Alexander von Middendorff and his expedition to Siberia (1842–1845)

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ABSTRACT. Alexander Theodor von Middendorff's name is closely associated with the exploration of Siberia and research on the natural history of the Russian Arctic. Yet it is surprising that, in the extensive literature in Russian and German on the environment of those regions, there are no specific analyses of Middendorff's important contribution to these areas of research. He is barely mentioned in English language studies on the history of exploration and science in Siberia and there are very few accounts of his life and work. The present paper is largely based on a number of newly discovered archival documents and contemporary literary sources and is an attempt to fill this lacuna. In this account, all dates are given according to the new style calendar.

Contents

Introduction

As far as is known to the authors, there exists only one account of the life of Alexander Theodor von Middendorff [Aleksandr Fedorovich Middendorf] in English. This is an entry about him by William Barr in the recently published *Encyclopedia of the Arctic*, which, because of the format of the work, is necessarily concise (Barr 2005: 1292–1293). The same writer has also contributed two detailed and useful papers on part of Middendorff's great Siberian expedition, that in the Poluostrov Taymyr [Taymyr Peninsula] in 1843 (Barr 1991, 1993). The first of Barr's papers offers a translation of Middendorff's reports on the expedition that were published first in 1844 and 1845 in the *Bulletin de Classe physico-mathématique publié par l'Académie Impériale des sciences de St. Pétersbourg* and then republished by Karl Ernst von Baer in the journal *Beiträge zur Kenntniss des Russischen Reiches und der angränzenden Länder Asiens* (Baer 1855). This appears to be the only one of Middendorff's many writings that is available in English. There is, however, a recent biography of Middendorff in Russian (Sukhova and Tammiksaar 2005). Because of the paucity of information concerning Middendorff and because his name and career deserve to be better known, the authors offer, in the present paper, rather more background biographical information than might be thought necessary in an equivalent paper about an aspect of the work of a more familiar figure.

In this paper an outline of Middendorff's life up until the Siberian expedition is followed by a description of the work and travels undertaken on it and an account of the scientific achievements accomplished during it. There is then an account of Middendorff's life after the expedition, during which he spent much time writing up the results, and of the other interests in which he engaged while middle aged and while in retirement.

Middendorff's early life

Middendorff was born in St Petersburg on 18 August 1815. His father, the Baltic German Theodor Johann von Middendorff (1776–1856), was the director of the St Petersburg Main Pedagogical Institute, and his mother Sophie Johanson (1782–1868) was an illegitimate daughter of a Baltic German landlord and of an Estonian serf (Lackschéwitz 1978: 66). However, Middendorff's parents were not married. In order to prevent any whiff of scandal reaching St Petersburg and having a deleterious effect on his father's career, he, together with his mother and sister, spent nine early years far away, on his father's estate at Pööravere in the province of Livonia, which consisted roughly of the southern part of the present-day Estonia and the northern half of present-day Latvia (Tammiksaar 2006).

Middendorff received elementary education from private teachers in Reval (now Tallinn). When his parents married, some years after his birth, Middendorff was legitimised and, therefore, was eligible to enter the gymnasium [high school]. In 1824–1828, Middendorff studied at Gymnasium No 3 in St Petersburg, and, in 1828–1832, he attended the Preparatory Section of the St Petersburg Main Pedagogical Institute (Middendorff 1832). Proceeding to higher education, he attended the University of Dorpat (now Tartu) where from 1832 to

1837, he studied medicine. He graduated on 2 June 1837 having prepared a doctoral thesis entitled *Quaedam de bronchorum polypis, morbi casu observato illustrata* [Certain matters concerning polyps in the bronchi, the incidence of the disease having been observed, are explained].

As he was keenly interested in science and following the Baltic German tradition of visiting several Universities, Middendorff continued his studies in Breslau, Halle, Königsberg, Prague, Vienna and Berlin where he met several of the leading naturalists of the time. In 1839, he returned to St Petersburg with the aim of joining a natural scientific expedition to any region of the Russian Empire. It seems very probable that it was this interest in travelling that enabled him to become acquainted with Karl Ernst von Baer (1792–1876), a member of the St Petersburg Academy of Sciences in zoology. Baer planned investigations in Russian and Norwegian Lapland, in the White Sea and Novaya Zemlya in the summer of 1839 and he selected the young and enthusiastic Middendorff as his travelling companion. However, because of the lack of immediate finance, the expedition had to be postponed until the summer of 1840 (Sukhova and Tammiksaar 2005: 21–22).

During 1839, in order to guarantee an academic position for Middendorff, Baer wrote to the Minister of Public Education of Russia with a proposal to elect Middendorff to a chair in zoology, with the main duty of establishing a museum, at the new University of Kyiv [Kiev] in the Ukraine (Baer 1839). Middendorff received this post and remained in Kyiv, apart from travelling on expeditions, until the summer of 1842. As Middendorff was an established academic, when Baer again began making preparations at the start of 1840 for the expedition to Lapland, it was easy for him to invite Middendorff to participate. In his letter to the St Petersburg Academy of Sciences, Baer stressed that the White Sea would provide more material for the collections of the zoological museum in Kyiv than would the Black Sea even though the latter was nearer (Sukhova and Tammiksaar 2005: 22).

The expedition of Baer and Middendorff to Lapland took place from the end of May to the beginning of October 1840. From Arkhangel'sk, the expedition travelled to the islands in the White Sea and adjacent areas (Kildin, Sosnovets, Nokuiev, and Anikiev). They continued with a journey along the coast of the Barents Sea as far as the harbour of Vardö in Norway (Middendorff 1860a: 152–155). From Norway, Baer returned to Arkhangel'sk by sea, while Middendorff travelled on foot across Kol'skiy Poluostrov [Kola Peninsula], from the mouth of the Kola River to Kandalaksha. During the journey, Middendorff focused his attention mainly on birds and, on the basis of his observations, he compiled the first account of the avian fauna of the area. Having recorded very many bird species in Lapland, he carried out a comparison of his results with those of equivalent studies of Norway, Iceland, Greenland and North America (Middendorff 1843a). The expedition also achieved some important cartographical results. Middendorff corrected the errors in the current maps, for example, in the coastline of Ozero [Lake] Imandra, in the direction of the course of the Kola River (it was not east-west but south-north), and even in the post road from Kola to Kandalaksha. Baer published a revised version of the map of the Kola Peninsula in the series edited by him, *Beiträge zur Kenntniss des Russischen Reiches und der angränzenden Länder Asiens* (Baer 1843: Tafel V). Despite this and despite the fact that Middendorff wrote a trenchant account of these errors (Middendorff 1853a: 112), the official Russian cartographers ignored the corrections and, as late as the 1850s, the Russian Military Topographical Depot published defective maps of the western area of the Russian Empire. This problem resurrected itself with regard to the cartographical results of Middendorff's Siberian expedition.

Having returned to Kyiv, Middendorff realised that he did not wish to continue on the staff of that University. Although he had been elected an extraordinary professor in zoology in April 1841, his ideal was a position as a senior lecturer in zoology at University of Dorpat, at which he had studied and in which area he identified himself culturally. Middendorff attempted to retire from the University of Kyiv, but that University refused to agree. Due to this Middendorff had psychological problems that continued until the beginning of September 1841 when he received a letter from Baer. This was the turning point in Middendorff's life as it offered him the opportunity of becoming the leader of an expedition to northern and eastern Siberia organised by the St Petersburg Academy of Sciences (Baer 1841a).

The background to the expedition to Siberia

Middendorff travelled in Siberia in 1843 and 1844 although the expedition lasted officially from 1842 to 1845. The background of the expedition is associated with the history of studies on permafrost. Thanks to the writings of Russian travellers, researchers were aware of the existence of areas with permanently frozen subsoil in eastern Siberia as early as the 18th century. In the 1820–1830s, however, doubts arose concerning this phenomenon among European investigators because observations in temperate latitudes proved that soil temperature increased with depth. Also, it was known that plants could be encountered everywhere in eastern Siberia and it was considered impossible that they could grow on the permanently frozen soil (compare Tammiksaar 2002a: 126).

In 1828, Fedor Shergin, a merchant of the Russian–American Company, sank a well in Yakutsk in order to secure better drinking water than could be obtained from the turbid Lena river. But, it soon became evident that, even at depth, the ground was permanently frozen. In 1829, the great explorer and dignitary of that company, Ferdinand von Wrangell (1797–1870) visited Yakutsk. Wrangell immediately realised the importance of the well from the scientific point of view, as prior to his great northeast Siberian expedition of 1820–1824, several

members of the University of Dorpat had asked him to study the phenomenon of permafrost in Siberia. Wrangell, whose tenacity was legendary, determined to continue with the sinking of the well, and promised Shergin that the expenses would be met by the Russian–American Company. The digging continued until July 1837 when the depth of the well was 382 feet (approximately 100 m) and the bottom of it began to thaw. Shergin sent his data to Wrangell, who, in his turn, forwarded them to the geologist Gregor von Helmersen (1803–1885) to be analysed and included in an article he wrote on the topic (Helmersen 1838). Wrangell asked Baer to report on Helmersen's article to the Academy of Sciences (Baer 2001: 26).

Baer was extremely interested in Shergin's observations. On 1 December 1837, he reported to the Academy, concerning Helmersen's article and suggested the establishment of a commission for continuing observations in the shaft. The commission, which was established immediately, decided that the shaft should not be dug any deeper as it might be dangerous to the diggers. It decided to keep the shaft open until it would be possible to organise regular geothermal observations within it. It also decided to send Shergin, as the only trustworthy observer, 30 thermometers with instructions concerning the observations required (Baer 2001: 27–28). To these instructions, Baer added questions concerning the thickness of the active layer (the surface layer that thawed in summer), the existence of permafrost in different conditions in nature, and the extent of freezing (whether down to the bed or not) in small rivers around Yakutsk. Shergin answered Baer's questions, but also informed him that he was intending to leave Yakutsk and could not perform the observations. In 1838, an attempt to find a trustworthy person from St Petersburg to replace him failed (Tammiksaar 2002a: 127).

Baer considered it extremely important to turn the attention of European researchers to the need to investigate permafrost. In 1837, he informed Alexander von Humboldt and the German geographer Heinrich Berghaus, concerning the observations in the Shergin shaft and advanced his preliminary views on the causes of the origin and of the physical peculiarities of permafrost (Baer 1838a, 1839). Baer sent two articles to the Royal Geographical Society in London, in which he suggested that the investigation of permafrost should also be started in North America (Baer 1838b, 1838c). Although some of the members of the society were doubtful about the precision of Shergin's measurements, it was suggested to the Hudson's Bay Company that it initiate measurements of air and soil temperatures in the northern regions of America (Tammiksaar 2002a: 127).

The discussions of the Shergin shaft in the St Petersburg Academy of Sciences coincided, by chance, with a suggestion from the governor of western Siberia that an extensive expedition be organised to that area. Baer considered that, as the possibility of dispatching a major expedition had not been approved, the idea of sending such an expedition specifically to western Siberia was premature. The Academy of Sciences concurred with Baer and to clarify the situation Baer compiled a questionnaire to be sent to Siberia in order to find out whether such an expedition would be practical.

Communications were slow and Siberian officialdom slower, and answers to Baer's questions were received only in 1841. At the general assembly of the Academy of Sciences on 27 August 1841, reporting on the answers to the questions, Baer suggested that a minor expedition be sent not to western but to eastern Siberia. He drew up general outlines for such an expedition and was prepared to present a more detailed plan to a commission, should the 'Academy… choose to establish one'. After Baer's report, the Academy concurred and abandoned the plan for an extensive expedition to Siberia that it had discussed in 1838 (Sukhova and Tammiksaar 2005: 30–32).

In a comprehensive report, *Ueber eine Reise in der hohen Norden von Sibirien*, Baer suggested that the projected investigations into permafrost in Yakutsk should be extended to the region of the Rivers Pyasina and Khatanga in the Taymyr Poluostrov [Taymyr Peninsula]. In his opinion, the Shergin shaft had to be used for further work, but more extensive observations of that kind should be carried out in order to study the conditions at which permafrost occurred in other regions of Siberia. Furthermore, observations in the area of the Pyasina and Khatanga, a region to which researchers had never been, could provide much new data on organic life in subarctic areas. Baer was particularly interested in the determining factors concerning the distribution of plants and animals as latitude increased and the peninsula offered attractive possibilities for research in that respect (Baer 1841b; Barr 1993: 169).

Very soon after this, on 3 September 1841, Baer wrote to Middendorff that, at the beginning of the year, the Academy was in financial difficulties. But when it that appeared that the British geologist Roderick Impey Murchison (1792–1871), had received relatively generous funding from the Russian government for an expedition during which he had identified the Silurian system, Baer decided to take steps to acquire the money necessary for the investigations in Siberia. He informed Middendorff that he had presented to the Academy a plan for such an expedition, but he had not mentioned the name of the person who might lead it. However, he had mentioned, Middendorff's name when speaking to some colleagues. 'You wanted to leave Kiev and go on a major expedition', Baer wrote, 'I am asking you whether you are still determined to go on such an expedition, even if it will last for three years, since in a shorter time it would be impossible to realise all the tasks [set for the expedition]' (Baer 1841a).

Middendorff immediately agreed. This is clear from Baers letter to him of 4 October: 'Having received your note (it was in the late afternoon of Tuesday), on the same night, I compiled a letter [concerning the expedition] on behalf of the commission, and the next morning it

was signed [by the other members of the commission] and at the meeting at midday it was announced and approved' (Baer 1841c). The meeting of the Academy on 24 September 1841 was the first occasion at which Middendorff was named as the leader of the expedition to Siberia.

On 10 October, the permanent secretary of the Academy, Paul von Fuss (1798–1855), informed Sergei Uvarov (1786–1855), the Minister of Public Education, that Middendorff intended to give up his post at the University of Kyiv and go to Siberia. Uvarov accepted the arguments put forward by Baer, but before drafting a letter of recommendation, he considered it necessary to apply to the Minister of Finance, Georg von Cancrin (1774–1845), to learn whether that ministry could provide the necessary funds for the expedition, estimated at 10–13 thousand roubles. Cancrin commissioned Konstantin Chevkin (1803–75), the chief of staff of the Corps of Mountain Engineers, to estimate the importance of an expedition that was primarily directed towards the solution of geological problems (Baer 1841d). Chevkin wrote to Uvarov that the Ministry of Finance saw no obstacles to providing the funding required. In his report, Uvarov also pointed out the arguments stressed in Fuss' note and the observations put forward by Cancrin. On 18 November 1841, the report was approved by Tsar Nicholas I and after that the Academy could proceed with launching the expedition (Sukhova and Tammiksaar 2005: 32–34).

Uvarov wrote about the intended expedition not only to Cancrin but also to the curator of the educational district of Kyiv. In the University of Kyiv, the information that Middendorff was departing on a long expedition and, consequently, intended to abandon the University, was accepted with understandable discontent and even indignation. The curator wrote to Uvarov that, as there was no one to replace Middendorff, either another professor of zoology had to be found for the University, or the expedition had to be postponed for a year. In his opinion, Middendorff had to be given time to finish the courses he had started and to find a zoologist to replace himself. Furthermore, the moving of the 'items' of the zoological museum founded by Middendorff into a new building of the University had started, and his supervision was necessary for the process to be completed successfully.

After the receipt of this letter, Uvarov asked Fuss whether the Academy could recommend somebody else for the Siberian expedition. Relying on the opinion of the expedition commission, Fuss replied that he could not nominate a zoologist for the University, and, consequently, the Academy would have to wait until the spring of 1842 before Middendorff could participate in the expedition (Sukhova and Tammiksaar 2005: 34).

Although Middendorff was appointed the leader of the expedition, he remained a professor of the University, not knowing whether somebody would be found to replace him in the chair of zoology. He was extremely troubled and Baer, supposing that Middendorff felt like a 'mouse in a trap', had to calm him. '... I also doubted', Baer wrote 'until at the end of the year [29 December 1841], at a festive general assembly of the Academy of Sciences our secretary ... told us about the plan for the expedition and you were mentioned as a candidate. Now there is no way back' (Baer 1842).

Although no candidate was found for Middendorff's post at the University of Kyiv, he went to St Petersburg in May 1842 to make preparations for the investigations that the expedition was intended to conduct. Baer read what literature existed about Siberia, and also the diaries and maps of those naval officers who had described the coasts of the Arctic Ocean under Vitus Bering's management during his second Kamchatka expedition (1733–43). It should be remembered, in this context, that, in addition to his own voyage to Alaska, Bering was responsible for a series of expeditions intended to map the north coast of Russia. These are more usually known as the Great Northern Expedition and were, on the whole, very successful. Baer and Middendorff made a five-day trip to the islands in the Gulf of Finland, where the latter discovered evidence of the influence sea ice and of glaciation. This was because Baer wanted Middendorff to search for evidence confirming the theory of Louis Agassiz (1807–1873) concerning glaciation during the Siberian expedition (Baer 1986: 283–284).

The commission responsible for the organisation of the expedition prepared thorough instructions for Middendorff. These stated the overall tasks of the expedition and gave specific instructions for geological, meteorological, ethnographical, zoological and botanical observations. The first part was compiled by Adolph Theodor Kupffer (1799–1865), Emil Lenz (1808–1865) and Baer himself; the biological instructions were compiled by the zoologist Johann Friedrich Brandt (1802–1879) and the botanist Karl Anton Meyer (1796–1855) (Baer and others 1843).

Since 1838, Baer had collected data on frozen soils from the literature, and also from reports of contemporary travellers who had visited northern regions of European Russia. In Baer's opinion, the summary of all the data available was the best instruction for the study of permafrost and he began to compile *Materialien zur Kenntniss des unvergänglichen Boden-Eises in Sibirien* (Baer 2001). In this work (finished in 1843), he also presented his own views on the phenomenon of permafrost, the reasons for its origin, the way it influenced other natural phenomena, and on its distribution. As Baer could not finish the manuscript before Middendorff's departure, he had to send it in instalments to Siberia (Tammiksaar and Sukhova 1999; Tammiksaar 2002a).

The work of the expedition

Departure

The route followed by the expedition is indicated in Fig. 1. It is marked as a black dashed line.

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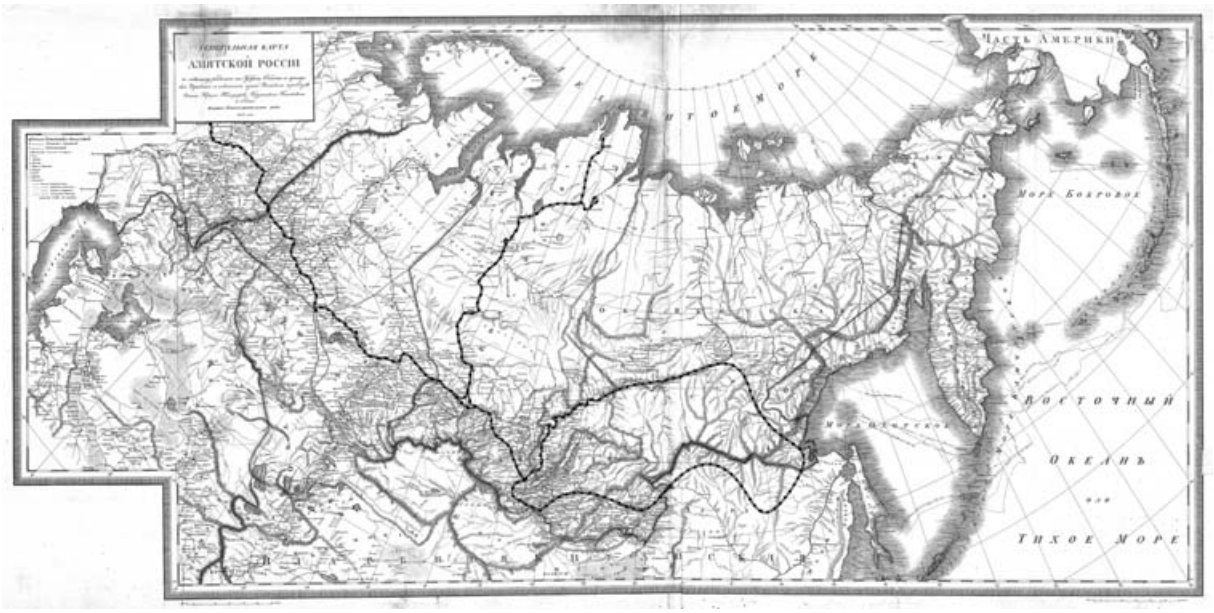

Fig. 1. Map of the expedition. The route is marked as a black dashed line. Original map by F.I. Pozniakov, dated 1825.

Middendorff departed from St Petersburg on 26 November 1842. He had two companions. They were Harald Emil Branth (1814–1854), a Danish forester, and an Estonian peasant, Michael Fuhrmann, who had been born in 1823. The party was heavily laden with books and scientific instruments. Middendorff described Branth as follows: '. . . sturdy and adaptable to changing weather, the build of a forester, an excellent shot, a talented painter and permanently ready to master all technical aspects of meteorological observations and of assembling specimens of natural objects for collections, gave evidence of being a good companion in travel, and I signed his application with pleasure' (Middendorff 1848a: xiv). Fuhrmann, Middendorffs personal servant, was included in the team as the person responsible for the preparation of biological specimens. During the expedition he learned how to take meteorological observations and also how to measure the temperature in the shafts sunk into the permafrost (Sukhova and Tammiksaar 2005: 36).

Middendorff arrived in Moscow on 29 November. The time that he stayed there was devoted to making further preparations for the expedition and he visited the zoological museum and the library of Moscow University. From Moscow, along the Great Siberian highway, the travellers made for Krasnoyarsk via Vladimir, Nizhniy Novgorod, Kazan, Perm, Ekaterinburg, Iskhim, Omsk and Tomsk. As Middendorff was in a hurry, only short stops were made. In Omsk, he met colleagues from the University of Tartu, the botanists Alexander von Schrenck (1816–1876) and Julius Stubendorff (1811–1878), and they greeted the new year, 1843, together. Schrenck who had returned from his own expedition to middle Asia with rich scientific material, greatly encouraged Middendorff, who wrote about this meeting to Baer: 'Both supported me with advice . . . I consider it a special gift of fate that I have met faithful friends everywhere' (Middendorff 1843b).

In Omsk, Middendorff visited the Topographical Depot of the Independent Siberian Corps (of the Russian Army) hoping to recruit a topographer who could accompany him on the expedition, carry out mapping and determine geographical co-ordinates on the route. He became acquainted with a non-commissioned officer, Vasiliy V. Vaganov (1820–1853), who, dissatisfied with the service, agreed to join the expedition (Middendorff 1867a: 15). Middendorff secured the approval of the Academy of Sciences and of the Minister of War, and Vaganov was appointed under his command, while he promised to cover the travelling and maintenance expenses of the topographer from the financial resources of the expedition.

The last week of January 1843 was spent in Krasnoyarsk, and from thence the party headed north to Turukhansk. At first they travelled by road. Then, having exchanged heavy winter carts [kibitkas] for lighter sledges, hauled by horses, they moved mainly along the ice surface of the Yenisey river (Middendorff 1867a: 17). Because of the width of the frozen river and because of the fog, blizzards, and dazzling snow, the banks of it were invisible for most of the time. Travelling was exceptionally difficult (Barr 1993: 171). On 9 March 1843, the party arrived at Turukhansk. There, the expedition was expected and in accordance with the orders of the governor of Yeniseisk, the travellers were to be provided with comfortable accommodation and the services of four local Cossacks. Furthermore they were to be provided with bread on a daily basis and at cost price (Baer 1844a: 145–146).

The travellers stayed in Turukhansk for almost a month. There they started their investigations: they drilled trial holes and measured soil temperature. On 4 April, they travelled north from Turukhansk, using dogs, along the ice surface of the Yenisey, to the settlement of Ust-Kureiskiy,

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and from thence, using reindeer, to the settlement of Dudino (on the River Dudinka), after that to Ozero [Lake] Pyasina. Eventually, they reached the settlement of Vvedenskoye on the River Pyasina (Middendorff 1867a: 18; Sukhova and Tammiksaar 2005: 38–39).

As the intention was to investigate areas inhabited by Nenets, Middendorff was anxious to retain the services of an efficient interpreter. At Vvedenskoye, Middendorff met a 70-year old inhabitant, Tit Lapukov, who knew the Nenets language and who agreed to act in that capacity. From Vvedenskoye, through the woodless tundra, and across the low divide between the rivers Pyasina and Boganida, the party arrived at the settlement of Korennoe Filipovskoye on the river Boganida (a tributary of the river Kheta, which, in its turn, debouches into the river Khatanga) on 28 April 1843 (Middendorff 1867a: 19). All the members of the expedition except Middendorff and Branth fell ill, and this gave Middendorff the opportunity to practice his medical skills.

To Poluostrov Taymyr

The travels of the expedition in the peninsula of Taymry are indicated in Fig. 2. This is Middendorff's own map compiled after the expedition.

At Filipovskoye, Branth carried out meteorological observations, while Middendorff sailed downstream on the river Kheta to the Khatanga to ascertain if it was possible to travel along this river to the Arctic Ocean. Reaching the settlement of Kazach'ye, where there was only a small Russian population, Middendorff learned that this was impossible because the fishing boats of the local people were not built for the transport of heavy cargoes. However, at Kazach'ye he saw the very boat, with the weather boards and even the nails preserved, that had been used by Khariton Laptev, in 1739–1740 on his survey of the Arctic coastline during which he navigated the sea now named after him and his cousin Dimitriy (Baer 1855: 135–136; Middendorff 1867a: 19–20). It had been left intact during all the years since and this immunity was possibly because of a prominent sign that proclaimed it to be the 'Property of the Empress' (that is Catherine II) (Barr 1993: 174).

After the trip to the Khatanga, Middendorff returned to Korennoe Filipovskoye arriving on 5 May. Shortly after this Vaganov, who later became a faithful and efficient companion in difficult times, also reached the settlement (Sukhova and Tammiksaar 2005: 39).

When it was evident that they could not reach the Arctic Ocean via the Khatanga river, Middendorff decided to follow nomadic Nenets down the river Taymyr. However, in order to do so, it was necessary to transport the frame of a boat, since the forests ended to the south of Korennoe Filipovskoye. Because of the lack of timber, the local people were ignorant of construction techniques for reasonable sized boats. It was necessary for the Cossacks to undertake that work under the supervision of Middendorff, who personally participated in the task. Branth and Fuhrmann stayed at Filipovskoye where they were to carry out meteorological observations and to assemble collections of specimens, while Vaganov, the interpreter, and three Cossacks were to accompany Middendorff on the trip northwards (Middendorff 1867a: 20).

On 19 May 1843, the party set off travelling with the help of reindeer and dogs, with the aim of meeting nomadic Nenets. When they did at last meet, it appeared that all the Nenets were ill. The whole area was affected by an epidemic of German Measles and this had a serious influence on the extent to which the expedition could draw upon the local peoples for support. The women were even unable to sew hides together to make the tent-walls. At a temperature of –22°C and in a heavy snowstorm, the travellers had to spend three days in an open tent. They also discovered that local Nenets had never travelled north of the river Verkhnaya [Upper] Taymyr, a tributary that debouched into the Ozero [Lake] Taymyr. They were afraid of travelling in that area because it was associated with evil spirits. It was difficult for Middendorff to secure a guide who would accompany his party to the river Taymyr. The guide 'considered it better to run away', as soon as they reached the banks of the river. The travellers were still very far from Ozero Taymyr from whence the intention had been to start sailing north. In addition, it appeared that the maps available on this part of the Taymyr region were not accurate. Middendorff commented that 'According to these maps, lake Taymyr had only small tributaries; the river bearing the same name is the only small source of the lake, but actually it is the biggest river by the amount of water [flowing in it]. . .' (Sukhova and Tammiksaar 2005: 41).

The party reached the Verkhnaya Taymyr on 14 June. The preparations for the voyage to the Arctic Ocean were protracted. Firstly, it was necessary to complete the construction of the boat of which only a bare frame had been transported thus far. The planking for this was taken from the sledges. The boat was approximately 3 m long and was named *Tundra* (Baer 1855: 141; Barr 1993: 176). Supplies, the instruments and food had also to be brought and an advanced depot of food was placed at Ozero Taymyr. During the party's travels during this preliminary work, the aims of the expedition had not been forgotten. Comprehensive maps were drawn and animals, plants and minerals were collected.

The main journey northwards started from 74°N, on 16 July. The party drifted in the newly constructed boat down the Verkhnaya Taymyr as far as Ozero Taymyr. Middendorff bought a dugout and 'a small boat' from the Nenets and with these in tow, they moved slowly north along the western bank of the river. Thanks to 'the rapid current of the river' they succeeded in completing the passage of the Verkhnaya Taymyr in a week, on and entered the lake on 22 July. Rocky banks protected the travellers against strong winds, but very quickly they ran out of food as hunting and fishing proved unsuccessful. They had to make do with a scanty amount of dried bread and small portions of raw fish. They reached the

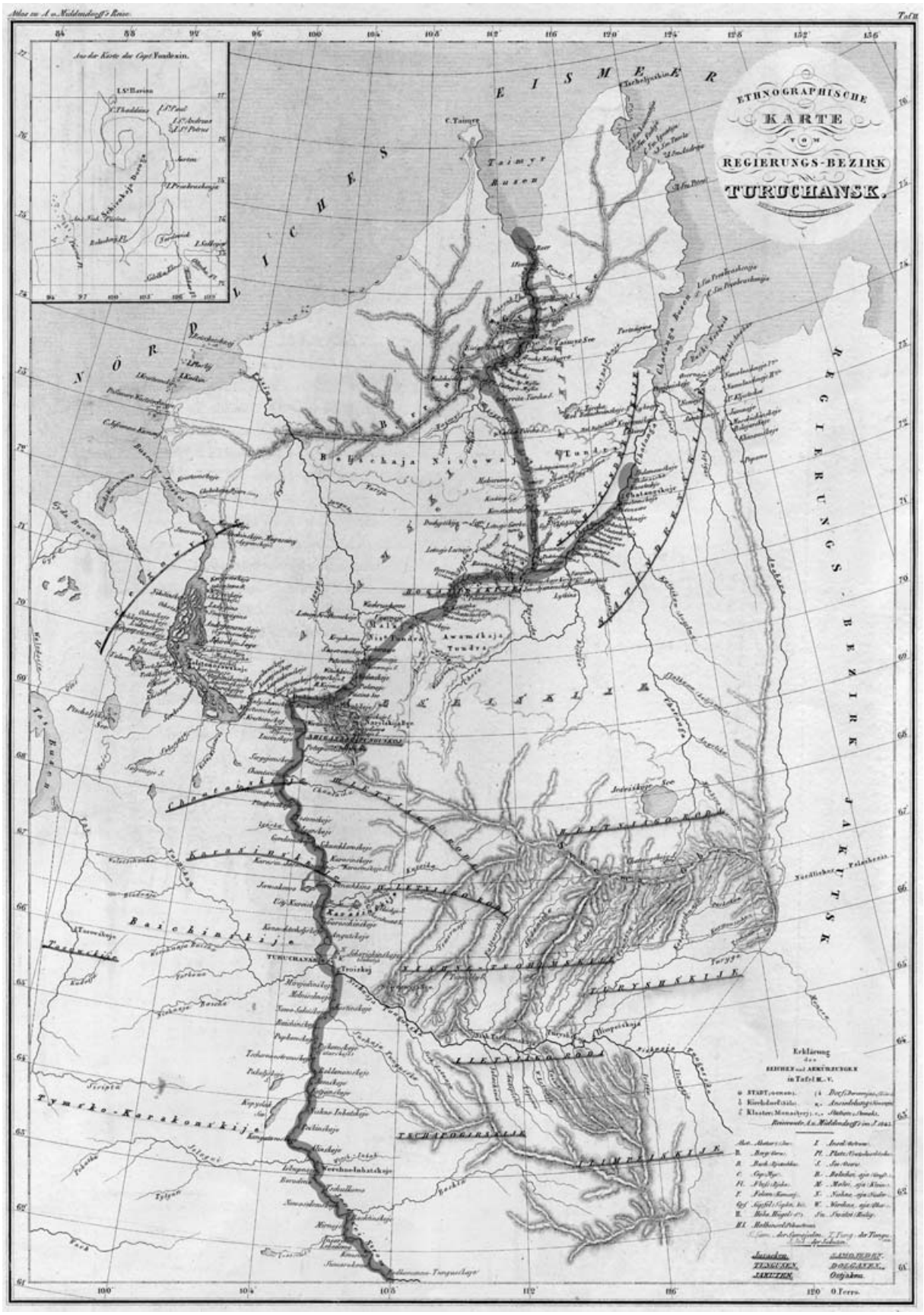

Fig. 2. Middendorff's map of his travels in the Poluostrov Taymyr. Middendorff 1859: Taf. II.

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entrance to the Nizhnaya [Lower] Taymyr river near a peninsula to which, on 8 August, Middendorff gave the name of Ernst von Hofmann (1801–1871), a geologist and friend. On Middendorff's birthday, 18 August, he spent one night in a cave in which approximately 100 hundred years before Laptev had done the same (Baer 1855: 144–145).

Having covered half the route, Middendorff discovered traces of man on 21 August. These were the remains of an axe handle, the cut-away tusk of a mammoth, and the jawbone of a horse. He concluded that Laptev had been there. He also found the remains of skeletons of mammoths, one mature and one juvenile, and he gave the place the name 'the bank of mammoths' (Baer 1855; 145; Barr 1993:178).

On 24 August, the party reached the Arctic Ocean, and immediately discovered an island in the Taymyrskiy Zaliv [Gulf], that Middendorff named after Baer. Middendorff made a great effort to continue northwards but after a short time the project had to be abandoned due to strong adverse winds and shoals. Having reached 76°N, the travellers had to return, 'weakened by hunger and cold, enduring inconveniences of different kinds such as those caused by the late season of the year' (Baer 1855: 146).

Progress southwards was complicated by silt in the water that impeded rowing, the ebb tide in the river, and the misty weather. Conditions were wretched and the men frequently had to disembark and wade in the freezing water (Baer 1855: 147). In addition, the nights became longer and colder. In ten days, on 5 September, the travellers reached the northern shore of Ozero Taymyr, but a heavy storm prevented them from moving on for several days. On 9 September, the storm suddenly ceased: 'It had hardly died out when blocks of ice coming from the upper Taymyr and covering the surface of the lake joined with new ice which adhering to the blocks began to freeze unbelievably quickly. With difficulty we managed to avoid the danger of being frozen in the middle of the lake. With great effort we reached the western bank of the river Taymyr opposite Mys [Cape] Lenz after the small boat had sunk, while the boat had been damaged by ice and filled with water' (Baer 1855: 149).

The travellers saved themselves but the collections that they had made were in the small boat. The place where the travellers had reached the shore was far from where the food supplies were stored. To reach this place, they had to construct sledges out of the boards with which the boat had been covered. This was the reversal of the operation they had had to undertake on the way northwards. There was, however, little snow and the sledges began to collapse very soon.

It was at this point, on 11 September, when circumstances were at their most severe, with winter rapidly advancing and food almost gone, that Middendorff made the decision that entitles him to a place in the very highest rank of explorers with regard to leadership. He decided to send his companions to find Nenets, leaving himself behind. It appears that he took this step since he was the weakest of the party and he believed that he would be an unnecessary encumbrance if he attempted to travel with the others. The aim was for them to return to rescue him once the Nenets had been found, and in the meantime he would be alone and starving. The consequences for Middendorff of a failure on the part of his companions to find the Nenets were obvious. He gave them the small amount of dried soup that remained and the meat of their trusty dog that was shot. This was serious since the dog was a valuable member of the expedition as it had been trained for zoological collecting. Middendorff was left alone on the shore 'sick, without shelter above (me), at the beginning of the Arctic winter, at 75°N latitude, subject to all severe attacks of foul weather' (Baer 1855: 151).

At this stage death was, quite literally, staring Middendorff in the face. He wrote to his family setting out his experiences:

> Almost twelve days had passed since my companions in misfortune departed. There was no hope for help. I was convinced that having been left all by myself, powerless, it meant as if I was buried. But I was still alive, as long as I was able to admire majestic mountains. Like our squirrels, I turned every day to the direction to which the wind was blowing: when the long sleepless night began, for me it opened the world of fancy, so that I even forgot about the hunger. A strong wind from mountain passes raved as if it was trying to throw me into the sky. Instead, unending blizzards whirled around me and soon I was completely covered with snow and entered into a dark night. I had no candles, so I was sitting there stock-still. A night followed a day, after that another day and another night, and when the third day was like the previous, I became frightened. Depression grew and grew. In the evening, maybe it was night already, anxiety seized me, and punishments as though in a dismal silent prison entered my mind. . . Inexplicable fear swept over me, I thought I would go out of my mind. Anxiety gripped my heart and it became unbearable. In vain I invented plans for escape: my brain became unidirectional and did not provide any other thought [except fear]. Suddenly an idea struck me like lightning from the sky. I hurriedly sacrificed the scanty remains of wood, thawed some three glasses of water from the snow before the beneficial fire died out again. I took the alcohol from one of the preparations, poured it into the water and drank. Having drunk it, I felt life anew rush in me. My thoughts again turned to people I loved, to the cloudless days spent with friends of my youth. Very soon I fell into deep sleep. How long I was sleeping, I do not know. When I awoke, I felt myself alive again. A feeling of gratitude warmed my heart. I took a needle from the surgical chest and made boots for myself from my fur-coat; the next day I finished the sledge and, having one white ptarmigan, I went to search for my companions (Middendorff 1843c).

Middendorff supposed that his companions had died, as 18 days had passed since they departed. However, his companions were not dead. They had soon encountered the Nenets who were waiting near the Verkhnaya Taymyr, but because of blizzards, they were delayed in returning to the place where Middendorff had been left. But as soon as possible the chief of the Nenets had set off, despite the atrocious weather, and Middendorff encountered him very soon after starting on his journey. Middendorff was extremely fortunate since his reserves of strength could not have lasted long. After this the party was soon reunited and the travellers proceeded to Korennoe Filipovskoye where they were reunited on 21 October with Branth and Fuhrmann (Baer 1855: 152).

A week later, the travellers started on the return journey. In Turukhansk, where meteorological observations were carried out, they spent over a month, from 18 November. Boxes with botanical and zoological collections gathered in Taymyr were sent to St Petersburg. After that, they travelled south by sledge and arrived in Krasnoyarsk on 14 January (Middendorff 1867a: 22). They stayed there only for two days and taking the Siberian route, headed towards Irkutsk. For part of the way from Krasnoyarsk to Irkutsk, Middendorff and his companions travelled together with a senator from St Petersburg, who had been given the task of carrying out an inspection in eastern Siberia. They stayed at Irkutsk for some time. There, Middendorff met Wilhelm Ruppert (1787–1849), the governor of eastern Siberia. As Middendorff had decided that it would be more efficient to travel together with the senator than alone because he had greater authority than Middendorff with regard to securing horses, they did not stay long in Irkutsk. Writing about the journey in one of his letters to Baer, Middendorff described himself as being 'pseudo-official' (Middendorff 1844a).

They left Irkutsk on 27 January 1844 and arrived in Yakutsk, the main destination of the expedition, on 18 February. There, it took no less than seven weeks to drill holes for thermometers in the Shergin shaft. Then, under Middendorff's personal supervision, geothermal observations began.

To the Sea of Okhotsk

At the same time, preparations were being made for a journey to the Sea of Okhotsk that was also part of the overall plan for the expedition. Middendorff tried to find a competent person in Yakutsk who could continue the observations in the Shergin shaft for the period during which the members of the expedition were exploring other parts of Siberia (Middendorff 1848a: 2–3, 98–101).

Here Middendorff observed a social problem. This related to immigrants to Siberia who had been made subject to a harsh regime of taxation. They were facing ruin and, although it was no part of his instructions, Middendorff took it upon himself to inform the Minister of Interior concerning the situation (Middendorff 1844b).

In the plans of the expedition, the Sea of Okhotsk had been touched upon only in the context of establishing the extent of the frozen ground in Siberia. In a letter to Uvarov in 1841, after having explained the necessity of carrying out investigations in Yakutsk and northern Siberia, Fuss noted: 'The solution of all the tasks set [the expedition] requires at least three years. It requires one winter for travelling to Yakutsk, one summer for travelling from Yakutsk to the Arctic or the Sea of Okhotsk, and returning to Yakutsk, performing repeated observations with the thermometers placed in the earth; one winter for travelling to Turukhansk, one summer for travelling to the Arctic Ocean to the mouth of the Khatanga, and one winter for returning, but in any case, the traveller must be presented with the possibility of using his time as he considers most convenient for himself and most suitable in the circumstances' (Fuss 1844).

On Baer's initiative, Middendorff changed the plan radically, making the route more rational and saving time for going to the Sea of Okhotsk. From Vvedenskoye, where they stayed for the winter, Middendorff had sent Fuss the budget for such a trip. He asked Baer to take steps to ensure that the money would be sent without delay. Later Middendorff wrote to Baer, 'Udskoye seems more and more important to me, so I am firmly determined to go there, even if the Academy will not provide me with money' (Middendorff, 1844b).

In the Academy, the question of including the Sea of Okhotsk in the expedition was placed on the agenda in 1844. In January, at a meeting of the Department of Physics and Mathematics, Middendorff's letter containing a report on the expedition up to the summer of 1843 was read to the participants. In this letter, dated 31 October, he informed the Department concerning his earlier intention to visit the fortress of Udskoye and applied to the Academy for extra money for the trip (Baer 1855: 104–105). In this connection, the vice-president of the Academy of Sciences, Mikhail A. Dondukov-Korsakov (1794–1869), applied on behalf of the Department of Physics and Mathematics to Uvarov at the end of January 1844. He wrote in his note: 'The most difficult and dangerous part of the expedition von Middendorff has performed with an accuracy and assiduity which exceeded all the expectations of the Academy, and with such success, as concerns scientific results' (Dondukov-Korsakov 1844: 88v). In the subsequent passage, he wrote that the Academy would provide Middendorff with additional means for scientific investigations on the coast of the Sea of Okhotsk if the observations into permafrost in the Yakutsk shaft proved successful. 'The environs of the Udsk fortress and Shantarskiye Ostrova [Islands] border a totally unknown region of the Amur and the Sea of Okhotsk equally unknown with regard to natural science. Even a few data on the climatological conditions of the region would be extremely important as at present the knowledge of this is most superficial. . .' (Dondukov-Korsakov 1844: 89v–90). The Academy of Sciences asked Uvarov to apply to the Emperor for

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permission to provide extra funding (5,000 silver roubles) for the continuation of the expedition. The permission was given, and the Ministry of Finance also approved the expenditure.

Middendorff, however, did not wait until official permission was given. Accompanied by two Cossacks and two Yakuts, who were able to build leather 'canoes', Middendorff and Fuhrmann headed for Amga on 7 April 1844 with the aim of moving on to Udskoye. Branth and Vaganov had departed from Yakutsk earlier, on 2 April, taking the instruments and indispensable supplies with them. To travel on the Sea of Okhotsk, they had to have with them ropes, anchors and leather to cover the boat, and also a great amount of food. This was because it was known that the area was sparsely inhabited and Middendorff could not be sure that food would be forthcoming from local people. The supplies were transported on sledges hauled by oxen, adding another to the long list of different modes of transport used by the expedition.

Middendorff and his companions travelled by post horses. At the beginning they made rapid progress. According to Middendorff, 'the road was ideal, trodden smooth, the perfect horses of the Yakuts living here rushed with us from post station to post station... In winter, the ice and snow cover of the ground relieves the travellers from making detours for marshy places, and the streams and lakes in which this route is rich...' (Middendorff 1867a: 24).

After Amga, however, the road changed considerably. It passed through an upland area, where high mountain ridges alternated with river valleys that included either rocky banks or marshy lowlands with numerous lakes and rivers. In summer, horses could cross the rivers at fords, but in spring these rivers were in spate. It was possible to move only by packhorses and the transport of the cargo became more complicated. Many pack and reserve horses were needed (Middendorff 1845a: 19–20).

Having overcome all the difficulties of the route, the travellers arrived at Udskoye on 9 June. There, the Yakuts covered the frame of the boat with leather, and the whole party sailed on the 'canoe' down the River Uda to the Sea of Okhotsk. Because of the strong winds, the travellers could not enter onto the sea for several days. Middendorff had to admit, sadly, that the area seemed to offer little scope for the naturalist. At last, thanks to the efforts of the large and enthusiastic team of helpers recruited by Middendorff, they were able to go to the Shantarskiye Ostrova. In a letter to Baer, Middendorff described his team as comprising '... one Dane, one Russian German, four Russians from Omsk, Nizhni-Kolymsk, Izhiginsk and Yakutsk, one Estonian, one Tungus and four Yakuts, among them one deported, one of the intelligentsia, one porter.' If there had been any alcohol, this team, according Middendorff, could have been very difficult to manage. But to thank them for good job, and, appreciating the realities of life in Siberia, when the investigations in the Shantarskiye Ostrova were complete, he delivered to each of his companions a double allowance of vodka (Middendorff 1844c).

To the Amur region

Having returned to the mainland, Middendorff sent Branth and Fuhrmann back to Udskoye. Branth with the collections had to return to Yakutsk in order to guarantee that the observations in the Shergin shaft would continue, while Fuhrmann had to stay in Udskoye to carry out meteorological observations. Middendorff and Vaganov travelled in a two-oared boat to the mouth of the River Tugur. From there they continued by reindeer to the territory of the Kilyak people then on a light boat belonging to a group of Kilyaks they sailed across Tugurskiy Zaliv [Bay]. Middendorff hoped to reach the mouth of the Amur, which according to local Kilyaks was at a distance of a three-day journey. To Middendorff, however, the distance appeared to be further than that and as there was not much time left until the end of the expedition, Middendorff returned to the mouth of the River Tugur (Baer 1855: 259–260; Sukhova and Tammiksaar 2005: 48).

From there, on 20 September 1844, Middendorff and Vaganov, accompanied by local Yakuts, headed west along the southern slope of the Stanovoy range, across the mountains and through 'dark virgin forests'. Moving on reindeer provided by the Yakuts, or on foot, the travellers reached the River Nemilen (a tributary of the Amgun), then passed the Bureiskiy range and reached the place where the headwaters of the Bureya approached those of the Selemdzha. On 15 November, they crossed the Selemdzha and headed for the River Zeya. They entered the river downstream of the place where the River Gilyuy debouched into it, sailed through a lake to the mouth of the Gilyuy, then ran down the Zeya through the steep gorges in the mountains. From this river system they crossed to the Amur drainage basin and, on 14 January 1845, reached the outpost of Ust-Strelochniy located near the confluence of the Rivers Shilka and Argun where the Amur takes its origin. From Ust-Strelochniy, travelling along the post highway via Nerchinsk and Kyakhta, Middendorff and Vaganov arrived in Irkutsk on 3 February (Middendorff 1867a: 26–27). Branth was waiting for them. On 20 March 1845, Middendorff and Branth returned to St Petersburg (Sukhova and Tammiksaar 2005: 48–49).

Middendorff's map of this area is illustrated in Fig. 3. This provides sufficient testimony to his great skill as a surveyor and cartographer in extraordinarily difficult circumstances.

The end of the expedition

The investigations, however, were not finished. From 1 May 1844 to 1 September 1845, Fuhrmann had performed meteorological observations at Udskoye. Then, until 1847, at the request of the Academy of Sciences, he carried out geothermal observations in Yakutsk, Vitimsk and Olekminsk. Geothermal observations in the Shergin shaft in Yakutsk were performed by Dmitriy P. Davydov, a permanent inspector of schools of the Yakutsk district,

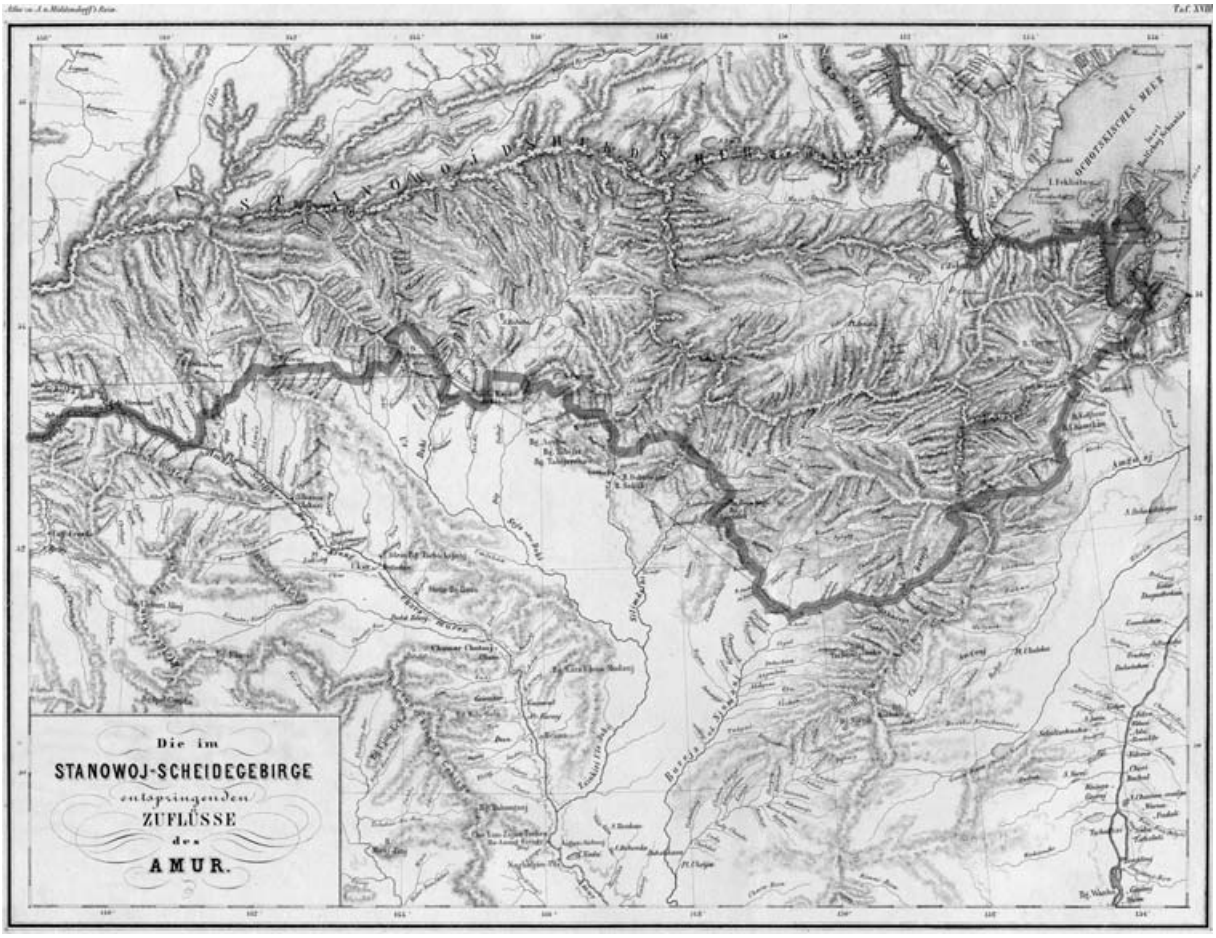

Fig. 3. Middendorff's map of a section of the lower Amur River. Middendorff 1859: Taf. XVIII.

'who was included in the staff of the northeast expedition as a researcher'. According to Branth's instructions, Davydov was to despatch the boxes containing the expedition's collections and instruments to St Petersburg. Here bureaucracy struck. The post-office refused to receive the boxes, as each of them weighed more than a pood (16.38 kg or 36 lbs), which was 'contrary to the postal laws'. So, the boxes had to be unpacked and the material sent in smaller packages (Sukhova and Tammiksaar 2005: 49).

Middendorff had regularly informed Baer and the Academy of Sciences concerning the progress of his investigations in Siberia. His letters and reports on the expedition were published in the bulletin of the Academy of Sciences, their contents were reported in the proceedings of the meetings of the Department of Physics and Mathematics, and were also published in the journal of the Ministry of Public Education. In his report on the activities of the Academy in 1844, Fuss provided an overview of the history and results of the expedition. Articles about Middendorff's progress were published by Baer and one of these, translated by Adam Johann von Krusenstern (1770–1846), was published in the journal of the Royal Geographical Society in London (Krusenstern 1844).

On 21 May 1845, after Middendorff's last letter had been reported, Baer was entrusted with the compilation of an account of the expedition for publication and presentation to the Emperor. On 25 March, Uvarov informed Nicholas I that the Middendorff's expedition had been successfully completed.

On the basis of Baer's account, Fuss prepared an extensive report for Uvarov. This review was used in the report presented to the Emperor on 5 April 1845. The question of possible honours to be awarded to the travellers was also touched upon in the report. Uvarov stressed that participants in marine expeditions were usually awarded orders and money, but the expedition to Siberia was more complicated than those, thereby hinting that more exalted titles would be in order. He suggested that Middendorff be awarded the order of St Vladimir of the 4th class, Branth the order of St Anna, and also that application be made for an award to Vaganov through Friedrich Wilhelm Rembert von Berg (1794–1874), the Chief of Staff of the General Headquarters of the army. The Emperor approved the awards and wished to read a brief account of the trip compiled by Middendorff personally. As required by Fuss, Middendorff compiled 'A brief account of the expedition to northern Siberia' and, on 23 April, Uvarov presented it, after revision by Baer and

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Fuss, to Nicholas I. Having learned the details about the expedition, the Emperor wrote on the manuscript 'Very interesting' and 'the bravery and determination [of the participants] deserve honour in every respect' (Sukhova and Tammiksaar 2005: 51).

On 7 April, that is before Nicholas I had received the brief survey of the expedition, the collegium of the Russian Empire and Tsarist Decorations had received an ukase from the Emperor concerning the awards to Middendorff and Branth. In addition to the order of St Vladimir, Middendorff was awarded 400 silver roubles per year in addition to his salary commencing on 5 April 1845 until the end of his service at the Academy of Sciences. Uvarov informed Fuss about the awards on 11 April and Middendorff, apparently, learned about them almost at the same time (Fuss 1845).

During the expedition, Middendorff had covered approximately 20,000 km**,** had explored extensive areas which investigators had never visited before, and had successfully accomplished the main tasks of the expedition. This may be concluded from a note of Fuss to Uvarov after the traveller had returned to St Petersburg: 'All these three objectives are so important in terms of knowledge of the physical relations on the Earth that any of them separately would have deserved a special expedition; but all three were entrusted to Middendorff... the investigation of the second and the third, in circumstances of extreme difficulty, could only have been successful with unusual physical and intellectual virtues, and such steadfast firmness that, as we know, are characteristic of our traveller' (Fuss 1845).

Scientific results of the expedition

According to criteria of evaluation that remain valid to this day, the quality and quantity of the scientific results of Middendorff's expedition are worthy of the highest praise. In this context it is essential to recall that the expedition was not large, indeed quite the opposite, since it had only four permanent participants, and it was not of long duration since scientific observations were only carried on in two years, 1843 and 1844. The sheer volume of the collections of specimens secured was impressive. In addition, much statistical data, archival materials and maps on the economy and history of Siberia were recorded from nine towns as well as from enormous areas of the countryside. Middendorff and his colleagues (19 German, Russian and Swedish scientists) required over ten years to analyse these data, although Middendorff, himself, was perhaps not at his best when undertaking this type of work. The data were published in three volumes *Reise in den äussersten Norden und Osten Sibiriens während der Jahre 1843 und 1844 mit allerhöchster Genehmigung auf Veranstaltung der Kaiserlichen Akademie der Wissenschaften zu St. Petersburg ausgeführt und in Verbindung mit vielen Gelehrten.* These three volumes contained six independent monographs (depending on the general structure of each monograph named parts or fascicules) and were written by different scientists. (Böthling 1851, 1853; Middendorff 1848a, 1851a; Ruprecht 1850; Trautvetter 1847; Trautvetter and Meyer 1855). All together 2242 pages were printed and 100 copper plates were prepared. The publication of this work, however, did not mean that the task was completed. In 1859, Middendorff began to make preparations for publishing a fourth volume as single author. In this, he made an attempt to generalise and to compare the results obtained with the latest results of other researchers in order to establish interrelations between organic and inorganic environmental components, and man and nature in Siberia. Volume 4 of the monograph consists of seven independent parts, each of which can be regarded as a separate monograph. These comprise 1694 pages and 16 copperplates (Middendorff 1860d, 1861, 1864, 1867a, 1867b, 1874, 1875).

For convenience, the results of the expedition may be classified under the following headings

Cartography

Middendorff was deeply interested in the history of cartography in Siberia. He undertook a major study of the history of the exploration of Siberia, making use of maps and drawings from the earliest times to the maps of the 18th century held in the Department of Geography of the St Petersburg Academy of Sciences. He compared these works with his own results. Middendorff, who was, himself, an excellent cartographical draughtsman, published his topographical data under the title *Karten-Atlas zu Dr. A. v. Middendorffs Reise in den äussersten Norden und Osten Sibiriens* as an appendix to his monograph (Middendorff 1859). This atlas, comprising 18 sheets, contained much new information about the physical geography of the Taymyr Poluostrov [Peninsula]. He, for instance, renamed the peninsula, earlier called Taymur, giving it the name Taymyr, the name used by the local people (Baer 1844b: 59). Middendorff also made additions to the maps of the inner regions of the peninsula. Thanks to his trip along the river Taymyr as far as Taymyrskiy Zaliv, the Byrranga mountains, the upper and lower courses of the Taymyr river and the western part of Ozero Taymyr were plotted on the map to a remarkable degree of accuracy considering the very difficult circumstances of the journey (Fig. 2). Middendorff followed the practice of explorers, both before his day and after it, of naming the features of this route after his friends. For example, Ostrov Béra [Baer Island] appeared in the map of Taymyrskiy Zaliv. Middendorff renamed the northernmost cape of Asia, earlier known as Mys Severo-Vostochniy, giving it the name Mys Chelyuskin in honour of the Russian naval officer, Semen Chelyuskin, who first reached that point in 1742 (Middendorff 1845b: 152, footnotes 1–2). This is the name it retains today. The cape that until then was known under the name Mys Severo-Zapadnyi, Middendorff renamed Mys Taymyr.

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Middendorff's first sheet, that was intended to represent the general geography of Siberia, is absent from the atlas. This omission is because the Russian Military Topographical Depot was intending to publish a new improved general map of Siberia in 1860, and Middendorff, quite justifiably, assumed that the cartographical data collected during his expedition on Taymyr peninsula would also be used in the drafting of that map (Middendorff 1859). But, in the event, a general map of the Asian part of the Russian Empire by F.I. Pozniakov, that had been published in 1825 was used for the Taymyr Poluostrov. An irony here is that, due to the influence of the great German cartographer August Petermann (1822–1878), Middendorff's geographical names started to be used in German and English maps as early as 1850–1854, much sooner than they were generally adopted in Russia (Sukhova and Tammiksaar 2005: 193–194).

A further point is that this adoption in Russia of Middendorff's names took place in unofficial maps much sooner that it did in official ones. In the 1870s, Russian maps appeared in which Mys Chelyuskin, for instance, was indicated, but the central cartographic institution of the Russian Empire, the Military-Topographical Depot, did not incorporate Middendorff's results in maps of Russian Asia. Thus an important map published in 1874, retained the old usage. It was only after the famous *Vega* expedition of Adolf-Erik Nordenskiöld (1832–1901) in 1878–1879, that the cartographical data on Taymyr collected by Middendorff were, at last, included in the official maps of Russian Siberia. That, unfortunately, took place not thanks to Middendorff but to Nordenskiöld (Selander 1882), since it was his maps and not those of Middendorff, which the Topographical Depot used in redrawing the maps of Taymyr. This is the reason why, in Russia, Nordenskiöld was considered the person responsible for attaching the name of Chelyuskin to the northernmost cape of Asia. Such misunderstanding existed even in the 20th century. It was only in 1958 that an article was published in Russia that mentioned Middendorff as the author of the name of Mys Chelyuskin (Sukhova 1958).

Climate

During the expedition to Siberia, meteorological observations were continuously carried out and previous handwritten and published records on the climate of Siberia were collected. Russian meteorology owes much to the members of the Middendorff expedition. Branth and Fuhrmann carried out the first long-term systematic climatic observations at Korennoe Filipovskoye (in Taymyr) and Udskiy Ostrog (on the Sea of Okhotsk). Having analysed all the data obtained, Middendorff devoted the third part of the fourth volume of his monograph to the problems of the Siberian climate that had been, until then, little studied (Middendorff 1861).

Although investigators had long been aware of the severity of the Siberian climate, Middendorff was the first to use the term 'poles of cold' in scientific terminology and, on the basis of the meteorological data available, considered Yakutsk the 'pole of cold' in the world (Middendorff 1861: 336). He reached the conclusion that the severity of the Siberian climate was not so much determined by the absolute altitude of Siberia above sea level, as had been thought by the great botanist Johann Georg Gmelin (1709–1755), with Heinrich Wilhelm Dove (1803–1879) and Alexander von Humboldt (1769–1859) concurring, as by the geographical peculiarities of the territory. The northern part of Siberia is open to northerly winds, with high mountain ranges in the southern part that prevent the ingress of warm winds from that direction. Furthermore, the Sea of Okhotsk, off the east coast of Siberia, very similar to the Arctic Ocean in that it is almost surrounded by land, assists in increasing the severity of the climate. According to Middendorff, the Ural mountain range was not a big obstacle to air masses coming from the Atlantic Ocean, but when the warm air reached western Siberia, it had lost most of its effect in mitigating the local climate (Middendorff 1854: 131–155, Middendorff 1861: 334–365).

Analysing the climate of Taymyr Poluostrov, Middendorff shared Baer's view on the Kara Sea as an 'ice cellar' and pointed out that the climate of the northern part of Taymyr was, because of the influence of that sea, almost as severe as that of Yakutsk (Tammiksaar 2002a; Tammiksaar and Stone 1997; Tammiksaar and others 1999).

The conclusions arrived at by Middendorff concerning the climatic conditions in east Siberia are well known today, but at the beginning of the 1860s they were novel and Middendorffs monograph was the first extensive survey of the climate of the region.

Permafrost

One of the important goals of the expedition was the collection of data on Siberian permafrost and the undertaking of geothermal observations in the Shergin shaft in Yakutsk (Tammiksaar 2002a: 127). Middendorff admitted in his monograph that this obligation did not fascinate him. However, being a conscientious person, he tried to answer the questions contained in the instruction *Materialien zur Kenntniss des unvergänglichen Boden-Eises in Sibirien* (1843) drawn up by Baer (Baer 2001) as precisely as possible (Middendorff 1848a: 83–183, 1861: 414–519). The results obtained in the investigation of permafrost confirmed the hypotheses derived by Baer, and refuted the suggestions of several scholars that forests did not grow in areas of permafrost.

Middendorff was the first to determine the geothermal heat flow in permafrost using the observations in the Shergin shaft. According to him, the thickness of permafrost at that location was 117 feet, or 30–35 m, the greatest thickness of permafrost in Yakutsk being approximately 180 m (Middendorff 1848a: 178). Middendorff considered the presence of permafrost in Siberia to be a normal phenomenon, taking into account the average annual air temperatures. However, such thick permafrost

as recorded in Yakutsk, was an exception rather than the rule. According to Middendorff, the thickness of the permafrost at a particular locality depended on the thermal conductivity of the geological layers present, on the type of relief and vegetation cover, and on the average annual air temperature in the locality considered.

He disagreed with Baer, whose concept was that permafrost was simply frozen water in the soil and Middendorff declared that dry soil could also freeze. In 1848, mainly on the basis of Baer's data, Middendorff fixed the southern boundary of permafrost in Siberia (Middendorff 1848a: 158–168). In addition, Middendorff was the first to indicate correctly the reasons for the origin of *Aufeis*, currently defined as 'a sheet-like mass of ice either on the ground surface or on the surface of river ice' (Brown and Kupsch 1974) or as 'a sheetlike mass of layered ice formed on the ground surface, or on river or lake ice by freezing of successive flows of water that may seep from the ground, flow from a spring or emerge from below river ice through fractures' (Permafrost Subcommittee 1988). These arise from the formation and development of extensive sheets of ice in permafrost areas, in cases in which a river freezes to the bottom in a shallow reach downstream from a deeper reach, causing the water to overflow the ice already formed, and to freeze in successive layers, thereby increasing the ice thickness.

He also introduced appropriate terminology into the scientific literature on permafrost (Middendorff 1853b). Following Baer's instructions, Middendorff described precisely other surface forms observed in regions of permafrost, such as underground springs, dried-up lakes, special characteristics of rivers, etc. (Middendorff 1861: 437–477).

Despite the fact that permafrost was an area of science previously unknown to him, Middendorff did not have cause to regret his work on the subject. His investigations earned the special attention of European scholars (Humboldt 1858: 42–47, footnote 167–169). He has been regarded since then as the first investigator of permafrost in the world because Baer's earlier and profound study of the topic has remained unpublished.

The glacial era in Siberia

In the first half of the 19th century, the theory of ice ages, under which ice sheets were envisaged as covering large areas in Europe, began to spread in scientific circles due to the studies of the Swiss scientists Jean de Charpentier (1786–1855) and Louis Agassiz (1807–1873). As Baer who had worked intensively for several years to prove the validity of the theory of ice ages (Tammiksaar 2002a: 131–132), considered Siberia to be of key importance, Middendorff was to search for traces of such events during his expedition. Middendorff discovered erratic boulders and glacial scorings on the rocks in Taymyr Poluostrov, but he believed them to be a result of the effect of sea ice, as he discovered evidence that the Arctic Ocean had covered a more extensive area in the past. Besides, the then commonly held view that the continental climate characteristic of the area had not changed considerably for a long period of time, and that, consequently, there had been no glaciers in Siberia, refuted the theory of the glacial era in the region. Taking into account all these facts, Middendorff reached the conclusion that there had been no glacial era in Siberia (Middendorff 1861: 436–439).

That conclusion was accepted by Baer and by other Russian geologists towards the second half of the 19th century. In the 1860s, however, several geologists were making efforts to find traces of the glacial era in Siberia, but in contrast to Middendorff, they found them. Duke Petr Kropotkin (1842–1921) who, in his important monograph *Studies on the glacial era* (Kropotkin 1876), stated that glacial eras had existed in Siberia, was one of the most prominent among these scientists. From that time, questions concerning the glacial eras in Siberia have frequently given rise to scientific discussion, but a unanimous position has not been reached. In the 1930s, glaciologists became convinced that Taymyr had indeed been covered with continental ice, but studies in the 1990s indicated no traces of it in that area (Svendsen and others 1999).

Flora

During his expedition, Middendorff and his companions (and especially Fuhrmann) took every opportunity to collect new plant specimens, observing carefully the conditions under which each grew. The material was later added to the collections of the St Petersburg Botanical Gardens becoming the basis for special studies on the flora of Taymyr Poluostrov, on the algae of the Sea of Okhotsk, on the flora of the area between the Aldan and the Sea of Okhotsk, and on the lichens of the whole area covered during the expedition (Sukhova and Tammiksaar 2005: 212). These investigations increased knowledge of the species composition of the eastern Siberian flora. Several new species were discovered during the expedition and some of these were named after Middendorff himself. A few of these were plants of considerable size, for example, a species of birch, Middendorff birch (*Betula middendorffii*) (Borodin 1908: 80).

Middendorff devoted the first part of the fourth volume of his monograph to the vegetation cover of Siberia (Middendorff 1864). This is certainly to be considered the first investigation of its kind in Russia. Special attention is paid to the northern boundary of the Siberian forests. Middendorff tried to explain the climatic and other physical phenomena upon which it depended. The observations indicated that the northern boundary of the forests could be regarded as linked to latitude, but that the distribution of plant species did not depend on the longitude. Analysing the data available on the western part of the Russian Empire and the northern boundary of forests in North America, Middendorff concluded that, in Siberia, the distribution areas of different tree species varied by latitude, while single specimens of a species could be encountered beyond the generally

accepted northern boundary of the species. Considering the genus larch (*Larix*) (for example, Dahurian larch (*Larix dahurica*) and Siberian larch (*Larix sibirica*)) the most widespread tree species in Siberia, of which single specimens and even whole forests could be encountered in very far northerly regions, Middendorff easily established the northern boundary of forests in the region. This, in turn, depended on the average air temperature in summer in the area in which larch grew, the extent to which there was protection from northerly winds, on the amount of direct solar radiation, on the relative fertility of the soil and on the water holding capacity of the soil. Taking into consideration these factors, it appeared that river valleys proved most favourable for the growth of these trees; in some places the boundary almost reached the coast of the Arctic Ocean. In watershed areas the situation was the direct reverse (Middendorff 1864: 527–541).

In his monograph, Middendorff paid much attention to the types of tundra in Siberia. He was the first to make an attempt to classify them. He refuted the concept accepted in the contemporary scientific literature that bogs were characteristic of tundra. He discovered that, in Siberia, tundra could also occur in uplands. With this in mind, he classified tundra as high or low. He divided high tundras, in their turn, into haircap (*Polytrichum*) and lichen tundras, and low tundra into peat moss (*Sphagnum*) and higher peat moss (*Sphagnum*) tundras; that is those that were the infillings of lakes. Middendorff compared steppe to tundra, as the reasons for the origins of each were considered similar in the 18th century. Middendorff disproved such a view: while steppes came into being due to dryness, tundra came into existence because of the lack of warmth. That is why steppes are encountered only in the areas of continental climate, but tundras in areas both of continental and of maritime climate (Middendorff 1864: 724–741).

Besides aspects of plant geography, Middendorff, having a keen personal interest in agriculture, devoted much attention to it with regard to Siberia. He established which plants were cultivated in that region and provided recommendations concerning which plants could be profitably grown in the more northern areas. The determining factors affecting agricultural possibilities in Siberia were related to the continental climate (Middendorff 1864: 700–701, Anhänge I–III**).**

Although Middendorff's treatment of the Siberian plants was written before the term ecology was introduced, he devoted a long chapter of it to the solution of what are now recognised as ecological problems. It is interesting to note that there has been little or no recognition by plant ecologists of his work in the development of their subject. Middendorff's name is mainly associated with the beginning of investigations in animal ecology (Warming 1896; Grisebach 1872).

Fauna

The investigation of the fauna of Siberia was the most attractive obligation of the expedition for Middendorff personally. He published 23 papers on the Siberian fauna in the proceedings of the St Petersburg Academy of Sciences and devoted four volumes of his monograph to this topic (Middendorff 1851a, 1853c, 1867b, 1874). He described species of different mammals, molluscs, crustaceans, amphibians, birds and insects on the basis of the collections given to the zoological museum of the Academy. Of special interest to contemporaries were his papers on molluscs.

Analysing data on molluscs throughout the world on the basis of the available Russian, German and British collections, Middendorff founded the science of malacozoology and wrote about its development in the Russian Empire (Middendorff 1847–1849, 1848b, 1851a: 163–463). Augustus Addison Gould (1805–1866), the noted American zoologist, wrote to Middendorff that, thanks to his investigations, the species of molluscs of the northern part of the Atlantic and Pacific Oceans might be compared (Gould 1849). Largely owing to these investigations on molluscs, Middendorff was elected an extraordinary member of the St Petersburg Academy of Sciences in 1850 and a full member in 1852. His investigations on molluscs were topical even in the twentieth century when, in 1926, interest was again focused on the molluscs of the Sea of Okhotsk (Sukhova and Tammiksaar 2005: 227).

A very important contribution to zoology was Middendorff's investigation of the brown bear (*Ursus arctos*) in Eurasia. In the 19th century, several specific morphological characteristics of bears used in their classification were discovered. Middendorff analysed the anatomy of the brown bear, its specific age characteristics and its appearance on the basis of collections in museums, personal observations and archaeological finds. He concluded correctly that, in the whole territory of the Russian Empire, there was only one species of brown bear (Middendorff 1851b, 1853c: 4–68).

Middendorff based his analysis of the species composition of the Siberian fauna on environmental conditions. He was convinced that the geographical distribution of an animal species started from a certain locality, and, depending on environmental conditions, the distribution area either increased or decreased. Regarding this supposition as a basic principle of zoogeographical distribution, Middendorff introduced the terms that, in modern conception, denote circumpolar and boreal zones.

To investigate zoogeography in Siberia, Middendorff devoted much attention to the reasons for the presence or absence of certain animal species in various areas. He also pointed out the role of man in the diversity of animal species stating that there existed a balance in nature that could be altered only by man. Proceeding from this, he put forward several proposals concerning the protection of different animal species throughout the world (Middendorff 1874: 829–875). It need hardly be mentioned how much in advance of his time were these ideas.

In addition to the analysis of the reasons for the extinction of species, Middendorff was also interested in migration. In his opinion, migration was evoked by the scarcity of food in a distribution area, by dry air, by cold, by the type of relief, by the destruction of forests, and by the activities of man. Investigating the reasons for the migration of seasonal species, Middendorff paid special attention to the migration of birds and published an important study, *Die Isepiptesen Russlands* (Middendorff 1855). Under *Isepiptesen*, Middendorff regarded similar migration routes used by different bird species. An analysis of bird migration including the starting and destination points, and the conditions of the areas covered enabled Middendorff to determine the main direction of bird migration in Siberia. He concluded that birds migrating to Taymyr moved along the meridian from south to north, in Europe, from southwest to northeast, and in eastern Siberia from southeast to northwest. He drew a conclusion that the migration route, in its turn, depended on major geographical forms like mountain ranges, the coastline of the sea and the magnetic waves of the earth, which birds used in navigation.

The number of questions that Middendorff tried to answer in his investigations of the Siberian fauna, or in which he took the initial steps, is remarkable. Perhaps the most surprising aspect of this is the fact that of his studies, the greatest international attention was directed towards his writings on the migration of birds. Nevertheless, Middendorff is definitely to be considered among the scholars who laid the foundations of the science of zoogeography in the Russian Empire and several of his conceptions are valid even in the present century (Yurgenson 1961).

He has one important bird species named after him, Middendorff's grasshopper warbler, *Locustella ochotensis*. A notable ornithological achievement of Middendorff was that he was the first to find the nests and eggs of the grey plover (*Pluvialis squatarola*) and the little stint (*Calidris minuta*) (Barr 1993: 184).

Mammoths

Naturalists began to take an interest in questions concerning mammoths as early as the 18th century, but of special importance were the finds of the 19th century that can be ascribed to the development of the sciences of geology and palaeontology. Middendorff discovered the remains of a mammoth in 1843 when he was travelling along the Nizhnaya Taymyr river. At the end of the 1850s, he began to analyse the material he had collected. He compiled an historical review of all similar finds in Siberia concluding that, in the past, mammoths had lived in the central and southern regions of Siberia, in climatic conditions quite similar to those of his time (Middendorff 1860b, 1860d). They became extinct not simultaneously as the supporters of the theory by Georges de Cuvier (1769–1832) had declared, but this happened over thousands of years due to the gradual cooling of the Siberian climate. The skeletons of mammoths, however, had been carried from their living areas northwards by the Siberian rivers. Middendorff was not seeking an answer to the questions of when and how the dead bodies of mammoths had become frozen, but he considered himself the first to state correctly that the remains of mammoths had been preserved thanks only to permafrost (Middendorff 1860b, 1860d: 281, 289). On this point Middendorff was wrong, as the priority for this view actually belonged to Baer who, in the instructions concerning Siberian permafrost compiled for Middendorff before the expedition, analysed this problem in detail (Baer 2001: 100–101). One is led to wonder why Middendorff made this claim when its refutation was in a document specifically directed at him. It is possible that Middendorff overlooked Baer's point or that he simply had not read it. One possible interpretation is that Middendorff wanted to usurp his mentor in this respect, knowing that Baer's priority was included in a private document, but as Middendorff had the highest personal integrity, this seems most unlikely.

Studying the history of the finds of the remains of mammoths in Siberia, Middendorff noticed that new finds were recorded at an interval of approximately 30 years. As each find was very important from the scientific point of view, Middendorff compiled, on behalf of the Academy, a special circular for the inhabitants of Siberia, in which there was a promise of financial compensation for information on finds (Middendorff 1860c). Encouraged by the circular, the local people provided much useful information. Among the important examples was a mammoth find in 1866 in the estuary of the Taz river (Baer 1866), and the famous Berezov mammoth in 1901 (Sukhova and Tammiksaar 2005: 271–273).

Ethnography

The expedition provided much material for ethnographers and linguists concerning unknown or little known nations and their customs. These included peoples such as Nenets, to whom Middendorff owed his life, Dolgans, Ostyaks, Yakuts, Tungus (Evenki) and Kilyaks (Nivkhi).

When Middendorff was collecting material in Siberia, ethnography as a scientific discipline was taking its first steps in Russia under the leadership of Baer (Tammiksaar 2002b). It began to progress more quickly when the Russian Geographical Society was founded in 1845. Middendorff, like Baer, considered that the investigation of the small nations living in the Russian Empire was very important. Due to the inherent conflict between them and the Russians, who were promoting a Russification policy, much data about these nations had been lost to science and there was great danger that the situation would deteriorate further as the nineteenth century proceeded. During the expedition, Middendorff collected numerous specimens of tools, fishing gear and festive adornments used by the people among whom he travelled. A major collection of these has been preserved in the Estonian National Museum in Tartu, which came into possession of them after Middendorff's death. He also collected songs and fairy-tales of the Siberian nations, described their

wedding and funeral customs, their attitude to children, and to justice and injustice. Middendorff also brought with him skulls and analysed the relations between physical anthropology and ethnography (Middendorff 1875).

Middendorff's writings on ethnography have been summed up as follows: 'Informally written, they remain unique in Siberian literature for their empathy with native views, their intimacy, and their lively descriptions of interactions' (Shimkin 1990: 39).

The linguist Otto von Böthlingk (1815–1904), member of the St Petersburg Academy, used the Tungus and Yakut words collected during the expedition in his grammar of the Yakut language and his Yakut-German dictionary (Böthlingk 1851, 1853).

Middendorff's successors

Although Middendorff did not lay the foundations of any particular school of thought, his investigations, and also his personality, set an excellent example for several investigators of the geography of the Russian Arctic. For many years it appears that Middendorff's opinion had to be sought concerning any projected expedition in the regions that he had studied so carefully.

Middendorff had had close contacts with the Baltic German geologist Friedrich Schmidt (1832–1908) of whom his wife was a distant relative. Largely owing to Middendorff, Schmidt became the leader of an expedition of the Russian Geographical Society to the Far East that lasted from 1859 to 1863 (Sukhova and Tammiksaar 2005: 116–117). During this expedition, the entire Amur river basin and the island of Sakhalin were studied in detail. Schmidt also guided an expedition of the Academy to the Taz estuary in 1866. This had the task of transporting the body of the mammoth found there to St Petersburg. According to Schmidt, Middendorff's view of the southerly distribution of mammoths was incorrect (Schmidt 1869: 116–118). Accepting his conclusions, Russian and European investigators agreed that mammoths had lived in those parts of northern Siberia that may be regarded as polar areas (Taube von der Issen 1902: 648).

Middendorff also played a very important role in the career of the Baltic German geographer Leopold von Schrenck (1826–1894), an explorer of the Amur area and later member of the St Petersburg Academy of Sciences. His first long expedition, in 1853–1857, during which the Russian Far East and the Amur area were studied, took place thanks to Middendorff (Schrenck 1853). He was also an example for Gustav Radde (1831–1903), a Russian naturalist of German nationality and an explorer of eastern Siberia in 1855–1858. Radde considered Middendorffs monograph on Siberia so important that he decided to follow its structure in his own bulky work on the natural history of east Siberia *Reisen im Süden von Ost-Sibirien in den Jahren 1855–1859 incl.* (Radde 1862–1864). Schrenck also adopted the same plan in the monograph *Reisen und Forschungen im Amur-Lande in den Jahren 1854–1856* (Schrenck 1858–1895).

The letters included in the private archive of the Middendorff family in Germany provide evidence of the fact that Eduard von Toll (1859–1902) owed his polar career, at least partly, to Middendorff. It seems probable that they met thanks to Middendorff's son, Ernst (1851–1916). He and Toll were frequent guests at the family home of a friend of Middendorff. Later, together with Ernst, Toll repeatedly visited Hellenorm (today Hellenurme), Middendorff's country estate. There, Toll also appears to have met Hermann Walter (1864–1901), his later companion in the ill fated *Zarya* expedition of 1900–1902 one aim of which was to search for Zemlya Sannikova [Sannikov Land] (Barr 1980). It is also worth mentioning that Alexander von Bunge junior (1851–1930), who was a member of the expedition to the Lena delta (1882–1884) in the framework of the first International Polar Year, and later the leader of an expedition to the Novosibirskiye Ostrova [New Siberian Islands] in 1885–1886 in which Toll participated, also belonged to Middendorff's circle of friends and acquaintances (Sukhova and Tammiksaar 2005: 97, 280). From the letters of Toll to Middendorff, it appears that the latter had convinced him to join Bunge's expedition. In token of his gratitude, he dedicated a chapter of his expedition report to Middendorff. Toll wrote that if he could join a further projected expedition of the Academy of Sciences to Taymyr, which did not, in the event, take place, he would try to do as much as Middendorff had done and then he could consider himself a real disciple (Toll 1889).

Middendorff at St. Petersburg

The expedition to Siberia, with Middendorff's employment as a 'temporary explorer' of the St Petersburg Academy of Sciences, took place, officially, from 30 November 1842 to 4 April 1845. Having returned, Middendorff was elected an adjunct in zoology at the Academy on the initiative of Baer, and his main task was to prepare for publication the materials of the expedition that were intended to be published in four volumes. The first volume was to be on geology, palaeontology and botany, the second was to be on zoology, the third ethnography and linguistics, while the fourth volume was to narrate the course of the expedition.

To write this monograph, Middendorff considered it necessary to study zoological collections in different European museums. With that aim he went to Germany, visiting Berlin and Kassel and to Great Britain visiting Southampton and London, in 1846. In Europe, he also attempted to secure co-authors for his monograph. These would be persons able to analyse the collections in those areas of science in which he was not an expert (Sukhova and Tammiksaar 2005: 55–58). In the event, fourteen scholars contributed to the work. In the first volume of the monograph, Middendorff analysed the physical and geological characteristics of permafrost (Middendorff 1848a: 85–183), in the first part of the second volume he

Fig. 4. Middendorff in 1855–1856. In private collection of Dr. Andreas von Middendorff, Hohne, Germany.

Fig. 5. Middendorff. Photograph probably taken in 1860–1870s in Tartu. In private collection of Dr. Andreas von Middendorff, Hohne, Germany.

treated malacology in Russia (Middendorff 1847–1849), and the second part of the third volume was devoted to the mammals, birds and amphibians of Siberia (Middendorff 1853c).

The St Petersburg Academy of Sciences placed a high evaluation on Middendorffs activities and elected him an extraordinary member of the Academy in 1850, and a full member in zoology in 1852. In addition to the work on the monograph, he classified the collections he had brought from Siberia for the zoological museum of the Academy. As an expert hunter, a skill he had acquired in his early childhood, he provided the zoological museum with many new exhibits, for example, from the Belovezhye primeval forest.

In the years 1855–1857, Middendorff acted as the permanent secretary of the St Petersburg Academy of Sciences, and upon him the whole work of the institution depended. From this time dates the earliest photograph of Middendorff (Fig. 4). In these years, he took part in the preparation of a new law for the Academy of Sciences. His aim was to improve the prestige of the Academy in the eyes of the public. This was a perennial problem but one which became acute in the mid 19th century. As the academicians were mainly Germans from the Baltic provinces of the empire, the leaders in Russian society, which was at the time tending more and more to pan-Slavism, distrusted them. He also tried to improve the financial situation of the Academy. In order to popularise the work of the Academy, he organised 'Middendorff evenings' that became very popular in scholarly circles of Baltic Germans in St Petersburg (Sukhova and Tammiksaar 2005: 69–75; 98–99).

As the chronic rheumatism from which he had suffered since the expedition to Siberia and that had troubled him permanently since 1846, deepened, he asked the St Petersburg Academy of Sciences to relieve him from the post of permanent secretary in 1857. He made several trips to the health resorts of Germany for convalescence purposes. In 1859, following the recommendations of his doctors, he decided to leave St Petersburg forever and move to the estate of Hellenurme in Livonia, now in southern Estonia, which his father had bought him when he was married in 1850. Having received permission, he left St Petersburg in 1860, but he retained his post as full member of the Academy of Sciences and the salary attached thereto until 1865 (Sukhova and Tammiksaar 2005: 78). A portrait of Middendorff at this time of his life is presented as Fig. 5.

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Middendorff at Hellenurme

At Hellenurme, in the peace of the countryside, Middendorff hoped to finish the monograph on Siberia and publish, in separate parts and fascicles, the fourth volume of it. The generalisation and comparison of his data with the results of other recent investigations was not one of his favourite occupations, as he was essentially a practical man. Living in the country provided ample scope for Middendorff to be deflected from the labour of classifying specimens. He became entirely devoted to practical agriculture, in which he had taken an interest in from his early youth. In Russia, his estate became well known as one in which the practices offered the best examples for agricultural development and young farmers from many different regions of the country visited it to study agricultural crafts (Sukhova and Tammiksaar 2005: 121, 123). In 1859–1860, Middendorff acted for a short period as president of the Free Economical Society of St. Petersburg, the greatest agricultural society in Russia, and in 1862, he was elected president of the most important agricultural society in the Russian Baltic provinces, the Livonian Public Benefit and Economic Society. He occupied this post until 1882. Middendorff was also known as an agrarian politician. During his presidency, the Livonian Society became a promoter of agricultural development in the region. On the initiative of Middendorff and in accordance with the principles elaborated by him, the tradition of holding agricultural exhibitions was introduced in the Baltic provinces that greatly contributed to the introduction of new agricultural methods (Rosenberg 1998: 178–179). In addition, the building of the St. Petersburg-Tartu-Riga railway was due the initiative of the Society. Among other initiatives, a comprehensive survey of the whole Livonian region was undertaken and agricultural credit co-operatives were set up. The Estonian Tori horse was bred on Middendorff's initiative and south Estonian farmers, to this day, owe to him the reddish brown cow that is so well adapted to the country, and so common in its fields (Sukhova and Tammiksaar 2005: 124–135, 145–146).

In addition to these successful agricultural developments, Middendorff also advised the Russian royal family in the organisation of agricultural exhibitions in Russia, and he accompanied the sons of Alexander II in their trips to the Mediterranean Sea and the Atlantic Ocean in 1867, to the Barabinskaya Step [Steppes] in 1868 (Middendorff 1870) and to Novaya Zemlya and Iceland in 1870 (Middendorff 1871, 1872). This last expedition is of particular interest as it demonstrates that even though Middendorff was by the time a relatively old man and in impaired health, his appetite for scientific work was in no way diminished. The expedition was primarily oceanographical and meteorological. After calling at Arkhangel'sk the vessel *Variag* crossed to the southern part of Novaya Zemlya and then proceeded westwards towards Iceland. An achievement of Middendorff on this, his final Arctic expedition, was the identification of the branch of the North Atlantic current that enters the Barents Sea (Barr 2005: 1293).

In this context, it should be noted that Middendorff was no stranger to the court. While in St. Petersburg, he had been tutor to the children of Nicholas I and Alexander II. Middendorff was invited to inspect the royal estates. He also checked the productivity of the cattle breeds of the European part of Russia (1883–1884) at the request of the Ministry of State Property (Sukhova and Tammiksaar 2005: 126–129). He participated in numerous agricultural exhibitions in Europe as an official representative of Russia. In 1878, at the request of the Governor of Turkestan, he studied the agricultural potential of the Fergana valley (Middendorff 1881).

The steps taken by Middendorff in agriculture and agrarian policy were very practical. Thus, his recommendations were often critical concerning the process of local government in Russia as his aim was to reduce taxes and the autocratic attitude of the state and state officials with regard to local people. His principle was that all the layers of the society and peoples living in the Empire should have good living conditions in order to avoid the strains that would, he feared, enable anarchy and communism to take control.

By the beginning of the 1880s, Middendorff's health had deteriorated. As his rheumatism had become more severe, it was necessary for him to give up his positions of responsibility. In 1885, Middendorff who had moved from Hellenurme (30 km southwest of Tartu) to his father's former estate at Pörafer (today Pööravere), 150 km away (northwest of Tartu) in 1876, returned to Hellenurme, the management of which had been undertaken by his son. There, Middendorff spent the last years of his life. At the end of the 1880s he was still able to walk, but at the beginning of the 1890s he had to spend more time in bed and could move only in a wheel chair (Fig. 6). He died at Hellenurme on 28 January 1894 and was buried in his family graveyard near the estate.

Conclusions

The expedition of Alexander Theodor von Middendorff to Siberia is undoubtedly the most outstanding Russian scientific expedition of the nineteenth century. In terms of the naming of places and species, it is, by far, the most prominent. No fewer than seven places are named after him and very many plants and animals, some of which have been noted above. While ambitious in concept it was very modest in execution. As noted, it had only four permanent participants and, of these, one, Fuhrmann was virtually Middendorff's personal servant, although it should be noted that he eventually undertook work that required a great degree of individual initiative and skill. The costs of the expedition were very modest in view of its achievements. The expedition made great use of the services and skills of the local people for which they were recompensed financially, and there was virtually no central logistical back up. Middendorff was an official

Fig. 6. Middendorff in the 1890s. Estonian Historical Archives, f. 1802, n. 1, s. 34, l. 5.

of the state and government licence promised him the necessary assistance of the various local authorities with which he came into contact. But, as has been noted, he, on occasion, found it convenient to enlist the tacit support of persons even higher in the imperial hierarchy than he was, for example, in the case of the senator with whom Middendorff travelled and who had greater influence with regard to the securing of post horses. This 'local' aspect of the expedition is illustrated by the wide variety of modes of transport adopted. In this context, Middendorff consulted with local peoples and used the transport means that they recommended. The only method that he did not adopt was the 'heavy' maritime approach of contemporary British expeditions to the Arctic.

It is necessary to reflect and comment on Middendorff's qualities as leader of his expedition. In the first place only one out of the four participants was a Russian. This was Vaganov. The others were Danish, Estonian and Baltic German, Middendorff himself. His control seems to have been loose and he did not hesitate to detach one or two of the members of the expedition for periods of some months to take readings of, for example, temperatures in remote locations. Considering the huge distances involved, this demonstrates great confidence in his colleagues. But when danger threatened, and one must suppose that this was a rather more frequent occurrence than one would understand from reading Middendorff's rather laconic account, he did not hesitate to do what seemed the best for the expedition as a whole rather than for himself personally. In the return from the Arctic Ocean through the Taymyr drainage system, when supplies were low and winter approaching, Middendorff, appreciating that he was the weakest of the party and the one most likely to hold the others up on what must be a rapid march southwards for relief, simply stayed behind himself. This betokens considerable courage on his part, and his meeting with the Nenets who were coming to rescue him should be noted as one of the great polar meetings of all time, comparable, for example, with that of Fridtjof Nansen (1861–1930) and Frederick Jackson (1860–1938) in Zemlya Frantsa-Iosifa [Franz Josef Land] in 1896.

The expedition had a long aftermath and part of this was political. As a result of it, official attention was directed towards the Amur valley, and eventually the whole area (approximately 50,000 km^2) was incorporated into the Russian Empire (Sukhova and Tammiksaar 2005: 282–299). With regard to the scientific results, it took Middendorff no fewer than 27 years to analyse and to publish them. The four-volume monograph includes 3936 pages of text and 116 copperplates and very many single illustrations in the texts (especially in the fourth volume). The data presented were the results of a many–sided scientific investigation ranging from studies of local economics to the ornithology of Siberia. Several investigators continuing research in Siberia followed Middendorff's example. It is impossible to determine in which field of investigation, Middendorffs monograph on Siberia has the greatest scholarly importance today. But all investigators of Siberia, from glaciologists to linguists, can find data of interest in it. They may be no longer topical, but they have an eternal value, as the monograph is, in the words of Baer, Middendorff's friend and mentor, an 'encyclopaedia of Siberia' (Lukina 1970: 122).

To sum up: there were no casualties on the expedition and it did what it set out to do and, moreover, did so within budget. This is the token of success in exploration and, for this alone, Middendorff deserves to be much better known than he is among the hierarchy of nineteenth century explorers of the north. It is the authors' hope that the present paper will go some way towards achieving this.

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