

# Early Frasnian sharks from central Iran

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## ABSTRACT:

HAIRAPETIAN, V., GINTER, M. & YAZDI, M. 2008. Early Frasnian sharks from central Iran. *Acta Geologica Polonica*, **58** (2), 173-179. Warszawa.

Two limestone bone-beds in the early Frasnian of the Chahrisih section, central Iran, yielded numerous chondrichthyan teeth and scales. The fauna includes, most probably, only two taxa: a hitherto unknown aztecodontid omalodontiform, *Manberodus fortis* gen. et sp. nov., and a multicuspid phoebodontiform, provisionally referred to as *Phoebodus* cf. *latus* GINTER & IVANOV, 1995. A new omalodontiform family, Aztecodontidae, including *Aztecodus* LONG & YOUNG, 1995 and *Manberodus* gen. nov., is proposed.

**Key words:** Chondrichthyes, Teeth, Scales, Omalodontiformes, Phoebodontiformes, Frasnian, Iran.

## INTRODUCTION

The record of phoebodontiform sharks from the Givetian of Gondwana is mainly restricted to the teeth reported as *Phoebodus fastigatus* from Morocco (KAUFMANN 1998), and *Ph. fastigatus* and *Ph. sophiae* by IVANOV & DERYCKE (1999) from Mauritania. No Frasnian phoebodonts from that supercontinent have hitherto been recovered (the identification of a typical Frasnian species, *Ph. bifurcatus*, in the material from Mauritania by DERYCKE & al. 1998 was subsequently corrected by IVANOV & DERYCKE 1999). As far as omalodontiforms are concerned, middle to late Givetian occurrences of *Omalodus* have been recently published from Mauritania and Morocco (IVANOV & DERYCKE 1999, HAMPE & al. 2004), in addition to previously known *Portalodus*, *Aztecodus* and *Anareodus* (the latter considered here as a junior synonym of *Aztecodus*) from the late Givetian–early Frasnian of Antarctica

(LONG & YOUNG 1995), and a few unillustrated teeth of *Portalodus* and *Aztecodus* from South Africa (ANDERSON & al. 1999). Devonian (Frasnian in part) shark micro- and macro-remains from the Kerman localities, southeastern Iran were first illustrated by JANVIER (1977, 1981); these comprise several tooth forms mainly referable to protacrodonts and cladodonts, and a few dozens of scales.

The present paper describes a new omalodontiform, *Manberodus fortis* gen. et sp. nov., forming together with *Aztecodus* LONG & YOUNG, 1995 a new family, Aztecodontidae; and a phoebodontid, *Phoebodus* cf. *latus* GINTER & IVANOV, 1995. This is the first record of the co-occurrence of aztecodontids and phoebodontids in early Frasnian strata of Iran and it provides new evidence on the distribution of Frasnian shark faunas.

The material comes from samples H1 and G14, both taken from the basal Frasnian limestone beds of

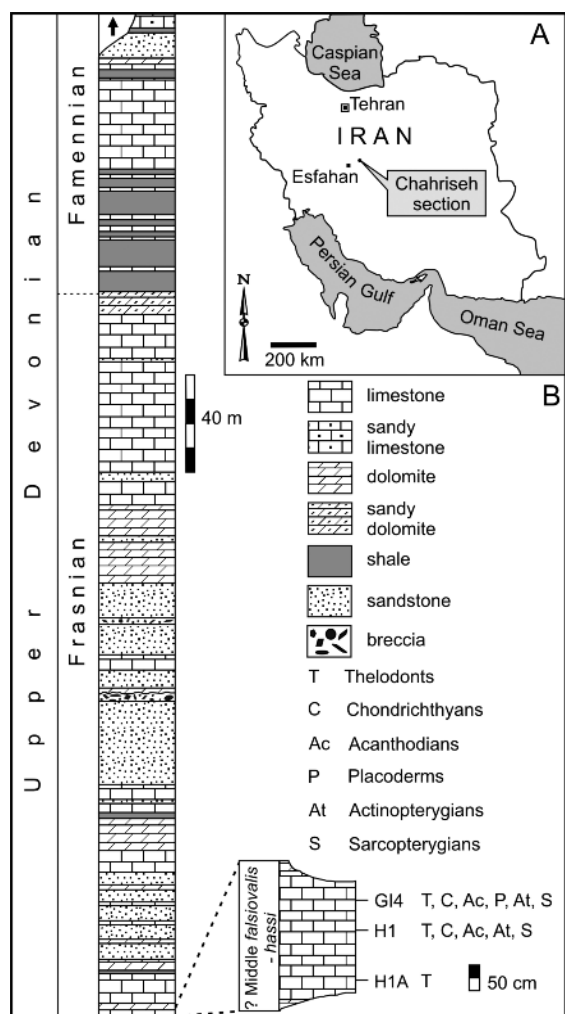


Fig. 1. **A** – Geographical map showing the position of the Chahriseh section, northeast of Esfahan, central Iran. **B** – simplified stratigraphic column of the section with an enlargement of the basal Frasnian deposits showing chondrichthyan-bearing horizons H1 and G14

an unnamed formation in the Chahriseh section (Text-fig. 1; see also HAIRAPETIAN & al. 2006 for general information, age constraints and palaeoecological interpretations). So far, from these bone-beds, TURNER & al. (2002) and HAIRAPETIAN & al. (2006) presented collections of thelodonts (*Turinia hutkensis* and *Australolepis seddoni*) and acanthodians (*Iranolepis ginteri*, *Nostolepis* sp. cf. *N. gaujensis*, *Milesacanthus* sp. aff. *M. antarctica*, diplacanthid fin spine frag-

ments, ischnacanthiform jaw bone fragments and ?tooth whorls) respectively. Besides chondrichthyan micro-remains published here, the samples (particularly G14) are also quite rich in placoderm scales and bone fragments (*Holonema* sp. and probably a bothriolepid), actinopterygian scales (*Moythomasia* sp. and *Orvikuina* sp.), as well as sarcopterygian (porolepiform or onychodontid and dipnoan) scales, teeth, tooth plates and bone fragments. The specimens are deposited in the Department of Geology, Azad University, Esfahan (AEU).

#### SYSTEMATIC PALAEOLOGY (HAIRAPETIAN & GINTER)

Class Chondrichthyes HUXLEY, 1880  
Subclass Elasmobranchii BONAPARTE, 1838  
Order Omalodontiformes TURNER, 1997

REMARKS: See GINTER & al. (2008, this volume).

Family Aztecodontidae nov.

REFERRED GENERA: *Aztecodus* LONG & YOUNG, 1995 and *Manberodus* gen. nov.

DIAGNOSIS: Omalodontiform sharks whose tooth-base is composed of a subrectangular root below the crown and is devoid both of a lingual extension and the prominent, labially directed lobe.

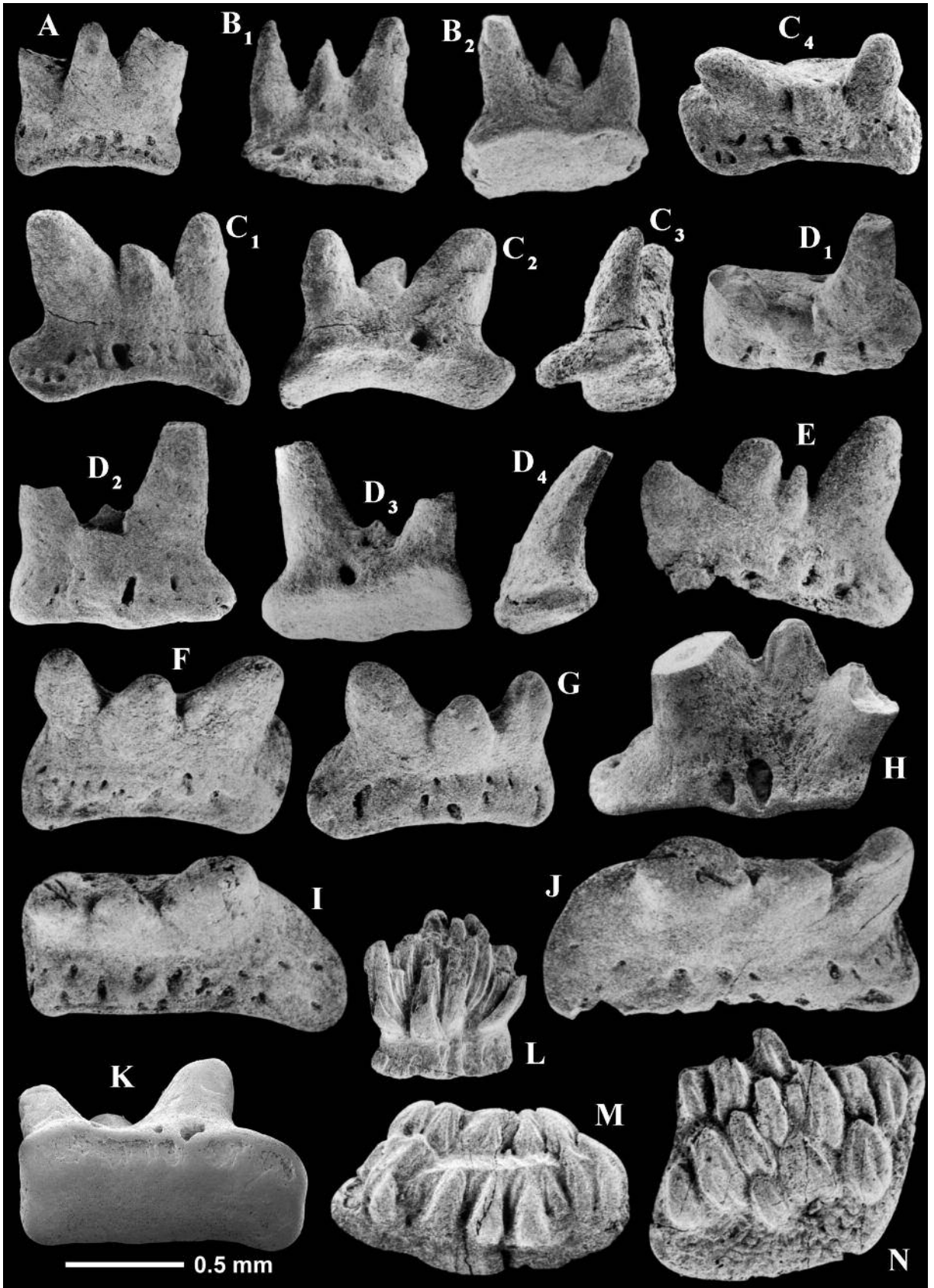
Genus *Manberodus* gen. nov.

TYPE SPECIES: *Manberodus fortis* sp. nov.

ETYMOLOGY: In honour of Dr. Manuel BERBERIAN (Najarian Association, USA), in recognition of his contributions on the tectonic evolution of Iran.

DIAGNOSIS: Asymmetrical teeth with an arched, subrectangular, lingually undeveloped base provided by a gentle labial extension. Crown composed of three

Fig. 2. Early Frasnian shark teeth and scales from sample G14, Chahriseh. **A-K** – *Manberodus fortis* gen. et sp. nov.; **A** – AEU 589 in labial view; **B** – AEU 590 in labial (B1) and lingual/basal (B2) views; **C** – AEU 591 holotype in labial (C1), lingual/basal (C2), lateral (C3) and occlusal (C4) views; **D** – AEU 592 in occlusal (D1), labial (D2) and lingual/basal (D3) and lateral (D4) views; **E** – AEU 593 in labial view; **F** – AEU 594 in labial/occlusal view; **G** – AEU 595 in labial/occlusal view; **H** – AEU 596 in lingual view; **I** – AEU 597 in labial/occlusal view; **J** – AEU 598 in labial/occlusal view; **K** – AEU 599 in basal view. **L-N** – Chondrichthyan scales; **L** – AEU 600 in crown view; **M** – AEU 601 in crown view; **N** – AEU 602 in crown view



robust unequal smooth cusps. Lateral cusps larger than median one. Cusps fused together near base. Intermediate cusplets absent, and boundary between crown and base indistinct. One or two very large vascular canal openings set on lingual side of base, close to the basal rim, whereas the labial face, with numerous irregularly placed foramina.

*Manberodus fortis* sp. nov.  
(Text-fig. 2A-K)

ETYMOLOGY: Latin *fortis* = robust, strong.

HOLOTYPE: Specimen AEU 591 (Text-fig. 2C) from Chahriseh, sample GI4, within the interval of the Middle *falsiovalis* through to *hassi* conodont Zones, early Frasnian.

DIAGNOSIS: As for genus.

MATERIAL: Two specimens from sample H1 and 110 specimens from sample GI4, Chahriseh.

DESCRIPTION: The crown is composed of three strong, labio-lingually compressed cusps of different sizes. One of the lateral cusps is slightly larger than the other and both are clearly larger than the central cusp. The bases of cusps (usually one-third of the largest cusp) are fused together. The central cusp is approximately 1.5-2 times narrower than the laterals. The surface of cusps is devoid of enameloid and ornamentation. The angle between the base and crown reaches 120°, and the angle between two lateral cusps ranges from 30° (e.g., Text-fig. 2A) to 80° (e.g., Text-fig. 2H). Generally, the crowns lack intermediate cusplets, only a single, probably pathological tooth with an additional cusplet (Text-fig. 2E) was found. The cusps are not positioned in a mesiodistal line; the central one is clearly displaced labially. The central cusp is less curved than the lateral ones which are lingually oriented.

The crown/base boundary is indistinct. The arched base is somewhat extended labially and very short lingually. It is broader than the crown, subrectangular in outline, without any articulation boss. Both right- and left-hand morphotypes exist in the collection; when they are viewed labially, the largest cusp is on the left (e.g., Text-fig. 2G, J: left-hand morphotype) and in others, it is positioned on the right side (e.g., Text-fig. 2F, I: right-hand morphotype). The side with the largest (?distal) cusp is slightly elongated and turned downwards. The base width (mesio-distally) falls in the

size range from 0.7 to 1.6 mm. A large canal opening or two openings of similar sizes are situated on the lingual side of the base, very close to the basal rim (Text-fig. 2C<sub>2</sub>, D<sub>3</sub>, and H). Numerous irregularly placed foramina are located on the labial face. The aboral side of the base is not perforated.

REMARKS: All omalodontiform teeth have a base shortened lingually and expanded labially but several diagnostic characters in the crowns and in the bases differentiate them. The labial extensions of the base in *Portalodus*, *Doliodus* and *Omalodus* are very prominent, much broader than in *Manberodus*. The form of subrectangular base in *Aztecodus* is quite similar to that of *Manberodus*, but there are several differences in the crown. Although both genera possess smooth and labio-lingually compressed cusps, the crown of *Aztecodus* consists of only two cusps of unequal size (sometimes there occurs a small accessory cusplet on the outer side of the larger cusp), well-separated by a crenulated ridge. The larger cusp base is considerably flattened, occupying three-quarters of the crown, whereas in *Manberodus* the largest cusp is in no case wider than a half of the total width of the crown. As is usual with the omalodontiform teeth from Antarctica, *Aztecodus* is also significantly larger than *Manberodus* and the crown/base boundary is distinct and marked by a shallow groove.

LONG & YOUNG (1995) also erected another very similar form, *Anareodus*, based on four teeth, distinguishing it from *Aztecodus* by having of “a much larger, flatter main cusp, in the more concave shape of the base with sigmoid curvature along its length and the absence of the two nutritive foramina”. However, both genera possess smooth cusps of different sizes (bases of larger cusps evidently flattened), well-separated by the same kind of crenulation, and a minute cusplet on the flank of the largest cusp (LONG & YOUNG 1995, figs 8I; 9A, H and J for *Aztecodus*; figs 8J; K; 10A and B for *Anareodus*). Since all original teeth of *Anareodus* seem to be damaged, the base features could not be determined with certainty, but in both genera, straight (LONG & YOUNG 1995, figs 8A-E; 9J; 10b) and vertically curved bases (LONG & YOUNG 1995, figs 8F; 9H; 10A, C) can be found. The only difference between *Anareodus* and *Aztecodus* seems to be a much smaller size of the second cusp in the former, but this feature most probably occurs due to heterodonty. We were unable to compare the histology of these two taxa (HAMPE & LONG 1999 analysed only *Aztecodus*), but taking the morphological data into consideration, we suggest that *Aztecodus harmsenae* and *Anareodus statei* are conspecific.

Asymmetrical teeth of the problematic omalodontiform, *Siberiodus mirabilis* IVANOV & RODINA, 2004, differ from those of *Manberodus fortis* in having crowns with three or five well-separated, slender cusps, ornamented by cristae, a distinct crown/base boundary, and a relatively thin, plate-like base.

STRATIGRAPHIC RANGE: Early Frasnian, Middle *falsiovalis* to *hassi* conodont Zones.

Order Phoebodontiformes GINTER, HAIRAPETIAN & KLUG, 2002

Family Phoebodontidae WILLIAMS in ZANGERL, 1981  
Genus *Phoebodus* ST. JOHN & WORTHEN, 1875

TYPE SPECIES: *Phoebodus sophiae* ST. JOHN & WORTHEN, 1875

*Phoebodus* cf. *latus* GINTER & IVANOV, 1995  
(Text-fig. 3)

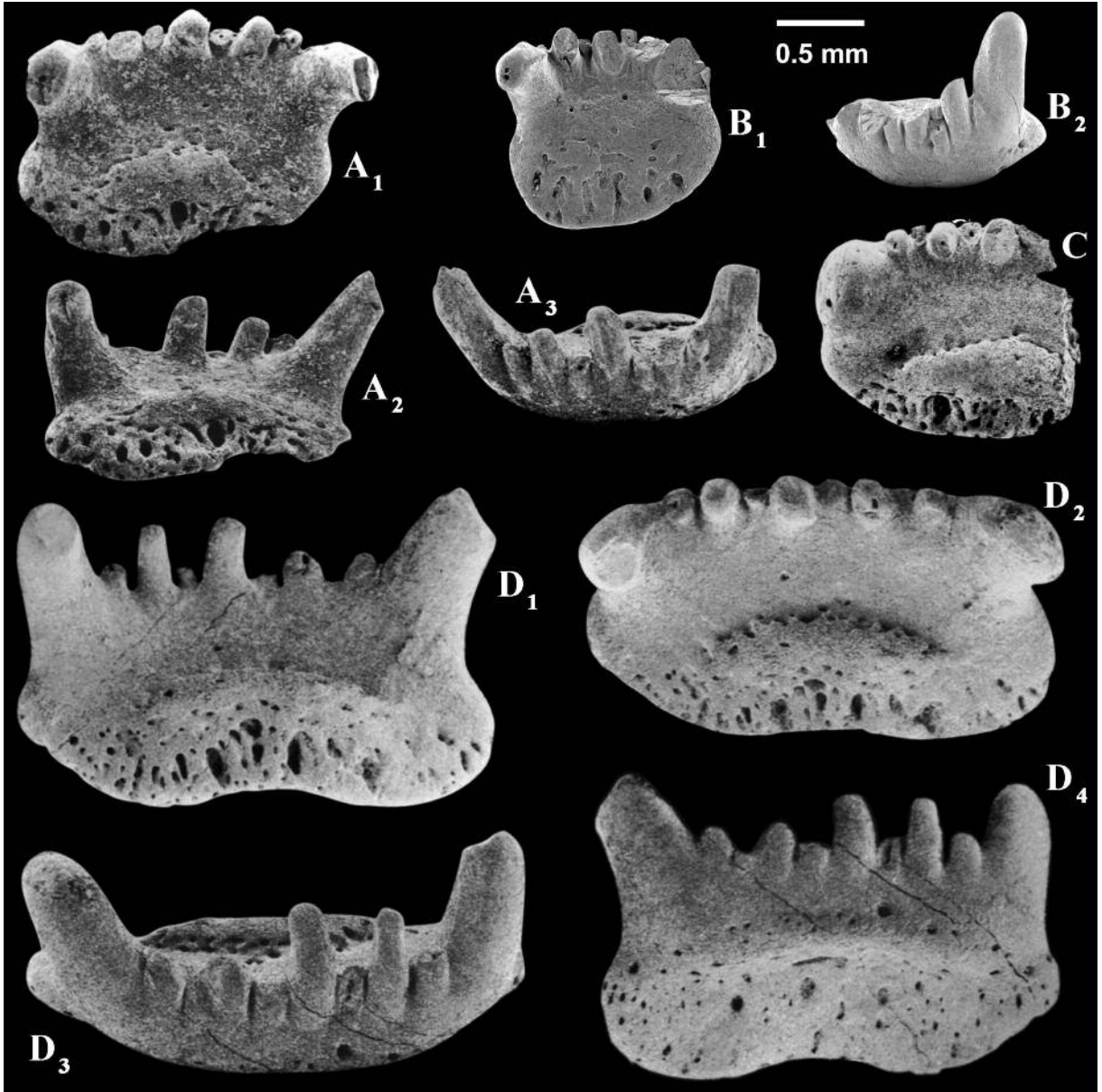


Fig. 3. Early Frasnian phoebodontiform teeth from sample G14, Chahriseh. A-D – *Phoebodus* cf. *latus* GINTER & IVANOV, 1995; A – AEU 603 in occlusal (A1), lingual (A2) and labial/occlusal (A3) views; B – AEU 604 in occlusal (B1) and labial (B2) views; C – AEU 605 in lingual view; D – AEU 606 holotype in lingual (D1), occlusal (D2), labial (D3) and labial/basal (D4) views

**MATERIAL:** One specimen from sample H1 and 57 specimens from sample G14, Middle *falsiovalis* to *hassi* conodont Zones, Chahriseh.

**DESCRIPTION:** The tooth-crowns have three types of densely packed cusps; the two largest ones on the lateral ends and several intermediate cusps, alternating with additional cusplets. The number of cusps and cusplets varies from seven to ten. The labial face sometimes has remnants of a few strong ridges (e.g., Text-fig. 3A<sub>3</sub>); the lingual face is smooth. The central cusp cannot be distinguished by size from the other intermediate ones.

Although the bases are largely worn, the base shape was possibly trapezoid or even slightly bi-lobed, if it is not only a result of abrasion. The lingual face of the base is well-developed. The button is large, oval, and mesio-distally elongated. Base width reaches 2.5 mm.

There is a rare additional tooth form in the collection showing a relatively narrow, seven-cusped crown and a rounded base (Text-fig. 3B<sub>1</sub>) with a button, which seems to be abraded. Teeth with less than seven cusps have never been found in the collection.

**REMARKS:** The overall appearance of the teeth described herein is comparable to that of *Ph. latus* from south Timan, Russia (GINTER & IVANOV 1995, IVANOV 1999), which is the only phoebodont with more than five cusps known to date. The Iranian specimens also share with the latter the characteristic ornamentation of cusps and the basal outline. However, they differ from *Ph. latus* in having a more lingually extended base and densely packed cusps in the crown. In the latter aspect they strongly resemble the other multicuspoid phoebodontid species, *Diademodus utahensis* GINTER, 2008 (this volume) from which they differ, in turn, by the better pronounced orolingual button. Thus, *Phoebodus* cf. *latus* appears to be an intermediate form between typical phoebodonts and diademodonts.

**STRATIGRAPHIC RANGE:** *Phoebodus* cf. *latus* ranges from the Middle *falsiovalis* to *hassi* conodont Zones. *Ph. latus* from Russia ranges from the Late *hassi* to *linguiformis* Zones (GINTER & IVANOV 2000). IVANOV & RODINA (2002) have recently reported an early Frasnian (*falsiovalis* Zone) occurrence of *Ph. latus* from the Middle Urals.

#### Chondrichthyan scales (Text-fig. 2L-N)

The scales found together with the above described teeth are compound, growing elements, usually com-

posed of a diamond-shaped, slightly convex base covered with a bunch of separate odontodes, randomly distributed or in irregular rows. They are somewhat similar to the scales from the Middle Devonian of the Cincinnati Arch region, named *Ohiolepis newberryi* by WELLS (1944, particularly pl. 3, figs 11, 12) and later thoroughly studied by GROSS (1973). However, none of the above tooth-based taxa was found together with the American *Ohiolepis* material, so we would consider direct attribution of this name to the Iranian scales as premature.

#### Acknowledgments

We are grateful to S. TURNER (Brisbane) and A. IVANOV (St. Petersburg) for their insightful reviews.

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*Manuscript submitted: 18<sup>th</sup> September 2007*

*Revised version accepted: 15<sup>th</sup> April 2008*