Devonian Trilobites at Buill, Chile (42°S)

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ABSTRACT

A calmoniid trilobite (Calmoniidae gen. nov. aff. *Bainella* Rennie, 1930), an undetermined phacopoid trilobite and a zaphrentid coral are described from slate boulders at Buill (42°24'S, 72°43'W) in the Andes of Chiloé. This faunule is consistent with early Devonian sedimentation of at least part of the rocks forming the accretionary complex of southern Chile, which outcrops extensively west of Buill, and was affected by metamorphism in Late Palaeozoic to Early Mesozoic times. The presence of a southern Gondwana faunal assemblage, which can be compared with Devonian faunas in Argentina, Bolivia, the Malvinas (Falkland) Islands and South Africa, suggests that this area lies towards the edge of an extensive shallow water platform during Devonian times.

Key words: Devonian, Trilobites, Southern Chile, Malvinokaffric.

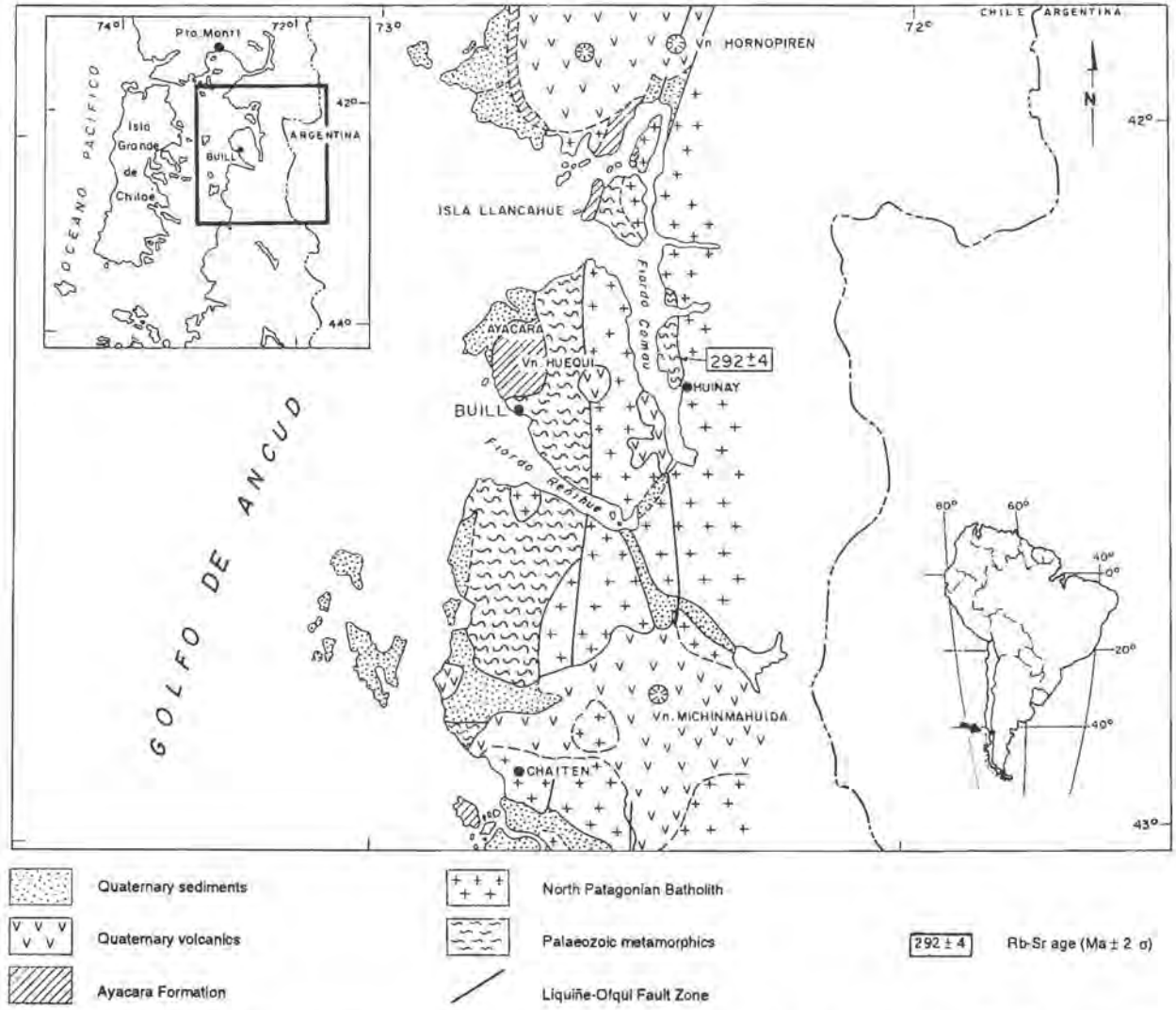
RESUMEN

Trilobites devónicos de Buill, Chile (42°S). Se describe un trilobites calmoniido (Calmoniidae gen. nov. aff. *Bainella* Rennie, 1930) un trilobites facopoide indeterminado y un coral zafréntido, recolectados en rodados de pizarras en Buill, Chile (42°24'S; 72°43'W), en los Andes de Chiloé. Esta fáunula es consistente con una edad de sedimentación devónica inferior, para al menos parte del complejo acrecionario del sur de Chile, que aflora extensamente al oeste de Buill y que fue metamorfizado en el Paleozoico Superior a Mesozoico inferior. La presencia de una asociación faunística de Gondwana meridional, que puede ser comparada con faunas devónicas de Argentina, Bolivia, Islas Malvinas (Falkland) y Sudáfrica, sugiere que esta área formaba parte de una extensa plataforma somera durante el Devónico.

Palabras claves: Devónico, Trilobites, Sur de Chile, 'Malvinokaffric'.

INTRODUCTION

The coastal regions of southern Chile, including Isla Grande de Chiloé (text-Fig. 1), are largely composed of low-grade metamorphic rocks representing a Late Paleozoic accretionary complex formed along the 'Pacific' margin of Gondwana (Forsythe, 1982; Hervé *et al.*, 1981). A unique fossil locality at Isla Potranca (Miller and Sprechmann, 1977) and Rb-Sr isochron dating (Davidson *et al.*,



Text-FIG. 1. Location of Buill within a simplified geological map of continental Chiloé, modified from Mapa Geológico de Chile (Servicio Nacional de Geología y Minería, 1982).

1987; Hervé *et al.*, 1988) suggest deposition as early as Devonian, with a subsequent history of deformation and reactivation extending through Permian to Early Mesozoic times.

The mainland opposite Isla Grande de Chiloé, is separated from the Coast Ranges by the Golfo de Ancud, a subsided block equivalent to the Central Valley of central Chile, here submerged. It is largely constituted by the northern extremity of the Mesozoic-Cenozoic Patagonian Batholith, but there are also sparse outcrops of stratified rocks with obscure contact relationships. These include the marine Ayacara Formation, which is probably Eocene-Miocene, and low-grade metasedimentary rocks at a few localities such as Huinay and the western part of Fiordo Reñihue where Buill is located. The age of deposition of these metasedimentary rocks and their consequent relationship to the Paleozoic accretionary complex to the west are unknown, but a Late Carboniferous metamorphic age has been obtained at Huinay (Pankhurst *et al.*, 1992).

At Buill (42°24'S;72°43'W), on the north shore of Fiordo Reñihue, a beach area of *ca.* 25x400 m, is covered solely by thousands of boulders of black slate. The size and lithological homogeneity of this occurrence is such that it clearly represents the more-or-less *in situ* weathering of a nearby outcrop which is not otherwise exposed. Fuenzalida (1979) found true outcrops of similar, but unfossiliferous slates on the forested hillside above Buill. They are referred to here as Buill slates. The slate boulders on the beach contain fossil remains, including trilobites described by Biese (1953) as 'Calymenidae von devonischen Habitus'. In Levi *et al.* (1966), E. Pérez refers to unidentifiable deformed fragments of trilobites, together with *Cyathocrinites* (?) and *Aulacophyllum*. Fuenzalida (1979) also noted the presence of fossil crinoids and corals. The present paper describes new fossil material collected from two beach boulders in February 1988, which establishes its Devonian age beyond doubt. The paleoecological, paleogeographical and tectonic significance of this assignment is briefly considered.

PALEONTOLOGICAL DESCRIPTION

TRILOBITES

The trilobites were originally reported by Biese (1953) and Levi, Aguilar and Fuenzalida (1966); they are of particular interest as trilobites are otherwise virtually unknown from Chile. Preliminary determinations were inconclusive, but included some fragmentary specimens attributed to Calymenidae. New material includes a calmoniid allied to *Bainella* which indicates an Early to Middle Devonian age.

Order Phacopida Salter, 1864
Family Calmoniidae Delo, 1935
Calmoniid gen. nov. aff. *Bainella* Rennie, 1930
(Plate 1, Fig. 1)

Repository: Colección Paleontológica, Departamento de Geología, Universidad de Chile, number CPDG (UCH) T-321.

Description: The poorly preserved specimen consists of an external mould of an incomplete thorax and pygidium. The manner of preservation has resulted in the loss of much detail, making interpretation difficult, but a latex cast shows the essential features (Plate 1, Fig. 1). In spite of the limitations of preservation, a notable feature is the extremely stout spines originating on some of the thoracic axial rings. It is clear from their distribution that spines do not originate from all the segments, but apparently from every second or third segment. This is perhaps most clearly shown at the front and back of the thorax. However, there are several ambiguities in determining the number of thoracic segments on the specimen, depending on how the intersegmental boundaries are drawn, and where the front of the pygidium is taken. It is possible to regard the anterior margin of the pygidium as lying just behind the posterior thoracic spine (which would then be on the last thoracic segment). If this is the case, the thorax would be complete, with 11 segments (like all calmoniids), and each transverse ring on the thorax would correspond with an axial ring; spines would be developed on the third, sixth, ninth and eleventh thoracic segments; nothing is seen of the articulating half-rings. In this case the thoracic pleurae can also be simply

interpreted: each transverse furrow being an interpleural boundary and no pleurae preserving pleural furrows. Under this explanation the pygidium would occupy about 30% of the sagittal length of the specimen. However, since calmoniids all have strong thoracic pleural furrows their absence would be rather surprising, even given the preservation of the specimen. This suggests that another interpretation should be considered. This would suppose that a smaller number of thoracic segments are present, with both interpleural furrows and pleural furrows present on the thoracic pleurae; some of the axial 'rings' would be interpreted as articulating half rings. For example, the second spine would be developed on the posterior half of its segment, with a well developed articulating half ring in front, and a strongly furrowed pleura showing up well on the left. Accepting an extra free segment behind the posterior spine, this would suggest that the spines were developed on alternate thoracic segments, and that nine thoracic segments were present on the specimen. The first two segments behind the head would be regarded as missing; of these, the second segment should bear a median spine, the first segment lacks one, while the occipital ring would be anticipated to carry a spine (as it does in many calmoniids), thus maintaining the alternating pattern along the whole axial length. Although this interpretation has some plausibility the presence of eleven thoracic segments is preferred for several reasons. First, if pleural furrows were present, one would expect them to curve towards the segmental boundaries as they approach the axis, which they do not; second, the axial length (sagittal) of the posterior thoracic axial rings would be out of proportion to the undoubted axial rings of the pygidium, which on calmoniids grade into one another; thirdly, the nine segment theory requires that one or two half rings be concealed by a preceding segment (otherwise there are not enough annulations on the specimen to account for a half ring on each segment) and there is no evidence for this; fourthly, because of the way they moulted it is quite common to find complete thorax + pygidium (thoracopygon) in Phacopida; they come together as a unit. Hence we accept that 11 segments are present, and that the proportions of the pygidium are about the same as they are in other species of *Bainella*, about twice as wide as long. The pygidial axis is rather low, occupying about one-third of anterior pygidial width. Up to eight narrow axial rings are indicated. The posterior end of the pygidium is turned very sharply upwards into a posterior spine of comparable stoutness to those on the thoracic axis. It is not known how long these spines were: obviously they are curtailed on the specimen, and may well have been a centimetre or more in length. No sculptural details are preserved.

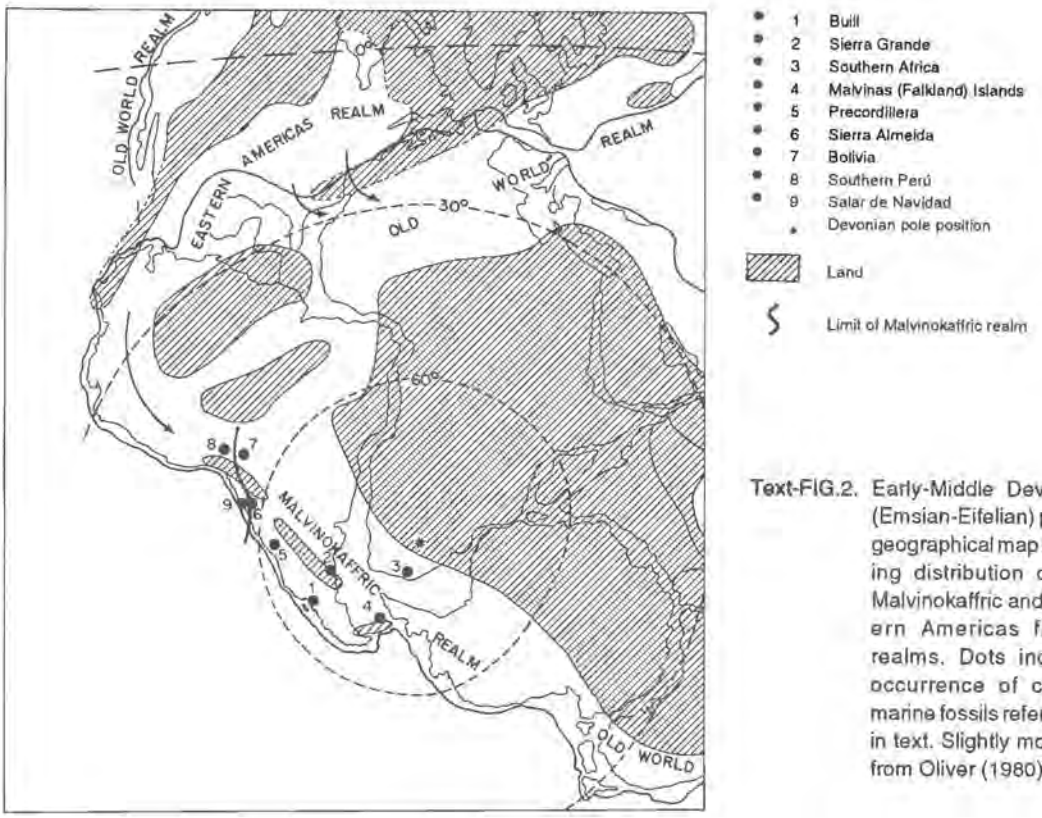
Discussion: The extremely robust dorsal spines are distinctive, regardless of the poor state of preservation. The pygidium is very much like that of certain species of *Bainella*, for example *B. cristagalli* (Woodward, 1873) from the Devonian Bokkeveld Group of South Africa (see Cooper, 1982, Fig. 97, I, J), especially with regard to the development of the posterior spine. Species of *Bainella* have dorsal spines arising from the axial rings of the thoracic segments, where they represent extensions of the midposterior margin of each ring: those of *B. cristagalli are* robust (Cooper, 1982, Fig. 107); some species from Bolivia *(e.g. B. (Belenops) insolita* (Eldredge and Branisa, 1980, Fig. 9B) are quite similar in this feature. However, no species of which we are aware has robust spines developed on only a few of the thoracic segments. In fact, in the trilobites as a whole, dorsal thoracic spines are rather common on all thoracic segments, but we know of no other example where such spines are developed sporadically along the length of the thorax. This is unusual enough to suggest that this form belongs in a new genus allied to *Bainella*. However, it is not realistic to name this new genus on the basis of the distorted material available, for which reason open nomenclature is employed. There is no reason to suppose any age other than Devonian (Emsian-Eifelian), during which period the radiation of such calmoniids occurred.

Undetermined Phacopoid

(Plate 1, Fig. 2)

Repository: Colección Paleontológica, Departamento de Geología, Universidad de Chile, number CPDG (UCH) T-322.

Discussion: The specimen displays nine thoracic segments, and an incomplete pygidium. It is clearly distinct from the form described above because the pygidium lacks a posterior spine, and axial spines are missing from the thorax. The pleurae show some indications of adaxial fulcra; the pygidium shows four axial rings. Both the form of the thoracic pleurae, and the structure of the pygidium suggest that this is a



Text-FIG.2. Early-Middle Devonian (Emsian-Eifelian) paleogeographical map showing distribution of the Malvinokaffric and Eastern Americas faunal realms. Dots indicate occurrence of coeval marine fossils referred to in text. Slightly modified from Oliver (1980).

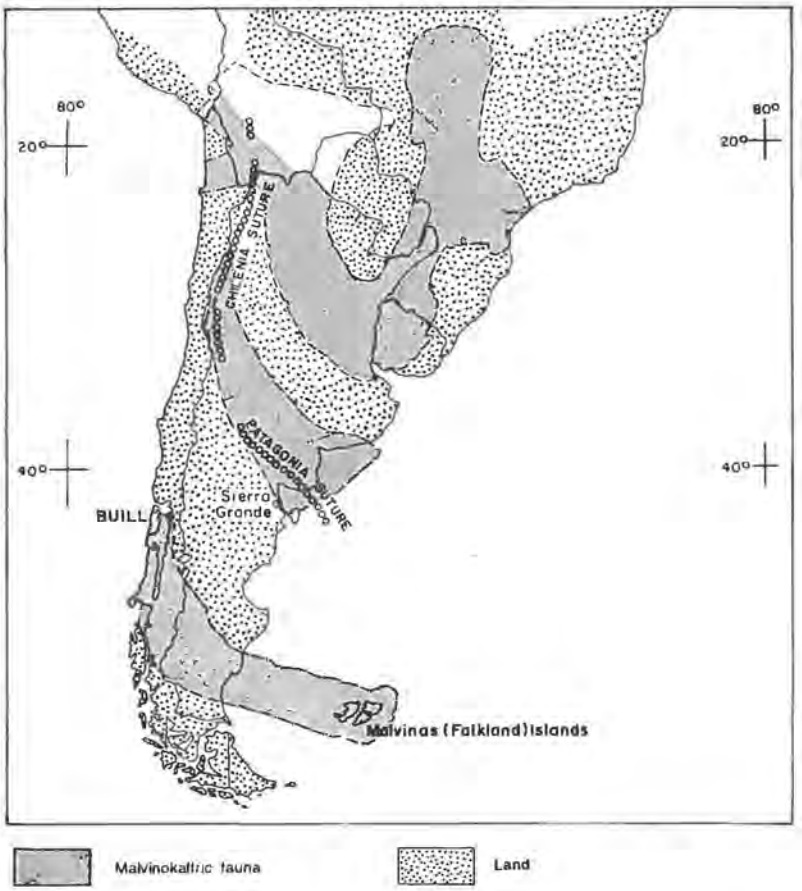
phacopoid, but the material is inadequate to draw any further conclusions.

CORALS

Dr. W.A. Oliver (written communication, 1990 to RF) examined the corals found at Buill, determining them as zaphrentids which give little information about age. However, their occurrence is consistent with a high latitude fauna (see below) too cold for hermatypic corals (Oliver, 1980). This leads to some scepticism about the earlier report of *Aulacophyllum* (Levi *et al.*, 1966) from the same locality.

GONDWANA DEVONIAN FAUNAS AT HIGH PALAEOLATITUDES

Those shallow water faunas that inhabited the flooded cratonic areas surrounding the earlier Devonian South Pole (text-Fig. 2) are often referred to as Malvinokaffric (Richter and Richter, 1942), comprising a largely endemic fauna which was adapted to cool temperatures and clastic substrates. Baldis (1975, 1979) and Baldis *et al.* (1982) have sought to differentiate eastern (classical Malvinokaffric) from western ('Austral Andean Province', Baldis, 1979, p. 209; 'Central Andean Province', Baldis *et al.*, 1982) boreal Gondwana trilobite faunas as being characterized by different genera. The latter includes trilobite faunas from the Precordillera, which are comparable to those of north west Argentina and Bolivia. Because the form from Chiloé is probably a new genus it is not yet possible to fit it into this more refined scheme. Calmoniid trilobites are among the most characteristic of high latitude Gondwana endemic faunas (Eldredge and Branisa, 1980). Hence the discovery of a peculiar calmoniid from southern Chile, scarce though the material is, does suggest that the Malvinokaffric *(sensu lato)* fauna is present there. The simple coral from the same beds is not inconsistent with this, since



Text-FIG. 3. Generalized late Early Devonian paleogeography of South America, after Barrett and Isaacson (1988). This model is based on the present day distribution of the land masses, but has been sligthtly modified to include the «Patagonia suture zone» marking the supposed collision of the Patagonian allochtonous terrane later in the Paleozoic (Ramos, 1989).

high latitude Gondwana localities also yield depauperate coral faunas (Oliver, 1980). Apparently the Chilean calmoniid is most closely related to the genus *Bainella*, which occurs in South Africa, Bolivia, Argentina and the Malvinas (Falkland Islands) (Cooper, 1982). Manceñido and Damborenea (1984) mentioned the presence of *Bainella* sp. at Sierra Grande, on the Atlantic coast of Patagonia (42°S). Isaacson *et al.* (1985) have discussed Devonian brachiopods from the Sierra Almeida, northern Chile. These include typical high latitude Gondwana genera, *Tropidoleptus* and *Australocoelia*. Malvinokaffric *(sensu lato)* faunas are also reported to be present in the Lake Titicaca region. However, Boucot *et al.* (1980) recorded an 'Eastern American realm' brachiopod fauna from the coastal area of southern Perú, and Isaacson *et al.* (1985) have implied that a fauna with similar affinities may occur at Salar de Navidad, only about 200 km westwards of the fauna in Sierra Almeida. Usually, Eastern American (Appalachian) faunas are supposed to typify warmer climatic belts than do high latitude Gondwana faunas, and the close juxtaposition of the two faunal province in Chile is remarkable.

TECTONIC CONSIDERATIONS

The following considerations are based on the assumption that the slate boulders with the Devonian trilobites are an integral part of the low grade metasedimentary units which crop out around Buill. To the authors, this is obvious beyond any reasonable doubt, and no alternative explanation has been produced.

There is clearly a general concordance between

the depositional age of the Buill slates at Chiloé and that of the accretionary complex rocks at Isla Potranca, Aisén, as suggested by the brachiopod identifications of Miller and Sprechmann (1977). Metamorphism of the sediments of the complex has consistently given younger Late Paleozoic to Early Mesozoic Rb-Sr ages.

It is interesting to note that the Devonian sedimentation of the rocks in Chiloé and Aisén took place at a time for which there is no indication of an active magmatic arc in the southwestern margin of present day South America. It is possible to conclude that at least part of the turbidite sequence that was later incorporated in the accretionary prism was deposited in a passive continental margin environment.

The occurrence of shallow water trilobites of Malvinokaffric affinities at Buill suggests, but does not prove, that this portion of the continent could have been connected via a continuous shallow water platform to other parts of South America and to South Africa. Different configurations of these hypothetical platforms have been given by Popp and Baldis (1989) and by Barrett and Isaacson (1989). A simplified version of the latter is shown in text-figure 3, where the suggested Patagonia suture (Ramos, 1984) has been added. In their paleogeographic reconstruction, Popp and Baldis (1989) show an ecological barrier in the area of marine sedimentation north of Sierra Grande, which would isolate the Buill region from the Malvinas (Falkland) Islands and South Africa. This does not seem to be in accordance with our conclusions, unless an alternative marine connection between the two areas existed elsewhere for example farther south. The occurrence of a Calmoniid trilobite aff. *Bainella* described here is relevant to this type of reconstruction as well as to the assessment of Patagonia as an exotic terrane (Ramos, 1984).

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PLATE 1

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Figures

1 Calmoniid gen. nov. aff. *Bainella* Rennie. x1.5. Latex cast from external mould showing prominent dorsal spines.

2 Undetermined phacopoid. x1.5.

PLATE 1