

Stratigraphic conclusions

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Occurrence. – Algeria and southern France Middle and Upper Aptian; Leg 47B, Site 398, 200 km west of Oporto, Upper Aptian; Crimea and European part of the Soviet Union, Upper Aptian.

Remarks. – The specimens from the *Hedbergella rohri* Zone were originally placed by BOLLI (1959) into *Planomalina* cf. *apsidostroba*. The reasons for a “cf” assignment were based on the sutures of the Trinidad specimens not being limbate and being curved forward to a lesser degree than in the type specimen. *P. apsidostroba* is today generally regarded as a synonym of *P. buxtorfi* from which *P. cheniourensis* differs in its more numerous chambers forming the last whorl and in the absence of a peripheral keel in the last 3–4 chambers.

MOULLADE (1966) had already pointed out that the forms from Trinidad placed by BOLLI (1959) into *P.* cf. *apsidostroba* belong to *P. cheniourensis*.

So far *P. cheniourensis* has been reported only from the Middle to Late Aptian, and *P. buxtorfi* from the Late Albian. Though the morphological features of the two taxa point to a close relationship neither form has so far been reported from the Early and Middle Albian which would provide the connecting link between the two taxa. A closer comparison of the Trinidad specimens regarded as very Late Aptian to earliest Albian in age with the respective holotypes could reveal features that might point to an intermediate morphological position. One such feature may be found in the last chambers which in the Trinidad specimens may not be as globular as in typical *P. cheniourensis* but already laterally somewhat compressed indicating a trend that eventually may lead to an acute periphery and finally to the development of a keel as is typical for *P. buxtorfi*.

Schackoina reicheli BOLLI 1957

Pl. 6, Fig. 29

1957 *Schackoina reicheli* BOLLI n. sp. – BOLLI, *Eclogae geol. Helv.* 50/2, 275; Pl. 1, Fig. 8–10.

1966 *Schackoina reicheli* BOLLI – MOULLADE, *Doc. Lab. Géol. Fac. Sci. Lyon* 15, 116.

1979 *Leupoldina reicheli* (BOLLI) – KAPTARENKO-CHERNOUSOVA, PLOTNIKOVA & LIPNIK, *Inst. Geol. NAUK (Kiev)* 74, Pl. 21, Fig. 3.

Occurrence. – The species was originally described from the *Leupoldina protuberans* Zone of Trinidad's Cuche Formation (BOLLI 1957a). In BOLLI (1959) its range was shown to extend also into the next younger *Planomalina maridalensis* Zone of the Maridale Formation. Its presence in the *Hedbergella rohri* Zone indicates that the species ranges throughout the Maridale Formation. Recorded also in the Ukraine and Crimea from the Upper Aptian.

Remarks. – Typical for the species are the tube like strongly extended final chambers of the last whorl. In the single, poorly preserved specimen found in the examined *Hedbergella rohri* Zone material this characteristic feature is partially preserved only in the last chamber; in the four earlier ones only the basal portions remain.

Stratigraphic conclusions

The *Hedbergella rohri* Zone fauna of the Maridale Formation described in this paper is regarded as being of Late Aptian to earliest Albian age based on planktic and benthic

foraminiferal evidence. On planktic foraminifera the following is relevant to such a determination:

According to CARON (1985) *Hedbergella trocoidea*, *Ticinella bejaouensis* and *T. roberti*, respectively, overlap in the *Ticinella bejaouensis* Zone since *H. trocoidea* becomes extinct at the top of the zone whereas *T. bejaouensis* and *T. roberti* appear at, or close to its base.

With regard to the shape arrangement of chambers and their number in the last whorl, these three taxa are morphologically very close (see CARON 1985: Fig. 25/17–18; Fig. 36/1–3, 13–15), the only major difference being that the *Ticinella* species contain secondary umbilical sutural apertures which are absent in *Hedbergella*. As the presence and absence of such secondary apertures can only be determined in well preserved specimens, it may at times be difficult to separate these three species with certainty. The morphology of the zonal marker *Hedbergella rohri* leaves little doubt that it is also very close to this group of species. Its occurrence in Trinidad together with *Planomalina cheniouensis*, which according to CARON becomes extinct within the *Ticinella bejaouensis* Zone, is a good indication for a Late Aptian–earliest Albian age of the *Hedbergella rohri* Zone fauna.

It is for these reasons that the *Hedbergella rohri* Zone is here regarded as an approximate time equivalent of the *Ticinella bejaouensis* Zone which according to CARON bridges the Aptian–Albian boundary.

Of the benthic foraminifera occurring in the investigated fauna, it is particularly the following agglutinated species whose wide distribution and known ranges support a Late Aptian to earliest Albian age:

- Dorothia filiformis*: Upper Aptian to Upper Cretaceous
- Dorothia gradata*: higher Lower Albian to Upper Cretaceous
- Gaudryina compacta*: Upper Aptian to Lower Albian
- Gaudryina dividens*: Upper Aptian to Lower Albian
- Gaudryina klamathensis*: Upper Aptian to Lower Albian
- Gaudryina reicheli*: Upper Aptian to Lower Albian
- Marssonella oxycona*: Upper Aptian to Upper Cretaceous
- Textularia bettenstaedti*: predominantly Upper Aptian to Lower Albian
- Verneuilinoides subfiliformis*: Upper Hauterivian to Lower Albian

Compared with the agglutinated taxa, only a small number of calcareous benthic species have comparable limited ranges that provide further indication for the assumed Late Aptian to earliest Albian age. These are:

- Lenticulina* (L.) *gaultina*: Aptian and Albian
- Lenticulina* (L.) *vocontiana*: predominantly Upper Aptian
- Ramulina berthelini*: Upper Aptian to Lower Albian
- Ramulina grandis*: Aptian to Cenomanian
- Conorotalites aptiensis*: Upper Barremian to Lower Albian
- Gavelinella intermedia*: Lower Aptian to Upper Cretaceous

Further evidence of a Late Aptian to earliest Albian age is provided by the absence of certain stratigraphically significant benthic species listed on pages 976–978 that are known to be restricted to an age either older or younger. They include *Marssonella praeoxycona*, *Lenticulina* (L.) *nodosa* and *Lenticulina* (S.) *spinosa* known only to occur

below the *Hedbergella rohri* Zone, or *Spiroplectinata annectans* and the genera *Pleurostomella* and *Pseudosigmoilina* of which the earliest occurrences are from the Middle Albian.

Based on the above evidence, the previously held view (BARTENSTEIN & BOLLI 1977, p. 561) that the *Hedbergella rohri* Zone occurred in the range Lower to Upper Albian has to be revised.

Index to genera and species, Part 1–5

(Part 1: 1957, Part 2: 1966, Part 3: 1973, Part 4: 1977, Part 5: 1986)

Legend

- 1 = Barremian Toco Formation, *Lenticulina barri* Zone
 Cuche Formation, *Lenticulina ouachensis ouachensis* Zone
 2 = Late Aptian Maridale Formation, Type locality, *Planomalina maridalensis* Zone
 3 = Late Aptian Maridale Formation, Co-Type locality, *Planomalina maridalensis* Zone
 4 = Early Aptian Cuche Formation, *Leupoldina protuberans* Zone
 5 = Late Aptian to earliest Albian Maridale Formation, *Hedbergella rohri* Zone.
 1:145 = number of paper and page. – New taxa are indicated with name and first citation in bold face.

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