Corals from Asturian substage in Cantabrian Mountains: A review

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The subdivision of the Pennsylvanian divided the Namurian, Westphalian and Stephanian regional stages in substages named with letters. During the second half of the 20th Century, some of these substages were more properly defined. Westphalian A, B and C were defined as Langsettian, Duckmantian and Bolsovian. The Stephanian A was renamed as Barruelian and the transition between Westphalian and Stephanian as Cantabrian. The Westphalian D, defined in continental strata from Saar-Lorraine, was proposed to be substituted by the Asturian substage with the stratotype in the Cantabrian Mountains. An extensive documentation with assemblages and stratigraphic distribution of plants, fusulinids, brachiopods, corals, molluscs and ostracods was presented. But a formal definition of the stratotype was never proposed. The Asturian substage in the Cantabrian Mountains comprises both marine and terrestrial strata rich in fossils and allows easy correlations with other areas. Recent studies have improved the stratigraphic data and the knowledge on the coral assemblages, mainly in the eastern area of Asturias and Palencia. The entire coral assemblage from Asturian substage in the Cantabrian Mountains is composed of 48 named species and 20 species described in open nomenclature. The short stratigraphic range of many of them may be the basis for the characterization of the Asturian stage with corals. Although some species are endemic in the Cantabrian Mountains, there are some species that are also present in other regions of the Palaeotethys. At the generic level there are significant similarities that should be the basis for wider correlations with North America and East Asia.

Introduction

The Pennsylvanian chronostratigraphic global stages (Cohen et al., 2011; Richards, 2013) are based in stratigraphic marine successions from Russia (Bashkirian, Moscovian, Kasimovian and Gzhelian). But the active Variscan orogeny during that time produced complex sedimentation environments (basins) that often are difficult to correlate. Because of that, many regional series, stages and substages have been defined in different continental areas. The chronostratigraphic regional stages in Western Europe were mainly based in continental successions and defined in several areas with diverse geological histories. Those areas are the Northern European Coal Belt, the Massif Central in France and the Cantabrian Mountains in Northwest Spain (see reports by Wagner and Winkler Prins, 1985a, b; 2016).

The early subdivision of the upper Carboniferous proposed by Jongmans and Pruvost (1950) divided the Namurian, Westphalian and Stephanian in substages named with letters (Namurian, A, B, and C; Westphalian, A, B, C, and D, and Stephanian, A, B, and C). However, along the second half of the 20th Century, some of these substages were more accurately defined, became named and stratotypes were proposed. So, Westphalian A, B and C were defined as Langsettian, Duckmantian and Bolsovian based on the East Pennines Coalfield in Northern England (Owens et al., 1985; Waters et al., 2011). The Stephanian A was formally renamed the Barruelian Substage with stratotype in southern part of the Cantabrian Mountains (north of the Palencia province). The identification of Stephanian strata older than Barruelian and the absence of an equivalent succession in the Massif Central led to the definition of the Cantabrian Substage. It is again based in successions in the southern Cantabrian Mountains (north of the Palencia province). The identification of Stephanian strata older than Barruelian was proposed to be substituted by the Asturian substage with stratotype in southern part of the Cantabrian Mountains (north of the Palencia province). The entire coral assemblage from Asturian substage in the Cantabrian Mountains is composed of 48 named species and 20 species described in open nomenclature. The short stratigraphic range of many of them may be the basis for the characterization of the Asturian stage with corals. Although some species are endemic in the Cantabrian Mountains, there are some species that are also present in other regions of the Palaeotethys. At the generic level there are significant similarities that should be the basis for wider correlations with North America and East Asia.
the data-base with the inclusion of the trilobites of distribution, but they never presented a formal proposal with the definition of a stratotype. But, the Asturian substage has been mostly accepted, and the name used by many authors (Oplustil and Cleal, 2007; Dimitrova et al., 2010; Cleal et al., 2011).

In the compilation of Wagner et al. (2002) the record of corals was incomplete; new stratigraphic data allow more precision in defining horizons and recent studies have increased the number of coral taxa, mainly of tabulates (Coronado and Rodríguez, 2014). The present paper is an homage to the authors of the first compilation and shows a more comprehensive relation of the coral distribution in the Asturian substage from Cantabrian Mountains. That kind of compilations is crucial for the subsequent definition of stages or systems. A good example of that is in Comas-Rengifo et al. (2015), whose analysis of brachiopod assemblages was used for the later definition of the base of the Toarcian in Peniche, Portugal (Rocha et al., 2016).

**Stratigraphy**

The Asturian substage in Cantabrian Mountains includes both marine and terrestrial strata. The sedimentation was syntectonic and took place in different domains and environments. Asturian sediments occur only in the central and eastern regions of Asturias, in the Liébana Valley (Cantabria) and in the northern Palencia. They are absent in western Asturias and northern León (Fig. 1), because those regions were uplifted and eroded during the Variscan orogeny. The central part of Asturias was covered by a marine-paralic basin (Central Asturian coal basin). It shows classical cyclothems with alternation of siliciclastic rocks, coal seams and less common limestone beds sedimented in a broad foreland basin. It comprises the upper part of the Lena Group (Caleras and Generalsas formations, with many limestone beds and some coal beds); and the lower part of the Sama Group (San Antonio and Maria Luisa formations without limestone and more abundant conglomerates and sandstones) (Leyva and Gervilla, 1983; Colmenero et al., 2002). The proposed type section near the Riosa village is located in that area and settled along an old mining railway (Wagner et al., 2002). In northern Palencia, the Vergaño Formation and its equivalent in the Casavegas syncline are mainly siliciclastic (Fig. 2). But limestone beds are usually thicker and more common than in the Central coal basin, receiving specific names (Cotarraso Limestone, Sierra Corisa Limestone, Casavegas Limestone, Lores limestone, etc.) (Van Ginkel, 1965; Van den Graaf, 1971). The sedimentation in eastern Asturias is composed mainly of limestones developed in calcareous platforms with local intercalations of siliciclastic rocks (Fig. 2). Two different areas yielded corals: the coast cliffs at Cuevas de Mar and Playa de la Huelga, where the Cuera limestone shows siliciclastic intercalations (Navarro et al., 1986) and the Picos de Europa mountainous region, where the Picos de Europa Formation is completely calcareous. All areas contain well-exposed sections rich in palaeontological content.

The presence of terrestrial and marine assemblages combined in the same sections allows an easy correlation with the previous Westphalian D defined in terrestrial facies from Saar-Lorraine and other basins in western Europe. Also with the global stages based in marine facies from Moscovian platform. The Asturian substage may be correlated with the Westphalian D from Central and western Europe, with the upper part of the Podolskian and the lower part of the Myachkovian substages from Russia and Ukraine. It also coincides with the middle part of the Desmoinesian stage from North America and with the upper

![Figure 1. Location of main outcrops yielding Asturian corals in Cantabrian Mountains. Asturias: CE - Cuesta Espinera, CM - Cuevas de Mar, CL - Carretera Lagos, LL - Llacerias, PH - Playa de la Huelga, RI - Riosa; Palencia: CA - Casavegas, CO - Cotarraso, SC - Sierra Corisa, VE - Vergaño.](image-url)
Figure 2. Lithostratigraphic succession at the studied outcrops. Abbreviations: CO Lst: Cotarraso Limestone, SC Lst: Sierra Corisa Limestone, CV Lst: Casavegas Limestone, LO: Lores Limestone.

Figure 3. Stratigraphical chart showing the extension of the outcrops yielding Asturian corals. Abbreviations: Langset. = Langsettian; Cant. = Cantabrian; Steph. = Stephanian.
part of the Weiningian stage in China (Richards, 2013) (Fig. 3).

The studied outcrops are located mainly in the eastern part of the Cantabrian Mountains, in the Palencia and Asturias provinces. They include the following sections (Figs. 1-3): Cuera limestone in the Playa de la Huelga (Huelga Beach) and Cuevas de Mar sections (Rodríguez, 1984; Navarro et al., 1986; Rodríguez and Ramírez, 1987; Coronado and Rodríguez, 2014), Picos de Europa Formation in the type area, mainly near Covadonga Carretera Lagos and Cuesta Espinera sections, (Rodríguez, 1984; Rodríguez and Kullmann 1999), Sierra Corisa Limestone, Cotarraso Limestone, Casavegas Limestone and other limestone units of the Vergaño Formation at the Palentine area (De Groot, 1963; Rodríguez and Kullmann, 1990).

**Coral assemblages**

The Pennsylvanian corals of the Cantabrian Mountains have been studied by De Groot (1963, and in Winkler Prins, 1971), Boll (1985), Rodríguez (1984), Rodríguez et al. (1986), Rodríguez and Kullmann (1990, 1999), Rinklef (1994), Fernández et al. (1995) and Coronado and Rodríguez (2014). The published data are summarised in Fig. 4.

Coral distribution is often conditioned by environments because some types of corals need shallow, warm, clean and agitated waters for living. This is true for hermatypic corals, but we have no control in the Palaeozoic corals on possible symbiosis with algae, the presence of hermatypic corals can’t be confirmed in the Carboniferous. But some inferences can be made. Hill (1938-41) proposed three types of corals having different environmental needs. Most colonial rugosans and some colonial tabulates lived mainly in reefal environments and in shallow platforms from tropical areas. We can infer that they were hermatypic. On the contrary, the Cyathaxonia fauna, composed of small undissepimented corals (and some small tabulate colonies) were regarded as living in deep water environments (Hill 1938-41). However, the record of those corals is wider, because they can also occur in shallow water that were not appropriate for colonial corals because of restricted, turbid or cold conditions. An intermediate fauna composed of solitary dissepimented rugosans may share environments with the two above-mentioned types. The undissepimented corals show usually wide geographical distributions and occur in different facies; but they are very conservative from the evolutionary point of view and many of them have long stratigraphic ranges. On the contrary, colonial corals evolved quite quickly (strong adaptation to environment) but show narrower geographic distributions. That is the reason for the low utility of corals as biostratigraphic markers. Nevertheless, in stressful conditions, such as those during the Asturian time, the solitary corals also show quick changes for adaptation to environment. They evolve quite quickly and may be used as biostratigraphic markers.

In the Asturian from the Cantabrian Mountains, the presence of changing environments allows to use the corals as a tool in characterizing that substage. In some studied sections, where environment was mainly shallow waters, colonial corals are dominant, but frequent solitary corals occur associated with them. It allows comparison with assemblages of deeper water or muddier facies.

The assemblages from Cuera limestone (Playa de la Huelga, and Cuevas de Mar sections, shallow platform with occasional reefal facies) are dominated by massive and fasciculate rugose and tabulate corals

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**Figure 4. Stratigraphical distribution of the named species in the Asturian from Cantabrian Mountains.**

| Pennsylvanian (pars) | Moscovian (pars) | Westphalian | Beobelian | Devonian | Carboniferous | Asturian (pars) |
|----------------------|-----------------|-------------|-----------|----------|--------------|----------------|
| Series Global        | Stages Global   | Stages      | Substages |          |              |                |
| Llandovery           |                 | Lower       |           |          |              |                |
| Cambrian             |                 | Lower       |           |          |              |                |
| Ordovician           |                 | Lower       |           |          |              |                |
| Silurian             |                 | Lower       |           |          |              |                |
| Devonian             |                 | Lower       |           |          |              |                |
| Carboniferous        |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |
| Upper               |                 | Lower       |           |          |              |                |
| Lower               |                 | Lower       |           |          |              |                |

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**Figure 4. Stratigraphical distribution of the named species in the Asturian from Cantabrian Mountains.**
(Ivanovia podolskianis Dobrolyubova, Convenia cantabrica De Groot, Arachnastrae molli Stuckenber, Multithecopsis hortense Rodriguez and Ramirez, Neomultithecopora Rodriguez and Dam, and N. cantabrica Rodriguez and Ramirez). But solitary corals are also common, both disseminated (Amygdalophylloides ivanovi Dobrolyubova, Kionaphyllym dibum Chi, Axilophyllym hortense Rodriguez, Caninia minima Rodriguez, Bothrophyllym pseudoco- cum Dobrolyubova, Bothroclisia sp., Asturiphyllym semenoffi Rodriguez) and undisseminated (Allotheophrystium niatkovi Fomichev, Cyathaxonia cornu Michelin, Trochophyllym? sp., Rotiphyllym exle De Groot).

The assemblages from Picos de Europa Formation (Carretera Lagos and Cuesta Espinera sections, outer platform and slope deposits) are completely dominated by very diverse undisseminated corals (Cyathaxonia cornu, C. degrootae Rodriguez, C. pinguis Rodriguez, Amplexocarina asturica Rodriguez, Trochophyllym variaible Rodriguez and Kullmann, Neoxont? multibtalatus Rodriguez and Kullmann, Duplicarina sp., Paraduplophyllium crussum Rodriguez, P. sp., Kabakovitchiella tri- forms Rodriguez and Kullmann, Lophothicium? espinerense Rodri- guez and Kullmann, Lophophyllidium breimeri De Groot, L. picoense Rodriguez and Kullmann, L. lamellatum Rodriguez and Kullmann, Wanneryphyllum carbonicum Rodriguez and Kullmann, Plerophyllym sp., Ufinia accelerans Rodriguez and Kullmann, Tachylasma sp., Calophyllym problematicum Rodriguez and Kullmann, Bradephyllum rectum, Bradephyllum. sp., Rotiphyllym exle De Groot and Zaphre- toides sp.). Neither colonial nor disseminated solitary corals have been recorded there.

The assemblages from North Palencia (Vergaño Formation and equivalents in the Casavegas Syncline) are very diverse. The Cotar- raso limestone, regarded as shallow platform deposits with interbedded siliciclastics yielded colonial corals (Arachnastrae molli Stucken- berg, Convenia cantabrica De Groot, Petalaizs maccayanus Milne- Edwards and Haine, Petalaizs obsinos De Groot, Lonsdaleoides hispanicus De Groot and Ivanovia freiselebeni Stuckenber), solitary disseminated (Dibunophyllym? gentisea De Groot, Axilophyllym quiringi Weissemel, Amygdalophylloides ivanovi Dobrolyubova) and solitary undisseminated corals (Cyathaxonia cornu Michelin, Polye- cilia cantabrica De Groot, Ufinia alternans De Groot, Lophophyllyl- ium sp.). The Sierra Corisa limestone, regarded as a main incursion of calcareous platform into deltaic deposits, shows assemblages domi- nated by solitary undisseminated corals (Cyathaxonia cornu Michelin, Cyathaxonia degrootae Rodriguez, Rotiphyllym exle De Groot, Bradephyllum? oppositum De Groot, Amplexocarina wagneri De Groot, Sochkineophrystium corsenzi De Groot, Ufinia alternans De Groot, Lophophyllylum breimeri De Groot, Lophophyllylum minus De Groot, Zaphreitites paralleloideis De Groot, Zaphreitites clithria De Groot). However, it also yielded some solitary disseminated (Bothrophyllym pseudoconicum Dobrolyubova, Axilophyllym quiringi Weissemel) and colonial corals (Arachnastrae molli Stuckenberg, Petalaizs obsinos De Groot, Cystolonsdaleia densicorne De Groot). The Casavegas limestone is a thin, marly bed in a mainly silstone and sandstone sequence containing also coal seams. It is partly equivalent to the Sierra Corisa Limestone. It yielded a quite diverse assemblage composed only of undisseminated corals (Amplexocarina palentina Rodriguez and Kullmann, Cyathaxonia cornu Michelin, Zaphreitites clithria De Groot, Calophyllym cantabricum Rodriguez and Kullmann, Sochkineophrystium accelerans Rodriguez and Kullmann, Ufinia alternans De Groot, Lophophyllylum minus De Groot).

Discussion

The whole assemblage from the Asturian substage in Cantabrian Mountains is composed of 48 named species (Fig. 4) plus about 20 additional species described in open nomenclature. It means a high diversity comparing with other Pennsylvanian substages (Rodríguez et al., 1986).

Few investigations have been completed on Pennsylvanian corals from Western Palaeotethys and indeed less in other more distant geo- graphic zones. Consequently, it is difficult to establish whether the many species recorded from the Asturian substage in Cantabrian Mountains are restricted to this stage or have longer ranges; but some facts can be stated. Their abundance, diversity and the restricted stratigraphic distribution of most of them show significant potential for the age determination and correlation of the Asturian rocks. For a good chronostatigraphic resolution, a coral biostratigraphic scale must be compared with other fossil groups. Fortunately, the time scale for the Asturian substage is well established with fusulinids and conodonts (Villa, 1995; Villa and Van Ginkel, 2000; Méndez, 1990, 2002, 2006; Wagner, 2002), which allows a precise stratigraphic location of corals. Thus, they can be used in conjunction with other fossils or sep- arately for dating of Asturian substage (Rodríguez et al., 1986).

Based on this most up-to-date compilation and assessment of data herein, it is recognised that several coral species are restricted to the Asturian substage and they are common in various outcrops from dif- ferent areas in the Cantabrian Mountains. The most diagnostic spe- cies are Amplexocarina asturica, Cyathaxonia degrootae, Rotiphyllym exle, Ufinia alternans, Lophophyllylum breimeri, Convenia cant- brica, Amygdalophylloides ivanovi, Kionaphyllym dibum and Neo- multithecopora cantabrica (Fig. 5). They occur in several outcrops and sometimes in abundance and represent the coral bulk for the iden- tification of the Asturian, because all these species occur only in that substage. Moreover, some of them have been identified in other areas of the Palaeotethys and may form the basis for wider correlations (Heritsch, 1936; Dobrolyubova, 1937; Fomichev, 1953; Kora and Mansour, 1991).

Some other species occur also in the Kasimovian, but they are not recorded in older strata than Podolskian/Asturian in the Cantabrian Mountains (i.e., Bothrophyllym pseudoconicum, Lophophyllylum. picoense, Lophophyllylum minus, Paraduplophyllum sp.). They may be also important for correlations. Consequently, the whole assemblage is easily distinguishable from the Kashirian and older assemblages.

There are some difficulties to correlate the coral assemblages within the Cantabrian Mountains and with external areas. The environment generates a strong control on the distribution of coral faunas. Corals are common in different facies in the Asturian from Cantabrian Mountains. Assemblages recorded in marls that were sedimented in waters with high turbidity are dominated by solitary undisseminated corals. On the contrary, assemblages recorded in limestones that were sedimented in clearer waters and were associated to algae, are domi- nated by solitary disseminated and colonial corals. However, a mix- ture of undisseminated, solitary disseminated and colonial corals
| Table 1. Distribution of rugose and tabulate coral genera in the Asturian substage from selected areas |
|---------------------------------------------------------------|
| **Actinophrentis** x  | **Cant.** x  | **Carn.** x  | **S. Pal.** x  | **Don.** x  | **Ur.-Arc.** x  | **E. Asia** x  | **Jap.** x  |
| **Allotropiophyllum** x  | x  | x  | x  | x  |
| **Amandophyllum** x  | x  | x  | x  | x  |
| **Amplexocarinia** x  | x  | x  | x  | x  | x  | x  |
| **Amygdalophylloides** x  | x  | x  | x  | x  | x  |
| **Arachnastraea** x  | x  | x  | x  |
| **Asturiphyllum** x  | x  | x  | x  | x  |
| **Axolithophyllum** x  | x  | x  | x  | x  | x  |
| **Barytichisma** x  | x  | x  | x  | x  | x  | x  |
| **Botriotophyllum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Bradyphyllynum** x  | x  | x  | x  | x  | x  | x  |
| **Calophyllum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Caninia** x  | x  | x  | x  | x  | x  | x  | x  |
| **Carinhiaphyllum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Chielasma** x  | x  | x  | x  | x  | x  | x  | x  |
| **Cladochonus** x  | x  | x  | x  | x  | x  | x  | x  |
| **Corwenia** x  | x  | x  | x  | x  | x  | x  | x  |
| **Cystolonsdaleia** x  | x  | x  | x  | x  | x  | x  | x  |
| **Dibunophyllynum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Donophyllynum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Echigophyllyum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Fomichevella** x  | x  | x  | x  | x  | x  | x  | x  |
| **Huangia** x  | x  | x  | x  | x  | x  | x  | x  |
| **Ivanovia** x  | x  | x  | x  | x  | x  | x  | x  |
| **Kabakovitchiella** x  | x  | x  | x  | x  | x  | x  | x  |
| **Kionophyllynum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Koninckocarinia** x  | x  | x  | x  | x  | x  | x  | x  |
| **Leonardophyllynum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Lonsdaleoides** x  | x  | x  | x  | x  | x  | x  | x  |
| **Lophophyllynum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Lophamplexus** x  | x  | x  | x  | x  | x  | x  | x  |
| **Lophotichem** x  | x  | x  | x  | x  | x  | x  | x  |
| **Lytvolasma** x  | x  | x  | x  | x  | x  | x  | x  |
| **Multithecopora** x  | x  | x  | x  | x  | x  | x  | x  |
| **Neokoninkophyllynum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Neomultithecopora** x  | x  | x  | x  | x  | x  | x  | x  |
| **Neosyringopora** x  | x  | x  | x  | x  | x  | x  | x  |
| **Omiphyllynum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Orygmophyllynum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Palaeacis** x  | x  | x  | x  | x  | x  | x  | x  |
| **Paradiplophyllynum** x  | x  | x  | x  | x  | x  | x  | x  |
| **Petalaxis** x  | x  | x  | x  | x  | x  | x  | x  |
| **Polycoelia** x  | x  | x  | x  | x  | x  | x  | x  |
| **Profischerina** x  | x  | x  | x  | x  | x  | x  | x  |
| **Pseudopavona** x  | x  | x  | x  | x  | x  | x  | x  |
| **Pseudotimania** x  | x  | x  | x  | x  | x  | x  | x  |
| **Pseudozaphrentoides** x  | x  | x  | x  | x  | x  | x  | x  |
| **Rotiphyllum** x  | x  | x  | x  | x  | x  | x  | x  |
have been recorded in some outcrops, allowing the correlation between different facies in the Cantabrian Mountains.

Most coral species are endemic from the Cantabrian Mountains, avoiding a detailed correlation at that level with other areas from Palaeotethys (west and east), North-America or Japan. However, at generic level, there are many similarities with assemblages described in all these areas and mainly with those from western and central Palaeotethys (Table 1). Genera such as *Amplexocarinia*, *Amygdalophylloides*, *Axolithophyllum*, *Bothrophyllum*, *Bradyphyllum*, *Caninia*, *Cystolonsdaleia*, *Kionophyllum*, *Lophophyllidium*, *Multithecopora*, *Paraduplophyllum*, *Petalaxis*, *Rotiphyllum*, *Syringopora* and *Zaphrentites* are widespread in those areas. The comparison of their species when carefully studied may allow further correlations in the Asturian stage.

**Conclusion**

Coral assemblages are abundant and diverse in the Asturian from Cantabrian Mountains. They occur in different environments and a mixture of undissepimented, solitary dissepimented and colonial corals have been recorded in some outcrops, allowing the correlation between different facies.

Their abundance and diversity as well as the short stratigraphic range of many of them show significant potential for the age identification and correlation of the Asturian rocks. Some species common in different outcrops and facies may be the basis for the characterization of the Asturian substage with corals.

Most species are endemic in Cantabrian Mountains and the correlation with other areas is difficult because of the scarcity of detailed researches in other regions of the Palaeotethys. However, at the generic level there are significant similarities and deeper studies on the assemblages from other sectors of the Palaeotethys could result in more precise correlations.

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