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Distribution of the Callovian and Lower Oxfordian ammonite faunas in Poland

ABSTRACT: Ammonite-familial spectra are determined for the Callovian and Lower Oxfordian of Poland in terms of relative abundance of specimens assigned to and specific diversity of particular families. The former mode of analysis appears as a more reliable paleobiogeographic tool than the latter. The recognized ammonite spectra suggest that in the Lower to Middle Callovian the entire area of Poland made part of the Submediterranean Province. In the Upper Callovian through Lower Oxfordian, southern and Central Poland remained within the Submediterranean Province, while northern Poland was considerably influenced by the Subboreal fauna.

INTRODUCTION

Basing upon the spatial distribution of various ammonite groups, two paleobiogeographic realms have been distinguished in the European Jurassic, *viz.* Boreal and Tethyan Realms. Beginning with the Callovian, the Boreal and Subboreal Provinces can be recognized within the Boreal Realm, and the Submediterranean and Mediterranean Provinces within the Tethyan Realm (Cariou 1973).

Throughout the Callovian and Lower Oxfordian, the Boreal Province was represented by exclusively cardioceratid faunas and covered the present-day Arctic, while the Mediterranean Province was characterized by considerable proportions of phylloceratids and lytoceratids and coincided with the Jurassic Tethys. The Subboreal and Submediterranean Provinces covered the rest of Europe. The former province is defined in the Callovian by a prevalance of kosmoceratids and cardioceratids, and in the Lower Oxfordian by an occurrence of cardioceratids and oppeliids (in specified proportions) with phylloceratids and lytoceratids lacking at all (Fürsich & Sykes 1977). The Submediterranean Province is defined (Hallam 1971, Cariou 1973) in the Callovian by a prevalence of oppeliids, macrocephalitids, reineckeiids, aspidoceratids, and some perisphinctids (*Grossouvria, Choffatia*); and in the Lower Oxfordian by a prevalence of oppeliids, aspidoceratids, and some perisphinctids (e.g. *Alligaticeras*).

In the Callovian and Lower Oxfordian, the extra-Carpathian Poland (*cf.* Text-fig. 1) was influenced by both the Subboreal and Submediterranean Provinces. The relative significance of these influences remains however controversial. Dayczak-Calikowska (1976, 1977) is of the opinion that beginning with the Callovian the extra-Carpathian Poland made entirely part of the Subboreal Province. With respect to the Oxfordian, this is supported by Malinowska (1976). In turn, Kopik (1976) claims that the Callovian ammonite assemblage from the vicinity of Częstochowa (exposures *5* in Text-fig. 1) shows a close relationship to the Submediterranean faunas.

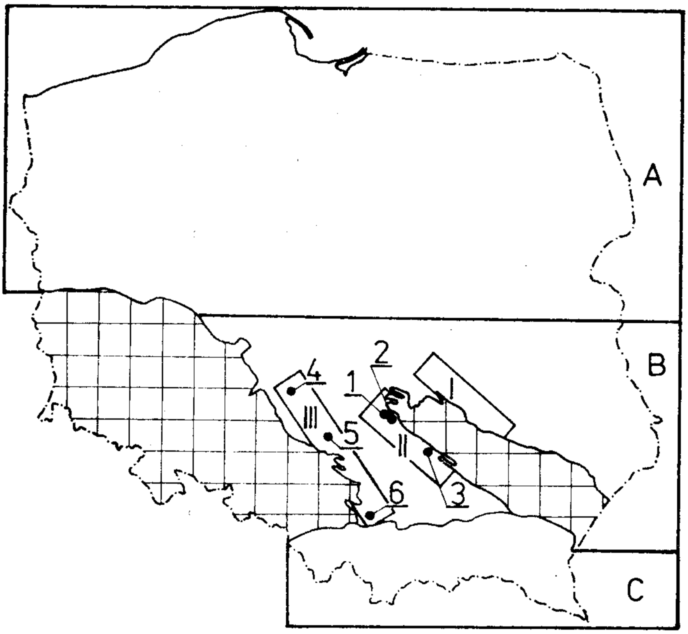

Fig. 1. Location of the considered regions, areas, and exposures; hachured areas are those without any Jurassic deposits

Regions: **A** — northern Poland, **B** — Central Poland, **C** — southern Poland (Carpathians)

Within *B* distinguished are areas: **I** — north-eastern margin of the Holy Cross Mts, **II** — south-western margin of the Holy Cross Mts, **III** — Polish Jura Chain

Within *II* distinguished are exposures: 1 — Mnin, 2 — Lasocin, 3 — Wola Morawicka

Within *III* distinguished are exposures: 4 — Wieluń, 5 — vicinity of Częstochowa, 6 — Zalas

These contrasting opinions reflect the occurrence of forms indicative of the both provinces in the extra-Carpathian Poland. Therefore, an approach that permits estimation of relative significance of particular ammonite groups in various areas is badly needed, as it has already been pointed out by Malinowska (1976).

METHODS OF INVESTIGATION

Paleobiogeographic provinces are defined and recognized in the considered stratigraphic interval by either an exclusive occurrence of a single ammonite group, or more commonly an occurrence of a few distinct ammonite groups. Where ammonites characteristic of distinct provinces mix, analysis of relative proportions of particular groups within a faunule may become a useful tool for recognition of the boundaries between the provinces (*cf.* Fürsich & Sykes 1977).

The relative proportions of particular ammonite groups are, however, to be determined and discussed at an adequate taxonomic level reflecting a reasonable compromise between distinctness of the provinces, and stability of the compared taxa. The latter concept is here meant as the least proneness to variation in range of a single taxon as conceived by diverse authors. The species level can obviously not provide any taxonomic stability of this sort (*cf.* Hallam 1972, 1977). Such a stability cannot be guaranted by the generic level either, as for example some authors regard *Putealiceras*, *Hecticoceras*, *Brightia*, and *Lunuloceras* as distinct genera, while others consider them to be subgenera of the genus *Hecticoceras*. The same problem arises also with the genera *Macrocephalites*, *Kepplerites*, *Peltoceras*, *Perisphinctes*, and *Cardioceras*, all of which range from a narrow to wide definition. Taxonomic instability of the generic level results also from the unclear status of such genera as e.g. *Bukowskites* and *Creniceras*. More or less universally accepted and unequivocally identifiable are only the ammonite family-groups. The present authors therefore study taxonomic composition of the Callovian and Lower Oxfordian ammonite assemblages at the family level. Its appropriateness to the analysis is also supported by the apparent distinctiveness of various ammonite families for the Callovian to Lower Oxfordian biogeographic provinces (*cf.* Cariou 1973, Gordon 1976).

Two distinct methods are commonly applied to the problem in recognition of relative proportions of ammonite groups within a faunule. To achieve this goal, one may either compare diversity of higher-rank taxa, *e.g.* specific diversity of genera (Malinowska 1976) or families (Fürsich & Sykes 1977), or analyse numerical abundance of taxa of a single level, most commonly families (Elmi 1969, Mattei 1966, Marchand & Thierry 1974, Gygi & Marchand 1976, Marchand & Gygi 1977). The present authors are of the opinion that the former approach is inappropriate because (*i*) all taxa are equally weighted regardless of their numerical abundance in the investigated area; (*ii*) taxa of a single level vary in their diversity which *a priori* biases the data; and (*iii*) because of variable preservation state etc, not all specimens can be identified equally precisely, *e.g.* to the specific level, which is required to get reliable results. All these doubts are removed when the other method is applied. Juvenile and/or poorly preserved specimens can usually be quite easily identified to the family level, and to determine numerical abundance of particular families within a faunule one has not to undertake any detailed paleontological study. The only disadvantage of this method is that one cannot apply it to analyse faunules for which merely taxonomic lists are given.

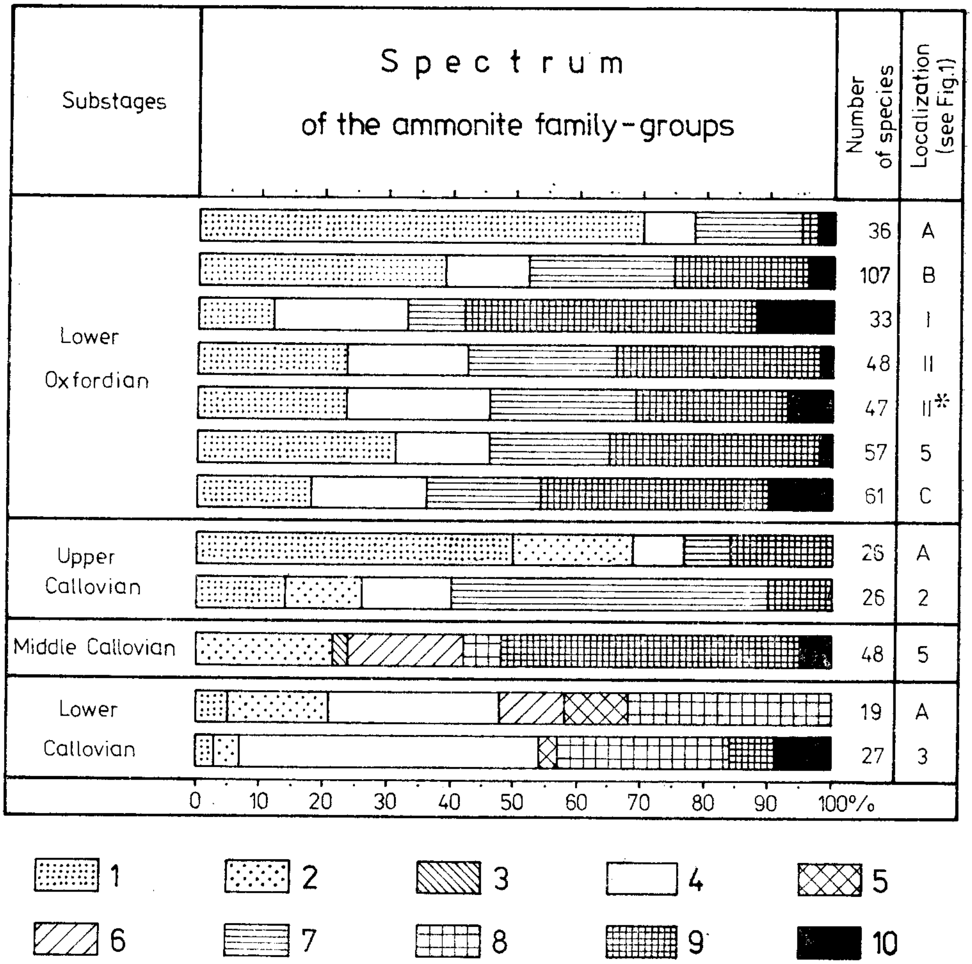

Fig. 2. Percent proportion of the total species number accounted for by the ammonite family-groups

1 — Cardioceratidae, **2** — Kosmoceratidae, **3** — Pachyceratidae, **4** — Perisphinctidae, **5** — Spiroceratidae, **6** — Reineckeiidae, **7** — Aspidoceratidae, **8** — Macrocephalitidae, **9** — Haploceratacea, **18** — Phylloceratidae and Lytoceratidae

Sources of data for the Lower Oxfordian: *A*, *B*, *C* — Malinowska (1976), *I*, *II* — Malinowska (1967), *II** — Matyja (1977), *5* — Malinowska (1963); for the Callovian: *A* — Dayczak-Calikowska (1977), *2*, *3* — Siemiątkowska-Giżejewska (1974), *5* — Różycki (1953) and Kopik (1976)

MATERIALS

The presented data (Text-figs 2—3) on the relative proportions of various ammonite families in the Callovian and Lower Oxfordian faunules of Poland derived from published (Siemiątkowska-Giżejewska 1974, Matyja 1977) and unpublished data of the present authors as well as from other investigations (Różycki 1953; Malinowska 1963, 1966, 1967, 1976; Kopik 1976; Dayczak-Calikowska 1977; Tarkowski 1978). The compared ammonite faunules are representative of either single exposures (*1—7* in Text-fig. 1), larger areas (*I—III* in Text-fig. 1), or large-scale regions (*A—C* in Text-fig. 1). Because of a variable stratigraphic precision of the sources of data, the ammonite distributions are studied for particular substages instead of zones, as one would like to do. This may considerably bias the analysis because, for example, the Lower Callovian faunule from Wieluń (exposure *4* in Text-fig. 1) represents the *macrocephalus* Zone and lower *calloviense* Zone (*koenigi* Subzone), whereas the Lower Callovian ammonites from Wola Morawicka (exposure *3* in Text-fig. 1) represent exclusively the upper *calloviense* Zone (*Calloviense* Subzone).

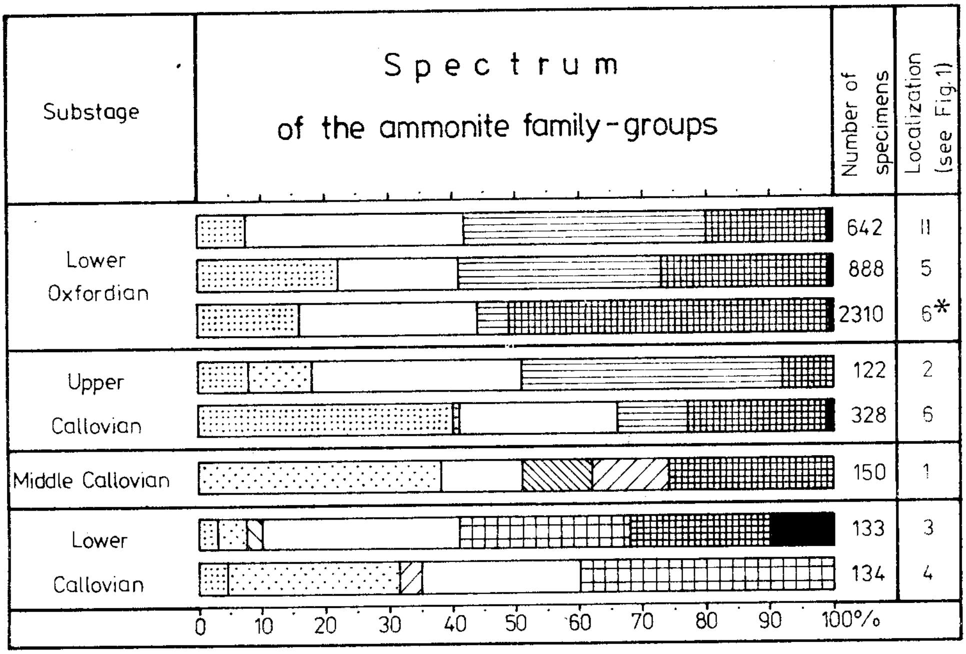

Fig. 3. Percent proportion of the total specimen number accounted for by the ammonite family-groups; for explanation of the symbols see Text-fig. 2

Sources of data: *II* — Matyja (1977), *6** — Tarkowski (1978), the other exposures — unpublished data of the present authors

Numerical abundances of the ammonite families have been determined exclusively for the Holy Cross margins and the Polish Jura Chain (region *B* in Text-fig. 1) since no adequate data from other regions are insofar available.

DISCUSSION

The two approaches to biogeographic analysis of the Callovian and Lower Oxfordian ammonites of Poland, *i.e.* the relative-abundance and specific-diversity methods, can be compared after the results obtained for the faunules derived from the Holy Cross margins and the Polish Jura Chain. The percent proportions of specimens assigned to the families Cardioceratidae, Kosmoceratidae, Phylloceratidae, and Lytoceratidae in the ammonite-familial spectra (Text-fig. 3) are much lower than the percent proportions of the respective species in the spectra (Text-fig. 2). This is probably due to the special attention paid during both the field work and taxonomic identification of a faunule to those groups that are regarded as stratigraphically important (cardioceratids and kosmoceratids in the present case) or biogeographically "exotic" for Poland (phylloceratids and lytoceratids). This interpretation is confirmed by the higher percent proportions of specimens than those of species assigned to families stratigraphically insignificant (aspidoceratids and haploceratаceans in the present case) or taxonomically poorly known (Lower Oxfordian perisphinctids). One may conclude that the relative-abundance approach removes the bias introduced by more or less subjective preferences for investigation of certain ammonite groups in more detail than others.

The ammonite spectra based upon specific diversity of particular families are also biased by the preservation state of the fossils. For example, merely two species of the aspidoceratid genus *Peltoceras* are reported (Dayczak-Calikowska 1977) from the Upper Callovian of northern Poland (region *A* in Text-fig. 1) known exclusively from boreholes; while a dozen or so congeneric species are reported (Siemiątkowska-Giżejewska 1974) from the Callovian outcrops (region *B* in Text-fig. 1). This difference may result notasmuch from the actual distributional pattern of the genus *Peltoceras*, as from the impossibility of species identification of whorl fragments obtained from borehole cores. In contrast to aspidoceratids, some other ammonite groups, *e.g.* kosmoceratids, can often be identified to the specific level after small whorl fragments. This variation in ammonite identifiability may considerably obscure the original specific diversities of the families. The bias is, however, removed when applying the relative-abundance method.

The incompatibility of the analysed data make for the moment impossible any precise causal analysis of the distribution of the Callovian and Lower Oxfordian ammonites of Poland. Nevertheless, some preliminary conclusions can be drawm.

Since the Aalenian to Upper Bathonian, the entire area of Poland made undoubtedly part of the Submediterranean Province (*cf.* Dayczak-Calikowska 1976, 1977). Beginning with the Lower Callovian, the ammonites typical of the Boreal Realm appear in Poland. Their relative proportion increases gradually from 7—18% of the total number of Lower Callovian species up to 12—70% of the total number of Lower Oxfordian species (*cf.* Text-fig. 2). In fact, the Callovian migration of Boreal forms southwards (Boreal Spreads of Arkell, 1956) is for long known (Siemiradzki 1891) and recorded commonly all over Europe (*see* e.g. Marchand & Thierry 1974).

In Central Poland, the proportion of the ammonites indicative of the Boreal Realm increases gradually throughout the Callovian and Lower Oxfordian but never exceeds 40% of the total number of species and 50% of the total number of specimens (*cf.* Text-figs 2—3). In contrast, cardioceratids and kosmoceratids increase rapidly in specific diversity during the Upper Callovian and Lower Oxfordian in northern Poland (Text-fig. 2); actually, the two families account for some 70% of the total number of species present in the substages, which may indicate that the Boreal Realm more considerably influenced northern Poland than the other regions.

The ammonite-familial spectra recorded in central and southern Poland (Text-figs 2—3) resemble the ammonite assemblages from the areas assigned undoubtedly to the Submediterranean Province (Gygi & Marchand 1976; Fürsich & Sykes 1977, Fig. 2). One may even note that the proportion of the Submediterranean forms is in some cases higher in Central Poland than in certain areas located more closely to the Jurassic Tethys; this refers to the Lower Oxfordian ammonite spectra of Herznach, Swiss Jura (Marchand & Gygi 1977), and Blumberg, Swabian Alb (Zeiss 1957).

The ammonite groups characteristic of the Submediterranean (haploceratids, aspidoceratids, macrocephalitids, reineckeiids, spiroceratids, and some perisphinctids) and Mediterranean Provinces (phylloceratids and lytoceratids) account in Central and southern Poland regions *B* and *C* in Text-fig. 1) for more than 50% of the total numbers of both species and specimens (Text-figs 2—3), which indicates that in spite of the occurrence of cardioceratids and kosmoceratids a considerable area of Poland made in the Callovian and Lower Oxfordian part of the Submediterranean Province.

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