Historical perspective of Otto Nordenskjöld's Antarctic penguin fossil collection and Carl Wiman's contribution

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ABSTRACT. The early explorer and scientist Otto Nordenskjöld, leader of the Swedish South Polar Expedition of 1901–1903, was the first to collect Antarctic penguin fossils. The site is situated in the northeastern region of Seymour Island and constitutes one of the most important localities in the study of fossilised penguins. The task of describing these specimens together with fossilised whale remains was given to Professor Carl Wiman (1867–1944) at Uppsala University, Sweden. Although the paradigm for the systematic study of penguins has changed considerably over recent years, Wiman's contributions are still remarkable. His establishment of grouping by size as a basis for classification was a novel approach that allowed them to deal with an unexpectedly high morphological diversity and limited knowledge of penguin skeletal anatomy. In the past, it was useful to provide a basic framework for the group that today could be used as 'taxon free' categories. First, it was important to define new species, and then to establish a classification based on size and robustness. This laid the foundation for the first attempts to use morphometric parameters for the classification of isolated penguin bones. The Nordenskjöld materials constitute an invaluable collection for comparative purposes, and every year researchers from different countries visit this collection.

Introduction

Evidence of Cretaceous and Palaeogene Antarctic terrestrial faunas comes almost exclusively from the James Ross Basin, Antarctic Peninsula (Fig. 1; Reguero & Gasparini, 2007; Reguero, Goin, Acosta Hospitaleche, Dutra, & Marenssi, 2013), and the knowledge of the Palaeogene terrestrial vertebrates in Antarctica has mainly been based on fossils from horizons of the La Meseta and Submeseta formations on Seymour Island (Isla Marambio), east of the Antarctic Peninsula (Fig. 2).

The early explorer and scientist Otto Nordenskjöld, leader of the Swedish South Polar Expedition of 1901–1903, envisioned the palaeontological and biogeographical importance of the James Ross Basin. He was the first to collect Antarctic penguin fossils. The site, indicated as 'fossil locality no. 11' on Nordenskjöld's map (Fig. 3), is situated about 50 m above sea level between the northeast shore and the 190 m high plateau occupying a major part of the northeast of the island. The area forms a smoothly undulating expanse covering some 100 m in length and width (see Wiman, 1905a, p. 2; 1905b, p. 248; Fig. 2). This locality was revisited in the 1980s by Argentine palaeontologists, who named it 'DPV 13/84' (Figs 2 and 3). Today, this is one of the most important sites for the study of fossilised penguins in Antarctic, and is key for the understanding of the evolution of the group (Acosta Hospitaleche, 2013, 2014; Acosta Hospitaleche & Reguero, 2010; Jadwiszczak & Mörs, 2011; Reguero et al., 2013).

The present contribution provides a summary of the historical context in which Otto Nordenskjöld conducted his famous expedition to Antarctica that allowed Carl Wiman to study the important collection of penguin fossils from Seymour Island. Details are also provided about the study of these specimens through the years, and the current state of this collection.

Historical context

At the end of the 18th century Captain James Cook and other explorers had concluded that if there were a southern continent, it was not as large as anticipated and was situated in a hostile environment. The scientific interest was replaced by a period of hunting, mainly concentrated on the newly discovered islands around the Antarctic continent; the sealing voyages came to outnumber by

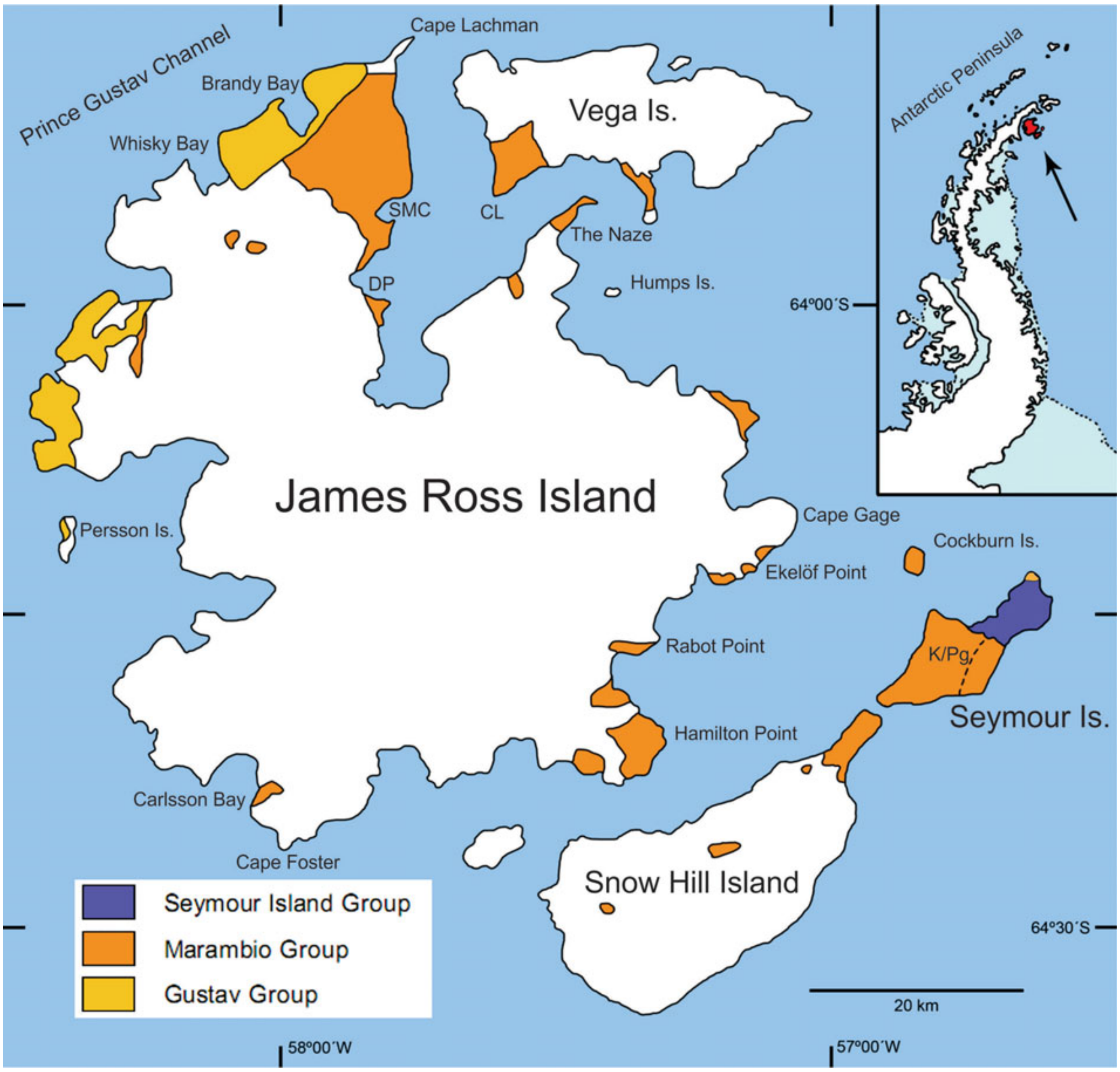

Fig. 1. Schematic geological map of the James Ross Basin, Weddell Sea, northeastern Antarctic Peninsula. White areas are either the James Ross Island Volcanic Group or snow/ice cover. Locality key: CL, Cape Lamb; DP, Dreadnought Point; SMC, Santa Marta Cove. K/Pg indicates the position of the Cretaceous–Palaeogene boundary on Seymour Island.

far the scientific expeditions for the coming century (Headland, 2004, p. 16).

Knowledge of the existence of fossils in Antarctica goes back to the early 19th century, when James Eigths described *in situ* fossilised wood from the South Shetland Islands (see Clarke, 1916, p. 196). With some uncertainties, the history of the first collection of Antarctic fossils centres on the Norwegian whaler Captain Carl Anton Larsen (Stilwell & Long, 2011, p. 26). The depletion of whales in the Arctic at the end of the 19th century had forced the industry to look for new hunting grounds. Larsen was sent to the area south of the Atlantic Ocean in the 1892–1893 season. During this whaling expedition, Larsen, at the time hunting seals on the Larsen Barrier, visited the shores of Seymour Island, situated in the Weddell Sea to the northeast of the Antarctic Peninsula (64°14′S, 56°38′W), looking for prey. On the night of 4 December 1892, a party from Larsen's whaling ship *Jason* landed on the east coast (south of Cross Valley) of Seymour Island (Zinsmeister, 1988, p. 6). Fossilised wood and mollusks were found and collected (Aagaard, 1930, p. 71; Destéfani, Cioccale, & Rabassa, 2001, p. 238). Later that month, Larsen met up with the 'Dundee Whaling Fleet', a Scottish whaling expedition commissioned by The Royal Geographical Society of Edinburgh, where he met the naturalist C.W. Donald on-board the ship *Active*. Having been out for several months, supplies were running short for the Norwegians, especially their beloved tobacco. Some of the crew traded their fossils for this stimulant, while Larsen kept his specimens and traded his

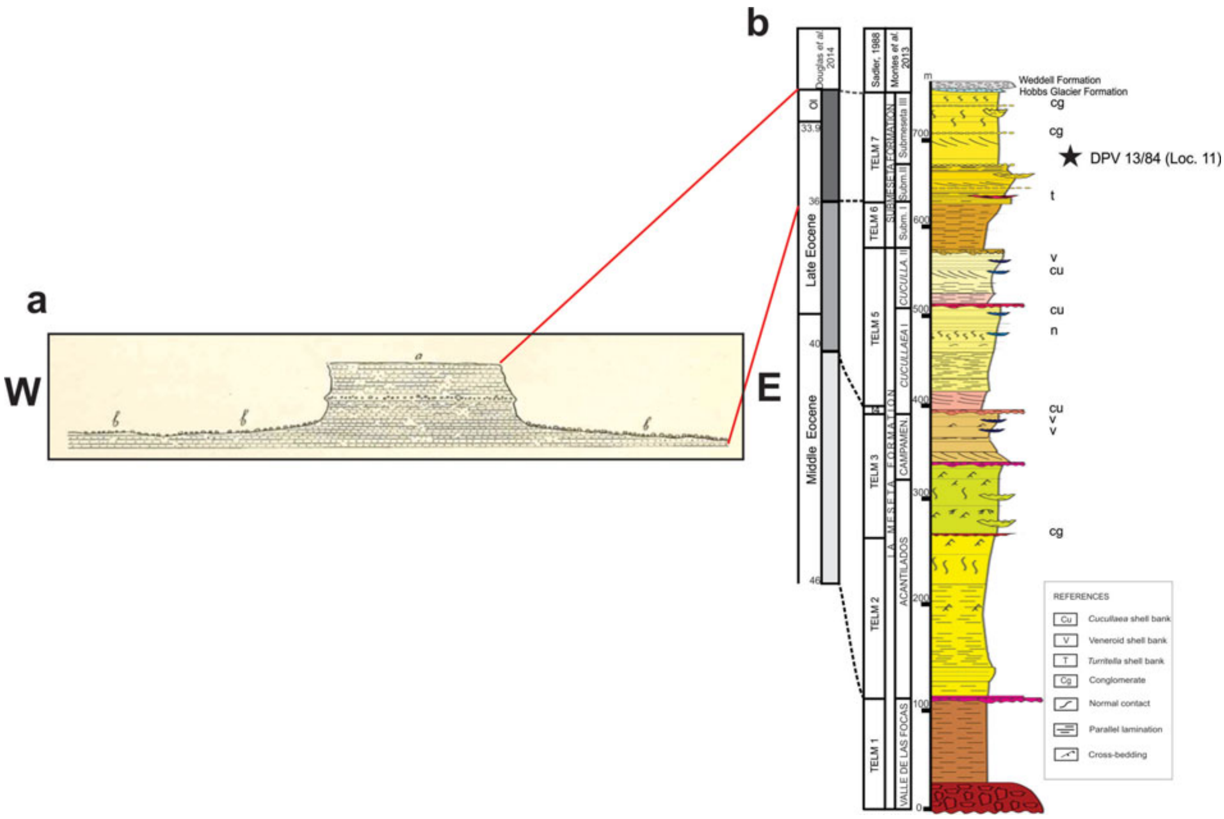

Fig. 2. a. Geological occurrence of the vertebrate remains, sketch map after Wiman (1905a, p. 2). b. Stratigraphic column of the La Meseta and Submeseta formations on Seymour Island, Antarctic Peninsula (modified from Montes et al., 2010). Chronostratigraphic interpretation of the La Meseta and Submeseta formations is based on dinocyst biostratigraphy and bivalve Sr isotope signatures (Douglas et al., 2014). Strontium date values are from Dingle & Lavelle (1998), Dutton, Lohmann, & Zinsmeister (2002), Ivany et al. (2008) and Reguero, Marenssi, & Santillana (2002).

akvait instead, thus securing his fossils for the University of Oslo (Aagaard, 1930, p. 84). The following season, 1893–1894, Larsen and his crew visited Seymour Island and collected more fossilised wood.

Two British scientists, G. Sharman and E.T. Newton, examined the material collected by the Norwegians and concluded that the fossils were probably from the Lower Tertiary. They published their findings in two scientific papers (Sharman & Newton, 1894, 1898). The news of Larsen's finds reached a young Otto Nordenskjöld and motivated him to organise an expedition to Antarctica (Larsson, 2001, p. 99; Nordenskjöld, 1901, 1904, p. xvii).

Who was Otto Nordenskjöld?

Nordenskjöld, a geologist, organised his first expedition (1895–1897) to the area between the Santa Cruz River and the Beagle Channel in Patagonia (Destéfani et al., 2001, p. 232). His aim was to study the Quaternary geology and glaciology in an attempt to discover if the ice ages of the Arctic had their equivalents in the south. He also studied the phenomena of parallelism, that the fauna and flora showed many similarities between the northern and southern high latitudes. His interest also involved the Selknam Indians; he was the first scientist to visit 'Cueva de Mylodon', Chile, where the remains of giant ground sloths were found. It was, however, his cousin, Erland Nordenskjöld, who later carried out a thorough excavation of the cave (Nordin, 2004, p. 69). But Otto's ambition reached further than that; he came close to extending the expedition southward using a Chilean gunboat. The target was the South Shetland Islands. Unfortunately, lack of time and political unrest put a stop to his plans (Larsson, 2001, p. 99; Nordenskjöld, 1904, p. xx).

At the end of the 19th century, there was a renewed scientific interest in the south polar region. A new aim for the exploration of the Antarctic region was stated in a resolution in 1895 at the Sixth International Geographic Congress in London (Headland, 2004, p. 18; Wråkberg, 2001, p. 32). One project involved a set of three expeditions that would monitor the continent for a full year (Nordenskjöld, 1904, p. xviii). The British participants chose the area south of the Pacific and the Germans settled for the coast in the southern Indian Ocean. Argentina had established an observatory on an island off the southern tip of South America, but needed a scientific expedition to push further south; this was where the Swedes stepped in (Destéfani et al., 2001, p. 231). In January 1900, Nordenskjöld revealed his plans to go to the Antarctic. In this year he also had the chance to go on a Danish

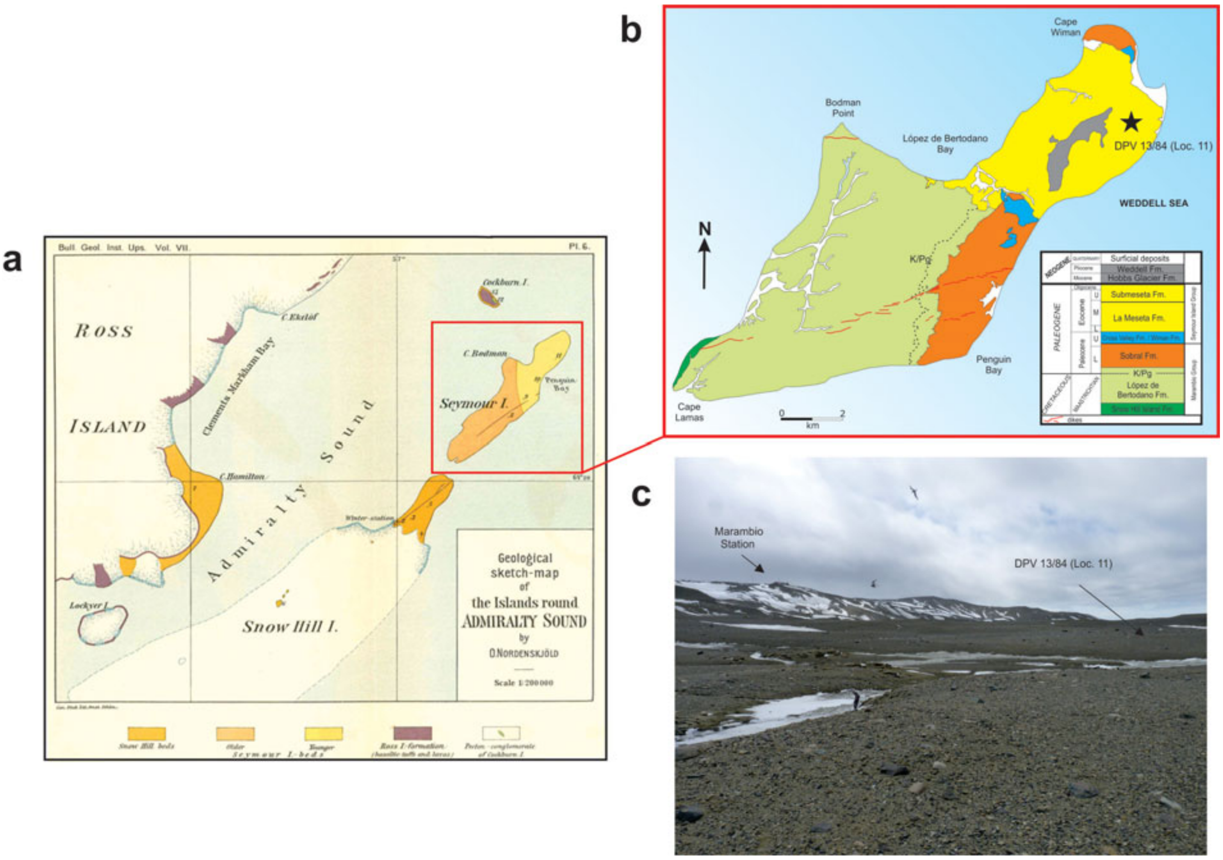

Fig. 3. a. Sketch map drawn by Otto Nordenskjöld (Andersson, 1906) showing the location of the locality no. 11 on Seymour Island. b. Geologic map of Seymour Island, Antarctic Peninsula, showing locality DPV 13/84 (black star). c. Landscape of the northeastern part of Seymour Island, showing the continuous and undulating surface exposure of the locality DPV 13/84 of the Submeseta Formation (looking east).

expedition to Greenland where he gathered experience in scientific work in a cold climate and learnt how to organise a polar expedition (Hjort & Ingolfsson, 2004, p. 192; Nordenskjöld, 1904, p. xxi; Wråkberg, 2001, p. 34). The now Danish ship *Antarctic* had previously been used for several Swedish Arctic expeditions. The Carlsberg Foundation generously let Nordenskjöld buy the vessel at a fair price. Captain Carl Anton Larsen was hired as a commander of the ship since he had extensive knowledge of navigation in ice-filled waters and was one of the few who had visited the area Nordenskjöld was aiming for (Andersson, 1941, p. 142).

Failing to secure government backing, Nordenskjöld managed to raise funds from private and commercial sources, as well as by taking out a large private loan (Goldberg, 2001, p. 59). To further raise funds he rented out the *Antarctic* to a Swedish Arctic expedition during the summer of 1901, although this meant that he had to delay his own departure (Nordin, 2004, p. 71). Nordenskjöld also allowed the crew to engage in sealing and whaling to finance the expedition – a bloody business that would horrify the scientists and delay their work. On 16 October 1901 the ship sailed from Gothenburg, Sweden. Ahead lay an ambitious scientific programme but also adventure – more than they had bargained for!

In July 1901, the Argentine leader of the Staten Island observatory, Horacio Ballvé, had asked if it were possible to include an Argentine naval lieutenant in the Swedish expedition. Nordenskjöld welcomed the idea but became concerned when he learnt that the intention was for the Argentine to stay at the station over the winter and not remain with the ship as it went north to winter in warmer waters. This, however, changed when the two men met for the first time in Buenos Aires; the expedition leader was charmed by the young naval officer chosen for the job, José Maria Sobral (Nordenskjöld, 1904, p. 32). Argentina supported the Antarctic part of the joint venture by offering free coal and provisions.

Geological context of the study area

The sedimentary sequence exposed in the James Ross Basin comprises a 6–7 km thick section from Late Cretaceous to latest Eocene and probably earliest Oligocene (MacDonald et al., 1988). It forms the only marine sequence of this age interval that is exposed in Antarctica. The high-latitude biota in both the Cretaceous and Palaeogene beds are unusually rich and comparable to those from New Zealand and southeastern Australia (Reguero et al., 2013).

The Palaeogene succession in the James Ross Basin (del Valle, Elliot, & Macdonald, 1992) is included in the Seymour Island Group and comprises all the Palaeocene to earliest Oligocene (Crame, Francis, Cantrill, & Pirrie, 2004; Hathway, 2000). The Palaeogene section, exposed mainly on Seymour Island, includes the uppermost part of the López de Bertodano Formation (Klb 10 of Sadler, 1988) of Danian (early Palaeocene) age, the Sobral Formation (early Palaeocene), the Cross Valley Formation (middle–late Palaeocene), the La Meseta Formation of the Thanetian (late Palaeocene)–Ypresian (early Eocene) age (Montes, Nozal, Santillana, Marenssi, & Olivero, 2013) and the Submeseta Formation of Lutetian (middle Eocene–earliest Oligocene) age (Montes et al., 2013). All these units were deposited in an incised valley (Marenssi, Santillana, & Rinaldi, 1998a) (Fig. 2). The latter three units, the Cross Valley, La Meseta and Submeseta formations, yield fossilised penguins (Acosta Hospitaleche, Reguero, & Scarano, 2013; Reguero et al., 2013), but all the material described by Wiman (1905a) comes from the Submeseta Formation (Fig. 2).

The new middle Eocene – earliest Oligocene Submeseta Formation (Montes et al., 2013) was previously considered as the Submeseta Allomember of La Meseta Formation (Marenssi, Santillana, & Rinaldi, 1996, 1998a). This is the youngest vertebrate bearing unit and constitutes the top of the sedimentary sequence of the basin. These beds correspond to the Facies Association III of Marenssi, Santillana, & Rinaldi (1998b), characterised by a uniform sandy lithology that indicate a tidal shelf influenced by storms. This formation is organised into three internal units (Fig. 2) named from base to top: Submeseta I, Submeseta II and Submeseta III (Montes et al., 2013).

The Nordenskjöld locality no. 11, or DPV 13/84, is one of the most important localities yielding penguin fossils. According to Montes et al. (2013), this unit corresponds stratigraphically to Submeseta II–level 38 (Figs 3 and 4).

History of the first collection of penguin fossils in Antarctica

The Swedish expedition's first visit to Seymour Island took place on 17 November 1901. After reading about Larsen's fossils, Nordenskjöld was excited over the prospect of being the first geologist to collect fossils in Antarctica. However, he soon became disappointed as he only found some badly preserved bivalves and silicified wood, just as Larsen had done. Nordenskjöld did not know that he had landed on a part of the island that is uncharacteristically devoid of fossils (Nordenskjöld, 1904, p. 103)! The expedition continued to sail southwards to explore the eastern side of the Antarctic Peninsula until ice prevented further progress. When returning three weeks later to look for a wintering place, he rounded the northern point of Seymour Island and followed its western side southward looking for a good harbour. Although they found several places to land, they chose to go further to find an even better spot (Nordenskjöld, 1904, p. 165). He continued past the narrow sound that separates Seymour Island from Snow Hill Island to the south. When he saw a small triangular piece of land next to the sea protected from the southerly storms by a rock ridge and a glacier he went ashore to have a closer look. Soon he found some ammonites, which had never been found in Antarctica before (Nordenskjöld, 1904, p. 166). He promptly decided to build his station here (Fig. 5) – a decision he would later regret when the rich fossil beds of the island he just passed, Seymour Island, were discovered (Destéfani et al., 2001, p. 239). The station was erected and the six in the wintering party (Fig. 6) – Nordenskjöld, the physician Erik Ekelöf, the meteorologist Gösta Bodman, the scientific assistant José Sobral and the two mates Ole Jonassen and Gustaf Åkerlundh – began their exploration of the area (Liljequist, 1993, p. 366).

On 28 April 1902, Nordenskjöld made a sledge trip to Seymour Island and found an abundance of Cretaceous specimens (Fig. 7). He now realised that the station should have been placed here instead (Nordenskjöld, 1904, p. 245). After the austral winter, on 21 November 1902, he returned to Seymour Island to work on the Cretaceous deposits (López de Bertodano Formation) in the southern part of the island and brought back very good fossils (Nordenskjöld, 1904, p. 362). On 2 December 1902, he returned again and found some badly preserved plants in the Cross Valley, and the next day, he continued along the beach to the northern part of the island. He went up to the flat area cut by valleys and dotted with small hills overlooked by the tableland (Fig. 8) (Nordenskjöld, 1904, p. 367). Here he found scattered bones of vertebrates (Simpson, 1971, p. 361). Back at the station, Ekelöf recognised the bones as bird material (Wiman, 1905a, p. 1). Nordenskjöld's happiness over this find was increased when, on the way back to camp, he also discovered undoubtedly Tertiary plants in Cross Valley (Cross Valley Formation, Palaeocene). These findings demonstrated that during the Tertiary the climate was temperate to subtropical, and that the specimens were of South American type (Andersson, 1944, p. 253). Nordenskjöld could now prove that this area had once been covered with forests where perhaps mammals roamed (Nordenskjöld, 1904, p. 369). On the 6 February 1903, Nordenskjöld was forced to go back to Seymour Island by boat together with Ekelöf and Jonassen. But this time they had a more gruesome task in mind than collecting fossils.

During the winter, the *Antarctic* had conducted research in the area of the Malvinas Islands and South Georgia to stay clear of the winter ice around Antarctica. After taking on new provisions and coal in Argentina, the ship headed south to pick up the wintering party. At the tip of the Antarctic Peninsula, they met dense pack ice – conditions much worse than the previous year. As the prospect of reaching Snow Hill Island seemed uncertain three men were set ashore at Hope Bay (Bahía Esperanza) at the tip of the Antarctic Peninsula. The party was led by a late joiner of the expedition, the geologist Johan

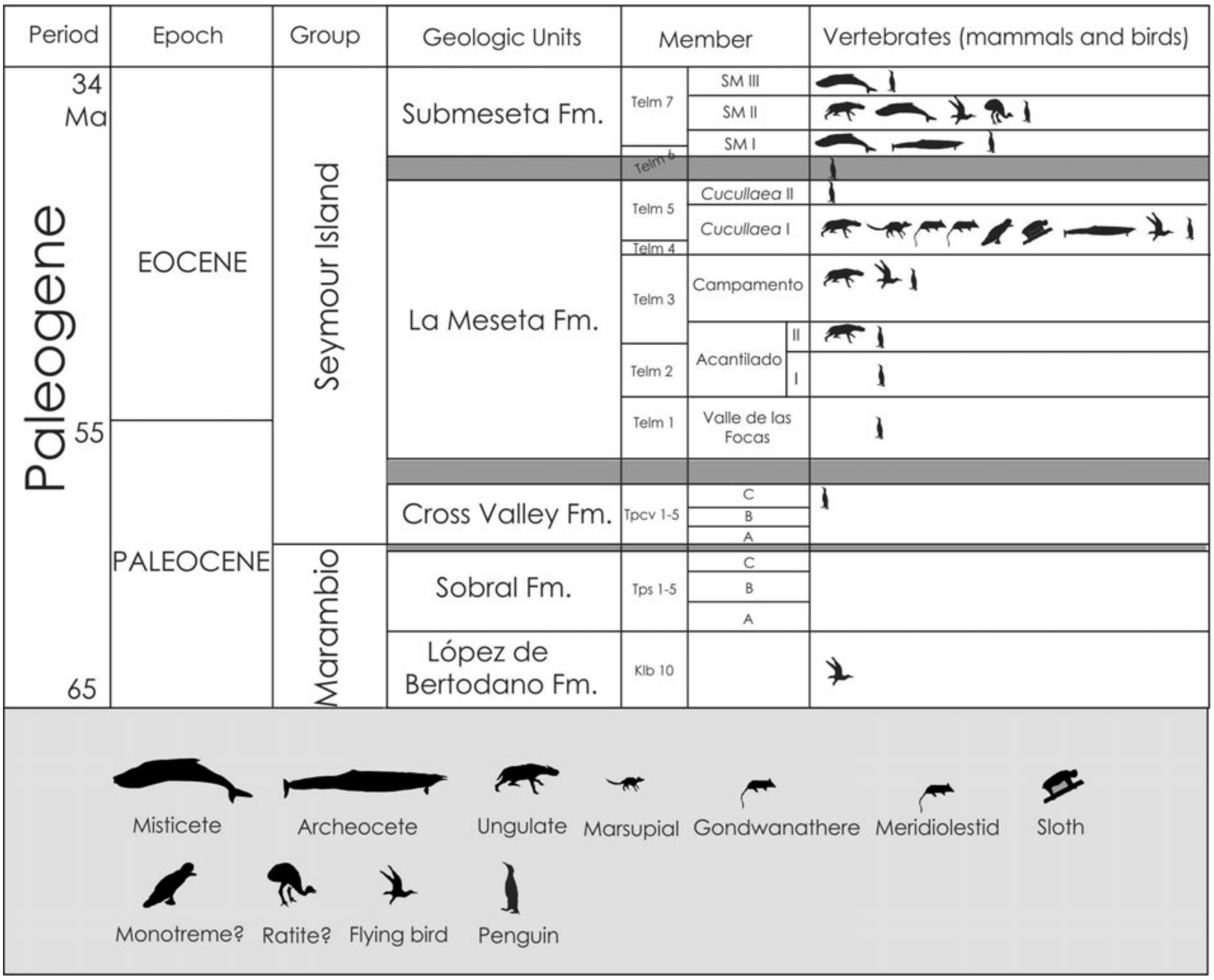

Fig. 4. Timescale, stratigraphy and vertebrate fossil (mammals and birds) record for the Palaeocene and Eocene rocks in the James Ross Basin, Antarctic Peninsula, West Antarctica. Temporal and sedimentary units not to scale.

Fig. 5. The winter station, Snow Hill Island, towards the northeast (photograph T. Mörs).

Gunnar Andersson. The other two were the cartographer Lieutenant Samuel A. Duse and the mate Toralf Grunden. Their mission was to get to the wintering station by foot and evacuate Nordenskjöld and his men back to Hope Bay if the ship did not make it there. However, unfavourable ice conditions and open water prevented the three men from reaching the station and they had to return to Hope Bay. Meanwhile, the ship tried to reach the station but got stuck in the ice. Five weeks later, on 12 February 1903, the ship was crushed by the ice and sank leaving the crew to take refuge on Paulet Island (Fig. 9) (Deståfani et al., 2001, p. 254). With the ship, a substantial part of the scientific material was lost (Andersson, 1905, p. 72). Now the Swedish expedition was marooned in three different places without means of returning to civilisation. Fortunately the crew had left information where the winter station was situated both with the Swedish consul in Buenos Aires and in a letter to Sweden. As winter approached the men at Snow Hill Island and Hope Bay realised what the ship's crew at Paulet Island already knew, that they had to survive the winter in Antarctica – the second for Nordenskjöld and his men at the station. This was the reason behind their return to Seymour Island in February 1903. Here was the closest penguin colony – which meant food for the second winter. For a week, Nordenskjöld and his two comrades killed some 400 Adélie penguins (*Pygoscelis adeliae*).

Fig. 6. The wintering party. From left, front row: Gösta Bodman meteorologist, Otto Nordenskjöld geologist and leader, José Sobral scientific assistant. Back row: Ole Jonassen assistant, Erik Ekelöf physician, Gustaf Åkerlundh assistant (photograph G. Bodman).

Fig. 7. The wintering party used dog sleds for the exploration of eastern Graham Land (photograph E. Ekelöf).

The two other parties of the expedition were lucky to have made their camps in the middle of penguin colonies, resulting in the same slaughter. At Hope Bay and Paulet Island they built stone huts to survive the winter, while the people at the station were quite comfortable in their house.

Next spring, the three men at Hope Bay reached the winter station after a chance meeting with Nordenskjöld on the ice on 12 October 1903 (Fig. 10). Two weeks later, on 30 October 1903, Nordenskjöld brought Andersson to Seymour Island. This time whale remains were discovered together with additional bird specimens 'further out towards the NE point' (Andersson, 1944, p. 253). On 5 November 1903, Andersson went to locality no. 11 a second time accompanied by Sobral to collect more vertebrate material (Wiman, 1905b, p. 248).

Fig. 8. Camp, probably at the penguin colony on southeast Seymour Island (photographer unknown).

Fig. 9. The sinking of the expedition vessel *Antarctic* on the 12 February 1903 (photographer unknown).

Three days later, new visitors were spotted approaching the station. This time it was a relief expedition from the Argentine corvette *Uruguay* under the command of Captain Julián Irizar. The collections and other effects were hastily packed since the Argentines did not want to risk getting stuck in the ice. But the surprises were not over for the day. Late in the evening, Captain Larsen and a few men arrived in a small boat that they had sailed and rowed from Paulet Island.

On her way home, the *Uruguay* picked up the rest of the crew from Paulet Island, and even Jurassic plant fossils collected at Hope Bay were rescued. By this time, the Sweden government had sent a relief expedition which was on its way. For a while the wintering party toyed with the idea of waiting for the Swedish ship and asking its captain to stay in the Antarctic over the summer. Battered by storms, the *Uruguay* returned to Buenos Aires where the expedition members and crew were received as heroes.

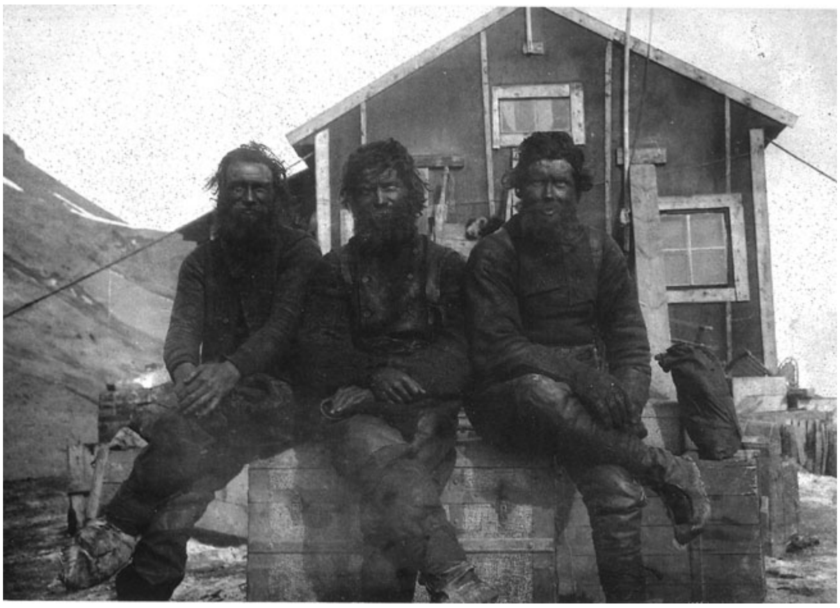

Fig. 10. The three men from Hope Bay reach the winter station. From left: Thoralf Grunden, Johan Gunnar Andersson, Samuel Duse (photograph G. Bodman).

The route taken by the materials and the palaeontological studies

When unpacking the vertebrate material in Uppsala, the expedition geologist J.G. Andersson and the zoologist K.A. Andersson realised that the bones must have belonged to giant penguins. The fact was further confirmed when comparing it with recent material (Wiman, 1905a b, p. 247). The task of describing the penguin and whale fossils was given to Professor Carl Wiman (1867–1944) at Uppsala University – this would be the first time he worked on vertebrates and the results were described in two well-known papers (Wiman, 1905a, 1905b).

In 1905, the giant penguin and whale material from Seymour Island was deposited at the Zoo-Palaeontological Department (today the Palaeobiology Department) at the Swedish Museum of Natural History in Stockholm, where they still reside (Holm, 1906; Jadwiszczak & Mörs, 2011).

Wiman described six species and made the first attempt to classify fossilised penguins (Fig. 11).

Fossilised penguins were not well-known at that time, and the specimens collected by Nordenskjöld were in some cases very fragmentary, delaying the identification of the bones. Instead of trying to classify them into the known systematic context, Wiman (1905) proposed grouping the remains in eight 'size groups' (Wiman, 1905b), according to their size and robustness. Each of these categories included several specimens belonging to different individuals that shared morphological features and could be conspecific. Materials were ordered according to size starting with the largest penguin and ending with the smallest ones as follows:

Group number 1 comprised the largest, partially preserved synsacrum (holotype NRM A 23a of *Orthopteryx gigas* Wiman, 1905). It is a large but not very robust element, slightly curved. The synsacrum was only known for a few species of fossilised penguins, and no other skeletal element was subsequently added to this category. For this reason, comparison with other species was not possible. This taxon was considered as 'essentially indeterminate' by Simpson (1971), whereas Jadwiszczak (2009) recently stated that this bone probably belonged to *Anthropornis nordenskjoeldi* Wiman, 1905. However, taking into account that a synsacrum is not a taxonomically diagnostic element, *O. gigas* was considered a valid name but also a *nomen dubium* by Acosta Hospitaleche & Reguero (2010).

Group number 2 remained unnamed and also consists of an incomplete synsacrum. Following the same criteria mentioned for group number 1, the synsacrum cannot be considered here a diagnostic element.

Group number 3 was identified as *A. nordenskjoeldi* on the basis of a tarsometatarsus and also comprises several other elements (coracoid, humerus, ulna, carpometacarpus, femur, tibiotarsus and synsacrum). Although all these elements were grouped, they do not belong to the same individual and the association here was based entirely on the similarities regarding their robustness and size.

Group number 4, recognised as *Pachypteryx grandis* Wiman, 1905 based on a tarsometatarsus, also contains isolated appendicular elements (tarsometatarsus, coracoid, radius, carpometacarpus, tibiotarsus).

Simpson (1946) proposed that the four abovementioned groups could be put into the same category, probably assigned to *A. nordenskjoeldi*, an idea later supported by Marples (1953). However, in the current systematic scheme (for example, Chávez Hoffmeister,

Fig. 11. Fossilised penguins from Seymour Island, Antarctic Peninsula collected by the South Polar Swedish Expedition (1901–1903) and described by Wiman (1905a). Left: *Palaeeudyptes gunnari*, NRM A.7, holotype, incomplete tarsometatarsus. Middle, top: *Delphinornis larseni*, NRM A.21, holotype, incomplete tarsometatarsus. Middle, bottom: *Ichtyopteryx gracilis*, NRM A.20, incomplete tarsometatarsus. Right: *Anthropornis nordenskjoeldi*, NRM A.45, holotype, incomplete tarsometatarsus. NRM, Naturhistoriska Riksmuseet of Stockholm. Scale bar = 5 cm.

2014; Ksepka, Bertelli, & Giannini, 2006, and references cited therein) *P. grandis* is considered a synonym of *A. grandis* (Wiman, 1905a), a species distinct from *A. nordenskjoeldi*.

Group number 5 was based on an incomplete tarsometatarsus attributed to *Eospheniscus gunnari* Wiman, 1905 – currently *Palaeeudyptes gunnari* (Wiman, 1905a) Simpson, 1971. Other isolated elements (coracoid, humerus, ulna, femur, tibiotarsus, synsacrum) were also included here. Although materials in this group were not associated, these bones were considered as most likely belonging to *P. gunnari* by subsequent researchers. Specimen MLP 96-I-6-13 represents the first articulated skeleton of *P. gunnari* (Acosta Hospitaleche & Reguero, 2010), presenting an opportunity to compare elements other than the tarsometatarsus.

The innominate group number 6 was based on fragments of a humerus, coracoid, scapula and femur. In a later review, the tarsometatarsus holotype of *Notodyptes wimani* Marples, 1953 (then recombined as *Archaeospheniscus wimani* (Marples, 1953) Simpson, 1971) from the same penguin assemblage (Marples, 1953) was also included in this set.

Group number 7 includes only the tarsometatarsus holotype of *Delphinornis larseni* Wiman, 1905a, still recognised as a valid species today (Myrcha et al., 2002).

Finally, group number 8 is represented by a broken tarsometatarsus (NRM A 20) identified as *Ichtyopteryx gracilis* Wiman, 1905a. It is the smallest species studied by Wiman (1905a, 1905b), but disregarded by Marples (1953) and Myrcha et al. (2002) because of its incompleteness. This species was also considered a *nomen dubium* (Simpson, 1971), but listed as a distinct species by Brodkorb (1963). Despite Simpson's (1971) assessment, this species was subsequently considered valid by several authors, for example Bargo & Reguero (1998) mentioned *I. gracilis* within the Argentine Antarctic collections. However, more recently Myrcha et al. (2002) excluded it from the Antarctic faunal lists arguing that the fragmentary state of the material makes a comparison impossible. Furthermore, it was recently proposed that *I. gracilis* and *Delphinornis gracilis* were synonymous species (Jadwiszczak & Mörs, 2011). The preservational state of *Ichthyopteryx* is inadequate to erect a species, and should be considered as a *nomen dubium* (Acosta Hospitaleche & Reguero, 2010) in agreement with Simpson (1971).

The whole of Nordenskjöld's collection was found at locality no. 11 (Wiman, 1905). As previously mentioned, this site, now known as fossil locality DPV 13/84, is one of the most important areas for fossilised penguins and other vertebrates in the Antarctic. Numerous specimens have been discovered there (Acosta Hospitaleche et al., 2013; Tambussi, Acosta Hospitaleche, Reguero, & Marenssi, 2006), including the associated skeleton of *P. gunnari* (Acosta Hospitaleche & Reguero, 2010), a few penguin skulls (Acosta Hospitaleche, 2013), hundreds of isolated penguin bones (Acosta Hospitaleche, 2014), volant birds (Tambussi & Degrange, 2013), several cetacean teeth and bones, and a complete skeleton of *Llanocetus denticrenatus*, the earliest known baleen whale (Fordyce, 2003; Mitchell, 1989), as well as remains of teleost fishes and sharks (Kriwet et al., 2016). Most of these fossils are now housed in the Museo de La Plata, Argentina, and the Swedish Museum of Natural History, Stockholm.

Every year, dozens of fossils are collected in this locality, increasing the number of known specimens from this site. Most of them are fragmentary fossils, and the majority belong to penguins. Nevertheless, they constitute an important contribution to the study of fossilised birds in general and penguins in particular.

References

Aagaard, B. (1930). *Fangst og forskning I Sydishavet* [*Catches and research in the South Polar Sea*]. I–II. Oslo: Gyldendal.

Acosta Hospitaleche, C. (2013). New crania from Seymour Island (Antarctica) that shed light on anatomy of Eocene penguins. *Polish Polar Research*, *34*, 397–412.

Acosta Hospitaleche, C. (2014). New penguin giant bones from Antarctica: systematic and paleobiological significance. *Comptes Rendus Palevol.*, *13*, 555–560.

Acosta Hospitaleche, C. & Reguero, M. (2010). Taxonomic notes about *Ichtyopteryx gracilis* Wiman, 1905 and *Orthopteryx gigas* Wiman, 1905 (Aves, Spheniscidae). *Alcheringa*, *35*, 463–466.

Acosta Hospitaleche, C., Reguero, M. & Scarano, A. (2013). Main pathways in the evolution of Antarctic fossil penguins. *Journal of South American Earth Sciences*, *43*, 101–111.

Andersson, J. G. (1905). De vetenskapliga arbetena ombord på Antarctic sommaren 1902–03 och slädfärden till Snow Hill 1903. [The scientific work onboard Antarctic during the summer 1902–1903 and the sledge journey to Snow Hill 1903] *Ymer*, *24*, 68–81.

Andersson, J. G. (1906). On the geology of Graham Land. *Bulletin of the Geological Institute of the University of Uppsala*, *7*, 19–71.

Andersson, J. G. (1944). *Antarctic. Stolt har hon levat, stolt ska hon dö. [Antarctic. Proudly has she lived, proudly she will die.]*. Stockholm: Saxon & Lindström.

Bargo, M. S. & Reguero, M. A. (1998). Annotated catalogue of the fossil vertebrates from Antarctica housed in the Museo de La Plata. I. Birds and land mammals from La Meseta formation (Eocene–?early Oligocene). In: S. Casadío (Ed.), *Paleógeno de América del Sur y de la Península Antártica* (Vol. 5) (pp. 211–221). Buenos Aires. Asociación Paleontológica Argentina, Publicación Especial.

Brodkorb, P. (1963). Catalogue of fossil birds. 1 (Archaeopterygiformes through Ardeiformes). *Bulletin of the Florida State Museum (Biological Sciences)*, *7*, 177–293.

Chávez Hoffmeister, M. (2014). Phylogenetic characters in the humerus and tarsometatarsus of penguins. *Polish Polar Research*, *35*, 469–496.

Clarke, J. M. (1916). The reincarnation of James Eights, Antarctic explorer. *The Scientific Monthly*, *2*, 189–202.

Crame, J. A., Francis, J. E., Cantrill, D. J. & Pirrie, D. (2004). Maastrichtian stratigraphy of Antarctica. *Cretaceous Research*, *25*, 411–423.

del Valle, R. A., Elliot, D. H. & Macdonald, D. I. M. (1992). Sedimentary basins on the east flank of the Antarctic Peninsula: proposed nomenclature. *Antarctic Science*, *4*, 477–478.

Destéfani, L. H., Cioccale, M. & Rabassa, J. (2001). The 1901–1903 Nordenskjöld Expedition and José Maria Sobral: the first Argentinian in Antarctica. *Ymer*, *121*, 231–269.

Dingle, R. & Lavelle, M. (1998). Antarctic Peninsula cryosphere: early Oligocene (c. 30 Ma) initiation and a revised glacial chronology. *Journal of the Geological Society of London*, *155*, 433–437.

Douglas, P. M. J., Affek, H. P., Ivany, L. C., Houben, A. J. P., Sijp, W.P., Sluijs, A., . . . Pagani, M. (2014). Pronounced zonal heterogeneity in Eocene southern high latitude sea surface temperatures. *Proceedings of the National Academy of Sciences, USA*, *111*, 6582–6587.

Dutton, A. L., Lohmann, K. & Zinsmeister, W. J. (2002). Stable isotope and minor element proxies for Eocene climate of Seymour Island Antarctica. *Paleoceanography*, *17*, 1–13.

Fordyce, R. E. (2003). Early crown–group Cetacea in the southern ocean: the toothed archaic mysticete Llanocetus. *Journal of Vertebrate Paleontology*, *23*, 50A.

Goldberg, F. (2001). Polarforskaren Otto Nordenskjöld 1869–1928. [The Polar researcher Otto Nordenskjöld 1869–1928.] *Ymer*, *121*, 51–72.

Hathway, B. (2000). Continental rift to back-arc basin: Jurassic–Cretaceous stratigraphical and structural evolution of the Larsen Basin, Antarctic Peninsula. *Journal of the Geological Society of London*, *157*, 417–432.

Headland, R. K. (2004). Antarctic odyssey: historical stages in development of knowledge of the Antarctic. In: A. Elzinga, T. Nordin, D. R. Turnerand U. Wråkberg (Eds.), *Antarctic challenges: historical and current perspectives on Otto Nordenskjöld's Antarctic Expedition 1901–1903* (pp. 15–24). Gothenburg: Royal Society of Arts and Sciences in Gothenburg.

Hjort, C. & Ingólfsson, O. (2004). Otto Nordenskjöldś contributions to glaciation history. *A bipolar effort with a southern focus.* In: A. Elzinga, T. Nordin, D. R. Turnerand U. Wråkberg (Eds.), *Antarctic challenges: historical and current perspectives on Antarctica* (pp. 188–199). Gothenburg: Royal Society of Arts and Sciences in Gothenburg.

Holm, G. (1906). Institutionsföreståndarnes. *Kungliga Vetenskapsakademiens årsbok*, [Head of department's yearly report]. *1906*, 138–140.

Ivany, L.C., Lohmann, K. C., Hasiuk, F., Blake, D. B., Glass, A., Aronson, R. B. & Moody, R. M. (2008). Eocene climate record of a high southern latitude continental shelf: Seymour Island, Antarctica. *Geological Society of America Bulletin*, *120*, 659–678.

Jadwiszczak, P. (2009). Review Penguin past: the current state of knowledge. *Polish Polar Research*, *30*, 3–28.

Jadwiszczak, P. & Mörs, T. (2011). Aspects of diversity in early Antarctic penguins. *Acta Palaeontologica Polonica*, *56*, 269–277.

Kriwet, J., Engelbrecht, A., Mörs, T., Reguero, M. & Pfaff, C. (2016). Ultimate Eocene (Priabonian) chondrichthyans (Holocephali, Elasmobranchii) of Antarctica. *Journal of Vertebrate Paleontology*, *36*, e1160911.

Ksepka, D. T., Bertelli, S. & Giannini, N. (2006). The phylogeny of the living and fossil Sphenisciformes (penguins). *Cladistics*, *22*, 412–441.

Larsson, K. (2001). Tre geologer i yttersta södern [Three geologists in the Far South]. *Ymer*, *121*, 97–116.

Liljequist, G. H. (1993). *High latitudes – a history of Swedish polar travels and research*. Stockholm: The Swedish Polar Research Secretariat in collaboration with Streiffert.

MacDonald, D. I. M., Baker, P. F., Garrett, S. W., Ineson, J. R., Pirrie, D., Storey, B. C., … Marshall, J. E. (1988). A preliminary assessment of the hydrocarbon potential of the Larsen Basin, Antarctica. *Marine and Petroleum Geology*, *5*, 34–53.

Marenssi, S. A., Santillana, S. N. & Rinaldi, C. A. (1996). *Stratigraphy of La Meseta Formation (Eocene), Marambio Island, Antarctica* (pp. 33–34). I Congreso Paleógeno de América del Sur, Santa Rosa.

Marenssi, S. A., Santillana, S. N. & Rinaldi, C. A. (1998a). Paleoambientes sedimentarios de la Aloformación La Meseta (Eoceno), Isla Marambio (Seymour), Antártida. *Instituto Antártico Argentino, Contribución*, *464*, 1–51.

Marenssi, S. A., Santillana, S. N. & Rinaldi, C. A. (1998b). Stratigraphy of the La Meseta Formation (Eocene), Marambio (Seymour) Island, Antarctica. In: S. Casadío (Ed.), Paleógeno de América del Sur y de la Península Antártica. *Publicación Especial de la Asociación Paleontológica Argentina*, *5*, 137–146.

Marples, B. J. (1953). Fossil penguins from the mid-Tertiary of Seymour Island. *Falkland Island Dependency Survey Science Report*, *5*, 1–15.

Mitchell, E. D. (1989). A new cetacean from the late Eocene La Meseta Formation, Seymour Island, Antarctic Peninsula. *Canadian Journal of Fisheries and Aquatic Sciences*, *46*, 2219–2235.

Montes, M., Nozal, F., Santillana, S. N., Marenssi, S. & Olivero, E. (2013). *Mapa geológico de Isla Marambio (Seymour), Antártida* (1st ed.). Scale 1:20.000... Serie Cartográfica.

Myrcha, A., Jadwiszczak, P., Tambussi, C. P., Noriega, J., Gazdzicki, A., Tatur, A. & del Valle, R. (2002). Taxonomic revision of Eocene Antarctic penguins based on tarsometatarsal morphology. *Polish Polar Research*, *23*, 5–46.

Nordenskjöld, O. (1901). Sydpolarforskningens nuvarande ställning och mål. [South Pole Research's current position and goals] *Ymer*, *21*, 51–75.

Nordenskjöld, O. (1904). *Antarctic. Två år bland sydpolens isar*. I–II. Stockholm: Bonniers.

Nordin, T. (2004). Beyond borders: Otto Nordenskjölds many missions. In: A. Elzinga, T. Nordin, D. R. Turnerand U. Wråkberg, (Eds.), *Antarctic challenges: historical and current perspectives on Otto Nordenskjöld's Antarctic Expedition 1901–1903* (pp. 66–78). Gothenburg: Royal Society of Arts and Sciences.

Reguero, M. A., Marenssi, S. A. & Santillana, S. N. (2002). Antarctic Peninsula and Patagonia Paleogene terrestrial environments: biotic and biogeographic relationships. *Palaeogeography Palaeoclimatology Palaeoecology*, *179*, 189–210.

Reguero, M. A. & Gasparini, Z. (2007). Late cretaceous–early tertiary marine and terrestrial vertebrates from James Ross Basin, Antarctic Peninsula: a review. In: J. Rabassaand M. L. Borda (Eds.), *Antarctic Peninsula and Tierra del Fuego: 100 years of Swedish–Argentine scientific cooperation at the end of the world* (pp. 55–76). London: Taylor and Francis.

Reguero, M., Goin, F., Acosta Hospitaleche, C., Dutra, T. & Marenssi, S. (2013). *Late Cretaceous/Paleogene West Antarctica: terrestrial biota and its intercontinental affinities*. London: SpringerBriefs in Earth System Sciences.

Sadler, P. (1988). Geometry and stratification of uppermost Cretaceous and Paleogene units of Seymour Island, northern Antarctic Peninsula. *Geological Society of America Memoirs*, *169*, 303–320.

Sharman, G. & Newton, E. T. (1894). Note on some fossils from Seymour Island, in the Antarctic regions, obtained by Dr Donald. *Transactions of the Royal Society of Edinburgh*, *37*, 707–709.

Sharman, G. & Newton, E. T. (1898). Notes on some additional fossils collected at Seymour Island, Graham's Land, by Dr Donald and Captain Larsen. *Transactions of the Royal Society of Edinburgh*, *22*, 58–61.

Simpson, G. G. (1946). Fossil penguins. *Bulletin of the American Museum of Natural History*, *87*, 1–99.

Simpson, G. G. (1971). Review of fossil penguins from Seymour Island. *Proceedings of the Royal Society of London B*, *178*, 357–387.

Stilwell, J. & Long, J. (2011). *Frozen in time: prehistoric life in Antarctica*. Collingwood: CSIRO Publishing.

Tambussi, C. P., Acosta Hospitaleche, C., Reguero, M. & Marenssi, S. A. (2006). Late Eocene penguins from West Antarctica: systematics and biostratigraphy. *Special Publication of the Geological Society of London*, *258*, 45–161.

Tambussi, C. P. & Degrange, F. (2013). *South American and Antarctic continental Cenozoic birds. Paleobiogeographic affinities and disparities*. Dordrecht: SpringerBriefs in Earth System Sciences.

Wiman, C. (1905a). Über die alttertiären Vertebraten der Seymourinsel. *Wissenschaftlichee Ergebnisse der Schwedische Südpolar–Expedition: 1901–03*, *3*, 1–37.

Wiman, C. (1905b). Vorläufige Mitteilung über die alttertiären Vertebraten der Seymourinsel. *Bulletin of the Geological Institute of the University Uppsala*, *6*, 247–256.

Wråkberg, U. (2001). Den internationella antarktisforskningen och Otto Nordenskjölds sydpolarexpedition 1901–03. [The international Antarctic research and Otto Nordenskiöld's South Pole expedition 1901–03] *Ymer*, *121*, 25–50.

Zinsmeister, W. J. (1988). Early geological exploration of Seymour Island, Antarctica. *Geological Society of America Memoirs*, *169*, 1–16.