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AMMONITE FAUNA FROM THE BYERS PENINSULA, LIVINGSTON ISLAND, SOUTH SHETLAND ISLANDS, ANTARCTICA

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Abstract

The Byers Group, exposed on the Byers Peninsula (Western Livingston Island, Antarctica), comprises thick Upper Jurassic–Lower Cretaceous sedimentary and volcanic succession, deposited in marginal fore-arc environments. The mudstones and coarse-grained sandstones of the Devils Point Formation and the President Beaches Formation, which are the most fossiliferous parts of the Byers Group, yielded various invertebrate fossils and plant remains. Relatively abundant and varied in species ammonite fauna was found in the upper Tithonian–lower Berriasian sediments in the Devils Point and a part of President Beaches areas, in the southwestern part of the Byers Peninsula. The main focus of this work is the biostratigraphic interpretation of the newly collected ammonites, belonging to the genera *Haplophylloceras* Spath, 1925; *Argentiniceras* Spath, 1925; *Spiticeras* Spath, 1922; and *Protancyloceras* Spath, 1924.

Key words: Tithonian–Berriasian, ammonites, Livingston Island, Antarctica

Introduction. The Upper Jurassic–Lower Cretaceous volcano-sedimentary sequences on the Byers Peninsula, western Livingston Island, occupy one of the largest ice-free areas in the South Shetland Islands (Fig. 1). Smellie et al. [1] and later Crame et al. [2] proposed formal lithostratigraphic schemes, establishing the following units: Anchorage, Devils Point, President Beaches and Chester Cone formations, included in the Byers Group. According to Hathaway and Lomas [3], the sedimentary and volcanic rocks in the Byers Group are arranged

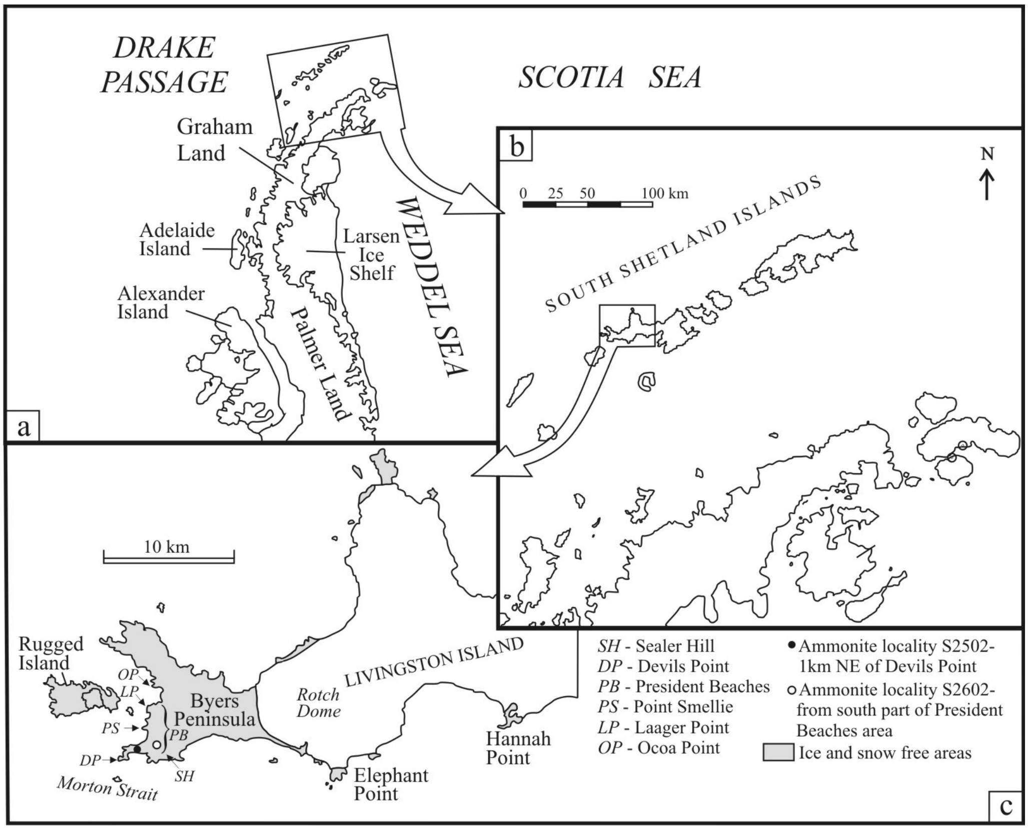

Fig. 1. Map of the Antarctic Peninsula region with position of the ammonite localities: a – the Antarctic Peninsula region; b – the northern Antarctic Peninsula and the South Shetland Islands; c – the western Livingston Island with the position of the Byers Peninsula and ammonite localities (after Hathaway and Lomas [3] with modifications)

in five formations, from bottom to top as follows: Anchorage, President Beaches, Start Hill, Chester Cone and Cerro Negro formations (Fig. 2). The sedimentary successions of the Byers Group are composed mainly of marine mudstone-dominated sequences, with subordinate siltstones, sandstones and conglomerates, and alluvial and lacustrine volcaniclastic sediments (Smellie et al. [1], Crame et al. [2], Hathaway and Lomas [3]). Parts of the marine rock types (especially the coarse clastic varieties) cropping out in the southwestern and western parts of the Byers Peninsula yielded abundant invertebrate fauna, including varied cephalopods. The ammonites from this part of the Byers Group have already been the subject of studies, mainly by Chilean paleontologists (González-Ferrán et al. [4], Tavera [5], Covachevich [6]).

The present study was carried out in the southwestern part of the Byers Peninsula, where different concepts about the lithostratigraphy and age of the sedimentary rocks have been proposed (Smellie et al. [1], Crame et al. [2], Hathaway and Lomas [3]). The sedimentary successions exposed in this part of the

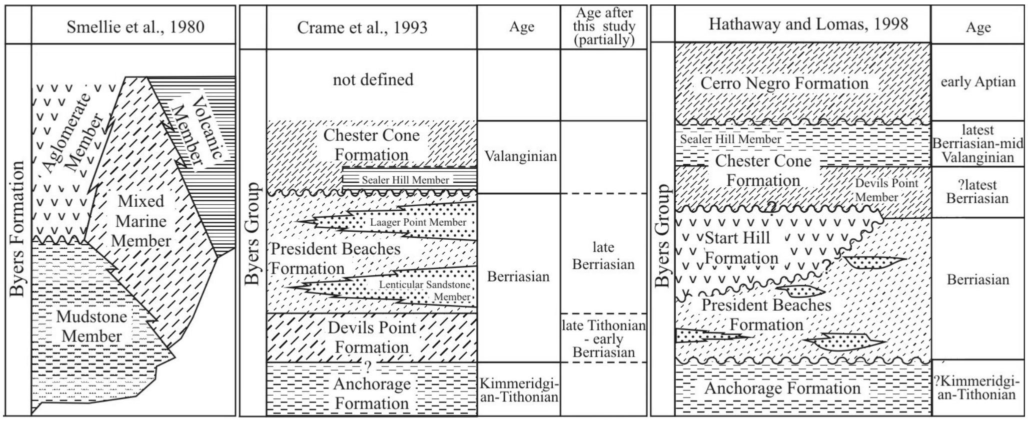

Fig. 2. Lithostratigraphic schemes after Smellie et al. [1], Crame et al. [2] and Hathaway and Lomas [3] for the Byers Peninsula (in Hathaway and Lomas, [3] with modifications)

Byers Peninsula belong to the Devils Point and President Beaches formations (after Crame et al. [2]) or to the President Beaches Formation and the Devils Point Member (Chester Cone Formation), respectively (after Hathaway and Lomas [3]) (Fig. 2). The main purpose of the study is the biostratigraphic interpretation of the newly collected cephalopod fauna. Based on our new data, here we specify the age and relations of the lithostratigraphic units in this part of the Byers Peninsula.

Stratigraphic framework. The first stratigraphic works on the Byers Peninsula were carried out by Hobbs [7], who studied different rock types and combined them into the "Younger Volcanic Group". González-Ferrán et al. [4] recorded the first ammonites (late Tithonian–late Barremian) from the western localities on the Byers Peninsula, subsequently described by Tavera [5] and Covachevich [6]. Afterward, Smellie et al. [1] proposed a more detailed lithostratigraphic scheme and combined the sedimentary and volcanic sequences on the Byers Peninsula into the Byers Formation, dividing it into four members as follows: Mudstone, Mixed Marine, Volcanic and Agglomerate (Fig. 2). Crame et al. [2] reviewed previous stratigraphic studies and promoted the Byers Formation to the rank of group. They defined four formations: Anchorage (Kimmeridgian–Tithonian), Devils Point (Berriasian), President Beaches (with two members, Lenticular Sandstone Member and Laager Point Member, Berriasian in age) and Chester Cone (with Sealer Hill Member – Valanginian) (Fig. 2). Hathaway and Lomas [3] revised the lithostratigraphic scheme of Crame et al. [2] and presented a new formal stratigraphic framework: Anchorage Formation (Kimmeridgian–Tithonian), President Beaches Formation and Start Hill Formation (Berriasian), Chester Cone Formation (with Devils Point Member and Sealer Hill Member – ?upper Berriasian to Valanginian) and Cerro Negro Formation (lower Aptian) (Fig. 2). Penecontemporaneous intrusive igneous rocks (mainly sills, dykes and plugs of basalt-basaltic andesite composition) occur in some of the sequences (Smellie et al. [1]).

Material. The newly collected ammonite faunas were obtained from two main localities in the most southwestern part of the Byers Peninsula. The first one (S2502) is situated approximately 1 km to the NE of Devils Point (Fig. 1). Sedimentary successions cropping out in this area consist mainly of medium- to coarse-grained, medium-bedded greenish sandstones, and minor dark grey thin-bedded mudstones. Ammonite specimens were collected from the dark grey mudstones, intercalated between coarse-sandstone beds. Most probably, the mudstone layers that yielded our ammonite specimens correspond to the upper part of section P.2175 of Crame et al. [2] (Fig. 6d, p. 1080).

More abundant and varied in species ammonite fauna was collected from the southern part of the President Beaches area (locality S2602) (Fig. 1). The sedimentary successions of this locality consist mainly of thick-bedded, fine- to coarse-grained, well-cemented greenish sandstones and rare dark grey, thin-bedded mudstones. The ammonite fauna was obtained from green, pebble-sized conglomerates in a small sand-body, from the lower–middle part of the President Beaches Formation. According to Lomas [8], this locality falls into the so-called association 4 (thick-bedded sandstones deposited by waning turbidity currents of low to moderate sediment concentration). The ammonite-bearing layer falls into the upper part of Lomas's bed-by-bed log P2619 that is exposed in the southwestern part of the Byers Peninsula ([8] Fig. 2, p. 487).

Most of the ammonites are fragments of phragmocones and body chambers. They are poorly preserved as internal moulds, with shell fragments attached in some specimens. All of the specimens are housed at the Museum of Paleontology and Historical Geology (Sofia University "St. Kliment Ohridski").

Results. The locality of the Devils Point area yielded one specimen defined as *Haplophylloceras strigile* (Blanford, 1864) (Fig. 3a). One more ammonite has been collected and conditionally identified as *Protancyloceras* sp. indet. (Fig. 3b). Based on that, we suggest late Tithonian–early Berriasian age for the rocks at the vicinity of Devils Point.

More abundant fauna was obtained from the pebble-sized conglomerates of the sand-body included in the President Beaches Formation. The collected ammonites from the southwestern part of the President Beaches area belong to the following taxa: *Spiticeras* (*Spiticeras*) *spitiensis* (Blanford, 1864) (Fig. 3c, d); *Spiticeras bilobatum* (Uhlig, 1903) (Fig. 3e); *Spiticeras tripartitum lovaldensis* Biro-Bagoczky, 1980 (Fig. 4a–c); and *Argentiniceras lonchochense* (Steuer, 1897) (Fig. 3f, g). Based on this ammonite assemblage, we assume late Berriasian age for this part of the President Beaches Formation.

Discussion. ***Devils Point area.*** Crame et al. [2] included a part of the Mixed Member, defined by Smellie et al. [1], in the Devils Point Formation. According to Crame et al. [2], the President Beaches Formation overlays the Dev-

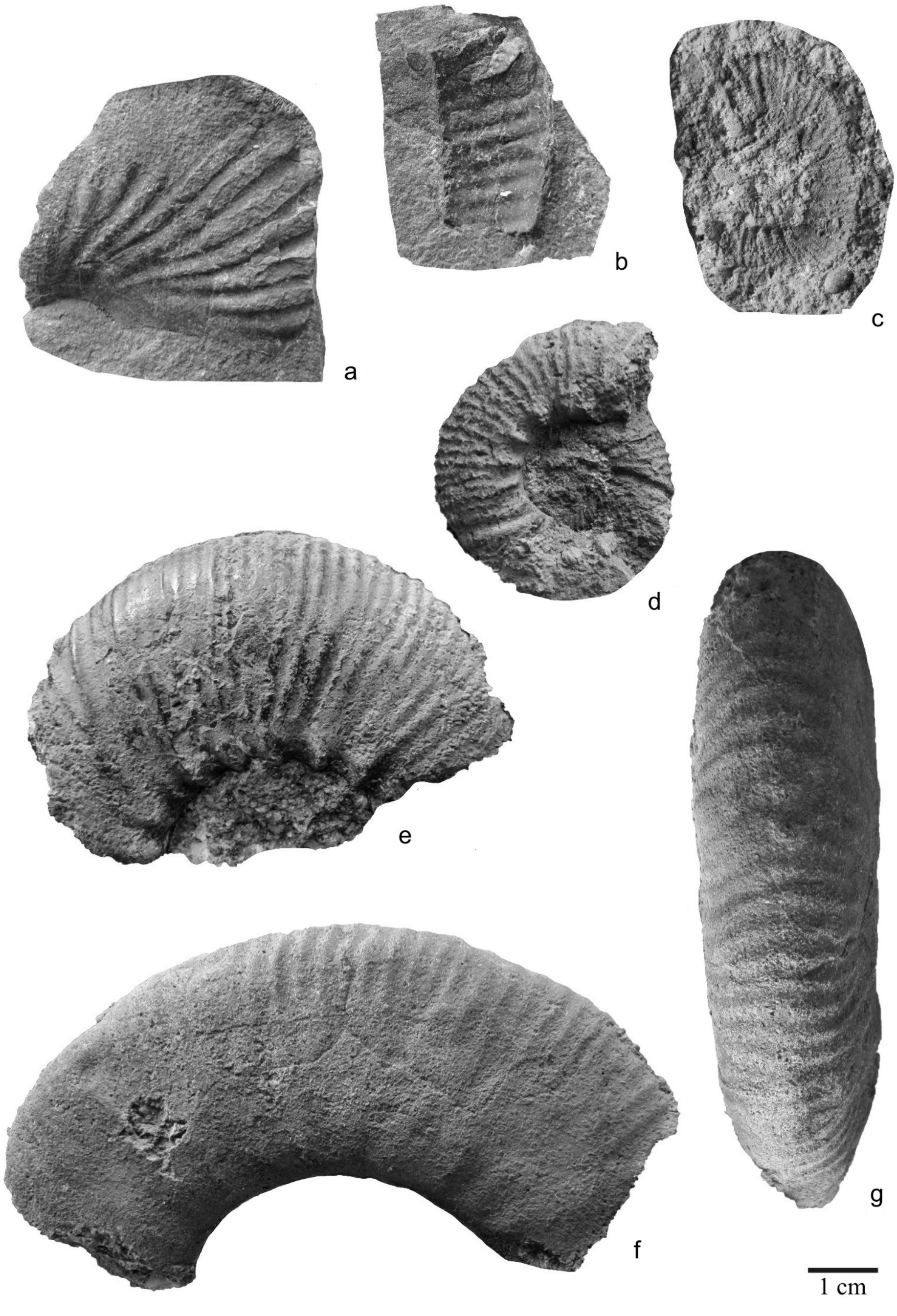

Fig. 3. Ammonites from the Byers Peninsula (Livingston Island): a – *Haplophylloceras strigile* (Blanford, 1864), Devils Point Formation, upper Tithonian – lower Berriasian; b – *Protancyloceras* sp. indet, Ibid.; c, d – *Spiticeras* (*Spiticeras*) *spitiensis* (Blanfrod, 1864), President Beaches Formation, upper Berriasian; e – *Spiticeras bilobatum* (Uhlig, 1903), Ibid.; f, g – *Argentiniceras lonchochense* (Steur, 1897), Ibid. (f – lateral view, g – ventral view)

Fig. 4. Ammonite from the Byers Peninsula (Livingston Island): a–c – *Spiticeras tripartitum lovaldensis* Biro-Bagoczky, 1980, President Beaches Formation, upper Berriasian (a – lateral view; b – ventral view, c – dorsal view)

ils Point Formation. Hathaway and Lomas [3] contested that the Devils Point Formation is older than the President Beaches Formation, and assigned the conglomerates and sandstones exposed in the Devils Point area to the Devils Point Member of the redefined Chester Cone Formation (Fig. 2). The latter authors retained the type section for the member proposed by Crame et al. [2], with small modifications concerning the lowermost part of the unit. They suggested a latest Berriasian age for the Devils Point Member, based on palynologic material from Zigzag Gully, but without any cited taxa (Hathaway and Lomas [3], p. 57).

Haplophylloceras strigile has a wide distribution in the SW Pacific Domain and has been reported from the upper Tithonian and lower Berriasian (Yin and Enay [9]). It has been recorded from the Hymalayan region, South Tibet, Yemen, Indonesia and Papua New Guinea (Yin and Enay [9]; Howarth [10]), as well as from the Antarctic region (Alexander Island – Thompson [11]; Howlett [12]). Yin and Enay [9] identified a *Haplophylloceras strigile–Corongoceras–Himalayites* assemblage from the upper Tithonian of eastern Himalayan Tibet and suggested an early Berriasian age for the overlying *Spiticeras* assemblage. *H. strigile* co-occurs with the late Tithonian *Blanfordiceras* fauna in Central Nepal (Yin and Enay [9]). According to Thompson [11], on Alexander Island, this species appears in association with *Spiticeras* in levels above the *Blanfordiceras* fauna, suggesting early Berriasian age. We believe that our example from the locality of the Devils Point area indicates a late Tithonian–earliest Berriasian age.

President Beaches area. Crame et al. [2] proposed the President Beaches Formation with two members, the Lenticular Sandstone Member and the Laager Point Member, composed mainly of different types of sandstones and conglomerates. Hathaway and Lomas [3] accepted the validity of this formal unit, but with different opinion about the position of the sand-bodies within the formation, and emphasized that both members consist of a number of discrete and stratigraphically unrelated sand-bodies. Based on an ammonite assemblage, composed of the genera "*Spiticeras*", *Blandfordiceras* and *Himalayites* and previously cited by Smellie et al. [1], Crame et al. [2] and Hathaway and Lomas [3] assumed Berriasian age for the formation (Fig. 2).

Our newly collected ammonites from the President Beaches Formation include the following taxa: *Spiticeras* (*Spiticeras*) *spitiensis* (Blanford, 1864); *S. bilobatum* (Uhlig, 1903); *Spiticeras tripartitum lovaldesensis* Biro-Bagoczky, 1980; and *Argentiniceras lonchochense* (Steuer, 1897) (Fig. 3, 4). Species of the genus *Argentiniceras* are typical components of the Berriasian ammonite fauna of the Andean region (Aguirre-Urreta et al. [13]). This genus has been also recognized in the SW Pacific realm, including the Antarctic region, India, Yemen (Tavera [5]; Krishna [14]; Howarth [10]). *Argentiniceras lonchochense* is a common element of the *Argentiniceras noduliferum* Zone, which, classically, has been referred to the lower Berriasian of Argentina and Chile (Aguirre-Urreta [15]; Aguirre-Urreta et al. [13]). Recently, the *A. noduliferum* Zone has been correlated to the upper part of the *S. occitanica* Zone (KIETZMAN et al. [16]). According to RICCARDI [17], the *A. noduliferum* Zone corresponds to the upper part of the *S. occitanica* Zone and to the lower part of the upper Berriasian *S. boissieri* Zone from the Standard Mediterranean zonation.

The mass occurrence of varied spiticeratid fauna has been documented from the Berriasian, although the first record of "true" *Spiticeras* is from the latest Jurassic (VENNARI and AGUIRRE-URRETA [18]). *Spiticeras spitiensis* is a cosmopolitan species, which has also been reported from the Berriasian of the South Shetland Islands (Byers Peninsula, Livingston Island) and from Alexander Island (Tavera [5]; Thompson [11]). *Spiticeras tripartitum* is endemic for the Andean region. It has been recorded from the upper Tithonian to the lower Valanginian of Central Chile and Central Argentina, but it is considered a characteristic species of the upper Berriasian (Aguirre-Urreta [15]). In the Andean biostratigraphic ammonite schemes, *Spiticeras damesi* is the index-species of a zone in the upper Berriasian, which corresponds to the *S. boissieri* Zone of the Standard European Tethyan zonation (Aguirre-Urreta et al. [13]; VENNARI et al. [19]). Riccardi [17] suggested that the *Spiticeras damesi* Zone may range through the upper part of the *S. boissieri* Zone to the lower part of the *T. pertransiens* Zone (lower Valanginian). SALAZAR SOTO [20] considered *Spiticeras damesi* a junior synonym of *Spiticeras tripartitum* and reported it from the upper Berriasian and lower Valanginian of Central Chile.

The stratigraphic range of the genus *Argentiniceras* and the recent revisions of the position of the *A. noduliferum* Zone, as well as the co-occurrence of *A. lonchochense* and *S. tripartitum,* allowed us to define late Berriasian age for this interval of the President Beaches Formation (Fig. 2).

Conclusions. Based on the newly collected ammonite fauna during the field season of February 2016, we revise and specify the age of some ammonite-bearing sediments cropping out in the southwestern part of the Byers Peninsula, at the vicinity of Devils Point and President Beaches. From two localities, a relatively abundant and varied in species ammonites belonging to the genera *Haplophylloceras* Spath, 1925, *Argentiniceras* Spath, 1925, *Spiticeras* Spath, 1922, and *Protancyloceras* Spath, 1924, were identified and dated their host rocks as upper Tithonian–upper Berriasian.

Based on the determined ammonites, we can conclude that the sediments cropping out in the Devils Point area are older than those exposed in the southern part of the President Beaches area. Moreover, the biostratigraphic interpretation of the ammonite fauna from the southwestern part of the Bayers Peninsula of Livingston Island allowed us to consider late Tithonian–early Berriasian age for the Devils Point Formation and late Berriasian age for the President Beaches Formation. Thus, the specified age gave us a reason to conclude that the Devils Point Formation underlies the President Beaches Formation, in accordance with the scheme of Crame et al. [2].

The ammonoid assemblages from the Bayers Peninsula show close affinity with the fauna both of the Andean and Indo-Pacific palaeobiogeographic provinces. Our study contributes to the knowledge about the faunal exchange and migration between these realms.

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