Ann. Naturhist. Mus. Wien	111 A	15–32	Wien, April 2009

GEOLOGIE UND PALÄONTOLOGIE

Thyromata nov. gen., a benthic foraminifer from the Late Eocene-Early Oligocene of the Paratethys

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(With 3 figures, 2 plates, and 1 table)

Manuscript submitted on April 30th 2008,
the revised manuscript on December 19th 2008

Abstract

A new genus of the Nonionidae, *Thyromata*, from Late Eocene to Early Oligocene of the Paratethys is based on the type species *Nonion curvisepta* SUBBOTINA ,1947. The shells of the genus are planispiral involute, biconvex, with limbate, sickle-shaped sutures. The primary aperture is interiomarginal, equatorial, restricted to the periphery of the previous whorl and with a thickened lip. The wall is bilamellar with a septal flap. The wall is optically granulate. Alar prolongations of the chambers with supplementary interiomarginal apertures at the base are characteristic. The main foramen and the supplementary foramina in the alar prolongations remain open. The species occurs in pelagic deep water sediments, mainly in *Globigerina* marl facies. It is geographically distributed over the entire Paratethys from Northern Caucasus to the French Prealps, and may constitute a biostratigraphic marker of the Eocene-Oligocene boundary interval.

Keywords: foraminifera, Nonionidae, taxonomy, Eocene-Oligocene boundary, Paratethys.

Introduction

Strong plate-tectonic movements at the end of the Eocene were the reason for the disappearance of the Tethys Ocean and created at its western end the Mediterranean and Paratethys Seas (Fig. 1). India collided with the Asian continental block, and an active mountain belt from the Western Alps to the Kopet Dagh divided these new bioprovinces. By Oligocene time they are separated into the Mediterranean-Iranian Province and the intra-continental Northern Peri-Tethys namely the Danubian Province and the Proto-Caspian Subprovince (RÖGL 1998; HARZHAUSER et al. 2002; POPOV et al. 2001, 2004). The continuous restrictions of connections from open oceans with the Paratethys drastically changed the environment and sedimentation in the basins from whitish *Globigerina* marl facies to dark, often bituminous shales. Late Eocene *Globigerina* marls are widely distributed from the Prealps (comp. UJETZ 1996) to the Asian Turan Province in the Beloglinian Basin (POPOV et al. 1993). In Early Oligocene time (Early Rupe-

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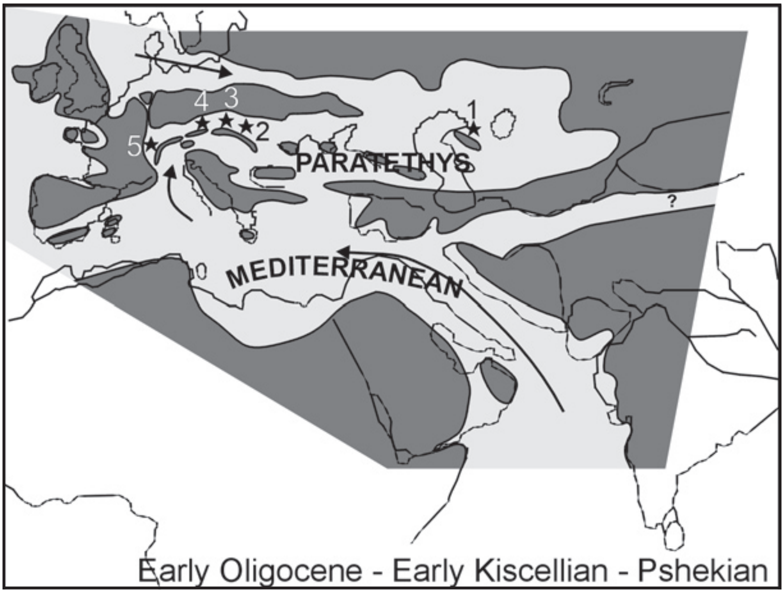

Fig. 1. Palaeogeographic map of the western Tethys (Mediterranean and Paratethys Seas) in the Early Oligocene (RÖGL 1998). Asterisks mark the sections with the occurrence of *Thyromata curvisepta* (SUBBOTINA, 1947): 1 – Northern Caucasus, 2 – North Hungarian Paleogene Basin, 3 – Waschberg Unit, Austria, 4 – Allochthonous Molasse and Lower Inn Valley, Austria, 5 – Prealps, France.

lian: Early Kiscellian in the western part of the Paratethys and Pshekian stage in the Turan Province) these restrictions caused a turnover in the marine fauna and flora. This change is well known in the Eastern Paratethys (Turan Province) from the Belaya Glina (white marls) to dark, commonly non-calcareous Maikop facies. The molluscan faunas change from *Propeamusssium fallax* assemblages to boreal immigrants with *Thyasira nysti*. Planktonic foraminiferal faunas change from large forms (e.g., *Globigerinatheka*, *Hantkenina*, *Subbotina corpulenta/cryptomphala*, *S. gortanii*) to small globigerinids (*Globigerina officinalis*, *G. postcretacea*) in the Northern Caucasus Basin (SUBBOTINA 1953, 1971) and Carpathian Foredeep (OLSZEWSKA 1998).

In the straits connecting the Paratethys to the open sea, in Armenia and the western Molasse Basin, *Globigerina* marls with larger species (e.g., *Subbotina gortanii*, *S. sellii*, *S. angiporoides*, *S. tapuriensis*) are still present in the earliest Oligocene (KRASHENINNIKOV 1974; UJETZ 1996, CICHA et al. 1998). The peak of isolation was reached during the Solenovian stage (middle Kiscellian). During this period light-coloured calcareous nannoplankton ooze of nearly monospecific assemblages with *Dictyococcites ornatus* (NP23) was deposited throughout the Paratethys basins. Smooth-shelled ostracods (*Dispontocypris oligocaenica*) and small endemic bivalves (*Urbnisia*, *Janschinella*, *Korobkoviella*, *Cerastoderma*, “*Cardium*” *lipoldi*) are characteristic for this facies. In the later part of the Solenovian, the Maikopian facies again replaced the nanno-ooze, whereas in the Carpathian Foredeep and Molasse Basin marine dark mudstones developed (POPOV

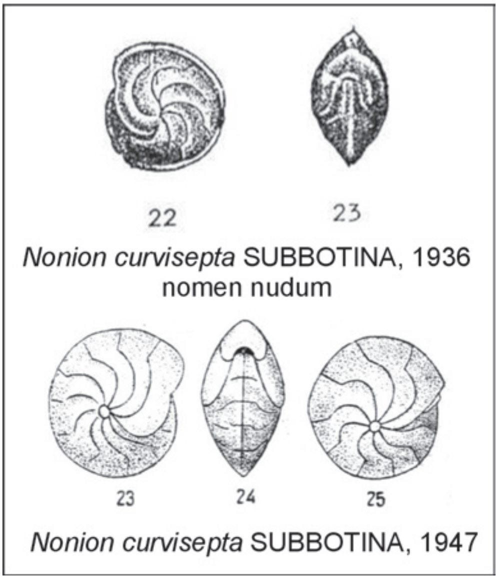

Fig. 2. *Nonion curvisepta* SUBBOTINA. Original figures from the publications of SUBBOTINA (1936, 1947) from the Northern Caucasus.

et al. 1993; KRHOVSKY et al. 2001). A re-connection of the Paratethys to the open seas occurred during the Late Rupelian (Kalmykian, Late Kiscellian).

From sediments marking the Eocene – Oligocene transition in the famous Kuban River section of Northern Caucasus, near the town Sulimova (Batalpashinsk), a new species of nonionids was described by SUBBOTINA (1936): *Nonion curvisepta*. In that publication the species was only named and figured without description, thereby constituting a nomen nudum according to art. 13.1.1 of Zoological Nomenclature. In the year 1947, SUBBOTINA refigured and described the species as new from a section along the river Assa in Northern Caucasus (fig. 2).

The occurrence of *N. curvisepta* is cited by SUBBOTINA in sediments of Early Oligocene age, Zone VII or *Bolivina* Zone. The accompanying foraminiferal fauna with the benthic species *Bulimina sculptilis*, *B. truncana*, *Bolivina nobilis*, and the planktonic species *Pseudohastigerina micra* support an age around the Eocene-Oligocene boundary.

The generic position of this species as a *Nonion* is discussed. According to the results of this investigation the species *N. curvisepta* is placed in a new genus.

This investigation is devoted to Dr. Ortwin Schultz, Geology & Palaeontology Department, Natural History Museum Vienna, for his continuous interest in research of the Cenozoic deposits.

Investigated sections and material

During investigations of Lower Oligocene sections in Austria the species *Nonion curvisepta* SUBBOTINA was found. It appears in two tectonically different regions (fig. 1). The most important outcrops are situated in the Waschberg Unit, a tectonically strongly disturbed unit extending northwest of Vienna between the Danube and the Czech border at Mikulov. The unit continues towards NE in the Ždanice and Pouzdřany Units that belong to the Outer Carpathian flysch belt. The sections are situated in the village Ottenthal, described in detail by Rögl et al. (2001). Samples containing *N. curvisepta* are from the lowermost part of the Ottenthal type section, Ottenthal Formation, lower Ottenthal Member. They are dark brown pelagic marls.

The calcareous nannoplankton present in these samples indicates an age of zone NP22, defined by *Reticulofenestra umbilicus*, *Lanternites minutes*, *Isthmolithus recurvus*, and the absence of *Coccolithus formosus*. The foraminiferal fauna is dominated by plankton: *Subbotina angiporoides*, *S. galavisi*, *S. linaperta*, *S. praeturritilina*, *S. tapuriensis*, *Globigerina officinalis*, *Catapsydrax unicavus*, *Globorotaloides suteri*, *Tenuitella evoluta*, *Pseudohastigerina praemicra*, *Chiloguembelina cubensis*, *C. gracillima*. Benthic species are small and commonly fractured. Stratigraphically important are: *Bolivina beyrichi carinata*, *B. koessenensis*, *B. reticulata*, *B.vaceki bavarica*, *B. vaceki vaceki*, *Bulimina alazanensis*, *B. truncana*, *B. sculptilis*, *Uvigerina moravia*, *Tritaxia kruhelensis*, *Planulina costata*, *Valvulineria palmarealensis*, *Anomalinoides alazanensis*.

The second region with the species *Nonion curvisepta* belongs to the Molasse Basin in Upper Austria. It is the tectonically disturbed southern part of the basin, the allochthonous Molasse or so-called “Schuppenzone”. The shallow counter-flash drilling CF-Nussdorf 6 crossed the Eocene-Oligocene boundary, and drilled underlying Upper Cretaceous marls. The drilling ended in Miocene sand, sandstone, and calcareous shale (Schors 1949). The location of the drill site is north of Salzburg, at the northern shore of Lake Obertrum, somewhat north of the overthrust of the Helvetikum tectonic unit onto the Molasse units.

This drill hole reveals continuous *Globigerina* marl facies that spans the Eocene-Oligocene boundary with a few horizons of dark clay with a pyritized fauna. Similar faunas are known from the Upper Eocene “Stockletten” of the Helvetikum Unit, but without *N. curvisepta*. According to J. Krhovsky (Praha, pers. communication) samples downhole to 44 m belong to nannoplankton zone NP22; the section from 44 m to 104 m falls in zone NP21, followed by NP19/20 from 107 m to 117 m. The Eocene/Oligocene boundary lies within zone NP 21 but can not be defined exactly in the section as index fossils for the boundary are missing. Planktonic foraminifera from the samples with *Nonion curvisepta* (38-92 m) are dominated by large species: *Subbotina cryptomphala*, *S. gortanii*, *S. praeturritilina*, *S. pseudoeocaena*, *S. tapuriensis*, *Catapsydrax unicavus*, *Globorotaloides suteri*, and additionally in the upper part common *Globigerina officinalis*, *Tenuitella evoluta*, *T. liverovskae*. Important benthic species are *Bolivina beyrichi beyrichi*, *Bulimina truncana*, *B. sculptilis*, *B. subtruncana*.

The record of a single specimen of *N. curvisepta* comes from a mud sample in the deep drilling Reith 1 of the RAG Oil Company, also from the allochthonous Molasse.

Figured specimens and samples are deposited at the Micropalaeontological Collection, Geology & Palaeontology Department, Natural History Museum Vienna, nos. 2008z0095/0001-0026.

Systematic Part

Order Foraminiferida EICHWALD, 1830

Suborder Rotaliina DELAGE & HÉROUARD, 1896

Superfamily Nonionacea SCHULTZE, 1854

Family Nonionidae SCHULTZE, 1854

Thyromata nov. gen.

Type species: *Nonion curvisepta* SUBBOTINA, 1947, p. 89, pl. 8, figs 23-26

Derivatio nominis: plural of antique Greek Thyroma = Thyromata, the openings that pierce the facade in the Hellenistic theatre.

Diagnosis: Test planispirally involute, biconvex; sutures sickle-shaped, thick, limbate; chambers not subdivided, but with constrictions by the laterally indented apertural chamber wall; wall bilamellar, finely perforate, optically granulate, calcitic; main aperture equatorial, restricted to the periphery, with a thickened lip. Characteristic are the symmetrical alar prolongations on both sides of the final chamber with additional interiomarginal supplementary apertures. Beside the main foramen, the additional apertures of the alar prolongations are transformed to supplementary foramina and communicate with earlier chambers. The terms used in the description follow the glossary of HOTTINGER (2006).

Occurrence: Late Eocene to Early Oligocene, Paratethys.

Discussion: Mineralogical investigations of the carbonate of the test were kindly performed by Prof. Dr. E. LIBOWITZKY (Mineralogy Dept., University of Vienna). Infrared transmission spectra of the test showed calcite, but two peaks at 1086 and 712 were close to wave numbers 1083 and 713 of aragonite (comp. JONES & JACKSON 1993). Therefore it could not be ruled out as a possibility that an original aragonitic shell had been partly converted to calcite. Aragonite in the wall would point to a systematical position under a group of aragonitic-walled families (Ceratobuliminidae, Epistominidae, Conorboididae, Robertinidae). But no genus in all these families shows a planispiral coiling and many of them have interior chamber subdivisions.

As the result of the infrared spectroscopy is inconclusive relative to the foraminiferal taxonomy, it was found necessary to study the material by x-ray diffraction:

X-ray diffraction was made of two specimens glued to the tip of a 0.5 mm glass rod. The glue consisted of Lakeside 70 cement which had been moistened by alcohol. This treatment of the Lakeside cement results in a rubber-like glue, which is without reflection in x-rays. The specimens were run in a Bruker AXS D8 Advance powder diffractometer. They were irradiated in a capillary specimen holder using Cu $k\alpha_1$ radiation with a primary Ge-monochromator. The x-ray equipment is housed in the Geological Institute of the University of Copenhagen. By x-ray diffraction, only calcite was found with no trace of aragonite.

Specimens for scanning electron microscopy were embedded in Lakeside 70 cement on glass slides and sectioned, polished and etched following the procedure described in HANSEN & LYKKE-ANDERSEN (1976). The optical orientation of the wall material was determined on crushed specimens observed under the light microscope between crossed nicols.

The new genus is placed within the family Nonionidae. It is separated from the genus *Nonion* by the presence of the supplementary apertures in the alar prolongations of the chambers. The same character prevents the genus from falling into subfamily Pulleniinae.

***Thyromata curvisepta* (SUBBOTINA, 1947)**

(figs 2-3; plate 1, figs 1-9; plate 2, figs 1-8)

1936 *Nonion curvisepta* SUBBOTINA – p. 12, 25, pl. 6, figs 22-23 (fide ELLIS & MESSINA) [nomen nudum].
1947 *Nonion curvisepta* SUBBOTINA – p. 89, pl. 8, figs 23-26.
1962 *Nonion" curviseptum* SUBBOTINA – LÜHR, p. 138, pl. 5, figs 2 a-c, pl. 9, figs 5-7, textfig. 10 c.
1982 *Nonion curviseptum* SUBBOTINA – SZTRAKOS, p. 11, tab 5, pl. 22, figs 3 a-b.

Description by N.N. SUBBOTINA (1947), translated from Russian: test absolutely involute, convex on both sides, rather thick. Last whorl consists of 10 chambers, which increase in size gradually. Chambers separated by sickle-shaped sutures; sutures slightly incised, straight near periphery. Median aperture half-moon shaped. Wall calcareous with very fine perforation, and smooth.

Diameter: 0.8mm; thickness: 0.45mm

New observations by light microscopy and SEM investigation: test planispirally involute, biconvex, slightly inflated, with a small shoulder towards the angled periphery. Sutures sickle-shaped, thick, limbate, flush with the surface to slightly elevated. Umbilical depression flat to very slightly sunken. Aperture interiomarginal, equatorial, a symmetrical crescentic opening at the base of the apertural face, restricted to the breath of the periphery of the previous whorl, with a thick everted lip (pl. 1, fig. 2). Chamber face above the aperture concave, bordered by an angled rim. A retrovert indentation on both sides of the aperture forms the sickle-shaped suture and divides the chamber lumen in two sack-like parts on both sides of the whorl. There are no internal structures.

The alar prolongations of the chamber with up to three interiomarginal supplementary apertures are characteristic of the species and genus (pl. 1, fig. 5). These apertures remain as intercameral foramina and provide communications between the alar prolongations of succeeding chambers. The main foramen connects the peripheral parts of the chambers.

The wall is bilamellar with a septal flap, optically granulate and very finely perforate. Between crossed nicols the lamellar structure of the wall is visible (pl. 1, fig. 9). The light areas shown below the outlined septa in pl.1, fig. 9 are the continuation of the chamber wall, visible by the somewhat thick and oblique section (comp. pl. 1, fig. 8). The surface of the thick wall is smooth, whitish with a glossy appearance.

Fig. 3. Pencil drawing of *Thyromata curvisepta* (SUBBOTINA), exhibiting the limbate, sickle-shaped sutures and the shoulder towards the periphery. Inv. no. NHMW 2008z0095/0001

In the species *T. curvispeta* two generations have been observed (pl. 1, figs 6-7); large specimens are microspheric and small ones belong to the megalospheric generation.

D i m e n s i o n s (tab. 1): 26 specimens measured from Ottenthal sections and from the allochthonous Molasse drill site CF-N6:

Diameter: 0.264 – 0.641 mm, mean 0.427 mm

Thickness: 0.176 – 0.357 mm, mean 0.246 mm

Number of chambers in the final whorl: 6 to 8

Investigated specimens: From the Waschberg Unit at Ottenthal, Lower Austria, Ottenthal Formation, Lower Ottenthal Member, Lower Oligocene, Kiscellian: 38 specimens (samples: Rö 19-84, Stradner -7.50 m, type section +58.6 m).

From the allochthonous Molasse in drill site CF-N6, from 38 to 92 m, 64 specimens, and from drill site Reith 1, 1 specimen. The investigated specimens occur from the Upper Eocene to the Lower Oligocene, in nannoplankton zones NP21 to NP22.

Thyromata curvisepta as a marker for the Eocene-Oligocene boundary

This easily recognized species is restricted to a short time interval around the Eocene - Oligocene boundary in the region of the Paratethys. Reports of the species are not very common. This may be due to the opinion that nonionids are no good markers for precise stratigraphy. Despite this problem, published records cover the entire area from Northern Caucasus to the French Prealps.

The primary descriptions of SUBBOTINA (1936, 1947) are from sediments in Northern Caucasus. In both cases (Kuban River section and River Assa) the Zone of *Bolivina* was considered to be Early Oligocene. In the revision of the Kuban River section KRASHENINNIKOV et al. (1996) placed the Zone with *Bolivina antegressa* in the topmost Eocene, corresponding to the Zone of *Turborotalia centralis*. For all the Euxinian-Caspian Basin the Zone with *Bolivina* belongs to the Late Eocene according to POPOV et al. (2004), and correlates with lower NP21 nannoplankton zone or upper P16 to P17 zones of planktonic foraminifera.

In the Central Paratethys this species was mentioned by SZTRAKOS (1982) from the North Hungarian Paleogene Basin. In his zonation of benthic foraminifera the discontinuous range of *T. curvisepta* covers the Zone of *Cylindroclavulina rudislosta* and Zone of *Bulimina sculptilis*, correlated with the *Globorotalia cerroazulensis* and the *Pseudohastigerina barbadoensis* Zones. These zones cross the Eocene-Oligocene boundary from the Buda Marl to the Tard Clay facies.

As mentioned above, there are occurrences in the tectonic Waschberg Unit in Austria, in the sections of Ottenthal (Early Kiscellian, Ottenthal Formation, Lower Ottenthal Member, nannoplankton zone NP22). *T. curvisepta* is found only in distinct levels of dark-brown clayey marl together with a rich plankton fauna, dominated by subbotinids. The other occurrence was observed in a yellowish *Globigerina* marl facies of the allochthonous Molasse, dated as Late Eocene to Early Oligocene, nannoplankton zones NP21 to NP22.

An interesting observation was made by LÜHR (1962) in the Oligocene of the Lower Inn Valley in Tyrol. The occurrence of *T. curvisepta* is restricted to his faunal assemblages

Tab. 1. Dimensions of studied specimens of *Thyromata curvisepta* (SUBBOTINA, 1947).

Sample	Diameter of Test in micrometer	Thicknes of Test in micrometer	Number of Chambers
Molasse Unit, Austria CF-N6 (41-44m)	352.24	183.66	7.5
	415.14	226.44	8
	332.11	188.70	
	377.40	206.31	7
	306.95	176.12	7
	372.36	188.70	7.5
	332.11	176.12	
	410.10	226.44	
	364.82	176.12	8
	616.42	37.27	7.5
	641.58	427.72	
Reith-1	528.36	276.76	8
Waschberg Unit, Austria Ottenthal Rö 19-84	528.36	352.24	
	427.72	276.76	
	515.78	276.76	
	478.04	264.18	
	452.88	251.60	7.5
	440.30	251.60	8
	498.16	276.76	7
	490.62	289.34	7
	457.91	276.76	7
	455.39	264.18	7
	352.24	206.31	7
	266.69	176.12	6
	264.18	176.12	6
	440.30	256.63	7.5
mean	427.00	246.00	6.7

B-C, which comprise the upper part of “Lower Zementmergel” to lower part of “Upper Zementmergel”. Oligocene sedimentation started in this basin with basal clastics, coal formation and laminated bituminous marls of the Häring Formation. A fast deepening of the basin is observed in the upper bathyal sediments of the Paisslberg Formation, which includes the former “Zementmergelserie” with an increase of planktonic foraminfera (ORTNER & STINGL 2001). Nannoplankton determination dated these marls as zone NP21-22 (STEININGER et al. 1976).

The most westerly occurrence of *T. curvisepta* was observed in the Western Paratethys in the “Marnes à Foraminifères” of the Prealps (chaînes subalpines, Haute-Savoie, France). The species was found in the Synclinale de Cenise, section Les Combes, and was determined by HAGN in CHAROLLAIS et al. (1980). The stratigraphic position of the section is Early Oligocene, *Cassigerinella chipolensis/Pseudohastigerina micra* Zone, nannoplankton zone NP21.

Comparing the occurrences in the entire Paratethys, *T. curvisepta* is a marker for the latest Eocene to Early Oligocene, as defined by calcareous nannoplankton zones NP21 to NP22.

Palaeoecology of *Thyromata curvisepta*

During Late Eocene the Northern Caucasus belonged to the deepwater basin of the Beloglinian Sea with the Belaya Glina Formation (white marls). Pelagic assemblages of “*Globigerina*” *tapuriensis* and “*Coccolithus*” *subdistichus* Zones dominated (KRASHENINNIKOV & MUZYLEV 1975). Fish-faunas also show a deep basin by the occurrence of, e.g., *Bregmaceros filamentosus* (POPOV et al. 2001).

Similar deep water *Globigerina* marls are also characteristic for all other occurrences of *T. curvisepta*. The records in the North Hungarian Paleogene Basin are from the upper part of bathyal Buda Marl, rich in planktonic foraminifera and with deep water benthics, e.g., *Cyclammina*, *Eggerella*, *Tritaxilina*, *Plectina*, *Ammomarginulina*, *Marginulina*, *Alabamina*, *Valvulineria*, costate *Uvigerina* (SZTRAKOS 1982).

A somewhat different fauna is observed in the Waschberg Unit in Austria. During nannoplankton zone NP22 a reduction in water circulation caused a decrease of the oxygen content in the bottom water: dark marls and reduced benthic assemblages were the result. An upper bathyal water depth is assumed. Note that *T. curvisepta* does not occur under the strong dysaerobic conditions of the laminated facies of upper Ottenthal Member (upper NP22).

The *Globigerina* marl facies in the allochthonous Molasse, and also in the Lower Inn Valley at Häring exhibits rich benthic assemblages with, e.g., *Cyclammina*, *Vulvulina*, *Tritaxia*, *Karreriella*, *Lenticulina*, *Bolivina*, *Bulimina*, *Uvigerina*, *Valvulineria*, *Cibicidoides*. A bathyal deposition depth was proposed by LINDENBERG et al. (1981).

For the Foraminifera Marls of French Prealps a paleoecological interpretation was given by UJETZ (1996). There exists a distinct change in assemblages from Eocene to Oligocene. In some Upper Eocene sections thick-walled benthic species occur with *Vaginulinopsis*, *Stilostomella*, *Gyroidinoides*, *Anomalinoides* in a well oxygenated environment, whereas in bathyal depth low oxygen conditions prevailed. In the Oligocene, pyritized faunas with *Chilostomella*, *Globobulimina* and small globigerinas dominated the dysaerobic environment.

According to the reported and studied occurrences the ecological conditions of *Thyromata curvisepta* are restricted to deep water, bathyal environments. The species does not occur under strong oxygen deficiency of the bottom water.

Acknowledgment

This investigation, the acquisition of material, and the nannoplankton determinations were supported by my colleagues: Jan Krhovsky (Ministry of Environment, Praha), Herbert Stradner (Geological Survey, Vienna), Roswitha Braunstein (Vienna), and by the RAG - Rohoel-Aufsuchungs-AG (Vienna). Russian text was kindly translated by Helena Shaverdo (Vienna). For the determination of the mineralogical composition of the test wall we are indebted to E. Libowitzky (Mineralogy Department, University Vienna) for the infrared spectroscopy and to T. Balic Zunic, (Geological Institute, University of Copenhagen) for the X-ray diffraction. The Museum of Natural History, Vienna provided light microscopy and SEM photography, where support was yielded by Franz Brandstätter and Oleg Mandic. The SEM facility (FEI Quanta) was made available in the Geological Museum, University of Copenhagen. We are grateful to the reviewer of the manuscript, Lukas Hottinger (Basel).

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Plate 1

Thyromata curvisepta (Subbotina, 1947), all specimens from Ottenthal, Lower Austria, Waschberg Unit, Ottenthal Formation, Lower Ottenthal Member, nannoplankton zone NP22.

Fig. 1. Lateral view, showing the sickle-shaped sutures, producing a small shoulder towards the periphery as well as the alar prolongation of the final chamber. Inv. no. NHMW 2008z0095/0002

Fig. 2. Apertural view. The equatorial main aperture which is restricted to the width of the periphery of the earlier whorl is bordered by a thick everted lip; the triangular, concave apertural face is bordered by a rim, and on both sides of the test, the alar prolongations of the final chamber extend down along the side of the earlier whorl exhibiting a basal, supplementary aperture. Inv. no. NHMW 2008z0095/0003

Fig. 3. Lateral view with explanation of test morphology. Inv. no. NHMW 2008z0095/0001

Fig. 4. Detail of fig. 5 with a supplementary foramen (sf) and the broken lip of the main aperture (li).

Fig. 5. Apertural view. The broken final chamber shows the alar prolongations (al) with supplementary basal apertures (sa). The broken lip (li) shows the position of the main aperture. The main foramen (f) of the penultimate chamber is an elongated oval opening at the base of the septum (s) with a lip, connecting with the earlier chamber. Supplementary foramina (sf) in the lateral part of the chambers connect successive lateral parts of the chamber lumina of the alar prolongations (al). Alar prolongations and main chamber are in open exchange and are not divided by septa. The shoulder (sh) is produced by the alar prolongations. Inv. no. NHMW 2008z0095/0005

Fig. 6. Equatorial section through a microspheric specimen. Inv. no. NHMW 2008z0095/0023

Fig. 7. Equatorial section through a megalospheric specimen with large proloculus. Inv. no. NHMW 2008z0095/0024

Fig. 8. Microspheric sectioned specimen in reflected light. The septa are inclined, with thickend lips at the foramina. No internal structures or subdivision of the chamber lumen are visible. Inv. no. NHMW 2008z0095/0006

Fig. 9. Sectioned specimen in transmitted light between crossed nicols (same specimen as fig. 8). Lamination and optically granular wall texture is visible; the lamination corresponding to two succeeding septa is displayed (arrow) to show the inner layer of the following chamber which forms a septal flap.

Abbreviations: a =main aperture, al = alar prolongation of chambers, f = foramen connecting the peripheral parts of chambers, li = lip, mch = main chamber, p = periphery, per = peripheral shoulder, s = septum, sa = supplementary aperture, sf = supplementary foramen connecting lateral parts of chamber lumina.

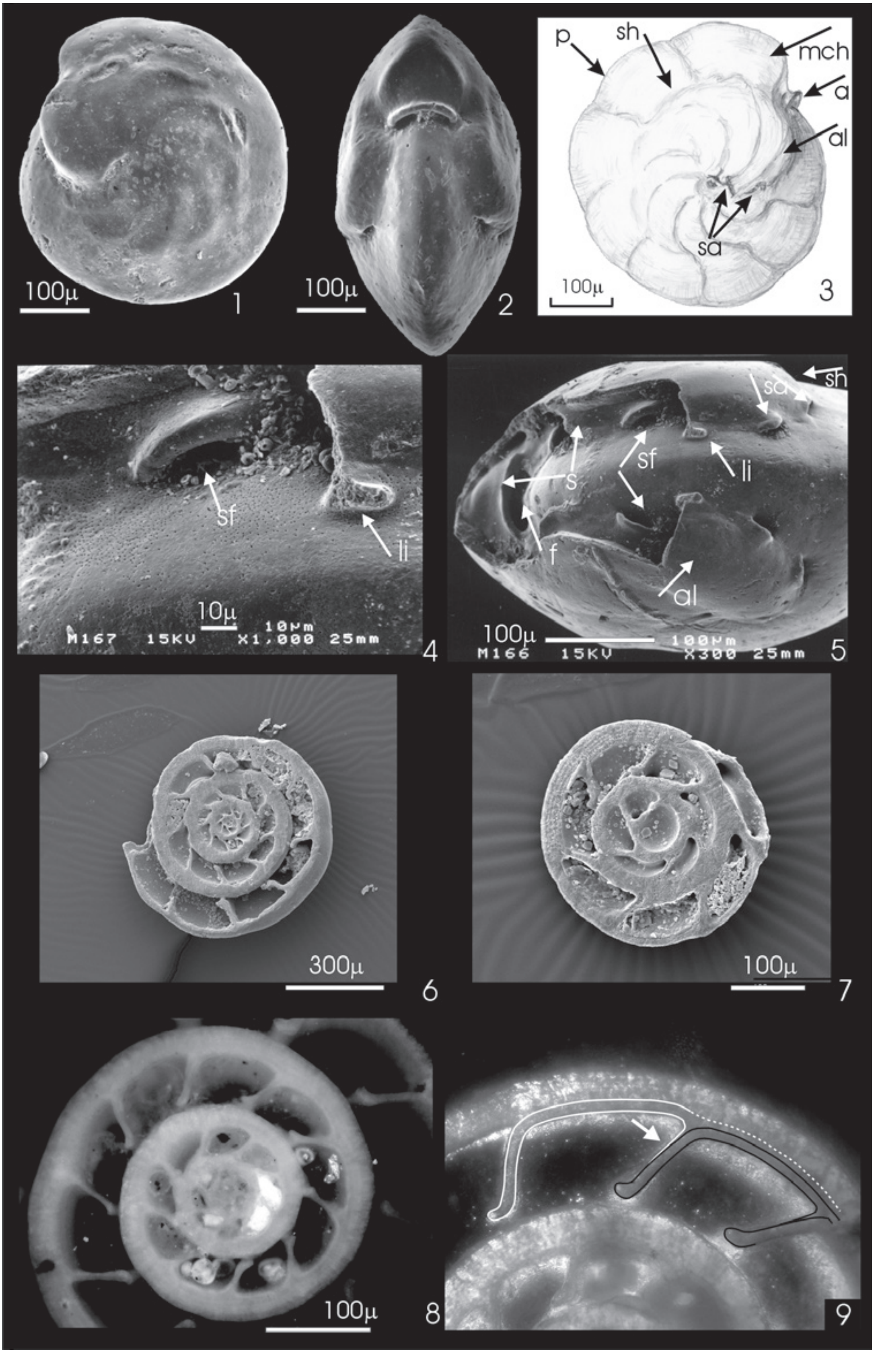

100μ
1
100μ
2
p
sh
mch
a
al
sa
100μ
3
sf
li
10μ
10μm
M167 15KV X1,000 25mm
4
sh
sa
s
sf
li
f
al
100μ
100μm
M166 15KV X300 25mm
5
300μ
6
100μ
7
100μ
8
9

Plate 2

Thyromata curvisepta (SUBBOTINA, 1947), all specimens from Ottenthal, Lower Austria, Waschberg Unit, Ottenthal Formation, Lower Ottenthal Member, nannoplankton zone NP22.

Fig. 1-2. Axial section through the proloculus (p). The chamber arrangement is displayed. In each chamber an equatorial main chamber (mch) is accompanied by two lateral chamberlets (lch) of alar prolongations (al). Fig. 2 between crossed nicols shows the secondary lamination of the chamber wall. Inv. no. NHMW 2008z0095/0025

Fig. 3. Detail of microspheric specimen (pl. 1, fig. 6). Arrow shows the position of septum in fig. 4.

Fig. 4. In the polished and etched section (detail of fig. 3) the median layer (ML) of the septum is visible; the chamber wall shows the secondary lamination (SL).

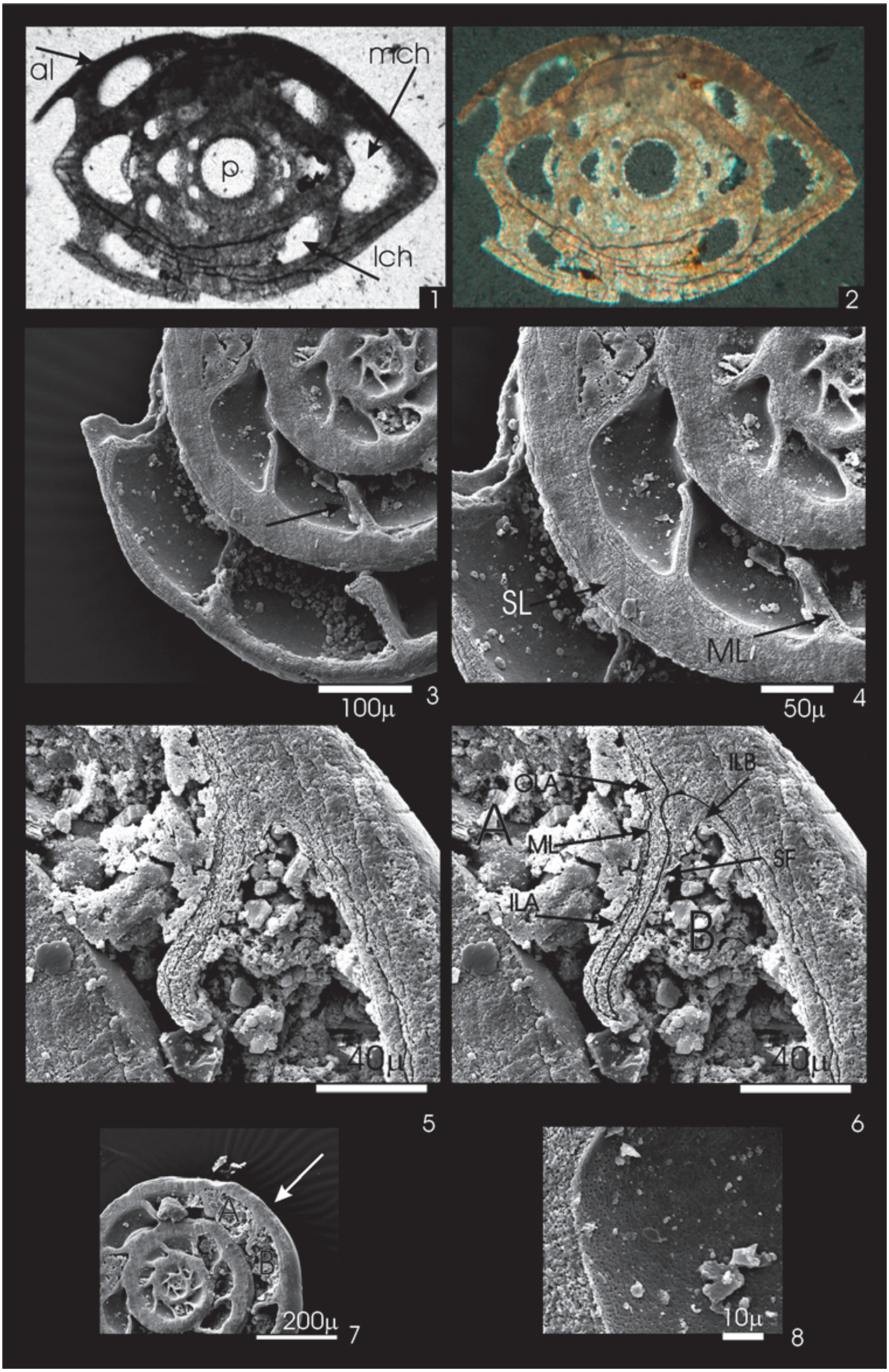
Fig. 5. Polished and etched section. The interpretation of wall lamellarity is shown in fig. 6.

Fig. 6. Interpreted section shown in fig. 5.The septum between chambers A and B is bilamellar, constructed by an inner and outer lamella (ILA = inner lamella of chamber A, OLA = outer lamella of chamber A), divided by a median layer (ML). Chamber B forms an inner lamella (ILB) which again is the septal flap (SF) on the front side of septum of chamber A.

Fig. 7. Part of microspheric specimen (pl. 1, fig. 6) with details of wall texture in the septum and outer wall between chambers A and B.

Fig. 8. Microperforate wall, visible at the inner side of a chamber of the microspheric specimen (pl. 2, fig. 4).

Abbreviations: al = alar prolongations, ILA = inner lamella of chamber A, ILB = inner lamella of chamber B, lch = lateral chamberlets, mch = main chamber, ML = median layer, OLA = outer lamella of chamber A, p = proloculus, SF = septal flap, SL = secondary lamination.


al
mch
p
lch
1
2
SL
ML
100μ
3
50μ
4
OLA
ILB
A
ML
SF
ILA
B
40μ
5
40μ
6
A
B
200μ
7
10μ
8

Micromeryx flourensianus

Specimen	Tooth position	Mesowear	Ns	Np	Pp
NHMW 2008z0050/0007 – P10	M1/2/3? sin	HR			
NHMW 2008z0050/0008 – P11	m3 sin		19	44	69.8
NHMW 2008z0050/0006 – P9	m2 sin		22	42	65.6
NHMW 2008z0050/0001 – S35	m2 dex		33	33	50.0
NHMW 2008z0050/0002 – S54	M1/2/3? sin	HR			
NHMW 2008z0050/0004 – S56	D4 dex		18	43	70.5
S60	m1/2? sin				
S61	M1/2/3? sin	HR	16	47	74.6
NHMW 2008z0050/0010	M1/2/3? sin	HR			

Bovid

Specimen	Tooth position	Mesowear	Ns	Np	Pp
NHMW 2008z0051/0015 – P18	M2 sin		12	44	78.6
S100	m12 sin		13	54	80.6
NHMW 2008z0051/0001 – S11	M2 sin	HS	15	49	76.6
NHMW 2008z0051/0002 – S12	M2 dex	HR			
NHMW 2008z0051/0009 – S128	m2 sin		20	53	72.6
NHMW 2008z0051/0003 – S13	M1 sin	HS			
NHMW 2008z0051/0012 – S131	M1 dex	HR	24	45	65.2
NHMW 2008z0051/0014 – S136	M3 dex	HR	9	39	81.3
S14	m2 sin		14	57	80.3
NHMW 2008z0051/0004 – S18	m2 dex		13	38	74.5
S124	M12 dex		10	74	88.1