Geologia Croatica	57/1	1–13	2 Figs.		2 Pls.	ZAGREB 2004

Iberopora bodeuri GRANIER & BERTHOU 2002 (*incertae sedis*) from the Plassen Formation (Kimmeridgian–Berriasian) of the Tethyan Realm

Felix **SCHLAGINTWEIT**

Key words: *Incertae sedis*, Upper Jurassic, Lower Cretaceous, Plassen Formation, Northern Calcareous Alps, Austria.

Abstract

Iberopora bodeuri GRANIER & BERTHOU 2002, formerly known as "crust problematicum" (SCHMID, 1996) is described from the Plassen Formation (Kimmeridgian–Berriasian) of the Northern Calcareous Alps (NCA). Here, it occurs either as an incrustation on corals/stromatoporoids or it forms nodular masses ("solenoporoid morphotype"). It is typically found in the fore-reef facies of the platform margin, and (upper) slope deposits where autochthonous dasycladales are absent. Water turbulence appears to control the morphological development of *Iberopora*. Thus, flat crusts appear in less agitated settings. The crusts are almost always accompanied by calcareous sponges/sclerosponges and abundant micro-encrusters, mostly *Koskinobullina socialis* CHERCHI & SCHROEDER and "*Tubiphytes*" *morronensis* CRESCENTI. The stratigraphic range of *Iberopora* known to date is Oxfordian–Berriasian. In addition to the Northern Calcareous Alps, it has been reported from the epicontinental area of NW-Germany, the northern margin of the Penninic and Tethyan ocean (Slovakia, Switzerland, Spain, Poland, Portugal) and the southern Tethyan domain (Greece, Romania, Yugoslavia). Until other morphological elements (e.g. reproductive organs or protoconch) are found, its systematic position remains uncertain. Currently, it is considered questionably to be an ancestral rhodophyceae or acervulinid-like foraminifera.

1. INTRODUCTION

Microproblematica are microfossils whose suprageneric taxonomic status is unknown. Many microproblematica display an encrusting way of life and can therefore be included in the group of "micro-encrusters" that during the Upper Jurassic were conspicuous components of microbial carbonate crusts (e.g. LEINFELDER et al., 1993; SCHMID, 1996; DUPRAZ & STRASSER, 1999, 2002). These forms are widespread in shallow water platform carbonates where they show more or less pronounced facies sensitivity: that is they can be used in the characterization of certain carbonate palaeoenvironments. However, in contrast, they are only rarely useful for biostratigraphic purposes. In a recent contribution, the new microproblematicum *Iberopora* n. gen. with the type-species *Iberopora bodeuri* n.sp. was reported from the Berriasian of Portugal by GRANIER & BERTHOU (2002). An adequate description (without generic, species diagnosis) was presented, but little information was provided concerning other occurrences, or facies, and stratigraphic data. As only one reference (the type region) was cited in the synonymy, almost nothing is known about its palaeogeographic distribution. In this discussion regarding Upper Jurassic to Lower Cretaceous material from the Northern Calcareous Alps of Austria and already published in part (SCHLAGINTWEIT & EBLI, 1999) the species was refered to as "Krustenproblematikum" SCHMID, 1996). Here we summarize the available data to provide more complete information concerning this so far poorly known taxon.

2. GEOLOGICAL SETTING OF THE ALPINE OCCURRENCES

After the drowning of the Upper Triassic shallow water carbonate platform of the Austroalpine shelf (e.g. TOLLMANN, 1985), several lithologies representing deeper water sediments prevailed during the lower and middle Jurassic as, for example, condensed sequences of red and grey limestones and radiolarites (e.g. BÖHM, 1992; GAWLICK, 2000). The reinstallation of a shallow water facies known as the Plassen Formation began in the Kimmeridgian and persisted only into the Lower Cretaceous (Berriasian) in accordance with a proposed model of a compressional regime related to the Late Kimmerian or Eohellenic orogeny (GAWLICK et al., 1999). For a long time it was generally accepted that these shallow water carbonates were deposited on uplifted slide-masses of Hallstatt Limestones with transgressive conglomerates at the base (e.g. TOLLMANN, 1987; STEIGER & WURM, 1980; MANDL, 2000). New investigations have shown that this model cannot be applied to the type-locality Mount Plassen in the Austrian Salzkammergut or to the Krahstein in the Styrian Salzkammergut (SCHLAGINTWEIT et al., 2003b). The deposition of shallow water carbonates in the central NCA began on rising thrusts (e.g. Trattberg Rise) caused by the closure of the Tethyan Ocean and by Late Jurassic nappe

Lerchenauerstrasse 167, D-80935 Munich, Germany;
e-mail: EF.Schlagintweit@t-online.de

Fig. 1 Topographic sketch map of Austria showing the occurrences of *Iberopora bodeuri* GRANIER & BERTHOU.

thrusting (FRISCH & GAWLICK, 2003, and references therein).

At mount Plassen, the Plassen Formation evolved by shallowing upward without interruption from cherty basin deposits (Oxfordian/Kimmeridgian boundary – WEGERER et al., 2003) into slope, platform margin (e.g. *Labyrinthina* grainstones) and back-reef deposits followed by sea-level controlled transgressive–regressive cycles of open lagoonal and tidal flat facies (SCHLAGINTWEIT et al., 2003a). The upper Tithonian of the type-locality is represented by muddy lagoonal limestones (wackestones, mudstones, floatstones) with gastropod lumachelles, stromatoporoid carpets, dasycladales and benthic foraminifera. Without a real transition zone ("facies telescoping"), bioclastic packstones with corals appear, followed by slope deposits reflecting the final drowning of the Plassen sedimentary megacycle. Thus platform margin and slope facies occur twice, in the initial shallowing upwards-phase (Kimmeridgian) and the final drowning succession (?uppermost Tithonian, Berriasian).

In these deposits, the *incertae sedis* microfossil *Iberopora bodeuri* GRANIER & BERTHOU has been detected at the Plassen, Krahstein and Trisselwand localities. It is noteworthy that, according to findings at the type-locality and the Trisselwand (SCHLAGINTWEIT & EBLI, 1999), the Jurassic–Cretaceous boundary can be fixed approximately as within this ultimate marginal facies.

In the following paragraphs, information on the three mentioned localities (Fig. 1) is summarized, along with mention of previous works, data on biostratigraphy and the microfacies of the samples containing *Iberopora bodeuri*.

Plassen near Hallstatt – Austrian Salzkammergut: FENNINGER & HÖTZL (1967), SCHLAGINTWEIT et al. (2003a).

At this locality, *Iberopora bodeuri* GRANIER & BERTHOU (Pl. 1, Fig. 3) is extremely rare and has so far not been found in the platform margin facies of the high-energy *Labyrinthina* shoals of Upper Kimmeridgian age. The lack of *Iberopora* there is obviously linked to the absence of prominent coral-patches. *Iberopora bodeuri* has been occasionally observed in bioclastic upper slope deposits (bioclastic packstones with echinoid remains) that rest on coral-bearing limestones at the summit of Mount Plassen. The coralline facies contain foraminifera such as *Coscinophragma* aff. *cribrosa* (REUSS) and rarely *Trocholina* sp. and *Protopeneroplis ultragranulata* (GORBATCHIK). Dasycladales are represented by *Anisoporella ?jurassica* (ENDO) and *Terquemella ?concava* BERNIER. From the reconstructed synoptic profile, the sample with *Iberopora bodeuri* can be placed in the lower Berriasian (for further details see SCHLAGINTWEIT et al., 2003a).

Krahstein – Styrian Salzkammergut of Austria: FLÜGEL (1964), STEIGER & WURM (1980), SCHLAGINTWEIT et al. (2003b).

The figuration of *Iberopora bodeuri* as "red algae" from the Plassen Formation of the Krahstein is one of the oldest references discovered in our research (Pl. 1, Figs. 1 and 5). It was reported by STEIGER & WURM (1980 – pl. 28, fig. 4) from "near-reef sparry detrital limestone (Rudstone/Grainstone)" containing corals, calcisponges, bryozoans and echinoid remains. According to our own investigations, these reefal debris limestones are of Late Kimmeridgian age (SCHLAGINTWEIT et al., 2003b). The samples containing *I. bodeuri* were collected near the summit of mount Krahstein (1564 m a.s.l.) – for locality and facies map see fig. 4 in STEIGER & WURM (1980). We assume a "fore"-reef depositional setting for the high-energy biosparitic limestones with echinoid fragments and bryozoa containing nodules of *I. bodeuri.* This assumption is supported by the discovery of the microproblematicum *Muranella parvissima* (DRAGASTAN) that, according to various authors, is typical of "fore reef" settings (RADOIČIĆ, 1969: p. 75, "outer reef zone"; ELIASOVA, 1981: "front of the reef"; DRAGASTAN & RICHTER, 1999: fig. 8). This interpretation provides an explanation for the often observed occurrence of *Iberopora bodeuri* in typical slope deposits (see locality Trisselwand). In the coral–sponge facies it is accompanied by *Thalamopora lusitanica* TERMIER, *Neuropora lusitanica* TERMIER, the "sclerosponge" sensu KOCH et al. (1994), *Cylicopsis verticalis* TURNŠEK, *Murania* n.sp. and most typically *Consinocodium japonicum* ENDO.

Trisselwand near Lake Altaussee – Austrian Salzkammergut: HÖTZL (1966), SCHLAGINTWEIT & EBLI (1999).

At the Trisselwand locality near Altaussee, *I. bodeuri* (Pl. 1, Figs. 2, 4, 6; Pl. 2, Figs. 4–7) occurs with a rich assemblage of microencrusters typical of platform margins and commonly along with indicators of slope facies such as "*Tubiphytes*" *morronensis* CRESCENTI (Pl. 1, Fig. 9; Pl. 2, Fig. 2), *Terebella lapilloides*

(MUENSTER) (Pl. 1, Fig. 8), *Mercierella*? *dacica* DRAGASTAN, *Carpathiella triangulata* MÍŠÍK, SOTÁK & ZIEGLER (Pl. 1, Fig. 7), "prism problematicum" sensu SCHMID (1996) (Pl. 1, Fig. 9) and *Koskinobullina socialis* CHERCHI & SCHROEDER. Their age is latest Tithonian–Berriasian. Here, only crustose layers of *Iberopora bodeuri* on fragments of "reef"-builders have been detected, not the nodular masses found at the Krahstein locality. This observation, however, may simply be sampling error. Besides the aforementioned microencrusters, limestones with *I. bodeuri* contain microbolitic crusts and also the calcareous sponges/sclerosponges with *Neuropora lusitanica* TERMIER, *Peronidella* sp. and *Cylicopsis* sp. ("sponge–coral facies").

3. PALAEONTOLOGY

Incertae sedis

Genus ***Iberopora*** GRANIER & BERTHOU 2002

Iberopora bodeuri GRANIER & BERTHOU 2002

(Pl. 1, Figs. 1–6; Pl. 2, Figs. 4–7)

1966 Codiacée crouteuse – RADOIČIĆ: pl. 70, fig. 1, Oxfordian/Kimmeridgian of the External Dinarides.

1980 Red algae – STEIGER & WURM: pl. 28, fig. 4, Plassen Formation of Mount Krahstein.

1986 *Archaeolithothamnium* sp. – ELIAS & ELIASOVA: pl. 8, Tithonian Stramberk Limestone of the Outer Carpathians.

1987 "microstructure porostromate A" – GRANIER: pl. 4, fig. a; pl. 51, figs. a–b, e, Lower to Middle Berriasian of Portugal.

1991 Mikroproblematikum 1 – FÜRSICH & WERNER: figs. 4e and 5h, Oxfordian of Portugal.

1995 "Incrostazioni algali su colonie di coralli, in un boundstone" – CARRAS: pl. 20, fig. 4, Kimmeridgian–Tithonian of Greece.

1996 Crust Problematicum – SCHMID: p. 205, fig. 125–126, Kimmeridgian of the Lusitanian Basin/ Portugal.

1998 "Krustenproblematikum" (sensu SCHMID, 1996) – HELM & SCHÜLKE: pl. 16, fig. 2, Oxfordian of NW Germany.

1999 "Krustenproblematikum" SCHMID – DUPRAZ & STRASSER: pl. 12, fig. 4, middle–late Oxfordian of Swiss Jura Mountains.

1999 Crust problematicum SCHMID, 1996 – SCHLAGINTWEIT & EBLI: p. 406, pl. 10, fig. 1, Uppermost Tithonian or lowermost Berriasian of the Plassen Formation of the Trisselwand, Upper Kimmeridgian of the Krahstein (both Northern Calcareous Alps).

2002 Krustenproblematikum SCHMID 1996 – DUPRAZ & STRASSER: p. 452 (not figured), Oxfordian of the Swiss Jura Mountains.

*2002 *Iberopora bodeuri* n.gen., n.sp. – GRANIER & BERTHOU: p. 121, pl. 2, figs. 2–4, Lower to Middle Berriasian of Portugal.

2003 *Iberopora bodeuri* GRANIER & BERTHOU – HELM et al.: pl. 1, fig. 3, Oxfordian of NW-Germany.

2003 *Iberopora bodeuri* GRANIER & BERTHOU – UTA & BUCUR: pl. 3, fig. 4, ?Berriasian of South Carpathians, Romania.

Description

The "skeleton" of *Iberopora bodeuri* is composed of tiny bubble-like superimposed cells occurring in layers parallel to the substratum. The size of the individual cells ranges from 0.015–0.03 mm in width to 0.01–0.02 mm in height. The cell (or chamber) wall is a thin micritic envelope; no connection whatsoever between adjacent or superimposed cells has been detected. Thin sparitic layers that occur more or less regularly intercalated in the "skeleton" are a determining characteristic (e.g. Pl. 1, Figs. 2, 5). According to GRANIER & BERTHOU (2002), these "bands of calcite" reach a thickness of up to 0.05 mm. The distance between layers ranges from 0.28 to 0.4 mm. Scrutiny of these "sparitic bands", shows that they are not continuous, but are typically interrupted by small vertical intercalations of "normal" micritic cells (see for example fig. 3 in GRANIER & BERTHOU, 2002). Characteristically, the upper part (in the direction of growth) is smooth whereas the lower part is irregular, sometimes tapering to form tooth-like shapes. It must also be noted that no sharp boundary (such as the cell wall as in sporangia of coralline algae) exists between the sparitic layers and the micritic cells.

In the Alpine Plassen Formation, *Iberopora bodeuri* occurs as two morphotypes, one crustose, the other nodular masses. In both morphotypes, no structural differentiation, e.g. a juvenile basal or an adult stage, has been found. The crustose type when attached to larger bioclasts such as corals or "stromatoporoids" may consist of just a few cell/chamber layers (Pl. 2, Fig. 5) or attain thicknesses usually ranging between 0.2 and 0.4 mm (Pl. 1, Fig. 2). The other form of typical appearance is nodular masses, the "solenoporoid" morphotype of SCHLAGINTWEIT & EBLI (1999). A digiform branching of the nodules (known for example from *Marinella lugeoni* PFENDER, see LEINFELDER & WERNER, 1993) has not been observed. The nodules can reach sizes of up to 23 mm in width and up to 17 mm in height (Pl. 1, Fig. 5). The "solenoporoid morphotype" has been observed exclusively in biosparitic limestones, thus indicating water energy as an important ecofactor, its relative strength controlling whether growth is nodular or crustose. Note, however, that the above mentioned sparitic layers occur in both the crustose and nodular morphotypes. No incrustations have been observed between cell layers of *Iberopora* with any other microencruster except *Koskinobullina socialis* CHERCHI & SCHROEDER (see also remarks). The surface of the nodular masses, however, may show incrustations by bryozoa or foraminifera.

Discussion

Although it had been figured in the literature (see synonymy), GRANIER (1987) and SCHMID (1996) were the first to pay particular attention to this micro-problematicum. The latter described it from the Kimmeridgian of the Lusitanian Basin of Portugal as "crust problematicum". SCHMID (1996 – p. 205) remarks on a possible relationship with red algae because of similarities with *Lithoporella*. The red algae *Lithoporella*, e.g. *L. melobesioides* (FOSLIE) has palisade-like, subparallel cells (about 0.046x0.018 mm) forming monostromatic layers. Occasionally large conceptacles (up to 0.45x0.25 mm) occur (e.g. POIGNANT & DU CHAFFAUT, 1970; POIGNANT, 1985). Thus *Lithoporella* differs distinctly and markedly from *Iberopora*. Some species of coralline red algae have been reported from the Late Jurassic (e.g. IMAIZUMI, 1965; JOHNSON & KASKA, 1965) but several authors have expressed serious doubts with respect to the stratigraphic attribution and taxonomic relationships of these taxa (see AGUIRRE et al., 2000). That there is obviously no thallus differentiation speaks against the assignment of *Iberopora* to "ancestral corallines". Coralline algae are composed of rectangular cell patterns but in *Iberopora* these cells are superimposed and do not form coaxial rows. *Marinella lugeoni* PFENDER also shows no thallus differentiation. Recently, the genus *Norithamnium* under the rhodophyceae, Order Corallinales, was introduced by SENOWBARI-DARYAN et al. (2002) from Upper Triassic reefal limestones. In contrast, SCHMID (1996) also suggests possible affinities of *Iberopora* with the Palaeozoic cyanobacteria *Sphaerocodium* (syn.: *Rothpletzella*), though nonseptate, fan-like arranged and branching filaments typical to *Sphaerocodium* are lacking (see MAMET, 1991 – p. 428).

GRANIER & BERTHOU (2002) offer yet another aspect of the relationship. They note similarities with *Solenomeris ogormani* (DOUVILLE) (= *Acervulina ogormani* acc. to MOUSSAVIAN & HÖFLING, 1993), long interpreted as a Solenoporacean alga, now regarded as an encrusting foraminifera (see PERRIN, 1992). Note that the flexibility of growth in *Iberopora* that creates either crustose layers or nodular masses is in fact also present in acervulinid foraminifera. Validation of evidence for this interpretation, cautiously favoured by GRANIER & BERTHOU (2002), would be the identification of a juvenile stage with embryonic apparatus. As a function of alternations in growth rates, *Acervulina ogormani* develops layers of small and flat chamberlets intercalated between larger, more rounded chambers (e.g. MOUSSAVIAN & HÖFLING, 1993 – pl. 2, fig. 7). These are indeed somewhat similar to those of *Iberopora bodeuri*. The main difference is the "wall of hyaline, optically radial calcite, coarsely perforate" of the Acervulinidae (see LOEBLICH & TAPPAN, 1988 – p. 596). These authors state that representatives of the acervulinidae are known from Palaeocene and younger strata. Last but not least, HELM et al. (2003) mention similarities in the structure of *Iberopora* to those of *Wetheredella* that may indicate a cyanobacterial origin.

Remarks

The association with *Koskinobullina socialis* CHERCHI & SCHROEDER has been mentioned by SCHMID (1996), HELM & SCHÜLKE (1998), DUPRAZ & STRASSER (1999), SCHLAGINTWEIT & EBLI (1999) and GRANIER & BERTHOU (2002). It is noteworthy that the association with the latter has been observed only in the encrusting, not the nodular morphotype sensu SCHLAGINTWEIT & EBLI (1999). This, however, can also be incidental (a sampling effect). HELM & SCHÜLKE (1998 – p. 86, 98), note transitions between the small chambers of *Koskinobullina* and "Krustenproblematikum" and a gradational transition between the fossil structures of both taxa. According to these authors (p. 98), "these circumstances suggest a colonial plasticity within "Krustenproblematikum" (a small chambered morphotype of *Koskinobullina socialis*)". The totally different wall structure – calcitic hyaline and perforated in *Koskinobullina* and microcrystalline calcitic (micritic) in *Iberopora bodeuri*, however, contradicts such an interpretation. The co-occurrence of two discrete taxa of encrusting organisms in the Upper Jurassic "reefal" facies is probably due to their flourishing in the same favourable environment. Accordingly, the common encrustation can be regarded as another example of biomuration as discussed by CHERCHI & SCHROEDER (1985 – p. 368) for colonies of *K. socialis* interbedded with corallinacean algae in Middle Cenomanian limestones: "*When the colonies are very large, the rhodophycean thalli are, in general, not able to cover the whole surface. In this case, the lateral extension of the rhodophyceans is frequently hindered by overgrowing individuals of K. socialis*". It appears most probable that the immuration of *K. socialis* by *Iberopora bodeuri* follows the death of the former since it could no longer feed when totally encapsulated by the latter. For further discussion see VOIGT (1970) for a Maastrichtian example involving a foraminifera and a worm-like organism.

Another point is the difference in the stratigraphic ranges of *Iberopora bodeuri* (Oxfordian–Berriasian acc. to present knowledge) and that of *Koskinobullina socialis* (Bathonian to Middle Cenomanian, acc. to

CHERCHI & SCHROEDER, 1985). For example, in the Alpine allochthonous Urgonian limestones (Upper Barremian–Albian) found in Upper Cretaceous conglomerates, *Koskinobullina socialis* is a common microencruster (SCHLAGINTWEIT, 1991 – pl. 8, fig. 17), but *Iberopora bodeuri* is not present in these limestones. In the Alpine Plassen Formation, *Koskinobullina socialis* CHERCHI & SCHROEDER may again occur alone, that is not intergrown with *Iberopora bodeuri* (Pl. 2, Figs. 1, 3) although the latter may be present in this fore-reef facies.

Palaeoecology

The lithology and microfacies in which *Iberopora bodeuri* is found, along with the associated biota, permit the following inferences regarding its palaeoecology. In the Alpine Plassen Formation, *I. bodeuri* has been found in facies indicating a hard substrate: corals, stromatoporoids or calcareous sponges requiring fixation. Where the platform margin-facies is represented by *Labyrinthina* shoals as in the Upper Kimmeridgian of Mount Plassen, Iberopora has not been detected. The facies in which *I. bodeuri* is found can be considered as seaward portions of coral-patches ("Fore-reef") and upper slope deposits with an association of corals, stromatoporoids and calcareous sponges. Also the co-occurrence of otherwise discrete microbial crusts is worth mentioning. In conclusion, *I. bodeuri* obviously was not as dependent on light penetration as were dasycladacean green algae (up to -20 m, e.g. MASSE, 1988), and furthermore it has been detected in facies where strictly photophile dasycladales are absent. Where fragments of them do occur under these conditions they are to be regarded as redeposited and allochthonous. In this connection, similarities to modern Cenozoic coralline algae can be drawn (e.g. ADEY, 1976; WRAY, 1979). Together with other microencrusters it occurs in the so-called "*Tubiphytes–Koskinobullina* association", typically found at the transition from shallower to deeper water facies (SCHMID, 1996 – p. 214). In the Upper Jurassic of Portugal this characteristic association has been referred by SCHMID (1996 – fig. 143) to an inner to middle ramp environment. In NW-Germany it occurs in coral reef facies and according to HELM et al. (2003), *I. bodeuri* is a pioneer organism that avoids cryptic niches inside coral reef facies thus suggesting a certain dependence on light. In summary, the occurrence of *I. bodeuri* is facies-dependent and it occurs mainly in reefal (outer infralittoral) and upper slope facies (upper circalittoral – see MASSE, 1988).

Palaeogeographic distribution

Germany

In the Süntel Mountains of NW-Germany *I. bodeuri* occurs in a coral–microbialite reef of Oxfordian age: the *Solenopora* biostrome facies sensu HELM & SCHÜLKE (1998). This facies – a parautochthonous biostrome – occurs "above and laterally adjacent to the reef core". Here *I. bodeuri* is usually intergrown with *Koskinobullina socialis* CHERCHI & SCHROEDER. HELM (1997) considered that early lithification of the *Koskinobullina socialis*/"Krustenproblematikum" agglomerates must be assumed because of the presence of borings in its walls. These borings also exist in the Alpine material of the Plassen Formation.

Switzerland

I. bodeuri was reported and figured by DUPRAZ & STRASSER (1999, 2002) from the Oxfordian of the Switzerland Jura Mountains. It occurs in the so-called Röschenz Member that stratigraphically includes the major part of the *bifurcatus* Zone (Upper Middle Oxfordian) and the lowermost part of the *bimammatum* Zone (Upper Oxfordian) (DUPRAZ & STRASSER, 1999 – fig. 2). Again, the occurrence with the enigmatic encruster *Koskinobullina socialis* CHERCHI & SCHROEDER was observed in coral–microbialite patch-reefs. Although rare in this habitat when compared with the occurrence of other microencrusters – serpulids, "*Tubiphytes*" or nubeculariid foraminifera, *Koskinobullina*–"Krustenproblematikum" occurs most frequently in framestone facies with branching corals.

Slovakia

Here, it occurs in the Stramberk Limestones (Tithonian) of the Outer Flysch Carpathians. It was figured by ELIAS & ELIASOVA (1986 – pl. 8) as *Archaeolithothamnium* sp. These redeposited boulders came from a former reef belt with corals and calcareous algae typical of reefal/platform margin facies such as *Teutloporella socialis* PRATURLON and *Nipponophycus ramosus* YABE & TOYAMA. *Iberopora bodeuri* is also common in the Stramberk Limestones of the Polish part of the Outer Carpathians (pers. comm. Dr. B. KOLODJZIEJ, Krakow).

Portugal

SCHMID (1996) was the first to pay particular attention to this encrusting microfossil *incertae sedis* from the Kimmeridgian. Hesitating to introduce a new taxon, SCHMID (1996) called it "Krustenproblematikum" (crust problematicum) and reported it as generally rare, sometimes with *Koskinobullina socialis* in mixed coral–siliceous sponge facies and coral–microbolite facies. Another occurrence is from one oncoid formed in a shallow lagoon. In the Lusitanian basin it was recorded as Mikroproblematikum 1 by FÜRSICH & WERNER (1991). Here it is associated with microbial crusts containing a diverse association of microencrusters, and coralline sponges (WERNER et al., 1994 – fig. 10).

Greece

I. bodeuri was figured as *"incrostazioni algali su colonie di coralli, in un boundstone"* from the Kimmeridgian of the "*Calcari di Distomon*" margin facies of

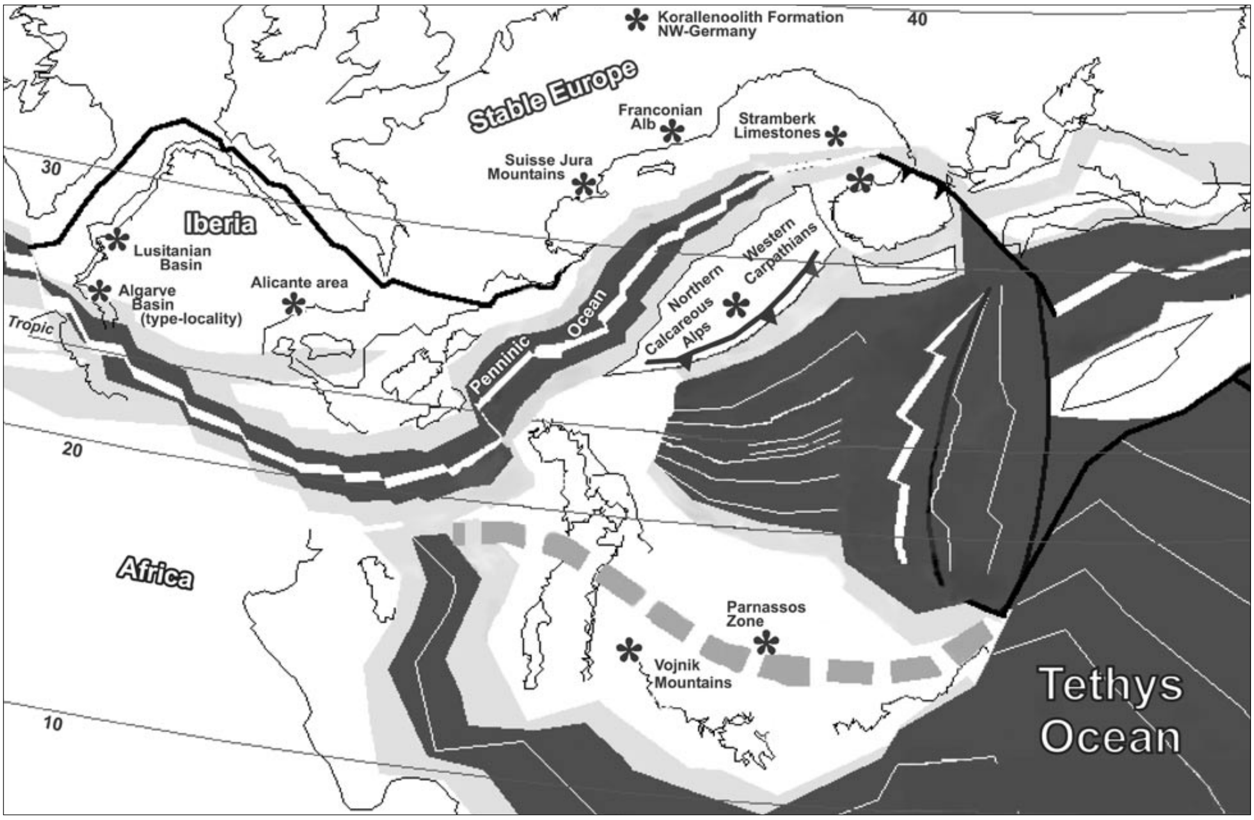

Fig. 2 Occurrences of *Iberopora bodeuri* GRANIER & BERTHOU in the western Tethyan realm (simplified palaeogeographic reconstruction of plate boundaries based on STAMPFLI et al., 1998, with integration of the results of GAWLICK et al., 1999).

the Parnassos Zone by CARRAS (1995 – pl. 20, fig. 4). Note also the co-occurrence with *Koskinobullina socialis* CHERCHI & SCHROEDER (CARRAS, 1995 – pl. 19, fig. 6). These biolithites and calcirudites contain corals, Ellipsactinidae, calcareous sponges, echinoids, Nerineids, large dasycladales and benthic foraminifera.

Romania

Recently, *I. bodeuri* has been reported by UTA & BUCUR (2003) from Berriasian microbialithic limestones of the South Carpathians associated with *Koskinobullina*, *Radiomura* and "*Tubiphytes*" *morronensis* CRESCENTI.

Yugoslavia

Another occurrence is in the Vojnik Mountains of the Outer Dinarides. RADOIČIĆ (1966 – pl. LXX, fig. 1) figured an "encrusting codiaceae" that seems to belong to *Iberopora bodeuri* but exhibits also some chambers of *Koskinobullina socialis* CHERCHI & SCHROEDER (= Microproblematica PR 6, RADOIČIĆ, 1966 – pl. CLIX, fig. 1). This occurrence is referred to as "calcaire organogèno-détritique", that is to say presumably reefal to peri-reefal facies. Detailed stratigraphic data are not available.

The occurrences of *Iberopora bodeuri* GRANIER & BERTHOU (see synonymy) have been plotted on a palaeogeographic map of the Oxfordian adapted from STAMPFLI et al. (1998) modified to include results from GAWLICK et al. (1999). The map (Fig. 2) shows that this species existed on both shores of Tethys. All occurrences known are in a belt of about 15 to 40º northern latitudes.

4. CONCLUSIONS

Iberopora bodeuri GRANIER & BERTHOU is a microfossil *incertae sedis* known from limestones ranging in age from Oxfordian to Berriasian. These limestones were deposited in ramp or carbonate platform environments of the Western Tethyan domain. It is a typical facies sensitive microorganism that occurs in reefal, fore-reefal and upper slope environments where it is associated with a diverse assortment of microencrusters and metazoans (corals, stromatoporoids, and calcareous sponges).

Acknowledgements

Thanks to Prof. H.-J. GAWLICK (Univ. Leoben), Prof. R. LEIN (Univ. Vienna) and Dr. O. EBLI (c/o Univ. Munich) for their contribution of the thin-section material. The manuscript has kindly been read by Dr. D. SCHMID (Univ. Munich). The remarks of one anonymous reviewer, Dr. B. GRANIER (Paris) and the assistance with the English of Dr. N.J. SANDER (Modesto, California) are kindly acknowledged.

5. REFERENCES

ADEY, W.H. (1976): Crustose coralline algae as microenvironmental indicators in the Tertiary.– In: GRAY, J. & BOUCOT, A.J. (eds.): Historical Biogeography, Plate Tectonics and the Changing Environment. Oregon State University Press, 459–464.

AGUIRRE, J., RIDING, R. & BRAGA, J.C. (2000): Diversity of coralline red algae: origination and extinction patterns from the Early Cretaceous to the Pleistocene.– Paleobiology, 26/4, 651–667, Lawrence.

BÖHM, F. (1992): Mikrofazies und Ablagerungsmilieu des Lias und Dogger der Nordöstlichen Kalkalpen [*Microfacies and depositional environment of Lias and Dogger of the Northeastern Calcareous Alps* – in German].– Erlanger geol. Abh., 121, 55–217, Erlangen.

CARRAS, N. (1995): La piattaforma carbonatica del Parnasso durante il Giurassico superiore–Cretaceo inferiore [*The carbonate platform of the Parnassos during the Upper Jurassic–Lower Cretaceous* – in Greek with Italian abstract].– Unpubl. PhD Thesis, University of Athens, 232 p.

CHERCHI, A. & SCHROEDER, R. (1985): *Koskinobullina socialis* CHERCHI & SCHROEDER, 1979: a colonial microfossil incertae sedis (algae?) from Jurassic–Cretaceous of the Mediterranean region.– Boll. Soc. Paleont. Ital., 23/2, 361–374.

DRAGASTAN, O. & RICHTER, D.K. (1999): Late Jurassic oolites from the Acrocorinth (NE-Peleponnesus): calcareous micro-algae as an exceptional paleoecologic indicator.– Bochumer geol. Geotechn. Arb., 53, 149–172.

DUPRAZ, C. & STRASSER, A. (1999): Microbialites and micro-encrusters in shallow coral bioherms (Middle to Late Oxfordian, Swiss Jura Mountains).– Facies, 40, 101–130.

DUPRAZ, C. & STRASSER, A. (2002): Nutritional modes in coral–microbialite reefs (Jurassic, Oxfordian, Switzerland): evolution of trophic strcture as a response to environmental change.– Palaios, 17, 449–471.

ELIAS, M. & ELIASOVA, H. (1986): Elevation facies of the Malm in Moravia.– Geol. Zborn. – Geol. Carpathica, 37/4, 533–550.

ELIASOVA, H. (1981): Some binding microorganisms of the Stramberk reef limestones (Tithonian, Czechoslovakia).– Véstnik Ustr. Ustav. Geol., 56/1, 27–31, Prag.

FENNINGER, A. & HÖTZL, H. (1967): Die Mikrofauna und -flora des Plassen- und Tressensteinkalkes der Typlokalität (Nördliche Kalkalpen) [*Microfauna and -flora of the Plassen and Tressenstein limestones of the type-localities, Northern Calcareous Alps* – in German].– N. Jb. Geol. Paläont. Abh., 128/1, 1–37.

FLÜGEL, E. (1964): Ein neues Vorkommen von Plassenkalk (Ober-Jura) im Steirischen Salzkammergut, Österreich [*A new occurrence of Plassen limestone, Upper Jurassic, in the Styrian Salzkammergut, Austria* – in German].– N. Jb. Geol. Paläont. Abh., 120/2, 213–232.

FRISCH, W. & GAWLICK, H.-J. (2003): The nappe structure of the central Northern Calcareous Alps and its disintegration during Miocene tectonic extrusion – a contribution to understanding the orogenic evolution of the Eastern Alps.– Int. Journ. Earth. Sci., 92, 712–727.

FÜRSICH, F.T. & WERNER, W. (1991): Paleoecology of coralline sponge–coral meadows from the Upper Jurassic of Portugal.– Paläont. Z., 65/1–2, 35–69.

GAWLICK, H.-J. (2000): Die Radiolaritbecken in den Nördlichen Kalkalpen (hoher Mittel-Jura, Ober-Jura) [*The radiolarite basins in the Northern Calcareous Alps, Upper Middle Jurassic, Upper Jurassic* – in German].– Mitt. Ges. Geol. Bergbaustud. Österr., 44, 97–156.

GAWLICK, H.-J., FRISCH, W., VECSEI, A., STEIGER, T. & BÖHM, F. (1999): The change from rifting to thrusting in the Northern Calcareous Alps as recorded in Jurassic sediments.– Geol. Rdsch., 87, 644–657.

GRANIER, B. (1987) : Le Crétacé inférieur de la Costa Blanca entre Busot et Altea (Alicante, Espagne): Biostratigraphie, sédimentologie, évolution tectono-sédimentaire [*The Lower Cretaceous of the Costa Blanca between Busot and Altea, Alicante area, Spain: biostratigraphy, sedimentology, tectono-sedimentary evolution* – in French].– Unpubl. PhD Thesis, Univ. Pierre et Marie Curie, Paris, 281 p.

GRANIER, B. & BERTHOU, P-Y. (2002): Algues calcaires fossiles, nouvelles ou peu connues, du Portugal. 1ere Partie [*New or poorly known fossil calcareous algae of Portugal. Part I* – in French].– In : BUCUR, I.I. & FILIPESCU, S. (eds.): Research Advances in Calcareous Algae and Microbial Carbonates. Proc. 4th IFAA Reg. Meet. Cluj–Napoca, August 29–September 5, 2001, 117–126, Cluj University Press.

HELM, C. (1997) : Faunistische Untersuchungen an einem Fleckenriff des Oberjura (*florigemma*-Bank; Süntel) [*Faunistical investigations of an Upper Jurassic patch-reef, florigemma-Bank, Süntel* – in German].– Unpubl. M.Sc. Thesis, University of Hannover, 105 p.

HELM, C. & SCHÜLKE, I. (1998): A coral–microbialite patch reef from the Late Jurassic (florigemma-Bank, Oxfordian) of NW Germany (Süntel Mountains).– Facies, 39, 75–104.

HELM, C., SCHÜLKE, I. & SCHLAGINTWEIT, F. (2003): Calcareous algae (“Porostromata”, Rhodophyta, Dasycladales) and microproblematica with algal affinity from the NW German Korallenoolith Formation (Oxfordian, Süntel Mountains).– Facies, 49, 61–86.

HÖTZL, H. (1966): Zur Kenntnis der Tressenstein-Kalke (Ober-Jura, Nördliche Kalkalpen) [*On the knowledge of the Tressenstein limestones, Upper Jurassic, Northern Calcareous Alps* – in German].– N. Jb. Geol. Paläont. Abh., 123/3, 281–310.

IMAIZUMI, R. (1965): Late Jurassic algae from Honshu and Shikoku, Japan.– Sci. Rep. Tohoku Univ., 2nd ser. (geol.), 37/1, 49–62.

JOHNSON, J.H. & KASKA, H.V. (1965): Fossil algae from Guatemala.– Prof. Contrib. Colorado School of Mines, 1, 152 p., Golden.

KOCH, R., SENOWBARI-DARYAN, B. & STRAUSS, H. (1994): The late Jurassic “Massenkalk-Fazies” of Southern Germany: calcareous sand piles rather than organic reefs.– Facies, 31, 179–208.

LEINFELDER, R.R. & WERNER, W. (1993): Systematic position and palaeoecology of the Upper Jurassic to Tertiary alga *Marinella lugeoni* PFENDER.– Zitteliana, 20 (Hagn/Herm–Festschrift), 105–122.

LEINFELDER, R.R., NOSE, M., SCHMID, D.U. & WERNER, W. (1993): Microbial crusts of the late Jurassic: composition, palaeoecological significance and importance in reef construction.– Facies, 29, 195–230.

LOEBLICH, A.R. & TAPPAN, H. (1988): Foraminiferal Genera and Their Classification.– Van Nostrand Reinhold, New York, 970 p. (two vols.).

MAMET, B. (1991): Carboniferous calcareous algae.– In: RIDING, R. (ed.): Calcareous Algae and Stromatolites. Springer Verlag, Berlin, 370–451.

MANDL, G.W. (2000): The Alpine sector of the Tethyan shelf – examples of Triassic to Jurassic sedimentation and deformation from the Northern Calcareous Alps.– Mitt. Österr. Geol. Ges., 92, 61–77.

MASSE, J.-P. (1988): L'étage bionomique des milieux benthiques néritiques actuels: signification bathymétrique et implications paléobathymétriques (The vertical bionomic zonation of modern benthic neritic environments: bathymetric significance and palaeobathymetric implications).– Géologie Méditerranéenne, 15/1, 91–102.

MOUSSAVIAN, E. & HÖFLING, R. (1993): Taxonomische Position und Palökologie von *Solenomeris* DOUVILLE, 1924 und ihre Beziehung zu *Acervulina* SCHULTZE, 1854 and *Gypsina* CARTER, 1877 (Acervulinidae, Foraminiferida) [*Taxonomic position and paleoecology of Solenomeris DOUVILLE, 1924 and its relationships to Acervulina SCHULTZE, 1854 and Gypsina CARTER, 1877, Acervulinidae, Foraminifera* – in German].– Zitteliana, 20, 263–276.

PERRIN, C. (1992): Ecological significance of Paleocene to Recent acervulinid foraminifera, their contribution to reef construction and other biogenic facies.– Géobios, 25/6, 725–751.

POIGNANT, A.-F. (1985): Présentation simplifiée d´une nouvelle classification génerique des Rhodophycées mésozoiques et cénozoiques. Informatisation [*Simplified introduction of a new generic classification of Mesozoic and Cenozoic Rhodophyceae. Computerization* – in French].– Bull. Soc. Géol. France, 1985, (8), I/4, 603–605.

POIGNANT, A.-F. & DU CHAFFAUT, S.A. (1970): Les algues des formations transgressives Maestrichtiennes, Paléocènes et Yprésiennes de la cote sud-orientale de la Corse [*Maastrichtian, Paleocene and Ypresian Algae from transgressive formations of the southeastern coast of Corsica* – in French].– Rev. Micropaléont., 12/4, 202–208, Paris.

RADOIČIĆ, R. (1966): Microfacies du Jurassique des Dinarides Externes de la Yougoslavia [*Jurassic Microfacies of the external Dinarids of Jugoslavia* – in French].– Geol. Transact. Rep. – Razprave in poročila, 9, 5–377, Ljubljana.

SCHLAGINTWEIT, F. (1991): Allochthone Urgonkalke im Mittleren Abschnitt der Nördlichen Kalkalpen: Fazies, Paläontologie und Paläogeographie [*Allochthonous Urgonian limestones in the middle part of the Northern Calcareous Alps: facies, palaeontology and palaeogeography* – in German].– Münchner Geowiss. Abh., (A), 20, 1–120.

SCHLAGINTWEIT, F. & EBLI, O. (1999): New results on microfacies, biostratigraphy and sedimentology of Late Jurassic–Early Cretaceous platform carbonates of the Northern Calcareous Alps. Part I: Tressenstein Limestone, Plassen Formation.– Jb. Geol. B.–A., 56/2, 379–418, Wien.

SCHLAGINTWEIT, F., GAWLICK, H.-J. & LEIN, R. (2003a): Die Plassen-Formation der Typlokalität (Salzkammergut, Österreich) – neue Daten zur Fazies, Sedimentologie und Stratigraphie [*The Plassen formation of the type-locality, Salzkammergut, Austria – new data on facies, sedimentology and stratigraphy* – in German].– Mitt. Ges. Geol. Bergbaustud. Österr., 46, 1–34.

SCHLAGINTWEIT, F., GAWLICK, H.-J., EBLI, O., RÜNSTLER, H. & SUZUKI, H. (2003b): Die Plassen-Formation (Kimmeridgium) des Krahstein, Steirisches Salzkammergut und deren Unterlagerung: Neue Daten zur Fazies, Biostratigraphie und Sedimentologie [*The Plassen Formation, Kimmeridgian, of the Krahstein, Styrian Salzkammergut, and its basement: new data on facies, biostratigraphy and sedimentology* – in German].– In: WEIDINGER, J.T., LOBITZER, H. & SPITZBART, I. (eds.): Beiträge zur Geologie des Salzkammergutes. Gmundner Geo-Studien, 2, 87–96, Gmunden.

SCHMID, D.U. (1996): Marine Mikrobolithe und Mikroinkrustierer aus dem Oberjura [*Marine microbolites and micro-encrusters from the Upper Jurassic* – in German].– Profil, 9, 101–251, Stuttgart.

SENOWBARI-DARYAN, B., KEUPP, H., ABATE, B. & VARTIS-MATARANGAS, M. (2002): First record of *Norithamnium* gen. nov. (Corallinales, Rhodophyta) from Late Triassic (Norian–Rhaetian) reefs of the Western Tethys.– In: BUCUR, I.I. & FILIPESCU, S. (eds.): Research Advances in Calcareous Algae and Microbial Carbonates. Proc. 4th IFAA Reg. Meet. Cluj–Napoca, August 29–September 5, 2001, 201–208, Cluj University Press.

STAMPFLI, G.M., MOSAR, J., MARQUER, D., MARCHANT, R., BAUDIN, T. & BOREL, G. (1998): Subduction and obduction processes in the Swiss Alps.– Tectonophysics, 296, 159–204.

STEIGER, T. & WURM, D. (1980): Faziesmuster oberjurassischer Plattform-Karbonate (Plassenkalke, Nördliche Kalkalpen, Steirisches Salzkammergut, Österreich) [*Facies patterns of Upper Jurassic platform carbonates, Plassen limestone, Northern Alps, Styria/Austria* – in German].– Facies, 2, 241–284.

TOLLMANN, A. (1985): Geologie von Österreich, Band 2 [*Geology of Austria, Volume 2* – in German].– Deuticke, Wien, 710 p.

TOLLMANN, A. (1987): Late Jurassic/Neocomian gravitational tectonics in the Northern Calcareous Alps in Austria.– In: FLÜGEL, H.W. & FAUPL, P. (eds.): Geodynamics of the Eastern Alps. Deuticke, Wien, 112–125.

UTA, A. & BUCUR, I.I. (2003): Microbial structures and microencrusters in the Upper Jurassic–Lower Cretaceous deposits from Buila–Vanturarita Massif (South Carpathians).– Studia Universitatis Babes–Bolyai, Geologia, XLVIII/2, 3–14, Cluj–Napoca.

VOIGT, E. (1970): Foraminiferen und (?) Phoronidea als Kommensalen auf den Hartgründen der Maastrichter Tuffkreide [*Foraminifera and (?)Phoronidea as commensalists in the hardgrounds of the Maastrichtian Tuffkreide* – in German].– Paläont. Z., 44/1–2, 86–92.

WEGERER, E., SUZUKI, H. & GAWLICK, H.-J. (2003): Zur stratigraphischen Einstufung von Kieselsedimenten südöstlich des Plassen (Nördliche Kalkalpen, Österreich) [*Stratigraphy of cherty sediments southeast of the Plassen, Northern Calcareous Alps, Austria* – in German].– Jb. Geol. B.-A., 143/1, 79–91.

WERNER, W., LEINFELDER, R.R., FÜRSICH, F.T. & KRAUTTER, M. (1994): Comparative palaeoecology of marly coralline–sponge-bearing reefal associations from the Kimmeridgian (Upper Jurassic) of Portugal and Southwestern Germany.– Cour. Forsch.-Inst. Senckenberg, 172, 381–397.

WRAY, J.L. (1979): Paleoenvironmental reconstructions using benthic calcareous algae.– Bull. Cent. Rech. Explor.-Prod. Elf-Aquitaine, 3/2, 873–879.

Manuscript received May 23, 2003.

Revised manuscript accepted May 04, 2004.

PLATE 1

Iberopora bodeuri GRANIER & BERTHOU and some associated microencrusters from the Plassen Formation of the Northern Calcareous Alps

1, 5 Nodular (solenoporoid) morphotype of *Iberopora bodeuri* GRANIER & BERTHOU. Locality Krahstein, Styrian Salzkammergut; (Upper) Kimmeridgian, scale bar = 2 mm. Sample Krah–118.

2–4, 6 Crustose (corallinoid) morphotype of *Iberopora bodeuri* GRANIER & BERTHOU. Note the intergrowth with *Koskinobullina socialis* CHERCHI & SCHROEDER (Fig. 6). 2, 4, 6: Locality Trisselwand near Altaussee (samples TK 15–1, TK 22), Lower Berriasian; 3: Locality Plassen near Hallstatt (sample PL 98), uppermost Tithonian or lowermost Berriasian; scale bar = 1 mm for Figs. 2, 3 and 0.5 mm for Figs. 4, 6.

7 Serpulid worm tube *Carpathiella triangulata* MÍŠÍK, SOTÁK & ZIEGLER 1999, cross-section. Locality: Trisselwand near Altaussee (sample TK 15–2); Lower Berriasian, scale bar = 0.5 mm.

8 Agglutinating polychaete, probably *Terebella lapilloides* MUENSTER, longitudinal section. Locality: Trisselwand near Altaussee (sample TK 15-1); Lower Berriasian, scale bar = 0.5 mm.

9 “Prismenproblematikum” SCHMID 1996 (1), section of “*Tubiphytes*” *morronensis* CRESCENTI (2) and nubecularid foraminifera (3). Locality: Trisselwand near Altaussee (TK 2); Lower Berriasian, scale bar = 0.5 mm.

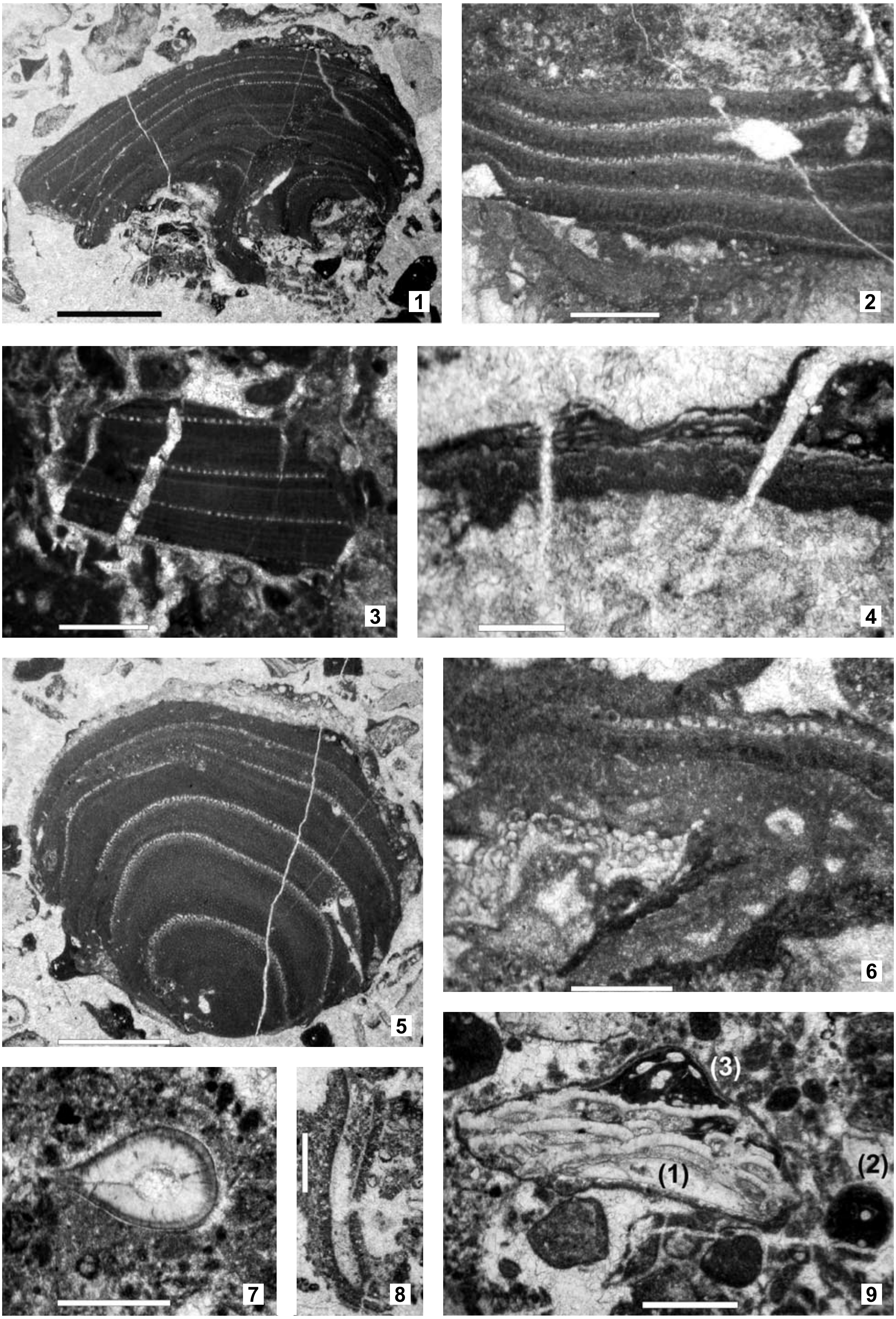
1
2
3
4
5
6
7
8
9
(1)
(2)
(3)

PLATE 2

Iberopora bodeuri GRANIER & BERTHOU, associated microencrusters and microfacies from the Plassen Formation of the Northern Calcareous Alps

1, 3 Colonial microproblematicum *Koskinobullina socialis* CHERCHI & SCHROEDER encrusting a stromatoporoid. Trisselwand near Altaussee (TK 2); (Lower) Berriasian, scale bar = 2 mm in Fig. 1 and 0.5 mm in Fig. 3.

2 Longitudinal section of "*Tubiphytes*" *morronensis* CRESCENTI. Trisselwand near Altaussee (TK 2); (Lower) Berriasian, scale bar = 1 mm.

4, 7 *Iberopora bodeuri* GRANIER & BERTHOU together with encrusting foraminifera and irregular dome-shaped microbial crust. Trisselwand near Altaussee (TK 15–1); (Lower) Berriasian, scale bar = 0.5 mm in Fig. 4 and 2 mm in Fig. 7.

5 Thin crust of *Iberopora bodeuri* GRANIER & BERTHOU (right side) on *Spongiomorpha asiatica* YABE & SUGIYAMA. Trisselwand (TK 22); (Lower) Berriasian, scale bar = 2 mm.

6 Fragment of *Iberopora bodeuri* GRANIER & BERTHOU. Trisselwand (TK 22); (Lower) Berriasian, scale bar = 0.5 mm.

PLATE 2