



Computer-based mollusc stratigraphy – a case study from the Eggenburgian (Lower Miocene) type region (NE Austria)

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Abstract

The Eggenburg Group comprises the type deposits of the Lower Miocene Central Paratethys regional stage Eggenburgian. In NE Austria these marine to estuarine deposits transgress in northwestern direction either on Palaeozoic rocks of the Bohemian Massif or on Oligocene to Lower Miocene fluviomarine sediments. They are known from three (palaeo)geographic units situated on the southeastern margin of the Bohemian Massif. These are: (1) the southern Marginal Zone, (2) the northwestern, N–S striking Horn Basin and (3) the northeastern crystalline plateau, termed the Eggenburg Bay. The present study investigates distribution patterns of the exceptionally diverse mollusc fauna composed of 321 taxa (species and subspecies) within and between those units. Hierarchical Cluster Analysis is employed, using Ward's method and squared Euclidean distance calculation. A comprehensive database with 1900 sets based on field, museum and literature investigations allows compilation of 50 taxonomic lists (samples) for 30 different localities and six lithostratigraphic units (four marine and two brackish formations). The resulting grouping pattern implies the existence of four groups – three corresponding with (palaeo)geography and one including low-diversity, taxon-poor samples. The analysis of the diversity distribution supports the interpretation that the lower diversity of samples from marine formations stems from secondary distortions such as diagenesis or insufficient sampling. Hence, the samples characterised by a species-richness value lower than half of the maximum species-richness value of the corresponding formation were excluded from analysis. The resulting grouping pattern verified the secondary distortion premise: the pattern remained the same except that the low-diversity cluster became restricted to samples of brackish origin. Among the marine samples, palaeoecological differences between two fully marine formations from the Eggenburg Bay were of minor importance, as they could not be clearly separated. In contrast, the individual palaeogeographic regions were shown to be taxonomically coherent, but inconsistent with one other. As palaeobiogeographic processes were implausible in such a small geographic area, the explanation of these differences is based on the time factor, including speciation, extinction and faunal migration processes. The relative stratigraphic position of the Horn Basin between the Marginal Zone and the Eggenburg Bay is implied by hierarchically ordered similarities. In order to also indicate their chronological ordinance, the index fossil distribution was analysed. The chronological pattern is unequivocally provided by the abundant presence of the Lower Eggenburgian pectinid *Chlamys gigas* (Schlotheim), which is restricted to the Marginal Zone and the Horn Basin, and by the abundant Upper Eggenburgian to Lower Ottangian pectinids *Flexopecten palmatus* (Lamarck) and *Chlamys holgeri* (Geinitz), which are restricted to the Eggenburg Bay. This refinement of the regional stratigraphic pattern shed

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light on the Eggenburgian marine flooding progression. Early in the transgression, the southern Marginal Zone was first marine flooded. At the same time the Horn Basin developed an estuarine environment. The next phase installed the fully marine environment in the Horn Basin. At the same time the Eggenburg Bay, still a mainland, represented a southward-pointing cape. It first became flooded at the beginning of the Upper Eggenburgian.

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1. Introduction

The conspicuously rich Lower Miocene mollusc occurrence from the southeastern margin of the Bohemian Massif (Fig. 1) has been known in the literature for more than 2 centuries. After the earliest reports by Stütz (1807), and collections by Partsch (1843), Hörnes (1856, 1870) described a large number of taxa in his comprehensive monograph on Austrian–Hungarian Neogene molluscs. Subsequently, Schaffer (1910, 1912), Steininger (1963) and Steininger et al. (1971) presented detailed documentations of that exceptionally diverse mollusc record.

The mollusc-bearing deposits belong to the Eggenburg Group (Steininger and Senes, 1971) and represent the Lower Miocene marine transgression onto the pre-Miocene relief of the Bohemian Massif. The Eggenburg Group represents the type deposits of the Central Paratethys Eggenburgian stage, yielding its historical ‘holostratotype’ and nine ‘faciostratotypes’ of Steininger and Senes (1971). Its highly diverse and typically well-preserved mollusc record offers an ideal opportunity to utilise a computer-based presence–absence data similarity analysis. Indeed, the comprehensive comparative analysis of the partly well-known taxonomic compositions in single localities (e.g. ‘holostratotype’ and ‘faciostratotypes’) is still missing. The purpose of the present study is to fill this gap by demonstrating the soundness of large binary datasets for the investigation of fossil distribution patterns and their controls. Thereby the Hierarchical Cluster Analysis proved to be particularly suitable in classifying such datasets.

The interpretation of the resulting similarity patterns took the following premises into consideration:

- (1) The habitat preferences and palaeoecology

were the main distribution controls of the synchronous mollusc fauna in the studied region. A palaeobiogeographic interference is highly implausible due to the small geographic extension of the area. Hence, inferred faunal similarities

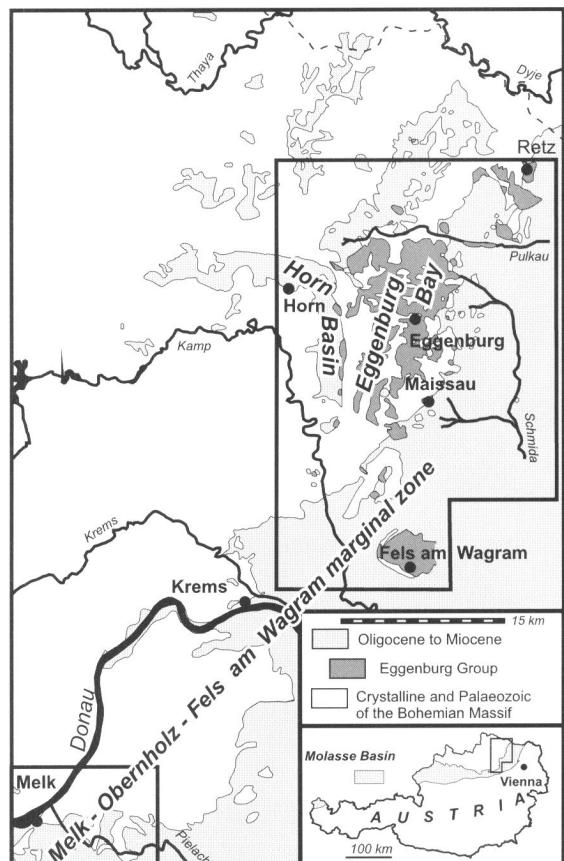


Fig. 1. Geographic, regional geologic and palaeogeographic setting of the study area. Note the distribution of the Eggenburg Group deposits into three different geomorphologic/palaeogeographic units: (1) Horn Basin, (2) Eggenburg Bay, and (3) the Marginal Zone.

should be directly related to palaeohabitat similarities for synchronous sites.

(2) The taxonomic differences of diachronous sites are additionally affected by speciation, extinction and migration processes due to climatic fluctuations and changing palaeogeographic patterns. The faunal change due to these factors remains directly related to time – the greater the age difference between studied sites, the greater the expected difference between their taxonomic inventories. Hence, if similarity distributions between samples disagree with the pattern expected by sample facies, then the similarity distributions are apparently set by the time factor.

2. General setting

2.1. Paratethys

The Paratethys Sea came into existence in the Lower Oligocene due to geographic isolation of the northern Mediterranean Tethys margin and was triggered by the rising Alpine island chain. Two different sedimentary evolution patterns developed in its eastern and in the western part. A large area spanning the Black Sea, Caspian Sea and Aral Sea was occupied by the Eastern Paratethys realm. A smaller area, extending through fore-Alpine, Dinaride and Carpathian molasse basins, was occupied by the Central and Western Paratethys realms (Rögl and Steininger, 1983; Rögl, 1998; Harzhauser et al., 2002).

The new palaeogeographic unit Paratethys was dominated by an evolution different from the Mediterranean region, as a consequence of intensive regional geotectonic events, infill of molasse sediments, and global and local sea-level fluctuations. These processes controlled alternating marine and non-marine phases in the region. Hence, several phases of geographic isolation were followed by renewed marine openings marked by faunal migrations. Apparent difficulties in correlating the regional stratigraphy to the global scale resulted in the development of a regional chronostratigraphic system. Accordingly, for the Central Paratethys eight regional stages spanning from the Lower Oligocene to Upper Miocene have

been introduced (Papp et al., 1968; Cicha and Senes, 1968; Baldi, 1969).

The Eggenburgian is a Lower Miocene stage of the Central Paratethys regional chronostratigraphic classification; it corresponds to the Lower Burdigalian of the standard classification and spans the time between the regional stages Egerian and Ottangian (Rögl, 1998). Its lower boundary correlates with the base of the Burdigalian (20.5 Ma). Its upper boundary is specified with 18.8 Ma by Rögl (1998). In its type area, investigated in the present study, Müller (in Roetzel et al., 1999) indicated the presence of the calcareous nannoplankton assemblage of the zones NN2–NN3 from the Kühnring Member (Figs. 2 and 3).

Molluscs, especially pectinid bivalves, allow a regional biostratigraphic zonation (Baldi, 1975;

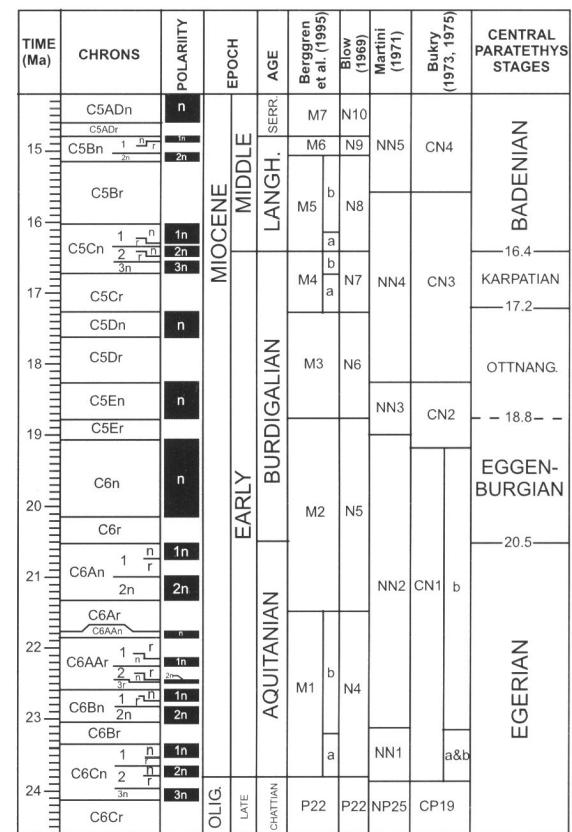
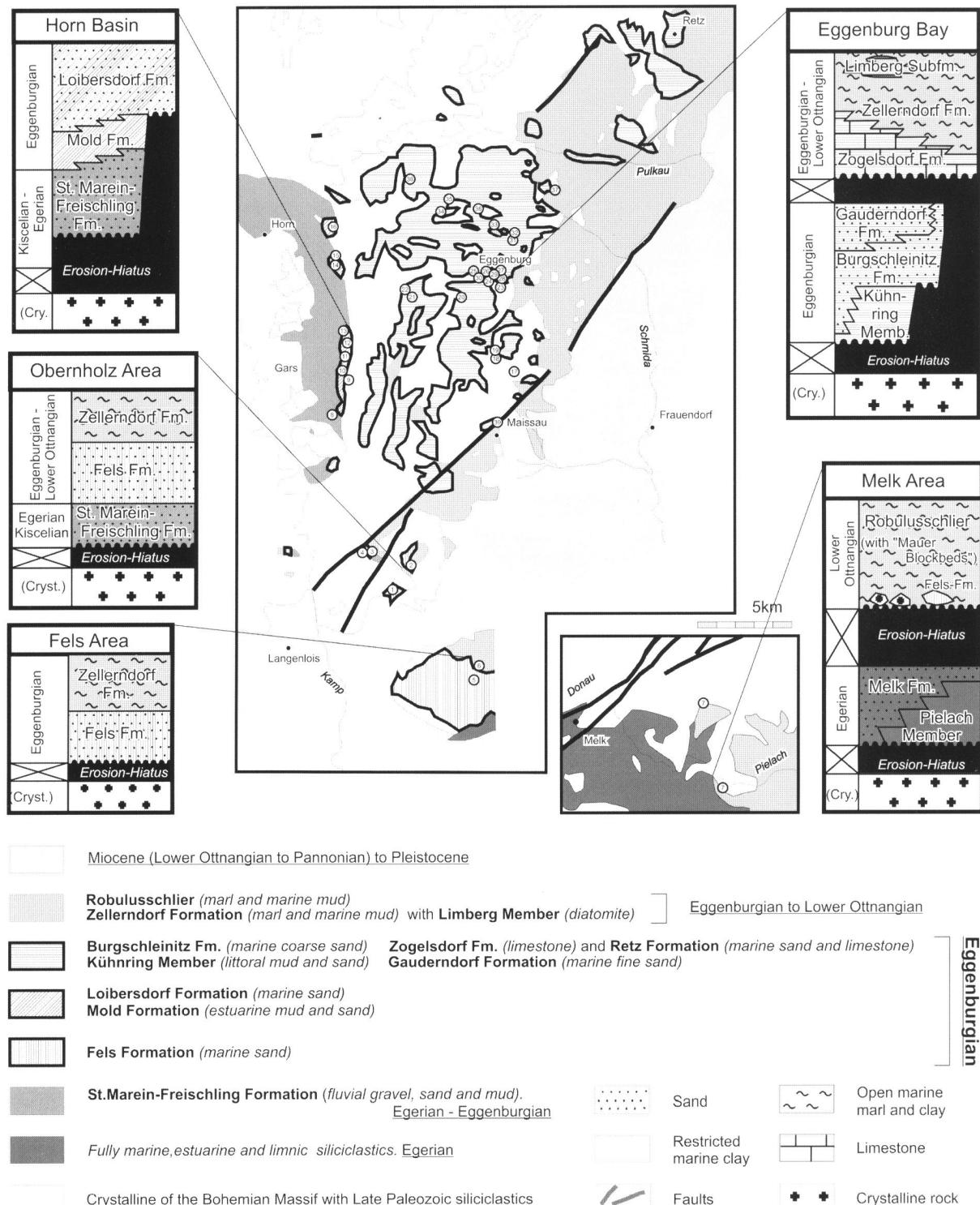


Fig. 2. Chronostratigraphic and biostratigraphic correlation of the Eggenburgian stage (compiled after Berggren et al., 1995, Steininger et al., 1996 and Rögl, 1998).



Baldi and Senes, 1975; Steininger et al., 1976, 1982). The base of the Eggenburgian is transgressively developed throughout the Central Paratethys, and an erosional hiatus is typically developed (Rögl and Steininger, 1983). Biostratigraphically, it is characterised through FOD (first occurrence datum) of *Chlamys gigas* (Schlotheim). The LOD (last occurrence datum) of *C. gigas* and FOD of typical Mediterranean pectinids like *Chlamys holgeri* (Geinitz) and *Flexopecten palmatus* (Lamarck) allow the differentiation between the Lower and the Upper Eggenburgian in a biostratigraphic context. The upper boundary is transitional in the studied region. It is biostratigraphically defined with the FOD of *Pecten hermannsenni* (Dunker) and *Chlamys albina* (Tepper) at the base of the Ottangian.

2.2. Eggenburg Group

The autochthonous sediments of the Eggenburg Group are exposed in NNE Austria, about 60 km NW of Vienna, in a triangular, 15×35 km large area striking in NNW–NNE direction up to the Czech border (Fig. 1). On Czech territory the related sediments – Lužice Formation and Úvaly Formation – can be followed for about 70 km in NNE extension, from the Austrian border up to the vicinity of Brno (Lexa et al., 2000). Mollusc-bearing sandstone boulders at the base of younger, Ottangian marls (about 35 km in southwestward prolongation to the furthermost autochthonous occurrence) indicate its once much larger distribution (Figs. 1 and 3).

The current lithostratigraphic classification of the Eggenburg Group (Steininger and Roetzel, 1991; Roetzel et al., 1999) follows the geomorphologic and palaeogeographic pattern of the pre-Miocene basement. The latter shows three main units (Fig. 1). The Southern Marginal Zone – extending from Melk to Obernholz and Fels am Wagram – represents an outer margin

of the Bohemian Massif toward the molasse basin, marking an open sea exposed region. In the west, the asymmetrical Horn Basin, about 200 m deep, dips eastward in the south and northward in the north; it follows an old buckled tectonic suture in the Palaeozoic Bohemian Massif. Finally, the Eggenburg Bay, an elevated, slightly eastwards dipping crystalline plateau in the eastern region, is characterised by a pronounced pre-Miocene relief with numerous escarpments and steep valleys. A south–north oriented ridge on its eastern margin generated by a strike-slip fault protected it from the open sea.

2.2.1. Southern Marginal Zone

The Eggenburgian transgressive sediments in the Southern Marginal Zone are separated by a hiatus either on Oligocene fluvial sands of the St.-Marain–Freischling Formation in the Obernholz area or on the crystalline basement in the Fels am Wagram area. The Fels Formation is a fully marine fining upwards succession passing into open marine marls of the Zellerndorf Formation. Deepening upwards is particularly well documented at Fels am Wagram by mollusc assemblages. These are dominated by thick-shelled, shallow infaunal representatives in basal coarse sands and thin-shelled, deep infaunal species in overlying fine sands of the Fels Formation (Steininger, 1963). In the Melk area the sandstone boulders with rich Eggenburgian-type mollusc fauna are resedimented in Ottangian marls together with large crystalline blocks and Oligocene sandstone and marl boulders (Amry, 1994).

2.2.2. Horn Basin

The Eggenburg Group of the Horn Basin includes the brackish water Mold Formation and the fully marine Loibersdorf Formation. The clays and sands of the Mold Formation represent an estuarine environment, superimposed on the St.-Marain–Freischling Formation, an Oligocene

Fig. 3. Geological setting and lithostratigraphic division of the studied sediments (modified after Höck et al., 1996). Sampled sites, listed in Table 1, are indicated by rings and corresponding numbers. Simplified lithological columns for different depositional areas are additionally provided. Their lithology ornaments superimpose colours and patterns indicating the lithostratigraphic units.

to Lower Miocene fluvio-lacustrine succession. Molluscs include elements tolerating different salinity ranges from the freshwater *Melanopsis* to the marine turritellids. The fauna is typically rich in individuals but apparently poor in total species number, pointing to a eutrophic environment. The superposing Loibersdorf Formation, a sandy, mollusc-rich, fining upward succession, represents the installation of a fully marine regime in the basin. The base with gravels and coarse sands is transgressively developed, onlapping partly on the crystalline basement. Fine sands in its upper part intercalate with coralline algae limestone layers. The mollusc fauna is dominated by large-sized, thick-shelled bivalves (*Glycymeris fichteli* (Deshayes), *Laevicardium kuebecki* (Hauer)), indicating a fully marine, warm, shallow-water environment.

2.2.3. Eggenburg Bay

Eggenburgian deposits of the Eggenburg Bay show two distinct transgressive successions. The first marine transgression onlapped directly onto the crystalline basement. It is generally a fining upward succession initiated by shallow, turbulent, fully marine water, coarse and medium sands of the Burgschleinitz Formation. These sands can laterally pass into muddy sands and clays of the Kühnring Member, representing sheltered intertidal and lagoonal subtidal areas. Typical shallow-water molluscs show morphologies and habitat preferences related to those from the Loibersdorf and basal Fels Formations. In contrast, the low diversity and specimen-rich mollusc fauna-bearing Kühnring Member is characterised by extensive *Crassostrea gryphoides* (Schlotheim) reefs; together with *Mytilus haidingeri* Hörnes beds and dense *Pirenella* accumulations they indicate fluctuating water salinity. Fine sands and silts of the Gauderndorf Formation characterise the upper part of the succession, reflecting a deepening and including the maximal flooding surface. The mollusc assemblage is dominated by the deep infralittoral bivalves *Pharus legumen major* Bocquoy, Dautzenberg and Dollfus, *Solen marginatus* Pultney and *Tellina zonaria* Basterot and has no counterparts in any other formation of the Eggenburg Group.

The superimposed Zogelsdorf Formation is separated by a marked hiatus and represents a renewed marine ingress into the Eggenburg Bay. This ingress produced a pronounced relief and extensive reworking horizons onlapping the Burgschleinitz and Gauderndorf formations as well as the crystalline basement. The Zogelsdorf Formation, a coarsening and deepening upward succession, includes basal conglomerates, coarse sands, sandstones, as well as coral algal and bryozoan detritic limestones. Mollusc shells, except for calcitic representatives (e.g. pectinids), are diagenetically leached and represented by casts and moulds. The Zogelsdorf Formation passes upsection into open marine clays and marls of the Zellerndorf Formation that are already dated as being of Ottangian age.

3. Data

The original database consists of 1900 datasets including, for each specific taxon (species and subspecies level), the locality, formation and references. The database compiles data obtained from collections, field excavations and literature

DATA:

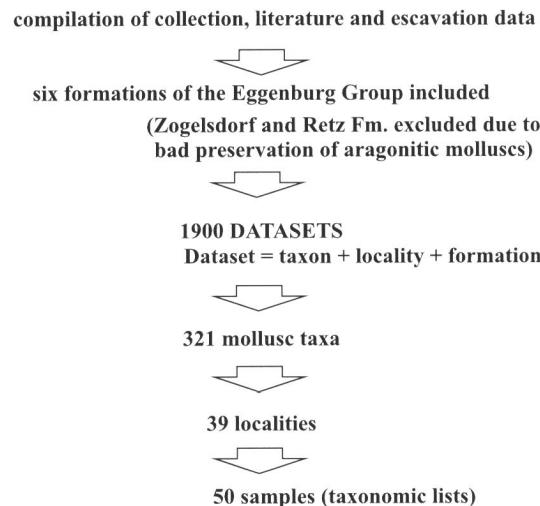


Fig. 4. Illustration shows the content of the database and the origin of included data.

Table 1

Studied sites with indicated palaeogeographic position, outcropping lithostratigraphic formations (F, Fels Fm.; M, Mold Fm.; L, Loibersdorf Fm.; K, Kühnring Sbfm.; B, Burgschleinitz Fm.; G, Gauderndorf Fm.) and coordinates

No.	Locality	Formation						Coordinates		
		F	M	L	K	B	G			
Marginal Zone Fels–Obernholz–Melk										
<i>Obernholz area</i>										
1	NW Wiedendorf	x	–	–	–	–	–	15°45'18"E, 48°29'51"N		
2	Bösendürnbach – house construction (cellar excavation)	x	–	–	–	–	–	15°46'0"E, 48°30'30"N		
3	Obernholz – parish pit (formerly sandpit Hammerschmied)	x	–	–	–	–	–	15°44'17"E, 48°30'50"N		
4	Obernholz – Kellergasse	x	–	–	–	–	–	15°44'30"E, 48°30'49"N		
<i>Fels area ('Fels Back')</i>										
5	Fels am Wagram – Dornergraben	x	–	–	–	–	–	15°48'51"E, 48°27'19"N		
6	Gösing	x	–	–	–	–	–	15°49'0"E, 48°27'47"N		
<i>Melk area ('Loosdorf Bay')</i>										
7	Mauer/Lochau	x	–	–	–	–	–	15°25'42"E, 48°14'6"N 15°26'0"E, 48°11'44"N		
Horn Basin										
8	Maiersch – claypit Frings	–	x	–	–	–	–	15°42'31"E, 48°34'50"N		
9	Nonndorf – forest margin	–	–	x	–	–	–	15°43'17"E, 48°36'4"N		
10	Nonndorf – acre	–	x	x	–	–	–	15°43'10"E, 48°36'17"N		
11	Loibersdorf – sandpit on the forestal path	–	x	–	–	–	–	15°43'20"E, 48°36'39"N		
12	Mörtersdorf – abandoned sandpit at SE end of the village, beside crossroad to Gars	–	x	x	–	–	–	15°43'20"E, 48°37'4"N		
13	Mörtersdorf – house construction on the right hand side of the road to Horn	–	x	–	–	–	–	15°43'7"E, 48°37'19"N		
14	Mold–Maria Dreieichen – Kirchensteig	–	x	x	–	–	–	15°42'38"E, 48°38'53"N		
15	Maria Dreieichen – Turritellid lagerstätte	–	x	x	–	–	–	15°42'47"E, 48°39'3"N		
16	Achberg near Maria Dreieichen – <i>Scutella</i> sands	–	–	x	–	–	–	15°42'39"E, 48°39'51"N		
Eggenburg region										
<i>Eggenburg Bay</i>										
17	Burgschleinitz – new material pit (1 km SE church in direction Maissau)	–	–	–	–	x	–	15°49'42"E, 48°35'53"N		
18	Burgschleinitz – former sandpit Hammerschmied	–	–	–	–	x	–	15°49'0"E, 48°36'12"N		
19	Burgschleinitz – Kirchenbruch	–	–	–	–	x	–	15°49'0"E, 48°36'19"N		
20	Kühnring – parish sandpit	–	–	–	–	–	x	15°47'34"E, 48°37'47"N		
21	Kühnring – Judenfriedhof	–	–	–	–	x	–	15°46'12"E, 48°38'8"N		
22	Kühnring – shark tooth lagerstätte on the Himmelreichstraße, 1 km N Judenfriedhof	–	–	–	–	x	–	15°46'3"E, 48°38'18"N		
23	Eggenburg – Brunnstube	–	–	–	–	x	x	15°49'5"E, 48°38'7"N		
24	Eggenburg – railway trench	–	–	–	x	–	–	15°48'42"E, 48°38'16"N		
25	Eggenburg – Stransky brickyard	–	–	–	x	–	–	15°48'10"E, 48°38'26"N		
26	Eggenburg – Bauernhansel pit	–	–	–	–	x	–	15°48'41"E, 48°38'21"N		
27	Eggenburg – Museumsplatz	–	–	–	–	–	x	15°49'4"E, 48°38'24"N		
28	Eggenburg – Raimundstollen	–	–	–	–	–	x	15°49'5"E, 48°38'18"N		
29	Eggenburg – Bärensteig	–	–	–	x	–	–	15°48'49"E, 48°38'23"N		
30	Eggenburg – Wienerstraße (road construction)	–	–	–	–	–	x	15°48'16"E, 48°38'23"N		
31	Gauderndorf – sandpit Zimmermann	–	–	–	–	x	–	15°49'33"E, 48°39'24"N		
32	Gauderndorf – former parish sandpit	–	–	–	–	x	x	15°49'38"E, 48°39'32"N		
33	Gauderndorf – former Zotter sandpits	–	–	–	–	x	–	15°48'53"E, 48°39'46"N		
34	Maigen – southern sandpits	+	–	–	x	x	x	15°46'36"E, 48°40'11"N		
35	Maigen – sandpit Stranzl	–	–	–	x	x	x	15°46'53"E, 48°40'27"N		
36	Kattau – mill	–	–	–	–	x	x	15°48'4"E, 48°40'11"N		
37	Roggendorf – Schloßtal ('Patellengrube')	–	–	–	–	x	–	15°51'16"E, 48°40'37"N		
38	Sigmundsherberg	–	–	–	–	x	–	15°45'16"E, 48°41'3"N		
<i>Outer margin</i>										
39	Maissau	–	–	–	–	x	–	15°49'23"E, 48°34'31"N		

Table 2

Data matrix: Distribution of mollusc taxa in analysed samples (numbers beneath formation labels correspond with localities listed in Table 1: 'x' marks taxon presence; grey field marks presence within formation)

No. Taxa	Fels Fm.							Mold Fm.						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
GASTROPODA														
1 <i>Haliotis (Haliotis) volhynica</i> Eichwald	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 <i>Haliotis (Haliotis) sp.</i>	x	-	-	-	-	-	-	-	-	-	-	-	-	-
3 <i>Emarginula (Emarginula) dujardini</i> Dollfus et Dautzenberg	x	-	-	-	-	-	-	-	-	-	-	-	-	-
4 <i>Emarginula (Emarginula) reticulata</i> Sowerby	x	-	-	-	-	-	-	-	-	-	-	-	-	-
5 <i>Scutus belardii</i> (Michelotti)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6 <i>Patella (Patella) ferruginea</i> Gmelin	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 <i>Patella (Patella) roggendorfensis</i> Schaffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8 <i>Patella (Patella) paucicostata</i> Schaffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 <i>Patella (Patella) spinosocostata</i> Schaffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10 <i>Patella (Patella) valliscastelli</i> Schaffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11 <i>Patella (Patella) manhartensis</i> Schaffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12 <i>Patella (Patella) anceps</i> Michelotti	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13 <i>Patella (Patella) miocaerulea</i> Schaffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14 <i>Patella (Patella) pseudofissurella</i> Schaffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15 <i>Callistoma (Ampullo trochus) laureatum</i> (Mayer)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16 <i>Diloma (Paroxystele) amedei amedei</i> (Brognart)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17 <i>Diloma (Paroxystele) amedei bicincta</i> Schaffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18 <i>Gibbula (Colliculus) cf. biangulata porella</i> (Gregorio)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19 <i>Tricolia</i> cf. <i>millepunctata</i> (Benoist)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 <i>Tricolia dollfusi</i> (Cossmann et Peyrot)	x	-	-	-	-	-	-	-	-	-	-	-	-	-
21 <i>Nerita (Theliostyla) plutonis</i> Basterot	-	-	-	-	-	-	-	-	-	-	x	-	-	-
22 <i>Theodoxus (Calvertia) giganteus striatulatus</i> (Sacco)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23 <i>Clithon (Vittoclinithon) pictus pictus</i> (Ferussac)	-	-	-	-	-	-	-	-	-	x	-	x	x	-
24 <i>Clithon (Vittoclinithon) pictus maculatus</i> (Grateloup)	-	-	-	-	-	-	-	-	-	x	-	x	-	-
25 <i>Hydrobia fontanensis</i> Dollfus et Dautzenberg	-	-	-	-	-	-	-	-	-	x	-	x	-	-
26 <i>Alvania (Alvania) venus</i> (d'Orbigny)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27 <i>Alvania (Alvania) montagui ampulla</i> (Eichwald)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28 <i>Tornus (Tornus) trigonostoma</i> (Basterot)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29 <i>Turritella (Haustator) eryna</i> d'Orbigny	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30 <i>Turritella (Haustator) eryna rotundata</i> Schaffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31 <i>Turritella (Haustator) vermicularis</i> Brocchi	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32 <i>Turritella (Haustator) vermicularis tricincta</i> Schaffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33 <i>Turritella (Haustator) vermicularis lineolatocincta</i> Sacco	x	-	x	-	-	-	-	-	-	-	-	-	-	-
34 <i>Turritella (Haustator) doublieri</i> Matheron	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35 <i>Turritella (Peyrotia) desmarestina</i> desmarestina Basterot	-	-	-	-	-	-	-	-	-	-	x	-	-	-
36 <i>Turritella (Peyrotia) desmarestina</i> mediosubearinata Mylius	-	-	-	-	-	-	-	-	-	-	x	-	-	-
37 <i>Turritella (Turritella?) terebralis</i> Lamarck	-	x	-	-	-	-	-	-	-	-	-	-	-	-
38 <i>Turritella (Turritella?) terebralis</i> eggenburgensis Sieber	-	-	-	-	-	-	-	-	-	-	x	-	-	-
39 <i>Turritella (Turritella?) terebralis</i> percingulatella Sacco	-	-	-	-	-	-	-	-	-	-	x	-	-	-
40 <i>Turritella (Turritella?) terebralis</i> subgradata Sacco	-	-	-	-	-	-	-	-	-	x	-	x	-	-
41 <i>Turritella (Turritella) gradata</i> gradata Menke	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42 <i>Protoma (Protoma) cathedralis</i> (Bronniart)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43 <i>Protoma (Protoma) cathedralis</i> paucicincta Sacco	-	-	-	-	-	-	-	-	-	x	-	-	-	-
44 <i>Protoma (Protoma) cathedralis</i> quadricincta Schaffer	-	-	-	-	-	-	-	-	-	x	-	x	-	-
45 <i>Petaloconchus intortus</i> woodi Mörsch	x	-	-	-	-	-	-	-	-	-	-	-	-	-
46 <i>Burtinella</i> cf. <i>subnummulus</i> Sacco	x	-	-	-	-	-	-	-	-	-	-	-	-	-
47 <i>Lemintina arenaria</i> (Linné)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48 <i>Melanopsis impressa</i> impressa Krauss	-	-	-	-	-	-	-	-	x	-	x	-	x	-
49 <i>Potamides (Ptychopotamides) papaveraceus</i> (Basterot)	-	-	-	-	-	-	-	-	-	x	-	-	-	-
50 <i>Pirenella plicata</i> (Bruguière)	-	-	-	-	-	-	-	-	-	x	x	-	-	-
51 <i>Pirenella plicata</i> papillata (Sandberger)	-	-	-	-	-	-	-	-	x	x	x	x	x	-

Table 2 (Continued).

No.	Loibersdorf Fm.								Kühnring Fm.								Burgschleinitz Fm.												Gaudendorf Fm.							
	9	11	12	14	15	16	12	21	25	29	34	35	17	18	19	20	22	23	26	31	33	34	35	36	37	38	39	23	27	28	30	31	32	34	35	37
1	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
5	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
6	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
7	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-		
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-		
9	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-		
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-		
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-		
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	
15	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
16	X	-	X	-	-	X	-	-	-	-	-	-	-	-	X	X	X	X	-	X	X	-	-	-	-	-	-	X	-	-	-	-	X	-	-	
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
21	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
29	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
30	X	-	X	X	-	-	-	-	-	-	-	-	-	X	-	-	X	X	-	X	X	-	-	-	-	-	X	-	X	X	X	-	X	-	-	
31	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	
32	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	X	-	X	-	-	-	-	-	-	-	X	X	X	X	-	-	-	-	-	
33	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
35	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
36	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	X	-	-	X	X	-	-	X	-	-	-	-	
38	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	X	-	-	X	X	X	-	-	-	-	-	-	
39	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	
40	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	
41	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
42	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
43	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	X	-	-	-	X	X	X	-	-	X	-	-	-	-	
44	-	X	-	-	X	X	-	-	-	-	-	-	-	-	-	X	X	X	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
50	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
51	-	-	X	-	-	-	X	X	X	X	X	-	-	X	X	X	-	X	-	-	X	-	-	-	X	-	X	-	-	X	-	-	-	-	-	

Table 2 (Continued).

Table 2 (Continued).

Table 2 (Continued).

No. Taxa	Fels Fm.							Mold Fm.						
	1	2	3	4	5	6	7	8	9	10	12	13	14	15
104 <i>Trophonopsis (Pagodula) capito</i> (Philippi)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
105 <i>Typhis (Ciphonochelus) cuniculosus</i> (Nyst)	-	X	-	-	-	-	-	-	-	-	-	-	-	-
106 <i>Ocinebrina schönni</i> (Hoernes)	-	-	-	-	-	-	-	X	X	X	X	-	-	-
107 <i>Ocinebrina crassilabiata</i> (Hilber)	-	-	-	-	-	-	-	X	-	-	X	-	-	-
108 <i>Purpura (Tritonalia) erinacea sublaevis</i> (Schaffer)	-	-	-	-	-	-	-	X	X	-	-	-	-	-
109 <i>Babylonia (Peridpsacus) eburnoides</i> (Matheron)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110 <i>Galeodes (Galeodes) cornutus</i> (Agassiz)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
111 <i>Dorsanum (Dorsanum) haueri</i> (Michelotti)	-	-	-	-	-	-	-	X	-	X	-	-	-	-
112 <i>Dorsanum (Dorsanum) haueri excellens</i> Schaffer	-	-	-	-	-	-	-	X	X	X	X	-	-	-
113 <i>Dorsanum (Dorsanum) haueri scalata</i> Schaffer	-	-	-	-	-	-	-	X	-	X	X	-	-	-
114 <i>Dorsanum (Dorsanum) haueri subsuessi</i> Schaffer	-	-	-	-	-	-	-	X	-	-	X	-	-	-
115 <i>Dorsanum (Dorsanum) ternodosum</i> (Hilber)	-	-	-	-	-	-	-	X	-	-	X	-	-	-
116 <i>Hinia (Uzita) limata</i> (Chemnitz)	-	-	-	-	-	-	-	-	X	-	-	-	-	-
117 <i>Latirus (Latirus) valenciennesi</i> (Grateloup)	X	X	-	-	-	-	-	-	-	-	-	-	-	-
118 <i>Euthriofusus (Euthriofusus) burdigalensis</i> Defrance (in Basterot)	-	X	-	-	-	-	-	X	-	-	-	-	-	-
119 <i>Olivella (Lamprodoma) clavula vindobonensis</i> Csepreghy-Meznerics	-	-	-	-	-	-	-	-	-	-	-	-	-	-
120 <i>Ancilla (Baryspira) glandiformis dertocallosa</i> (Sacco)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
121 <i>Tudicla (Tudicla) rusticula rusticula</i> (Basterot)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122 <i>Tudicla (Tudicla) rusticula hoernesi</i> (Stur)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
123 <i>Cancellaria (Trigonostoma) umbilicaris pluricostata</i> Kautsky	X	-	-	-	-	-	-	-	-	-	-	-	-	-
124 <i>Cancellaria (Trigonostoma) ampullacea</i> (Brocchi)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
125 <i>Cancellaria (Trigonostoma) puschi</i> R.Hörnes et Auinger	-	-	-	-	-	-	-	-	-	-	-	-	-	-
126 <i>Clavatula (Clavatula) asperulata subsculpta</i> Schaffer	-	-	-	-	-	-	-	X	-	-	-	-	-	-
127 <i>Clavatula (Clavatula) mariae</i> (R. Hörnes et Auinger)	-	-	-	-	-	-	-	-	-	-	X	-	-	-
128 <i>Clavatula (Clavatula) mariae persculpta</i> (Schaffer)	-	-	-	-	-	-	-	X	X	-	-	-	-	-
129 <i>Perrona (Perrona) semimarginata</i> (Lamarck)	X	-	-	-	-	-	-	-	-	-	-	-	-	-
130 <i>Perrona (Perrona) semimarginata praecursor</i> (Schaffer)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
131 <i>Conus (Lithoconus) mercati</i> Brocchi	-	-	-	-	-	-	-	-	-	-	-	-	-	-
132 <i>Conus (Chelycoconus) bitorosus exventricosus</i> Sacco	-	-	-	-	-	-	-	-	-	-	-	-	-	-
133 <i>Conus (Chelycoconus) mediterraneus</i> Hwass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
134 <i>Conus (Dendroconus) berghausi</i> Michelotti	-	-	-	-	-	-	-	-	-	-	-	-	-	-
135 <i>Conus (Conolithus) cf. dujardini</i> Deshayes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
136 <i>Subula (Oxymeris) fuscostata modesta</i> (Tristan)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
137 <i>Ringicula (Ringiculella) auriculata paulucciae</i> Morlet	X	X	-	-	-	-	-	-	-	-	-	-	-	-
138 <i>Retusa (Cylichnina) clathrata</i> (Defrance)	X	-	-	-	-	-	-	-	-	-	-	-	-	-
139 <i>Roxania (Roxania) elongata</i> (Grateloup)	X	X	-	-	-	-	-	-	-	-	-	-	-	-
140 <i>Cylichna (Cylichna) cylindracea</i> (Pennant)	X	-	-	-	-	-	-	-	-	-	-	-	-	-
141 <i>Scaphander (Scaphander) lignarius grateloupi</i> (Michelotti)	X	-	-	-	-	-	-	-	-	-	-	-	-	-
142 <i>Cepaea aff. eversa larteti</i> (de Boissy)	-	-	-	-	-	-	-	-	-	-	X	-	-	-
SCAPHOPODA														
143 <i>Dentalium (Antalis) kickxi transiens</i> Steininger	X	X	-	-	-	-	-	-	-	-	-	-	-	-
BIVALVIA														
144 <i>Nucula (Nucula) laevigata</i> Sowerby	X	-	-	-	-	-	-	-	-	-	-	-	-	-
145 <i>Nuculana (N.) guembeli</i> (Hoelzl)	X	-	-	-	-	-	-	-	-	-	-	-	-	-
146 <i>Lembulus emarginatus</i> (Lamarck)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
147 <i>Arca (Arca) grundensis</i> Mayer	X	-	-	-	-	-	-	-	-	-	-	-	-	-
148 <i>Arca (Arca) biangula</i> Lamarck	-	-	-	-	-	-	-	-	-	-	-	-	-	-
149 <i>Arcopsis lactea</i> (Linné)	X	-	-	-	-	-	-	-	-	-	-	-	-	-
150 <i>Anadara fichteli</i> (Deshayes)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
151 <i>Anadara fichteli grandis</i> (Schaffer)	-	-	X	-	-	-	-	-	-	-	-	-	-	-
152 <i>Anadara moltensis elongata</i> (Schaffer)	-	-	-	-	-	-	-	X	X	-	X	X	-	-
153 <i>Anadara diluvia</i> (Lamarck)	-	-	-	-	-	-	-	-	X	-	-	-	-	-

Table 2 (Continued).

Table 2 (*Continued*).

Table 2 (Continued).

Table 2 (Continued).

Table 2 (Continued).

Table 2 (*Continued*).

No. Taxa		Fels Fm.	Mold Fm.
		1 2 3 4 5 6 7 8 9 10 12 13 14 15	
258 <i>Lutraria (Lutraria) sanna</i> Basterot		x x - - - - -	- - - - - -
259 <i>Lutraria (Lutraria) sanna maxima</i> Schaffer		- - - - -	- - - - -
260 <i>Lutraria (Lutraria) lutraria jeffreysi</i> (Gregorio)		- - - - -	- - - - -
261 <i>Solen (Solen) marginatus</i> Pultney		- x - - - -	- - - - -
262 <i>Ensis ensis</i> (Linné)		- - - - -	- - - - -
263 <i>Pharus legumen major</i> Bocquoy, Dautzenberg et Dollfus		- - - - -	- - - - -
264 <i>Donax (Paradonax) perradiata</i> Hözl		- - - - -	- - - - -
265 <i>Iphigenia lacunosa tumida</i> (Brocchi)		- - - - -	- - - - -
266 <i>Angulus (Peronidia) nysti pseudofalax</i> Hoelzl		x - x - - -	- - - - -
267 <i>Arcopagia subelegans</i> D'orbigny		x - - - - -	- - - - -
268 <i>Gastrana fragilis gracilis</i> Schaffer		- x - - - -	- - - - -
269 <i>Tellina (Peronaea) planata</i> Linné		- - - - -	- - - - -
270 <i>Tellina (Peronaea) zonaria</i> Basterot		- - - - -	- - - - -
271 <i>Sanguinolaria (Psammotaea) labordei major</i> (Schaffer)		- - - - -	- - - - -
272 <i>Solenocurtus candidus</i> (Renier)		- - - - -	- - - - -
273 <i>Solenocurtus basteroti</i> des Moulinis		- - - - -	- - - - -
274 <i>Arctica girondica</i> Cossmann et Peyrot		x x - - - -	- - - - -
275 <i>Coralliophaga transsilvanica</i> (Hoernes)		x - - - - -	- - - - -
276 <i>Coralliophaga hoernesii</i> (Schaffer)		- - x - - -	- - - - -
277 <i>Glossus werneri</i> (Hoernes)		- x x - - -	- - - - -
278 <i>Glossus miotransversus</i> (Schaffer)		- - x - - -	- - - - -
279 <i>Glossus subtransversus major</i> (Hoelzl)		x x - x x -	- - - - -
280 <i>Glossus cf. lunulatus</i> (Nyst)		- x - - - -	- - - - -
281 <i>Polymesoda convexa</i> (Brongniart)		- - - - -	- x - -
282 <i>Polymesoda convexa angusta</i> Hoelzl		- - - - -	- x - -
283 <i>Polymesoda brongniarti</i> (Basterot)		- - - - -	- - x - -
284 <i>Cyrena eggenburgensis</i> Schaffer		- - - - -	- - - - -
285 <i>Congeria basteroti</i> Deshayes		- - - - -	x - x - -
286 <i>Venus burdigalensis</i> Mayer		- - - - -	- - - - -
287 <i>Venus aquitanica</i> (Cossmann)		x - - - -	- - - - -
288 <i>Venus multilamella</i> Lamarck		x x - - -	- - - - -
289 <i>Venus (Mioclausinella) cincta</i> (Eichwald)		- - - - -	x - - -
290 <i>Periglypta haueri</i> (Hoernes)		- - - - -	- x - -
291 <i>Circomphalus haidingeri</i> (Hoernes)		- - - - -	- - x - -
292 <i>Circomphalus plicata oblonga</i> (Schaffer)		- - - - -	- - - - x
293 <i>Pitar (Chionella) italicica</i> Defrance		- - - - -	- - - - -
294 <i>Pitar (Chionella) italicica subtriangula</i> (Sacco)		- - - - -	- - - - -
295 <i>Pitar (Chionella) lilacinoides</i> (Schaffer)		x x x x - -	- - - - -
296 <i>Pitar (Chionella) raulini</i> (Hoernes)		- - - - -	- - - - -
297 <i>Pitar (Chionella) gauderndorfensis</i> (Schaffer)		- - - - -	- - - - -
298 <i>Pitar (Cordiopsis) schafferi</i> Kautsky		- - - - -	- - - - -
299 <i>Pitar (Cordiopsis) incrassata</i> (Sowerby)		- x - x - -	- - - - -
300 <i>Dosinia (Pectunulus) exoleta</i> (Linné)		- - - - -	- - - - -
301 <i>Dosinia (Pectunulus) lupinus</i> Linné		- - - - -	- - - - -
302 <i>Dosinia (Pectunulus) lupinus miolincta</i> Schaffer		- - - - -	- - - - -
303 <i>Venerupis basteroti</i> (Mayer)		- - - - -	- - - - -
304 <i>Paphia benoisti praecedens</i> Kautsky		- x x - - -	- - - - -
305 <i>Paphia subcarinata</i> (Schaffer)		- - - - -	- - - - -
306 <i>Paphia salmocensis</i> Fischer		- - - - -	- - - - -
307 <i>Sphenia anatina</i> (Basterot)		- x - - - -	- - - - -
308 <i>Tugonia ornata</i> (Basterot)		- - - - -	- - - - -
309 <i>Hiatella arctica</i> (Linné)		x - - - - -	- - - - -

Table 2 (Continued).

Table 2 (Continued).

No. Taxa	Fels Fm.														Mold Fm.																							
	1	2	3	4	5	6	7	8	9	10	12	13	14	15	1	2	3	4	5	6	7	8	9	10	11													
310 <i>Cyrtodaria neuvillei</i> Cossmann et Peyrot		x	-	-	-	-	-	-	-	-	-	-	-	-																								
311 <i>Panopea menardi</i> Deshayes		x	x	x	-	-	-	-	-	-	-	-	-	-																								
312 <i>Pholas dactylus muricatus</i> Da Costa		-	-	-	-	-	-	-	-	-	-	-	-	-																								
313 <i>Pholas desmoulini</i> Benoit		x	-	-	-	-	-	-	-	-	-	-	-	-																								
314 <i>Pholadomya alpina</i> Matheron		-	-	-	-	-	-	-	-	-	-	-	-	-																								
315 <i>Pholadomya alpina panopaeaformis</i> Schaffer		-	-	-	-	-	-	-	-	-	-	-	-	-																								
316 <i>Pholadomya alpina rostrata</i> Schaffer		-	-	-	-	-	-	-	-	-	-	-	-	-																								
317 <i>Pholadomya eggenburgensis</i> Schaffer		-	-	-	-	-	-	-	-	-	-	-	-	-																								
318 <i>Thracia (Cyathodonta) pubescens</i> (Pulteney)		x	-	-	-	-	-	-	-	-	-	-	-	-																								
319 <i>Thracia (Cyathodonta) eggenburgensis</i> Schaffer		-	-	x	-	-	-	-	-	-	-	-	-	-																								
320 <i>Brechites miocaenicus</i> (Vadász)		-	-	-	-	-	-	-	-	-	-	-	-	-																								
NAUTILOIDEA																																						
321 <i>Aturia aturi</i> (Basterot)		-	x	-	-	-	-	-	-	-	-	-	-	-																								
No.	Loibersdorf Fm.	9	11	12	14	15	16	12	21	25	29	34	35	17	18	19	20	22	23	26	31	33	34	35	36	37	38	39	Gaudendorf Fm.	23	27	28	30	31	32	34	35	37
310	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
311	-	x	x	-	-	-	-	-	-	-	x	x	-	-	-	x	-	x	-	-	x	-	-	x	x	-	x	x	-	-	x	-	-	x	-	-		
312	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-			
313	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
314	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
315	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-			
316	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-			
317	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-		
318	-	-	x	-	-	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	x	-	x	x	-	-	x	-	-		
319	-	-	-	-	-	-	-	-	-	x	x	-	x	-	-	-	-	-	-	-	x	-	-	x	-	x	x	-	-	x	-	-	-	-	-	-		
320	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
321	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-	-			

(Fig. 4). The investigated collections are housed in: (1) the Institute of Palaeontology, University of Vienna, with emphasis on rich excavation material, (2) the Krahuletz Museum in Eggenburg, including type specimens of Schaffer (1910 and 1912) and housing the most representative collection of the Eggenburg Group fossils, and (3) the Höborth Museum in Horn. A considerable number of datasets was obtained from the large private collection of Gerhard Putzgruber in Straß am Kamp (Lower Austria). Faunal lists by Schaffer (1914), Steininger (1963, 1971), Steininger and Roetzel (1991) and Amry (1994), including data from collections of the Natural History Museum and the Geological Survey in Vienna, were incorporated.

The mollusc preservation is satisfactory and enabled a well-founded database. The exception is the Zogelsdorf Formation, where mollusc shells are mostly dissolved; this formation was therefore

excluded from the statistical analysis. After database completion, 50 samples (site/formation defined faunal lists) from 39 sections were available for the similarity analysis (Tables 1 and 2). A total of 321 taxa were identified on the species and subspecies level (Table 2). The identifications followed the taxonomic concept established and documented by Steininger et al. (1971), and a comprehensive taxonomic revision of such a large number of taxa would go beyond the scope of the present study. Identifications of taxa not included in the latter monograph were based on Hörnes (1856, 1870), Sacco (1887–1904), Kautsky (1936), Glibert (1945, 1949, 1952 and 1957), Hölzl (1957, 1958), Baldi (1962, 1973), Steininger (1963) and Amry (1994); the systematic classification of the latter taxa followed Sieber (1955, 1956, 1958 and 1960). Compare Mandic (1996) for more details on taxonomy and data collection.

Table 3

Diversity distribution in analysed samples indicated through number of occurring taxa

Region	(Sub)Formation	Locality no.	Number of occurring taxa				
			Gastropoda	Bivalvia	Scaphopoda	Nautiloidea	Total
Fels-Obernholz– Melk Marginal Zone	Fels Fm.	5	45	46	1	0	92
		7	19	32	1	1	53
		4	3	16	0	0	19
		6	7	6	0	0	13
		3	1	11	0	0	12
		1	0	6	0	0	6
		2	0	2	0	0	2
Horn Basin	Mold Fm.	14	29	13	0	0	42
		10	14	12	0	0	26
		13	16	5	0	0	21
		15	11	1	0	0	12
		11	5	3	0	0	8
		12	4	0	0	0	4
		8	0	3	0	0	3
		12	40	30	1	0	71
	Loibersdorf Fm.	9	24	35	0	0	59
		10	24	35	0	0	59
		15	22	22	0	0	44
		14	5	15	0	0	20
		16	4	13	0	0	17
		35	4	4	0	0	8
Eggenburg Region	Kühnring Subfm.	21	4	3	0	0	7
		24	6	0	0	0	6
		25	2	3	0	0	5
		34	2	0	0	0	2
		29	1	0	0	0	1
		20	21	49	1	0	71
		17	14	41	0	1	56
		18	8	41	0	0	49
		35	11	32	0	0	43
	Burgschleinitz Fm.	26	6	27	0	0	33
		33	8	23	0	0	31
		34	9	22	0	0	31
		39	3	21	0	0	24
		37	9	12	0	0	21
		22	1	12	0	0	13
		36	2	11	0	0	13
		19	0	6	0	0	6
		23	3	2	0	0	5
		38	1	4	0	0	5
	Gauderndorf Fm.	32	0	3	0	0	3
		32	26	37	0	1	64
		23	15	35	0	0	50
		31	12	24	0	1	37
		28	4	17	0	0	21
		36	2	15	0	0	17
		34	3	10	0	0	13
		27	2	8	0	0	10
		30	4	4	0	0	8
		35	0	7	0	0	7

4. Analysis

Hierarchical Cluster Analysis of datasets organised into a presence-absence data matrix (Table 4) was conducted using Ward's method (Ward, 1963) and the binary squared Euclidean dissimilarity measure (cf. Sneath and Sokal, 1973, Lessépérance, 1990). The SPSS for Windows (© SPSS Inc., 1989–1999) computer programme package was used. Only this method yielded interpretable groupings. Other methods available in the SPSS programme (e.g. Average-Linkage between Groups and Centroid Clustering) produced chaining effects (cf. Romesburg, 1990; Everitt, 1993).

Analyses of similarities between samples and of similarities between formations were independently analysed.

4.1. Similarities between samples

The analysis (Fig. 5) distinguished four clusters characterised by different sizes and clearly different grouping criteria. Three of them, which are apparently restricted to marine formations, correlate exactly with three palaeogeographic units, namely Eggenburg Bay, Horn Basin and the Southern Marginal Zone. The remaining group, which is also the largest one, includes not only all brackish-marine samples but also various marine ones. Note that this latter group includes all palaeogeographic units as well as all four fully marine formations. The species-richness distribution provides an insight into and potential explanation for such a grouping (Table 3) within the cluster. This group clearly consists of samples

showing lowered species richness; this difference makes their correlation with other species-rich groups impossible. Thus, the species richness of the large cluster is influenced by two different processes, which are regarded here as the primary and secondary distortion factors.

The primary factor is defined by environmental conditions because the fauna from brackish-marine environments is diminished due to the environmental stress of a eutrophic habitat and salinity fluctuations. Table 4 clearly shows that the Kühnring Member (with 19 taxa) and the Mold Formation (with a total of 58 taxa) strongly contrast to fully marine formations, whose diversities range between 109 and 150 taxa. Another indication of the different environmental frame for marine and brackish-marine assemblages is the gastropod/bivalve ratio. Whereas brackish-marine formations show gastropod dominance, bivalves prevail in the fully marine faunas. Enhanced diversity of the Mold Formation compared with the Kühnring Member could be related with the greater complexity and wider range of habitat types within an estuarine system versus the coastal lagoon, although a secondary distortion through leaching cannot be principally excluded.

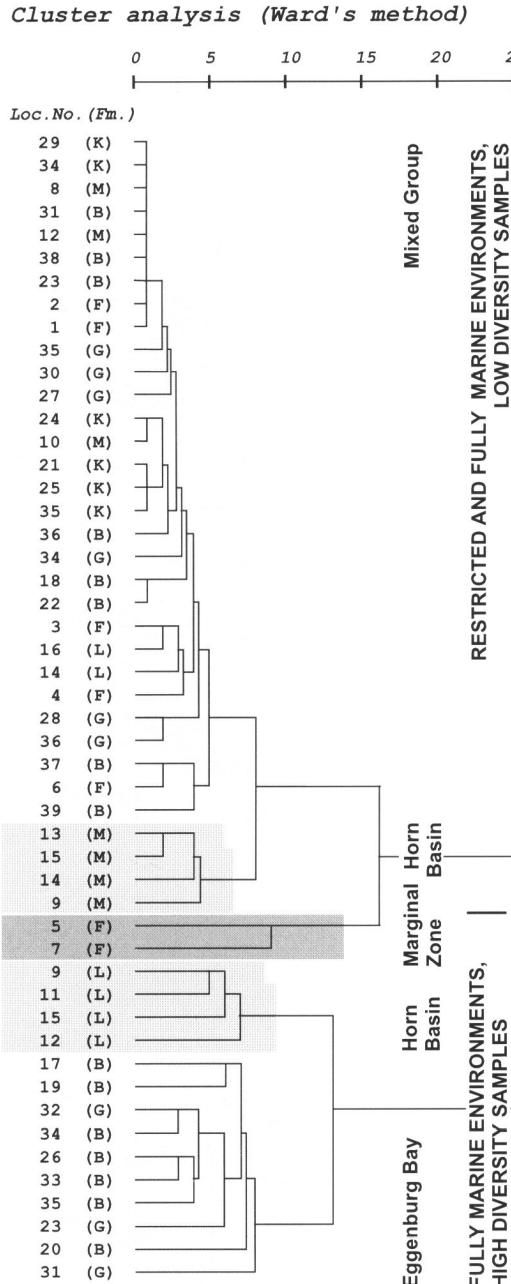
The fully marine samples from the same cluster are probably characterised by lower species richness (Table 3). In contrast to primarily decreased diversity in brackish-marine units, such lower values in fully marine units are apparently the result of various secondary factors and processes such as taphonomic loss, preservation, bad outcrop/sampling conditions or insufficient sampling rate.

The premise of secondary distortion was tested

Table 4
Diversity distribution in analysed formations indicated through number of occurring taxa

Region	(Sub)Formation	Number of occurring taxa				
		Gastropoda	Bivalvia	Scaphopoda	Nautiloidea	Total
Fels-Obernholz-Melk Marginal Zone	Fels Fm.	61	74	1	1	137
Horn Basin	Mold Fm	35	23	—	—	58
	Loibersdorf Fm.	63	72	—	1	136
Eggenburg Region	Kühnring Subfm.	13	6	—	—	19
	Burgschleinitz Fm.	46	102	1	1	150
	Gauderndorf Fm.	39	69	1	—	109
Whole studied area	All studied formations	142	177	1	1	321

by filtering the data matrix from samples where record loss was most obvious. A distortion was regarded as probable for cases in which the sample's species-richness value was lower than the maximal sample species-richness value within the



Cluster analysis (Ward's method)

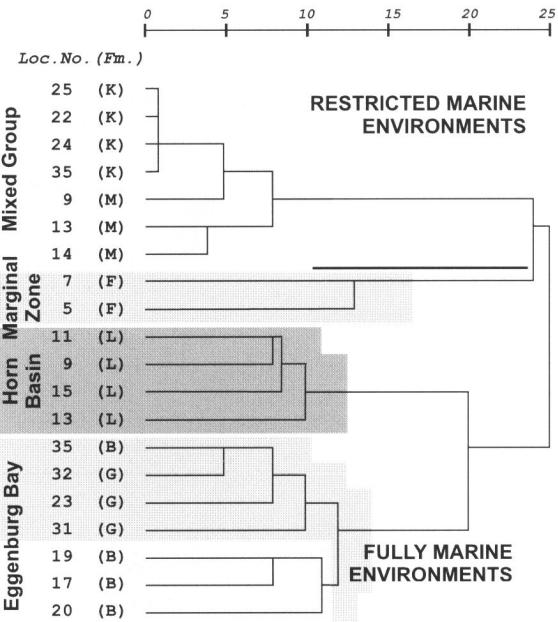


Fig. 6. Illustration shows the Hierarchical Cluster Analysis results for the database, presented in Table 1, with excluded secondarily distorted samples (see text). Note that only fully marine environment samples became grouped according to their palaeographic/geomorphologic origin. Compare also explanations for the previous figure.

given formation, divided by two. Those samples fulfilling that criterion were excluded from the analysis. The result confirmed the premise of the analysis distortion by secondary record loss: the

Fig. 5. Results of the Hierarchical Cluster Analysis of the complete database presented in Table 1. Samples are defined by the site number (see Table 1 and Fig. 3 for locality designation and regional geologic and geographic position) and the sampled formation (B, Burgschleinitz Formation; G, Gauderndorf Formation; L, Loibersdorf Formation; F, Fels Formation; K, Kühnring Member; M, Mold Formation). Except for the large group in the upper part of the dendrogram, the grouping follows geomorphology and palaeogeography, respectively (grey-shaded areas from base to top): Eggenburg Bay, Horn Basin and the Outer Margin, but only fully marine environments are included. The large group beyond comprises different samples from marine and restricted marine environments characterised by low species richness (compare Table 1). The samples in the estuarine Mold Formation form therein a small subgroup.

Table 5

Typical taxa of Eggenburg Group marine formations (F, Fels Fm.; L, Loibersdorf Fm.; B, Burgschleinitz Fm.; G, Gauderndorf Fm.)

Formation				Taxa				Formation				Taxa			
F	L	B	G					F	L	B	G				
2	-	-	-	<i>Sandbergeria perpusilla</i>				-	1	11	1	<i>Pecten pseudobeudanti</i>			
2	-	-	-	<i>Calyptraea (Calyptraea) depressa</i>				-	3	7	-	<i>Anomia ephippium</i>			
2	-	-	-	<i>Drepanocheilus (A.) speciosus megapolitana</i>				-	2	4	-	<i>Anomia rugosa</i>			
2	-	-	-	<i>Ringicula (R.) auriculata paulucciae</i>				-	6	9	3	<i>Ostrea (Ostrea) lamellosa</i>			
2	-	-	-	<i>Roxania (Roxania) elongata</i>				-	4	6	-	<i>Ostrea (Ostrea) edulis adriatica</i>			
2	-	-	-	<i>Glycimeris (G.) pilosa deshayesi</i>				-	4	4	-	<i>Ostrea (Ostrea) frondosa</i>			
2	-	-	-	<i>Ostrea sacyi</i>				-	4	3	-	<i>Chama gryphoides</i>			
2	-	-	-	<i>Lucinoma borealis</i>				-	1	5	4	<i>Plastomiltha multilamellata</i>			
2	-	-	-	<i>Astarte (Tridonta) levigrandis</i>				-	3	7	-	? <i>Taras (Taras) rotundatus</i>			
2	-	-	-	<i>Cardium rittergulderi</i>				-	1	6	4	<i>Bucardium hoernesianum</i>			
2	-	-	-	<i>Cerastoderma edule felsense</i>				-	4	2	1	<i>Bucardium burdigalimum grande</i>			
2	-	-	-	<i>Laevicardium sandbergeri</i>				-	1	4	4	<i>Tellina (Peronaea) planata</i>			
3	-	-	-	<i>Rudicardium grande</i>				-	2	3	5	<i>Tellina (Peronaea) zonaria</i>			
2	-	-	-	<i>Arctica girondica</i>				-	3	2	-	<i>Circomphalus haidingeri</i>			
2	1	-	-	<i>Xenophora cumulans transiens</i>				-	3	2	2	<i>Pitar (Chionella) italicica</i>			
1	3	-	-	<i>Semicassis (Semicassis) subsulcosa</i>				-	2	5	3	<i>Pitar (Chionella) raulini</i>			
2	1	-	-	<i>Latirus (Latirus) valenciennesi</i>				-	3	6	5	<i>Pitar (Cordiopsis) schaefferi</i>			
3	1	-	-	<i>Chlamys incomparabilis</i>				-	2	3	1	<i>Dosinia (Pectumulus) exoleta</i>			
6	6	-	-	<i>Chlamys gigas</i>				-	2	3	2	<i>Paphia subcarinata</i>			
2	1	-	-	<i>Chlamys gigas plana</i>				-	-	3	-	<i>Patella (Patella) roggendorfensis</i>			
2	1	-	-	<i>Cerastoderma edule gresseri</i>				-	-	-	2	<i>Terebralia bidentata fusiformis</i>			
2	1	-	-	<i>Angulus (Peronidia) nysti pseudofalax</i>				-	-	2	-	<i>Mytilus galloprovincialis</i>			
2	2	-	-	<i>Glossus wernerii</i>				-	-	1	-	<i>Chlamys holgeri</i>			
-	3	-	-	<i>Turritella (Turritella) gradata gradata</i>				-	-	5	-	<i>Chlamys holgeri inaequicostata</i>			
-	3	-	-	<i>Strombus (Canarium) bonelli praecedens</i>				-	-	1	-	<i>Chlamys holgeri sulcata</i>			
-	3	-	-	<i>Trona (Trona) loibersdorffensis</i>				-	-	2	-	<i>Chlamys bollensis</i>			
-	4	-	-	<i>Purpura (Tritonalia) erinacea sublaevis</i>				-	-	2	-	<i>Chlamys flabelloides</i>			
-	4	-	-	<i>Conus (Lithoconus) mercati</i>				-	-	4	-	<i>Chlamys varia</i>			
-	3	-	-	<i>Subula (Oxymeris) fuscata modesta</i>				-	-	7	-	<i>Chlamys multistriata</i>			
-	4	-	-	<i>Laevicardium kuebecki</i>				-	-	1	-	<i>Chlamys costai</i>			
-	3	5	5	<i>Turritella (Haustator) eryna rotundata</i>				-	-	1	-	<i>Chlamys justiniana</i>			
-	2	3	4	<i>Turritella (H.) vermicularis tricincta</i>				-	-	4	-	<i>Flexopecten palmata crestensis</i>			
-	5	3	3	<i>Turritella (T.?) terebralis eggenburgensis</i>				-	-	2	-	<i>Himites brussoni taurinensis</i>			
-	3	8	4	<i>Protoma (P.) cathedralis paucicincta</i>				-	-	1	7	<i>Mactra bucklandi</i>			
-	4	1	1	<i>Natica (Nacca) transgrediens</i>				-	-	-	5	<i>Pharus legumen major</i>			
-	3	1	-	<i>Natica (Nacca) epiglottina moldensis</i>				-	-	7	5	<i>Iphigenia lacunosa tumida</i>			
-	5	3	-	<i>Natica (Nacca) millepunctata tigerina</i>				-	-	3	4	<i>Sanguinolaria (P.) labordei major</i>			
-	1	4	3	<i>Tudicla (Tudicla) rusticula rusticula</i>				-	-	3	-	<i>Venus burdigalensis</i>			
-	3	-	1	<i>Anadara moltensis elongata</i>				-	-	4	3	<i>Pitar (Chionella) gauderndorfensis</i>			
-	3	7	2	<i>Mytilus (Mytilus) haidingeri</i>				-	-	3	4	<i>Venerupis basteroti</i>			
-	1	6	3	<i>Isognomon rollei</i>				-	-	-	2	<i>Tugonia ornata</i>			

Numbers mark the quantity of samples with latter taxa in each indicated lithostratigraphic unit.

low-diversity group was entirely cleaned of marine intruders by becoming restricted to representatives of the Mold and Kühnring formations (Fig. 6).

Apart from distortion, both cluster analyses principally show the same trend. Both data matrices become clustered into four groups and the lithostratigraphic units tend to cluster together.

The analyses clearly distinguish between marine and brackish-influenced formations but not between palaeoecologically different marine formations. They recognise the palaeogeographic units but ignore facies differences within them, as neither analysis could clearly separate the Burgschleinitz Formation samples from the Gauderndorf Formation ones. By evoking the introductory premises about the processes that influence the taxonomic contents in recent and fossil assemblages, it becomes obvious that the factor of time must be the cause of the clustering.

4.2. Similarities between formations

The Cluster Analysis of formations showed exactly the same pattern as above (Fig. 7). The Gauderndorf and Burgschleinitz formations are closely related, the Loibersdorf Formation is quite similar to the former ones, and the Fels Formation is completely different from all of them. The Kühnring Member and Mold Formation group together at a high level of similarity, but its relation to the others is non-interpretable and absent, respectively, according to the high rescaled similarity index value.

Clearly, the formations representing different habitats are taxonomically more similar than those representing the same habitats but different palaeogeographic units. Yet, as already pointed out, a palaeobiogeographic influence in such a small geographic area is improbable. Thus, the faunal differences must have a time-biased background. Hereby the Loibersdorf Formation (Horner Basin) attains a mediate position, whereas the relative age of the deposition at the Southern Margin (Fels Formation) and in the Eggenburg Bay (Burgschleinitz and Gauderndorf formations) is not unequivocally defined through Cluster Analysis, but rather through the distribution of biostratigraphic markers.

5. Discussion

The computer-based comparison of complete mollusc occurrences of the studied region demonstrated their diachronous origin, implying that the Eggenburgian flooding event in the Southern Marginal Zone, Horn Basin and Eggenburg Bay appeared successively. Whereas the relative hierarchical order of that flooding is well underpinned through the presented Cluster Analysis, its chronology must be inferred from the distribution of characteristic fossils (Table 5).

5.1. Pectinids

The pectinids are a powerful tool in the biostratigraphic classification of Neogene shallow-water marine deposits. They have a high preservation

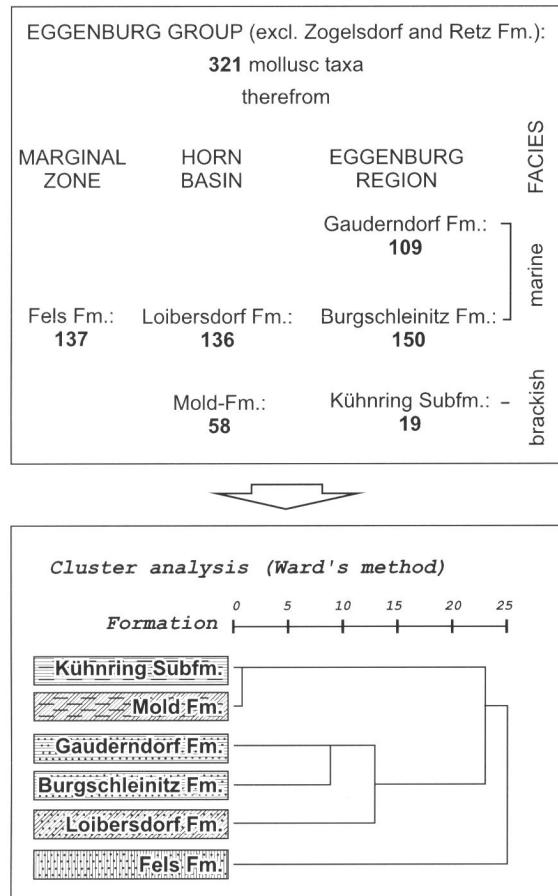


Fig. 7. Diversity (species-richness) distribution and resulting Hierarchical Cluster Analysis for studied formations of the Eggenburg Group. The analysed occurrences correspond with the grey-shaded areas in Table 2.

potential due to their calcite shell mineralogy and are widely distributed, commonly occurring in accumulations (Mandic and Piller, 2001). The patterns of Lower Miocene stratigraphic distribution of Central Paratethys pectinids are described by Baldi and Senes (1975), and a *Chlamys gigas* (Schlotheim)–*Pecten hornensis* Deperet and Roman Biozone has been introduced for the Eggenburgian stage. The authors recognised two subzones that can be distinguished by the occurrence of *Chlamys gigas* (Schlotheim) in the lower part and *Chlamys holgeri* (Geinitz) and *Pecten hornensis* Deperet and Roman in the upper part. Indeed, the Hungarian pectinid assemblage zonation of Bohn-Havas et al. (1987) also recognised a Lower Eggenburgian *Chlamys gigas* (Schlotheim) assemblage zone (characterised with the FOD of *C. gigas* (Schlotheim) and *Pecten pseudobeudanti* Deperet and Roman) and the Upper Eggenburgian *Chlamys palmatus* (Lamarck)–*Chlamys crestensis* (Fontannes) assemblage zone (defined by the FOD of *C. palmatus* (Lamarck) and *Chlamys holgeri* (Geinitz)). *C. gigas* (Schlotheim) is, in fact, restricted here to the Fels and Loibersdorf formations, and *C. holgeri* (Geinitz) and *Flexopecten palmatus crestensis* (Fontannes) are restricted to

the Burgschleinitz Formation. This provides a clear biochronological framework (Fig. 8).

Pectinids seem to provide a still finer biostratigraphic framework in the region. Roetzel et al. (1999), for example, additionally recognised a level characterised by the abundant occurrence of *Chlamys gigas plana*, based on their monospecific accumulations in the Fels area. In the Obernholz area they occur together with larger *Chlamys gigas gigas*, which dominate the population in the Horn Basin and form monospecific beds. These authors also argue for an Eggenburgian age of the Zogeldorf Formation based on the absence of typical Ottangian species, e.g. *Chlamys albina* (Teppner) and *Pecten hermanni* Dunker, noting also the FOD of the typical Eggenburgian pectinid *Pecten hornensis* Deperet and Roman within that formation.

5.2. Giant cardiods

The Eggenburgian is characterised by the occurrence of giant cardiid species; they show a conspicuous distribution pattern not only in the studied region but also in regions with time-equivalent sediments. Hence, *Ruditocardium grande*

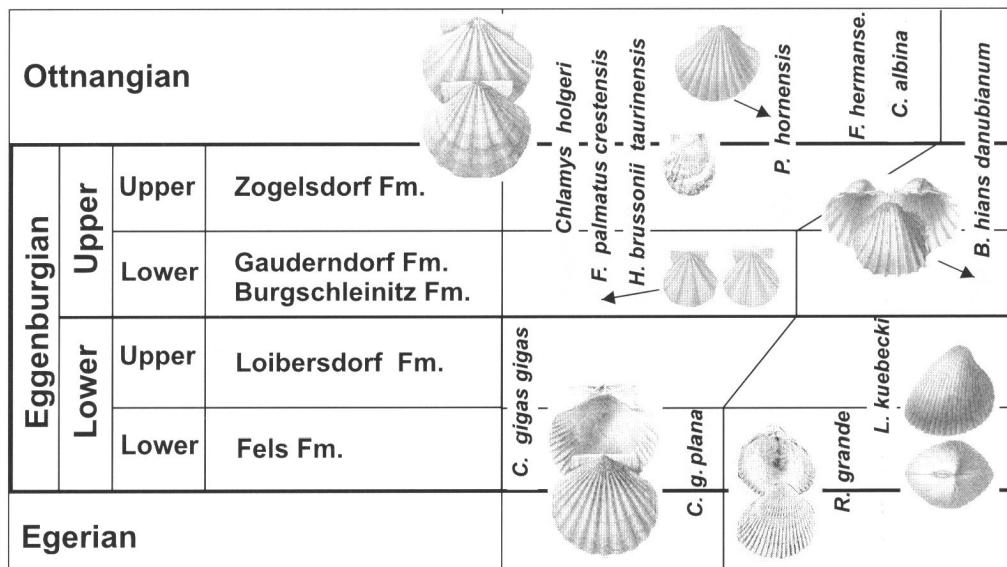


Fig. 8. Stratigraphic distribution of pectinid and large cardiid bivalves in the studied region (modified after Roetzel et al., 1999).

(Hölzl) is restricted to the Fels Formation, *Laevicardium kuebecki* (Hauer) is restricted to the Loibersdorf Formation, and *Bucardium hians danubianum* (Mayer) to the Burgschleinitz and Gauderndorf formations.

Rudicardium grande (Hölzl) is originally described from basal Eggenburgian beds of the Kaltenbachgraben in Bavaria (Hölzl, 1973) and from several sites in Hungary (Baldi, 1986). It apparently provides a good biostratigraphic marker for an initial Eggenburgian bio-horizon.

Laevicardium kuebecki (Hauer) is restricted in Hungary to a horizon superposing the earliest Eggenburgian beds with *Rudicardium grande* (Hölzl) (Baldi, 1986). In Korod in the Transylvanian Basin (Hörnes, 1870), Budafok in Budapest (Baldi, 1971), and in the Kaltenbach section in Bavaria (Hölzl, 1973) it occurs together with large specimens of *Chlamys gigas gigas* (Schlotheim). This conspicuously correlates with the typical fossil assemblage of the Eggenburgian type horizon represented by the Loibersdorf Formation.

Finally, also in Hungary, the first appearance of *Bucardium hians danubianum* (Mayer) is bounded on the Upper Eggenburgian *Flexopecten palmatus* (Lamarck) zone as documented by Baldi (1971) from the Eggenburgian ‘faciostratotype’ Budafok. This characteristic species has its maximum abundance during the Middle Miocene.

In conclusion, the distribution of giant cardiids implies a chronological order for the studied formations, putting the Fels Formation at the base of the succession.

6. Conclusions

The results of the Hierarchical Cluster Analysis support the stratigraphic division of the Eggenburg Group into four lithostratigraphic units proposed by Mandic (1997) and adopted by Roetzel et al. (1999). The differing ages of depositional units in the region apparently accurately explain their different faunal compositions. These data also support a detailed palaeogeographic reconstruction of the spectacular Lower Miocene marine flooding of the SE Bohemian Massif.

Hence, at the time when the Southern Marginal

Zone was reached by the Eggenburgian transgression and when the Fels Formation was deposited, the Horn Basin was either in a late phase of the riverine-lacustrine deposition or more probably had already developed a narrow estuary facies belt represented by the deposition of the Mold Formation. The flooding of the estuary and the northward shift of the riverine environment followed in the next phase, when the fully marine regime of the Loibersdorf Formation developed in the Horn Basin. The topographically higher, eastward inclined Eggenburg Bay was at that time a southward pointing cape. The Upper Eggenburgian transgression reached this area of the Eggenburg Bay with the FOD of *Flexopecten palmatus* (Lamarck) and *Chlamys holgeri* (Geinitz) and predominantly fully marine regimes were installed. They are represented by deposition of the Burgschleinitz and Gauderndorf formations, bordered by lagoonal deposits represented by the Kühnring Member.

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Erratum to Mandic & Steininger, 2003, p. 269

Table 1 (revised)

Studied sites with indicated palaeogeographic position, outcropping lithostratigraphic formations (F: Fels Fm.; M: Mold Fm.; L: Loibersdorf Fm.; K: Kühnring Sbfm.; Burgschleinitz Fm.; G: Gauderndorf Fm.) and coordinates.

No.	Locality	Formation	Coordinates						Locality codes				
			F	M	L	K	B	G					
Marginal Zone Fels–Obernholz–Melk													
<i>Obernholz area</i>													
1	NW Wiedendorf		x	—	—	—	—	—	15°45'18"E; 48°29'51"N	6			
2	Bösendürnbach – house construction (cellar excavation)		x	—	—	—	—	—	15°46'0"E; 48°30'30"N	7			
3	Obernholz – parish pit (formerly sandpit Hammerschmied)		x	—	—	—	—	—	15°44'17"E; 48°30'50"N	4			
4	Obernholz – Kellergasse		x	—	—	—	—	—	15°44'30"E; 48°30'49"N	4			
<i>Fels area ("Fels Back")</i>													
5	Fels am Wagram – Dornergraben		x	—	—	—	—	—	15°48'51"E; 48°27'19"N	1			
6	Gösing		x	—	—	—	—	—	15°49'0"E; 48°27'47"N	5			
<i>Melk area ("Loosdorf Bay")</i>													
7	Mauer/Lochau		x	—	—	—	—	—	15°25'42"E; 48°14'6"N	2			
									15°26'0"E; 48°11'44"N	7			
Horn Basin													
8	Maiersch – claypit Frings		—	x	—	—	—	—	15°42'31"E; 48°34'50"N	15			
9	Nonndorf – forest margin		—	x	x	—	—	—	15°43'17"E; 48°36'4"N	9M, 12L			
10	Nonndorf – acre		—	x	—	—	—	—	15°43'10"E; 48°36'17"N	13			
11	Loibersdorf – sandpit on the forestal path		—	—	x	—	—	—	15°43'20"E; 48°36'39"N	11			
12	Mörtersdorf – abandoned sandpit at SE end of the village, beside crossroad to Gars		—	x	x	—	—	—	15°43'20"E; 48°37'4"N	14M, 9L			
13	Mörtersdorf – house construction on the right hand side of the road to Horn		—	x	—	—	—	—	15°43'7"E; 48°37'19"N	10			
14	Mold–Maria Dreieichen – Kirchensteig		—	x	x	—	—	—	15°42'38"E; 48°38'53"N	8M, 15L			
15	Maria Dreieichen – Turritelid lagerstätte		—	x	x	—	—	—	15°42'47"E; 48°39'3"N	12M, 14L			
16	Achberg near Maria Dreieichen – Scutella sands		—	—	x	—	—	—	15°42'39"E; 48°39'51"N	16			
Eggenburg region													
<i>Eggenburg Bay</i>													
17	Burgschleinitz – new material pit (1 km SE church in direction Maissau)		—	—	—	x	—	—	15°49'42"E; 48°35'53"N	18			
18	Burgschleinitz – former sandpit Hammerschmied		—	—	—	x	—	—	15°49'0"E; 48°36'12"N	36			
19	Burgschleinitz – Kirchenbruch		—	—	—	x	—	—	15°49'0"E; 48°36'19"N	19			
20	Kühnring – parish sandpit		—	—	—	x	—	—	15°47'34"E; 48°37'47"N	20			
21	Kühnring – Judenfriedhof		—	—	—	x	—	—	15°46'12"E; 48°38'8"N	21			
22	Kühnring – shark tooth lagerstätte on the Himmelreichstraße, 1 km N Judenfriedhof		—	—	—	x	—	—	15°46'3"E; 48°38'18"N	35			
23	Eggenburg – Brunnstube		—	—	—	x	x	—	15°49'5"E; 48°38'7"N	37B, 27G			
24	Eggenburg – railway trench		—	—	x	x	—	—	15°48'42"E; 48°38'16"N	25			
25	Eggenburg – Stransky brickyard		—	—	x	x	—	—	15°48'10"E; 48°38'26"N	29			
26	Eggenburg – Bauernhansel pit		—	—	—	x	—	—	15°48'41"E; 48°38'21"N	22			
27	Eggenburg – Museumsplatz		—	—	—	x	—	—	15°49'4"E; 48°38'24"N	34			
28	Eggenburg – Raimundstollen		—	—	—	x	—	—	15°49'5"E; 48°38'18"N	30			
29	Eggenburg – Bärensteig		—	—	—	x	—	—	15°48'49"E; 48°38'23"N	35			
30	Eggenburg – Wienerstraße (road construction)		—	—	—	x	—	—	15°48'16"E; 48°38'23"N	35			
31	Gauderndorf – sandpit Zimmermann		—	—	—	x	x	—	15°49'33"E; 48°39'24"N	39B, 23G			
32	Gauderndorf – former parish sandpit		—	—	—	x	—	—	15°49'38"E; 48°39'32"N	28			
33	Gauderndorf – former Zötter sandpits		—	—	—	x	—	—	15°48'53"E; 48°39'46"N	23			
34	Maigen – southern sandpits		—	—	—	x	x	—	15°46'36"E; 48°40'11"N	34K, 26B, 32G			
35	Maigen – sandpit Stranzl		—	—	—	x	x	—	15°46'53"E; 48°40'27"N	12K, 20B, 37G			
36	Kattau – mill		—	—	—	x	x	—	15°48'4"E; 48°40'11"N	34B, 31G			
37	Roggendorf – Schloßtal ("Patellengrube")		—	—	—	x	—	—	15°51'16"E; 48°40'37"N	33			
38	Sigmundsherberg		—	—	—	x	—	—	15°45'16"E; 48°41'3"N	38			
<i>Outer margin</i>													
39	Maissau		—	—	—	x	—	—	15°49'23"E; 48°34'31"N	31			