Dynamiques environnementales
Journal international de géosciences et de l'environnement

42 | 2018
Du glint baltique au lac Peïpous

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Electronic version
URL: http://journals.openedition.org/dynenviron/2649
DOI: 10.4000/dynenviron.2649
ISSN: 2534-4358

Publisher
Presses universitaires de Bordeaux

Printed version
Date of publication: 1 July 2018
Number of pages: 390-397
ISSN: 1968-469X

Electronic reference
Laurent Touchart, Quentin Choffel, Olga Motchalova and Alice Ray, "Lake Chudsk (Peipus) and limnological research in Imperial Russia", *Dynamiques environnementales* [Online], 42 | 2018, Online since 01 June 2019, connection on 02 May 2021. URL: http://journals.openedition.org/dynenviron/2649 ; DOI: https://doi.org/10.4000/dynenviron.2649

Lake Chudsk (Peipus) and limnological research in Imperial Russia

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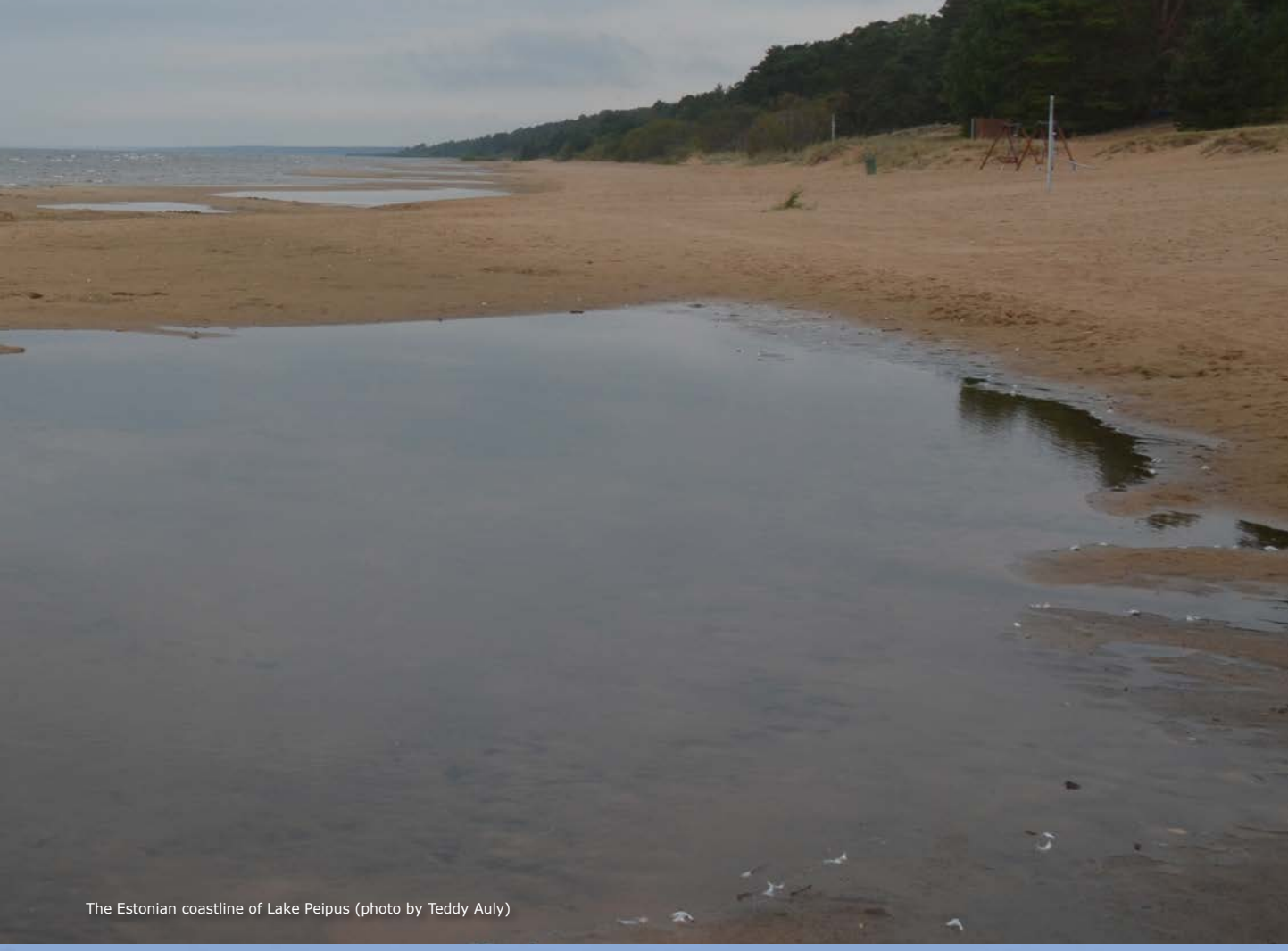
Version française p. 236

Abstract

At the beginning of limnology, Lake Chudsk was entirely included in the Russian Empire. The first research answered the need to better understand and preserve fishery resources. Karl von Baer initiated the project in the 1850s. In the same years, research was carried out on the entire lake and its outfall, the Narva, in order to channel its energy while lowering the lake water level and then take advantage of its energetic potential. In the 1860s, the geologist Gregor von Helmersen wrote the first complete monograph of Lake Chudsk, but it was not until the 1895 campaign led by the geographer Joseph Spindler that the first bathymetric map of the lake was produced and the isothermal pattern of the temperature at all depths were plotted. Before Estonia became independent at the end of the First World War, most of the limnologists working on Lakes Chudsk and Pskov were German-Baltic scientists of Russian citizenship, favoring the encounter of several scientific cultures.

Dynamiques Environnementales 42
Journal international des géosciences et de l'environnement
2nd semestre 2018, p. 390-397.



The Estonian coastline of Lake Peipus (photo by Teddy Auly)

Key words

Epistemology of limnology, history of geography, Russia, Estonia, Lake Peipus, Lake Chudsk, Imperial Russian Geographical Society.

Introduction

In the 19th century, while world limnology was born on the shores of Lake Geneva, a lake six times bigger at the other end of Europe was also studied for the very first time. This water body, Lake Chudsk, was located in the Russian Empire. Since 2004 the western part of the lake has belonged to the European Union, and thus, in France, it has only been known as Peipus, its Russian-German-Estonian name. It seems interesting to recall the Russian-German-Estonian scientists who initiated the first scientific studies of the fifth largest natural lake on the continent.

Through all the influences encountered around this lake, a main question arises. Indeed, the lake of the Chudsk had vast dimensions extending over more than 3500 km², and it belonged to one of the greatest scientific force of that time, when Dokoutchaev enriched the world's natural history with a new scientific branch: the pedology. So, was Lake Chudsk the support for significant progress for global limnology, or, at least, for Russian limnology, or was it only a reflection of the global research of the 19th century? If so, was Lake Chudsk only an ordinary field of study, where the theoretical hypotheses developed elsewhere only received a local application and simple validations? A second question arises then: were the German-Balts of Russian nationality, who were the main local scholars of that time, influenced by German and Scandinavian scientific culture in their practice and did they bring a specificity to local limnology?

In an attempt to answer these questions, it will be necessary to dissociate the effects of applied research from those of fundamental research, in order to understand the limnology applied to Lake Chudsk then. It could be a very applied approach as the Anglo-Saxon type, turned towards fishing, navigation and drinking water, while at the same time making great fundamental progress, as with the American scientist Birge; or a fundamental approach as the Swiss model, in which biology and anatomy of aquatic organism were based on the study of water masses, their thermal regime, and their oscillations, as recommended by Forel; or even, an Austro-German model, *Seekunde* way, in which Penck, Richter, and Halbfass focused their research on the study of the geomorphological basin and the water masses inside. Meanwhile, taking into account the differences between fundamental and applied researches will help to determine the role of Lake Chudsk in Russian limnology.

The impulse of the first research by applied limnology

Applied research dominated the first studies of Lake Chudsk and its Pskovians extensions, first in order to ensure fish stock sustainability which provides the richness of the lake itself, and then in order to develop the outfall from the water body.

Limnology applied to fishing

In the first third of the 19th century, fishing activities suffered from the irregularity of catches from one year to the next; a fact that was included in a global downward trend that worried the Russian authorities. Their reaction was to create the "Special Committee for the Investigation of the Causes of Fishing Catches Reduction", administred by the Ministry of National Property of Russia and the Russian Geographical Society. This committee worked on Lake Chudsk in 1851 and 1852. The leader was the biologist Karl von Baer (Karl Maksimovitch Bèr for the Russians), one of the co-founder of the Russian Geographical Society (Heydenreich, 1908). With A. Schultz (Choults) from Dorpat University (Tartu), Baer wrote a reference book after his expedition on Lakes Chudsk and Pskov (Бэр, 1860). The book was the first volume in the large collection "Research on the State of Fishing in Russia". Many other volumes were published subsequently, first supervised by Baer himself, especially on the Caspian sea, then under N. Danilevsk's direction, especially on the White sea and Artic Seas (Данилевский, 1862). On the three reports devoted to Lake Chudsk itself (the rest is devoted to the Baltic sea), two of them dealt with all aspects of physical geography, the last one, known as report number 7, made clear and well-argued recommendations on the measures to be taken in order to preserve fish stocks.

Based on Baer's conclusions, the "regulations for limiting fishing in Lakes Chudsk and Pskov" were written. They remained famous in Russia, on the one hand because they were the first ever written in the Russian Empire,

and on the other hand because of their outstanding longevity, as they were applied until the beginning of the 20th century (Яани, 1983, **Таммиксар**, 2015). It is true that, to broaden their point of view, Baer and Schultz went to Sweden right after the Chudsk expedition, where they studied Scandinavian fishing techniques, as well as the legal rules (Тишкина, 2014).

While the committee led by Baer was working collectively on this topic, A. Tidebel, in a more personal and literary way, conducted an extensive study on fishing gear and techniques (Тидебель, 1856). He insisted on the importance of the cold season, including when the water body became covered by ice. He described the winter seine which was so heavy that it required a dozen of men with several horses to be handled (see Old photo board). According to A. Tidebel, the giant net used in Lake Chudsk was an old loan from the Russian region of Lake Seliger, 350km to the southwest, more particularly from fishermen on the meridional island, localized in Ostachkov village.

Old photo board on fishing on the lake Chudsk. Source : FOTIS, Rahvusarhiivi fotoinfosüsteem (p. 239). a) 1919, activity demanding a large workforce. b) 1925, individual ice phishing. c) 1940, collective ice fishing on the lave. d) 1940, fishing with trap 1940.

In 1911 and 1912, the expeditions led by Innocent Kouznetsov placed the fishery resource back in its geographical environment. Many new data on the thermal and glacial regime were collected in connection with in-depth study of fish population. The results were published in several volumes from 1912 to 1914 in the collection *Works of the scientific expedition applied to the study of Lake Pskov* (see figure 1). Concerning physical data, only Lake Pskov, located in the South of the lacustrine detroit, was concerned for both the synthesis reports (Кузнецов, 1912a,b, 1913a, 1914) and raw data (Кузнецов, 1913b). However, for economic activities, the publication was based on former studies that were simultaneously realized on both the shores of Lake Pskov and the shores of Lake Chudsk in the strict sense, and on Lake Teploye which unites them (Кузнецов, 1913c).

Figure 1: The title of the general collection of works o the Kuznetsov Expedition (p. 241).

Waterway development studies

The same 1850s, when the first studies applied to fishing was realized, was also the decade that initiated the first research for the construction of the dams of the Narva River (see photo 1). Yet, in order to raise structures on the lake outfall, designers and technicians needed to know the water level variations of the lake that give birth to it. The need for knowledge became more important with the spring flood of 1844, which flooded the northern shores of the lake and the upper part of the outfall. In that context, the military engineer Timofeev started his research from 1853 to 1858 (Яани, 1983) and he recommended lowering the lake level by digging a bypass canal (*Дроздик,* 2008).

Photo 1: Narva river, outflow from lake Chudsk. Picture taken from Narva city towards the upstream and the Russian city of Ivangorod, whose the fifteenth century fortress, built by the Grand Prince of Moscow Ivan II the Greta, is visible on the lent (Source : L. Touchart, March 2013) (p. 241).

In conjunction with water level management, both lacustrine and fluvial, and the improvement of navigation, a few pioneers began to work on the Narva River's potential hydraulic energy. In1896, Professor Choke began the first studies for the Kreenholm textile mill (*Дроздик,* 2008). Located on a small island of the Narva River, the biggest textile mill of the Russian Empire operated thanks to a set of mills, so the drive force of the lake outfall was vital and had to be controlled. Assigned by the Ministry of Transport of the

Russian Empire, the engineer Dobrotvoski resumed Choke's studies a few months later and deepened the issues of navigation in 1897 (*Дроздик,* 2008). Professor Rikhert improved the former proposals in 1901 (Яани, 1983).

This led to a deeper study, with a large amount of resources, led by the engineer Eugene König (Evgueni Leopoldovich Kenig for the Russians), with the help of Jivilov. To evaluate the complete possibilities for the development of the waterway, the gauging of the lake and the different alternatives for canal construction, König built from 1902 to 1906 a set of meteorological stations, a network of limnimetric stations measuring water levels, installed a series of surveyor's rod from the sea to the lake and made a very accurate map from 1/9000. Indeed, König was the first to doubt the fact that the flooding on the northern shore of Lake Chudsk and on the outlet of the Narva was only due to a natural sedimentary dam, a thickening of sandy bars which raised the top of the slope and slowed down the evacuation of lake water through its spillway. Without ruling out this hypothesis, the engineer considered the possibility of an increase in run-off in the catchment area, due in particular to forest clearing (Кениг, Живилов, 1909). This is why it was so important to continuously measure water levels everywhere, from upstream to downstream, at all seasons, with higher measurement frequency during springtime. According to König, the profitability of the project could have been provided by the transfer of one part of the hydroelectricity to St Petersburg.

The relay taken by fundamental limnology

Apart from the pioneering studies of the regional geographer, from *kraeved* for the Russians, P. Boutyrski, who worked in the 1830s from the city of Pskov (Яани, 1983), but only with local audience, the first findings on Lake Chudsk were discovered by the Russian Academy of Science and its geologists. Then, the powerful Society of Geography took over all limnological studies.

Gregor von Helmersen's geological studies

In 1861 and 1862, the Russian Academy of Sciences and the Ministry of Finance commissioned Gregor von Helmersen (Grigori Petrovitch Guelmersen for the Russians), born in Estonia. At that time, he was really famous for his previous geological expedition to the Altaï and his pioneering study of Lake Teletskoye at the foot of the rejuvenated ancient mountain. The German-Baltic scholar of the Russian Empire published his book in German and in Russian a few months later (Helmersen, 1864, Гельмерсен, 1865).

It was a fundamental geological work, which followed the applied works and considered them, until t'en, as the main scientific data provider on Lakes Chudsk and Pskov. The first lines of the book clearly showed this connection, since it began as follows: "since the Germans immigrated to Livonia and Estonia and settled there, Lake Peipus has often been mentioned for the importance of its landscapes in the history of the country. Its importance for fishing, its importance as a navigable waterway and as an ice road for traffic and trade may be recalled" (Helmersen, 1864, p.3, translated from German). Later in the book, he also recommended digging a bypass canal to allow excessive lake water to be discharged into the river downstream of the natural outlet. As for the inset map, without any indication of depth, it was co-signed by Helmersen and Baer (see figure 2). But other passages were very far from direct application and Hermersen was producing a geographical monograph – a limnological monograph as Forel would say thirty years later – leaving no aspect behind. The chapter concerning shoreline erosion by waves thus formed an original and pioneering work, one of the very first in lake geomorphology (see figure 3).

Figure 2: The northern third of the map drawn by Helmersen and Baer in 1864 (p. 242).

Figure 3: The 1865 Helmersen chapter dealing with shoreline erosion (p. 243).

The work of geographers and the complete limnological study of Joseph Spindler

The first geography manual on the lake in the region focused on the southern annex that Russians now call Lake Pskov and Estonians Pihkva. It was the result of the work of the geographer Ivan Vassilyov (Vasilyov, 1879). At that time, the ancient names of Petit Chudsk or Talabsk were still widely used, gradually replaced by the nearest major Russian city. Thus, the title of the book bore the two names of Lake Pskov or Lake Talab. Presented by the author's notes of the Pskov library as a historian and archaeologist specializing in history-geography, considered by A. Yaani as regionalist geographer (Jani, 1983), Ivan Vassiliov made a synthesis of existing data. He started with the toponymy and origin of the various names of the lake (see figure 4), giving his own original opinion, and continued with the geographical situation and dimensions of the water body itself, but also of its banks and its islands. However, almost half of the book detailed the fishing catches from Petit Lake Chudsk and in this sense was indicative of the state of knowledge of the time, based on the applied research previously mentioned. The little book contained no figures and compiled many statistics.

After this first partial attempt which only concerns the southern annex of Chudsk, the expedition led by Joseph Spindler (Iossif Chpindler) made an irresistible leap in limnological knowledge of this region. The navigation, sampling and measurement campaign in 1895 was commissioned and financed by the Imperial Russian Geographical Society. As a geographer and officer of the Russian Navy, Spindler (Шпиндлер) joined forces with the chemist from the University of Tartu, A. Zengbusch (Зенгбуш). Their results were published the following year in *Izvestia of the Society of Geography* (Шпиндлер, Зенгбуш, 1896). The article included the first complete bathymetric map of Lake Chudsk (see figure 5) and several original thermal profiles (see figure 6). Joseph Spindler worked as a geographer and cartographer and traced isobaths and isotherms from many measurements taken at all depths along transect crisscrossing the lake. He also interpreted the distribution of temperatures in the lake, emphasizing their relative homogeneity which he attributed to "wind mixing" ("ветровое перемешивание"). Joseph Spindler also noted the importance of turbidity, in connection with the large amount of suspended matter, both organic and mineral. On the whole, without expressly saying so, he sensed that Lake Chudsk was the very type of the great pellicular lake (see photo 2). His colleague A. Zengbusch analyzed the water samples, as well as those from the bottom silt, and he gave the first chemical composition tables.

Figure 4: The first page o Vassiliov's book in 1879. The geographer historian analyzes here the appellations of the lake and tries to find the origin of the Talabsk, which is one of those next to lake Pskov. It indicates that in Middle Ages it was not distinguished from lake Chudsk, of wich it is only an annex separated by a strait, simply called the Lake (Ozero) by locals (p. 244).

Figure 5: Bathymetry map drawn by Spindler expedition in 1895 (p. 244).

Figure 6: Thermal profiles from Spindler expedition in 1895 (p. 245).

Photo 2: Peipus lake, from estonian side (Source : Q. Choffel, July 2017) (p. 245).

In spite of this, none of the great masters of Russian geography of that time studied Lake Chudsk directly. The first Russian institutional geographer, who held the first chair of geography at a Russian university in 1884, Dimitri Anchin, was certainly interested in the region, but he preferred to conduct his research on small lakes. 250 km south-

east of Pskov, during his 1894 field work, the founder of the Russian limnological geography included lakes Zhizhitskoye, Dvinie and Velinskoye in his sample of water bodies for the construction of his typology on the geomorphological origin of lacustrine basins and his studies on water level variations and hydrological regimes (Karpov, 1954).

Conclusion

Applied fisheries research, led by the team of a well-known scholar, Karl von Baer, was Lake Chudsk's major contribution to the emerging international limnology. Bounds were then forged with Sweden and Finland. On the scale of the Russian Empire too, Lake Chudsk and its Pskov annexes were the first support for the development of this branch of applied sciences, serving as a model for Russian legislation. That was before the largest lake on the planet, Lake Caspian, gave rise to similar studies under the impulse of Karl von Baer himself.

In fundamental research, Lake Chudsk was not the place of major discovery. He was, however, a faithful mirror of world limnology and its Russian-Germanic variation. As everywhere at that time, bathymetry and water temperature were among the main areas of research. Despite his beautiful bathymetric chart, Joseph Spindler did not reach the international notoriety of the Frenchman André Delebecque, nor even of his Russian compatriot Fyodor Drijenko, honored by the gold medal for hydrography at the 1889 Paris World Fair, who led the famous bathymetric campaign of Lake Baikal from 1896 onwards (Kolioti, 1997). Despite the accuracy of his many thermal profiles, Joseph Spindler did not obtain the recognition of the Swiss François-Alphone Forel, nor even the one of the Russian geographer Alexander Voeikov for his conceptualization of the thermal balance of the lake. Although, Voeikov relied on figures from all the major water bodies in northern Europe, including Lake Chudsk, he preferred deep lakes, especially Ladoga, to support his calorific count dissociating the masses of deep superficial water (Войков, 1903, Wojeikow, 1903). Even though he made some assumptions about the frequency of mechanical mixing of Lake Chudsk, Joseph Spindler had less influence than J. Sáringer (1901) on the construction of a typology of lakes, and it was Lake Balaton, not Lake Chudsk, which forever remained the archetype of the pellicular lake (Papon and Touchart, 2003).

On a regional scale, Lake Chudsk reflected a limnology structured according to Russian administrative criteria and practiced by a mixture of German-Baltic and Russian scholars on a cultural level. Russian management of scientific research was clearly represented on the one hand in the organizating and financing power of the Society of Geography, and on the other hand in the predominance of large limnological campaigns, modeled on oceanographic practice, following the example of Stepan Makarov at the head of the Vityaz ship between 1885 and 1889. However, the geographical monographs of Lake Chudsk did not have the same impact as those of Leon Berg on the Aral Sea (Берг, 1908) or of Serge Sovietov on Lake Onega (Sovetov, 1917). Dazzled by the latter, Alfred Fichelle (1919: 70) began his French report by writing that "limnology is undoubtedly one of the branches of geography most worked on by Russian scientists." Within this Russian administrative framework, which placed geographers in charge of limnological campaigns, most of the great individuals practicing research emanated, however, from German-Baltic scientists of Russian citizenship, who were noticeably geologically inclined, such as Gregor von Helmersen.

In the second half of the nineteenth century and the first years of the twentieth century, Lake Chudsk held its place in European limnology, like a great lake among others. Entirely included in the Russian Empire since the beginning of the 18th century, Chudo-Pskovian Lake benefited from this stability, allowing for comprehensive research without any geographical break. But the First

World War and, in 1920, the Treaty of Tartu marked the end of unitary scientific research on the entire lake. A border would now cross in the middle of the water for a quarter of a century, separating newly independent Estonia from newly Soviet Russia. Thus, the extensive research carried out by Sokolov in the 1930s was only in the eastern part. But this is another chapter in the history of limnology.

References (p. 247).