high energy environment, but this hardly fits with the thin shell. Perhaps one should not place too much confidence on such theorizing. It might be mentioned, however, that other large late Jurassic brachiopods were certainly adapted to living in high energy environments. Thus the huge terebratulid *Juralina immanis* (Zeuschner) lived in the reef environment of the Tithonian-Volgian Stramberk Limestone of the Czech Republic and was accompanied by the remarkable '*Rhynchonella*' *pachytheca* Zeuschner, which is almost solid shell. Also in that assemblage is *Loboidothyris*? *insignis* (Schübler) and an asymmetrical *Septaliphoria asteriana* (d'Orbigny). These were discussed in Ager (1965, pp. 153–156). A similar fauna was described from Woźniki in neighbouring Poland by Książkiewicz (1974).

Torquirhynchia speciosa (Münster, 1839)

Plate 1, figures 12–14

Description. Two specimens from Iran may be attributed to this distinctive species, which is characterized by its extremely wide shells. The larger of the two measures 38 mm long, 41 mm wide and is 23 mm deep. The

second specimen is smaller but of similar proportions. Strangely enough, one specimen is dorsally skewed and the other sinistrally. There are about 25 costae of the 'tetrahedra' type on each valve. Otherwise the external characters are similar to the other species, with a massive erect beak and fairly sharp beak ridges. Childs (1969) recorded and figured *T. speciosa* from the Upper Kimmeridgian to Lower Volgian near Ingolstadt in Germany.

CONCLUSIONS

The brachiopod assemblage from the Mozduran Formation clearly indicates a latest Jurassic age. Though brachiopods are not the best of fossils for stratigraphical purposes, the balance of evidence suggests an early Tithonian age, younger than that given by contemporary foraminifers. They also suggest a shallow water, high energy environment, and are particularly interesting from the palaeogeographical point of view. Their affinities are all with extra-Alpine Europe, and with the Russian Platform and Urals in particular. One notes, however, the absence of regular members of the comparable European assemblages of this age, such as *Rhynchonella sensu stricto* and *Septaliphoria asteriana* (d'Orbigny). Nevertheless, the fauna is very much one of the Boreal Province. This also contrasts with the suggestion given earlier in this paper of a tropical habitat, but this may be simply a matter of geographical connections rather than of actual latitude. Certainly there is no sign of Tethyan forms such as the pygopids and nothing from the Ethiopian Province, which extended as far north as Sinai and the southern part of the Arabian Peninsula at this time.

It is concluded therefore that in late Jurassic times, Iran was part of the European Plate, as has been previously suggested for Turkey (Ager 1988) on the basis of similar brachiopod evidence.

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