ZDM Mathematics Education (2007) 39:107–118
DOI 10.1007/s11858-006-0014-z

ORIGINAL ARTICLE

Documents on the mathematical education of Edmund Külp (1800–1862), the mathematics teacher of Georg Cantor

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Accepted: 11 December 2006 / Published online: 10 February 2007

Abstract Despite some studies by the historian Wilhelm Lorey, Edmund Külp is rather unknown today. His role in the development of mathematics and mathematics teaching in the nineteenth century, however, deserves closer attention. Having been the director of the höhere Gewerbe—und Realschule in Darmstadt, he can be counted among the founders of the Technische Hochschule Darmstadt. Moreover, he had been, still at the Realschule, the mathematics teacher of Georg Cantor. Recently detected documents concerning Külp's mathematical formation in Brussels by A. Quetelet permit revealing insights into the evolution of Külp's mathematical ideas and of his views on the context of mathematics in Germany. The contribution presents extracts from these documents (in French) and analyses them. Furthermore, the paper discusses possible influences exerted by Külp on Cantor.

1 Findings and losses

In his *Vita* accompanying the submission of his doctoral thesis in 1867, Georg Cantor (1845–1918)[1] expressed an extraordinary gratitude to his mathematics teacher at the Darmstadt *Realschule* where he passed the *Abitur* examination in 1862:

> Darmstaedtiae scholam realem, deinde scholam polytechnicam, quae rectore beato Pr. Dr. Külp florebant, quatuor per annos frequentavi (Cantor 1932, 31).[I]

Although it was entirely unusual to mention one's school teacher(s) in such a *Vita*, this personal remark has as yet attracted almost no attention. There was one exception, however, which might have focussed more interest on Külp. In the wake of preparing the *Festschrift* commemorating Niels Henrik Abel's 100th birthday in 1902, its editor Carl Størmer became aware that Abel mentioned, in a letter to Hølmboe of October 24, 1826, to having replied a letter by "a mathematician Külp in Darmstadt" who had required some clarifications of his seminal paper in Crelle's journal. Størmer had tried to find this answer and —thanks to mediation by Friedrich Engel—had succeeded in detecting Külp's *Nachlass*, in the possession of Jacob Schneider, married to one of Külp's granddaughters, himself a physicist, formerly Röntgen's assistant in Giessen and then physics teacher at the *Realgymnasium* in Darmstadt. They found Abel's letter to Külp which was then published simultaneously by the Academy of Sciences in Kristiania [Oslo] and in the *Crelle* Journal, in 1903 (Størmer 1903).

Even then, however, no research on Külp was initiated, although the biographical information provided by Schneider showed a close relation between Külp and Adolphe Quetelet (1796–1874). If nothing else, the boldness alone of the young man challenging the correctness of Abel's expositions should have merited closer analysis. It was only about 40 years later that

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[1] On set theory, Cantor's major creation, see Steiner (1980).

Wilhelm Lorey (1875–1955), well known as historian of mathematics at German universities, stumbled on Külp when he undertook a series of researches for the history of mathematics and physics at Giessen University. For his part, he succeeded in finding Jacob Schneider's son, Ludwig Schneider (1902–1988), a physics teacher, too, at the *Oberschule* in Großumstadt—not far from Darmstadt—and still in the possession of Külp's *Nachlass*. Lorey, then, was the first to untertake research on Külp. He prepared two papers, one about the correspondence between Abel and Külp and the other on Külp's doctoral degree at Giessen University of 1824. Both, alas, went unpublished so that Külp remained unknown.[2]

For my own part, I was attracted to Edmund Külp firstly by studying Lorey's *Nachlass* (see Schubring 1987) where I found these two manuscripts and related research in the archive of Giessen university, and later by working on Quetelet's *Nachlass* in Brussels. To my surprise, I found that a number of letters from Külp to Quetelet sent between 1820 and 1832 there; a correspondence documenting an extraordinary enthusiasm for mathematics instilled in the young Külp by Quetelet, a highly gifted teacher. It was now my turn to search for Külp's descendants and—despite the scarcity of information in Lorey's extant correspondence—dedicated archivists and a teacher, Bernhard Füßler at Ludwig Schneider's former school, now the Max-Planck-Schule, led me to his son, Horst Waldemar Schneider, still living nearby, in Büdingen. He revealed, however, the sad and disappointing news that after the death of both his parents in 1988 their house had been sold and—while some books had been given to an antiquarian—all *Nachlass* material was destroyed.

2 Biographical elements

Edmund Külp was born on April 16, 1800,[3] in Lampertheim, a village at the river Rhein belonging since 1803 to the Grand Duchy Hessen-Darmstadt, as the oldest of eight children to Georg Friedrich Külp, a protestant-reformed pastor in the nearby Nordheim, and to Külp's wife, a daughter of the pastor in Lampertheim, Abegg. The brother of his mother, Daniel Abegg, was to become decisive for the direction in which he developed and was formed. This wealthy uncle offered to take care of Edmund; thus he took over the education of the young boy. Edmund moved therefore in 1808 to Elbing, a town in Western Prussia (near Danzig), where his uncle lived, and became a student at the *Gymnasium* of this town. In 1816, his uncle moved from the East to the West, to Mannheim, in the state of Baden. Edmund accompanied him and studied 1 year more in the *Lyzeum* of Mannheim. After that year, he left school without passing an examination like the *Abitur* entitling for university studies.[4] Neither at the school in Elbing nor in Mannheim had he displayed any interest or skills in mathematics.

3 Mathematics and military: "l'amour ardent pour la plus belle des sciences"

In fact, no university studies had been intended; rather, it was a military career for him which his uncle had in mind and to which he had persuaded young Edmund. This was quite an unusual career pattern at the time for students of a *Gymnasium*. Even more unusual was the place chosen for preparing that career: Brussels. Brussels was then a part of the Kingdom of the United Netherlands, newly formed in 1815. A certain explanation might be provided by the fact that the Netherlands, dominantly of reformed confession, had always been a privileged place to begin or to continue theological studies for students originating from German territories of reformed confession. Moreover, the prestigious *Athénée Royale* at Brussels where Edmund was to continue for 4 years his school studies from 1817 or 1818 on, provided an entry for studying at the *artillerie en genie* School in Delft, which gave access to careers as an engineer or as an officer in the army.

When young Külp moved to Brussels, his mathematics teacher from 1819 on there happened to be Quetelet.[5] He instilled in Külp a love for mathematics which was to be characteristic for Külp's further life

[2] The Abel paper was intended to be published in the honour of Poul Heegard's 70th anniversary in 1941 in a Norvegian journal. Due to wartime it was not published before 1945, and later efforts by Lorey to get it published failed, apparently due to anti-German feelings in Norway after the end of Nazi occupation. Only the first page of the manuscript is extant in Lorey's *Nachlass*. The second paper was destined for the *Nachrichten der Giessener Hochschulgesellschaft* where his other papers on the Giessen history were published in 1937, 1938, 1940 and 1941, but maybe failed because the *Nachrichten* were discontinued due to paper scarcity in the wartime and were not resumed after WW II.

[3] Størmer's indication (1903, 3), who related 1801 as the year of birth, is wrong, as Külp's great-great-grandson confirmed again.

[4] Actually, in this period, there were no strict prescriptions to have passed such school examinations for being allowed to enrol at a German university.

[5] Before, from 1815 on, Quetelet was mathematics teacher at the *Collège* in Gand. Since 1820 member of the Academy of Sciences at Brussels, he founded there in 1826 the Observatory and became its director, as well as the secretary of the Academy.

and which he now combined with a new vision uniting mathematics and military to constitute his desired career. Külp was a very successful student at the *Athénée*; he obtained several awards—the award in mathematics was given in the form of a laurel crown, as J. Schneider related to Størmer (Størmer 1903, p. 3).

The first letter from Külp to Quetelet dates from September 3, 1820, when Quetelet was temporarily absent from Brussels, staying in Gand [Gent], while Külp still studied at the *Athénée*.[6] He told his teacher that he was tutoring privately some younger students in geometry and algebra. The letter documents a unique interest displayed by Külp's uncle in uniting mathematics and military. The uncle had learned that Lazare Carnot, the famous general, mathematician and politician, living exiled in the Prussian town Magdeburg, was teaching his son Hippolyte there, and he proposed to his nephew the bold idea of joining that son in becoming instructed by Carnot!

> J'ai reçu une lettre de mon Oncle dans laquelle il me proposa de devenir l'élève du General Carnot qui instruit son fils qui est à peu près du même âge que moi, et qui a sa résidence à Magdebourg; Je l'ai refusé; quoiqu'il soit heureux pour l'homme qui aime à s'instruire, d'avoir Carnot pour maitre; Mais connaissant Monsieur Quetelet, le choix ne m'a pas été difficile.[II]

Külp was more interested in pursuing a career in the army, asking therefore for concrete information regarding the engineering studies at the School in Delft, the prerequisite for entering the military service:

> J'ose vous demander si, comme me l'a dit Allard,[7] les eleves qui ont suivi votre Cours, et celui de Monsieur Thyrg, et qui se destinent au genie, ne doivent rester qu'une année à l'école de Delft, et qu'ensuite ils sont nommés après avoir été quelques mois aspirants. Je Vous prie de me donner là-dessus des renseignemens, parceque de telles choses m'interessent; pas pour y aller, je me perfectionnerai assez ici, mais pour savoir comment cela s'arrange. [...] J'espère que Vous aurez la complaisance de me repondre vers ce temps sur ce que je Vous ai demandé plus haut au sujet de l'ecole de Delft. Etes-Vous decidé de rester toujours à Gand?[III]

For unknown reasons, Külp did not continue in Delft, but returned to Mannheim where his uncle was still living. The next letter dates from more than 2 years later, December 8, 1822. It documents Külp's profound love for mathematics and a sentimentality for his former mathematics teacher, while expressing likewise enthusiasm for astronomy:

> Votre aimable lettre m'a tout à fait changé; je commence à être moins mécontent de ma situation actuelle, quoique j'aie l'assurance parfaite de n'être jamais si heureux que lorsque j'ai étudié sous vos auspices la plus belle des sciences. Au reste sois homme, et saches maîtriser la douleur! Il y a ici un superbe observatoire, où je vais trouver Monsieur Nicolay [?], président de cet établissement. Que l'astronomie est sublime! Qu'il est beau de pouvoir admirer de cette manière des ouvrages d'un Dieu tout puissant!
> Si je ferai quelques progrès dans cette science divine, je tâcherai dans la suite d'avoir une place dans un établissement pareil; sinon j'irai peutêtre joindre le fameux mécanicien Reichenbach à Munich. Helas je ne vois qu'avec trop de sûreté, que je me doive éloigner de plus en plus de celui qui a été plus que mon professeur. Que le destin est cruel.[IV]

Although Külp reflected here upon a career related to science or to instrument making, the military plan is still present and remains combined with mathematics. The letter reveals a project dating from the last period in Brussels to join as a voluntary the struggle of the Greeks for independence from the Ottoman Empire then emotionalising the classically minded Europe. Külp gave up his plan to join these volunteers when he heard how badly they were treated by the Greeks and that they were saved by the hated enemy:

> L'envie d'aller secourir les Grecs m'est tout à fait passé depuis que j'aie entendu mon cousin et plusieurs autres, qui étant partis dans les dispositions les plus louables, sont revenus en mendians, après avoir surmonté mille obstacles, et reçu quelques coups et point de vivres de leurs nouveaux compatriots, et après avoir été secourés par les Turcs. On ne le croiroit pas. Mais je vous assure que c'est la verité. Le bon Monsieur Lebroussart[8] m'excusera sans doute si je suis devenu infidèle à ma parole; car l'enthusiasme n'apaise point la faim. Les tems de Themistocles sont passés. Notre pauvre patrie n'aura que trop besoin de nos bras dans quelques années. Dieu veuille que je me trompe.[V]

The love for mathematics continues to be pronounced, together with excessive enthusiasm for Quetelet, as for

[6] All the following quotations are from the *Nachlass* Quetelet, *Archives de l'Académie royale des sciences, des lettres & des beaux-arts de Belgique*. I am grateful to the Archives for the kind permission to publish the Külp letters.

[7] one of the younger students he was tutoring.

[8] Lebroussart was another favourite teacher at the *Athénée*.

instance in his letter of January 1, 1823, still from Mannheim:

> aimant la plus belle des sciences, il m'est si doux de m'entretenir de tems en tems avec la personne qui m'a comblé de tout de bonté et m'a appris à me conduire dans cette vie.[VI]

Studying mathematics or physics continues, too, to be seen as an element for a military career—the concrete forms for the latter changed often, however, this time for studies in Vienna and entering the Austrian army:

> J'ai voulu un peu étudier la Physique; mais il est singulier que depuis que j'aie lu la theorie sur la lumière de nôtre Euler, cette science ne me plait pas, je ne vois que trop d'hypotheses, ingenieuses en effet, même probables, qu'une tête accoutumé à des demonstrations rigoureuses admet avec peine et avec un certain deplaisir. Au reste j'espère et je souhaite de tous mon cœur que cette petite haine disparaîtra, surtout quand je me rapelle de n'avoir pas été au commencement grand amateur de la Mécanique. J'entrerai probablement dans l'école polytechnique à Vienne, d'où je prendrai alors service dans l'armée autrichienne. L'état ne me plait pas. Mais qu'y faire! J'aimerai mieux en effet de me retirer pour étudier ma science favorite. Je vois cependant grâces aux réflexions que m'avoit faites renaître votre dernière lettre, que l'homme ne vit point que pour lui seul, qu'il soit malheureux ou heureux, il a besoin d'autrui.[VII]

The most radical expression and apogee of uniting mathematics and military practice—apparently nurtured by a certain vision of how mathematics became useful as a science in the liberation policy of the French Revolution—presents, however, at the same time the change to a somewhat more realist view and to a decision to devote himself exclusively to science, this again nurtured by a secularized vision of serving God. In his letter of April 21, 1823, he explains:

> Le désir de devenir un jour un fameux guerrier a uniquement dirrigé [sic !] mes futils efforts sur les Mathématiques. Connaissant tant soit peu quelques branches de cette science divine, j'ai voulu commencer ma carriére brillante, et répandre la Terreur parmi les ennemis, les faire mourir tous pour le Salut de ma patrie. Mais tous ces rèves sont passés, tranquille dans ma chambre[.] j'aime à cultiver l'art d'Archimede et de m'en approprier les beautés. Qu'il-est douce ensuite après quelques heures d'étude de s'entretenir avec Pascal, d'admirer avec lui les ouvrages du Tout puissant, et de connoître la faiblesse et la grandeur humaine![VIII]

Külp never ceased, however, to express his admiration and devotion to this former teacher, as in the letter of October 8, 1823:

> Oh que je sente bien la perte immense que j'ai faite en devant m'éloigner du pays où reste celui, qui m'éclaircissait avec tant de bonté les difficultés, qui m'arretoient dans le cours de mes études, qui secondait et guidait mes efforts. Oui je lui dois tout. Son image m'accompagne pour ainsi dire partout, et m'inspire ce que je dois faire. Qu'il est heureux celui d'avoir un tel maître. Mais qu'il est malheureux d'en être séparé![IX]

4 Dichotomy between French and German mathematics

The second crucial dimension which is revealed by Külp's letters is the profound epistemological and conceptual difference between French and German mathematics which neatly confirms my earlier analysis of distinct mathematical communities in these countries which applied different ''paradigms'' in their mathematical research and teaching practice (Schubring 1996). Külp had been socialized by Quetelet who was following the French paradigm of ''physico-mathématique'' enhancing applications (see ibid., pp. 371ff.). The combinatorial school, on the other hand, in vigour in Germany since about 1780, aimed at establishing a general theory of combinations of any kind. Abstracting from particular qualities of elements, it studied all possible forms of their ordered arrangement and establishing new combinations by separation, transposition, permutation, etc., of individual or compound elements. Returning to Germany, Külp soon not only became aware of this difference, he even had to suffer from the bitter conflict, and to change completely the career he had envisaged.

In his very first letter to Quetelet from Germany, dated December 8, 1822, Külp already mentioned the differences; firstly, in a rather general manner:

> J'ai parlé pendant ce tems à quelques autres personnes versées dans les Mathématiques, et qui m'ont réconcilié jusqu'à un certain point avec les Mathématiciens Alemands.[9, X]

[9] Külp's use of the French language is not perfect, but I will not correct it except there where it is necessary for understanding. It deteriorates somewhat the longer he had left Brussels. Külp signed his letters initially as ''Kulp'', changing this only from 1830 on.

But in the same letter, he gave a more concrete hint, mentioning with emotion that German mathematicians were attributing no value to descriptive geometry:

> Votre mémoire plait ici beaucoup, mais celui de Monsieur Dandelin n'est pas tout à fait compris à ce qu'il me paroit.[10] Cela vient sans doute de ce que la plupart d'entr'eux disent que la geometrie descriptive de G. Monge est gentille, et rien de plus. Oh qu'ils sont bêtes![XI]

The next letter of January 1, 1823, showed him already engaged in an emotionalized debate about the relative worth of French and German mathematicians. Though Külp here erroneously undervalues Gauß—a view which he corrected shortly later, his arguments characterize the dichotomy as it used to be put: real use for applications versus abstract speculations. One of his opponents later proves to be the mathematics professor Franz Ferdinand Schweins (1780–1856).

> J'avois dernièrement une petite dispute avec deux mathematiciens sur le genie de Gauss et de la Place, ils vouloient absolument donner la préference au premier. Je leur disois: n'ayant étudié les ouvrages ni de l'un, ni de l'autre, il me parait cependant d'après l'avis des personnes distinguées que l'essai sur la théorie des nombres n'est qu'une pure spéculation d'esprit d'un génie vaste et profond; et que l'utilité réelle qu'on a tirée de la Physique céleste du savant français surpasse de beaucoup les avantages qu'on a puisés chez notre Allemand; qu'enfin qu'il est aussi difficile de faire une exposition du système du monde telle que celle de la Place, que de faire mille combinaisons differentes avec les nombres pour en trouver les propriétés singulières. Nous n'avons point parlé des ouvrages astronomiques de Gauss. Mon opinion est peutêtre fausse, je suis même blamâble de vouloir être juge entre deux genies si effrayants; puis ont ils lu leurs ouvrages immortels? Mais je ne pouvois pas voir leur air de suffisance sans être rempli de la plus vive indignation parce qu'ils savent écrire et un peu compter, et, connaissant les lunaisons, les voilà dejà devenus juges de Gauss et de la Place.[XII]

The confrontation eventually turned to disdain when Külp decided to qualify for a doctorate in mathematics and chose for this the university at Heidelberg, near Mannheim. And the principal mathematics professor there turned out to be the very same Schweins with whom he had already had that confrontation, but who was one of the mayor practitioners of the Combinatorial School in Germany to boot. On April 21, 1823, he reported to Quetelet:

> Je me trouve donc à l'université de Heidelberg, où j'ai suivi les cours de Philosophie et de logique et les leçons de Geometrie et d'analyse (les derniers n'ont pas été fort brillans). Monsieur Schweins un des premiers professeurs en Mathématiques de cette université, veut absolument que je m'occupe sérieusement du calcul combinatoire, que j'ai en horreur, et qui me paroît un peu drôle d'après ce qui ce fameux professeur me dit, en vante, et je n'ai pas envie du tout de m'y mettre.
>
> Je vous prie en conséquence de m'advertir ce que vous tenez de ce calcul combinatoire, puisque je veux me préparer peu à peu à un examen de docteur en philosophie. Le livre qu'il a écrit sur cette partie singulière des Mathematiques est fort volumineux, et l'auteur m'assure qu'il est nécessaire de le connoître parfaitement pour vouloir faire un examen brillant.[XIII]

Külp thought that he would be able not only to sustain this psychic pain occasioned by having to study this stuff, but also to show himself versed in it, since he planned to demonstrate, in his doctoral thesis, the worth of the ''French'' approach. He asked therefore Quetelet in that same letter to advise him in the choice of a suitable topic:

> Je vous prie ensuite de me communiquer le sujet qui conviendroit le mieux d'être traité en forme de thèse. Car j'aimerais de montrer à ce Schweins combien il a tort de parler aussi peu respectueusement des Mathematiciens français. Cet individu a placé encore deux de ses éléves à l'université, et ces deux perroquets crient plus haut que leux maître. C'est un peu hardi de ma part, blamable même de vouloir disputer avec un vieux professeur, dont la réputation paroit faite. Ce n'est point un orgueil méprisable, mais plutôt une noble reconnaissance qui m'engage de faire mon examen à cette université. Helas pour quoi ai je une volonté si bonne? et des moyens si mediocres? Au reste du courage, et tout ira bien.[XIV]

A postscriptum to this letter shows the young man's boldness. He had decided to travel to Göttingen and to ask Gauß personally for advice regarding the subject of the planned dissertation; Külp was so lucky to succeed in being received and well advised:

[10] Germinal Dandelin (1794–1847), graduate of the *École polytechnique* Paris in 1814, engineer and mathematician, specialized in conic sections.

> J'ai eu le bonheur d'avoir fait la connaissance du célébre Gauss, il m'a donné plusieurs mémoires où il démontre toute la force de son génie étonnant. Je serais resté chez lui à Göttingue, mais les voyages qui vont commencer au mois prochain m'ont fait préférer d'aller à Heidelberg. Il approuve mon plan, et blâme la faiblesse de monsieur Schweins, qui ose même balancer sur le merite de Gauss et de la Place. O vanitas vanitas.[XV]

The tensions with his doctoral supervisor soon intensified. In his next letter, of May 12, Külp went so far to regret to be born in Germany and to be thus confronted with this pernicious combinatorial calculus to which one had to conform if one desired to obtain a position:

> Je regrette de plus en plus d'être né Allemand. [...] Presque tous les Mathematiciens allemands s'occupent uniquement de ces calculs pernicieux sous tous les rapports. Pardonnez si le commençant ose parler avec trop de hardiesse. En vain Gauss, Bessel et Thibaut et quelques autres géométres emploient toutes les forces de leur génie à les inviter de ne point négliger le reste de la science. La maladie s'est emparée trop puissament des esprits. Chacun donc qui est obligé à faire des études à une université du pays dont il fait partie, doit se conformer aux vues singuliéres de son professeur, s'il veut éspérer de remplir un jour une place dans sa patrie. [...] Oui, je suis obligé de m'occuper sérieusement d'un très gros livre de 774 pages qui ne traite de ce calcul. Le résultat de toutes les recherches pénibles est la découverte d'aucune nouvelle verité. Tout ce qu'on y démontre est demontré d'une maniére cent fois plus simple et plus convenable au caractère de la science. Qui veut étudier les Mathématiques, ne doit point les faire consister dans un travail de main.[XVI]

He complained that he had recently to fill four sheets of paper to develop all the combinations of a certain formula. Külp reiterated his plea to Quetelet to communicate him a subject by which he might show the richness of a French-minded approach. Shortly afterwards, a letter by Quetelet arrived, eventually, but without the desired proposition. In his reply to May 23, Külp explained therefore again the urgency and his intention of confronting, indicating his new intention to devote himself entirely to mathematics and to find a teaching post in Germany:

> Je vous ai annoncé dans ma dernière lettre que je suis decidé de me donner uniquement aux Mathematiques et que j'aie l'espoir d'être placé un jour dans ma patrie. En vertu de cette résolution louable peut être un peu hardie j'aimerais de faire au plus vîte possible mon examen, pour être débarassé de ce calcul combinatoire [...]. Monsieur Gauß m'a dit dans le temps de prendre quelques intégrales peu connues, de tâcher de les trouver ou les reduire au moins à celles qu'on suppose de connaître. Au reste j'aimerai un sujet où l'on pourroit employer un peu la Geometrie descriptive, qui n'est presque point connue chez les Allemands. Mais un traité où ne regneroit que cette belle science seroit presque declaré nul par la plupart des Mathematiciens allemands et surtout par mes examinateurs. [...] Car je vous dis franchement que j'aimerai en même tems me venger un peu du mépris que les professeurs d'ici semblent affecter pour les philosophes français. M. Gauß et quelques autres n'ont point cette maladie dangereuse, c'est au contraire le plus grand plaisir pour un français d'entendre Gauß parler de Lagrange et de laPlace etc. On attend ici Bessel, le celébre astronome, et que vous connoitrez sans doute par la réputation. C'est le plus grand ennemi du calcul combinatoire.[XVII]

When Quetelet's answer containing the proposal of a subject for the doctoral dissertation finally arrived, Külp's situation had decisively changed. Külp had no longer sustained the tensions and had cut off the connection to the Heidelberg mathematicians. Showing Schweins a paper by Dandelin dealing with descriptive geometry sent to him by Quetelet. he became aware of the mocking attitude of the latter and began to shout at him and at his two ''parroting'' assistants:

> Ayant été dernièrement par exemple chez Monsieur Schweins (Il est le plus grand géométre et le plus habile analyste qui jamais existé selon son propre jugement, qui grâces au bon sens n'est que confirmé par deux de ses éléves, qui ont la complaisance de rire de toutes leurs forces à tout ce que dit leur maitre orgueilleux) pour lui communiquer l'excellent memoire de Monsieur Dandelin, il semblait encore d'après sa maniére ordinaire vouloir se moquer de ce bel ouvrage, et de cette partie sublime de la science dont l'immortel Monge est l'inventeur heureux. Je ne pouvois plus me tenir; Monsieur, lui dis-je, vous n'êtes point ami de la science, pardonnez moi, vous êtes un combinateur zélé, mais le beau, le

> sublime de la science vous est caché. Il devenait furieux, les deux rieurs pour la première fois ne rioient pas, je prenois le parti de partir en les saluant tous les trois respectueusement. Ma reponse etoit, il est vrai, trop arrogante pour un jeune homme si peu versé encore dans les Mathematiques, mais j'espére que les circonstances l'excuseront un peu. J'ai agi à cette occasion contre toutes les règles de la saine politique en oubliant que ce beau triolet sera probablement mon examinateur.[XVIII]

This emotional explosion concurred, unfortunately, with a financial catastrophe. His uncle had lost almost his entire fortune:

> mon cher oncle a perdu une grande partie de sa fortune considerable, en se rendant caution pour un de ses anciens amis. Il est vrai qu'il lui reste encore quelque chose de quoi vivre, qu'il partagera même sincèrement avec moi; mais sachant qu'il est accoutumé dès sa plus tendre jeunesse de ne se refuser aucune commodité de la vie, et d'accomplir le moindre de ses voeux, j'ai résolu de chercher un emploi quelconque, afin qu'il ne sente pas la perte par le bien, que sa bonté infinie le forcerait pour ainsi dire de faire pour moi.[XIX]

Külp had to sacrifice the intended academic career (''de joindre un jour les savans'') and to seek an ordinary profession. Even so, he expressed a sentimental gratitude to Quetelet for having instilled in him the love for mathematics:

> en guidant et secondant mes faibles efforts, et en éclaircissant les difficultés, qui sans cesse se présentent à moi dans le cours de mes lectures et de mes traveaux, et en soutenant en moi l'amour ardent pour la plus belle des sciences.[XX]

5 Doctoral degree and deistic speculations

Yet, Külp was not despairing entirely but continued to work on mathematics—actually, to work on the problem posed by Quetelet, on the ''focale régulière'', the focal line was a preferred topic of Quetelet. And in his next letter, of October 8, he reported on his progress and that he was working hardly, 10 hours each day. Thus, he expressed the audacious wish to later practice mathematics together with Quetelet:

> Ma passion pour les Mathématiques n'a été jamais si forte, je m'en occupe au moins dix heures par jour, et cela comme on doit le faire pour pouvoir tirer quelques fruits de ses traveaux. [...] Je croyois de trouver en Allemagne le paradis, mais j'ai trouvé les enfers. [...] Dans le doux espoir de pouvoir un jour cultiver la premiére des sciences auprès de celui qui me l'a faite connoître et aimer.[XXI]

A few months later, Külp had found an expedient to the blocking of any scholar's career: using the argument of *Heimat* and identifying the state of Hessen-Darmstadt to which Nordheim now belonged as his home, he applied to the only university of this state, Giessen, to obtain a doctoral degree in mathematics. And the ''home'' argument was backed by relying on relations between theology professors: On January 2, 1824, Külp wrote from Nordheim to Friedrich Wilhelm Daniel Snell (1761–1827), nominally professor of philosophy and history in Giessen, but also versed in theology and elementary mathematics, applying for a doctoral degree from the Philosophical Faculty, describing his mathematical studies in Brussels and competencies, and adding a letter of recommendation by a Heidelberg theology professor, Schwarz. In fact, he was admitted to the oral examination, on February 14, and—based on the submitted dissertation *de curva focali regulari*, hence following Quetelet's proposal—passed it with honours in mathematics. Upon his own request, he was exempted from the prescribed oral disputation in Latin, firstly since the Faculty deemed mathematics not so well suited for Latin disputations, but secondly since Külp had declared not to aspire to a university post. In fact, as a consequence of his sacrifice, he had explained to aspire only to a teaching position at a *Gymnasium*. His main support in the examination had been the Giessen physicist Georg Gottlieb Schmidt (1768–1837), thus showing that at least physicists were not adherents of the combinatorial school.[11]

Külp reported of his successes only briefly to Quetelet in his letter of March 29, 1824:

> J'ai depuis peu le plaisir de faire la connaissance de Mr Schmidt; Mathématicien bien distingué et partout reconnu comme le premier physicien de l'Allemagne. Il a été le principal interrogateur dans mon examen que vient d'avoir lieu à l'université de Giesen et qui a été assez brillant.[XXII]

In fact, Quetelet learnt of this dissertation only in 1829 when he visited Külp in Darmstadt upon his journey to

[11] This account of how Külp obtained the doctoral degree is based on Lorey's archival researches of 1941; *Nachlass* Lorey A. I. 6, Nr. 3.

German observatories and to the *Naturforscher* meeting in Heidelberg; immediately, he made it known in his journal.[12]

Külp himself had preferred to expose his new deistic speculations, based on Pascal, to Quetelet:

> Je m'occupe maintenant beaucoup de la théologie, qui souvent me charme à un tel point que je crois me trouver dans une région moins terrestre. Chaque homme, qui veut mériter ce nom, ne doit pas croire en aveugle. Il faut qu'il résolve les questions importantes qu'il soit de proposer sur son Dieu et sur l'immortalité de son âme. [...] ayant lu attentivement plusieurs auteurs célébres qui ont traité tout différement ces points qui nous regardent si profondément, et médité serieusement sur leurs diverses opinions, enfin je suis parvenu d'être d'accord avec moi même et de pouvoir régler toutes mes démarches avec sens et jugement par la vue de ces points importants. J'oserois nommer l'homme l'asymptote de Dieu. Il me paroit de vous entendre rire de cette singulière idée. Mais il est permis de se présenter les choses selon la manière propre, si elle ne se trouve pas en contradiction manifeste avec ce qu'elle doit réprésenter. En vertu de mes fréquentes réflexions je suis intimement convainçu que l'homme continuera à se perfectioner dans une série d'autres vies et de se rapprocher continuellement de cet Être infini, immuable, éternel, veritablement immense et parfaitement un et simple et que je nomme Dieu sans jamais pouvoir l'atteindre.[XXIII]

6 Modest career and teacher of Cantor

Despite Külp's hope to become a *Gymnasium* teacher, he seems to have been without employment for the next years. Only in 1827, he obtained a position as mathematics teacher, but firstly for primary teacher formation, at a *Normalschule*, as he told Quetelet in his next letter of January 18, 1830:

> Depuis que j'ai quitté Bruxelles, les Mathematiques et la physique ont été l'objet principal de mes études; j'ai travaillé avec quelques succés de sorte que je fus nommé en l'an 1827 régent des mathématiques à l'école normale pour le grand duché de Darmstadt.[XXIV]

[12] Correspondance mathématique et physique, Tome V, 1829, p. 405.

From the *Normalschule*, he changed to the *Realschule* in Darmstadt, and from 1833 on to the *höhere Gewerbeschule*, combined with that *Realschule*. Since 1848, Külp—already before endowed with the *Professor* title—was the director of these schools, the nuclei of the later Polytechnical School Darmstadt. In the later years, as director, Külp concentrated on teaching physics, but cooperated closely with the other mathematics teacher, Philipp Fischer (1818–1887), a former student of Külp. It is characteristic for their teaching that Külp succeeded in adapting mathematics and physics teaching to his beloved French spirit of mathematics. In fact, the main textbook used there continuously was the *Cours complet des Mathématiques Pures* by Louis Benjamin Francœur, or more exactly its German translation and adaptation in eight volumes by Külp and Fischer. Moreover, Külp had published textbooks of his own, on *Algebraische Analysis* (1851), and on *Differential—und Integralrechnung* (1856), also based on French conceptions.

From 1860 to 1862, the textbooks used in Cantor's classes were Fischer's adaptation of Francœur's analytical geometry and Külp's on algebraic analysis.

The eight ''books'' adapted by Külp from Francœur's French textbook series covered the entire range of school mathematics as taught in his *Real*—and *Gewerbeschule*: arithmetic, elementary algebra, elementary geometry, plane analytical geometry, higher algebra, solid analytical geometry, differential and integral calculus, calculus of variations and differences. The third book, on elementary geometry, shows a peculiar notion of one of the basic concepts of geometry—of the angle. It is not defined by, say, the inclination of two lines intersecting in a point, but by the area (''Flächenraum'') contained between these lines assumed to be extended infinitely (Francœur 1850, p. 6). Measuring angles implied, hence, to operate with infinite quantities. A main application of this peculiar notion was the ''proof'' of the parallel postulate, based on the comparison of a stripe of fixed breadth and of infinite length with an angle. The stripe being an infinite of the first order will vanish as compared to any angle being it even as small as one wishes, since the angle is defined as a quantity of the second order (ibid., 19).

The students at the Darmstadt school were, hence, accustomed throughout their geometry teaching to operate freely with infinite quantities.

Most explicitly, these conceptions had been elaborated in the 1780s by the German mathematician Johann Schultz, but they had been made popular by French mathematicians and textbooks authors like Legendre and Lacroix who ascribed it to Louis

Bertrand from Geneva (Schubring 1982, 467 ff.). Accepted as a ''French'' theory, it re-entered German mathematics, especially by Külp's adherence to French approaches, popularizing thus to operate with quantities assumed to be infinite.

Appendix: Translations

I I frequented for 4 years the *Realschule* at Darmstadt, nowadays the Polytechnical School, which flourished due to its Rector, the late Prof. Dr. Külp.

II I received a letter from my uncle in which he suggested to me to become a student of General Carnot who is teaching his own son being of about the same age as me, and whose residence is at Magdeburg. I refused; although anybody who loves to be taught would be lucky to get Carnot as his master. But knowing Mr. Quetelet, my choice has not been difficult.

III I dare ask you whether it is correct—as Allard had told me—that the students who followed your course and that of Mr. Thyrg and which aim to become engineers need to stay only one year at the school in Delft and will enter that career after some months of service as candidates. I should like to entreat you to give me information about this, since these are things which interest me—not really for going there, since I will perfect myself sufficiently here but for knowing how this can be arranged. I hope that you will be so kind as to answer me within this time period (until reopening of classes) about what I had asked you before regarding the school in Delft. Have you decided to remain forever in Ghent?

IV Your kind letter made me completely change my mind; I have begun to be less dissatisfied with my present situation, although I am perfectly sure of never having been as happy as when I studied the most beautiful of all the sciences under your auspices. For the rest of it, I tell myself to be a man and to learn to cope with the grief! Here, there is a magnificent observatory where I met Mr. Nicolay, director of this establishment. How sublime is astronomy! How beautiful is it to be thus able to admire the works of an almighty God! If I make some progress in this divine science, I will subsequently try to obtain a post in a similar establishment; if not, I will perhaps go and join the famous mechanic Reichenbach in Munich. Alas, I am realizing with too much certainty that I will have to go ever more farther from the one who has been more than my professor. Oh, how cruel fate is!

V All my desire to go and succour the Greeks has gone since I have heard that my cousin and several others who had set out with the most laudable intentions returned as beggars after having overcome thousands of obstacles and after having received some shocks and no food from their new compatriots and after having been rescued by the Turks. One would not believe it. But I assure you that this is the truth. The good Monsieur Lebroussart will without doubt excuse me for having broken my word, as enthusiasm will never appease hunger. The times of Themistocles are past. Our poor fatherland will be in dire need of our arms within some year. May God make that I am wrong.

VI loving the most beautiful of all the sciences, it is so sweet for me to correspond from time to time with the person who lavished so much goodness on me and who taught me how to conduct myself in this life.

VII I wanted to study a bit of physics, but it is strange that this science does not please me since I read Euler's theory of light; I see too many hypotheses, indeed ingenious, even probable ones, but which a mind accustomed to rigorous proofs will hardly admit and only with some disgust. I hope and I desire with my whole heart, however, that this small hate will disappear, especially when I recall not having been a greatly enamoured with mechanics in the beginning. I will probably enrol at the Polytechnical School of Vienna, whence I will proceed to enlisting in the Austrian army. I do not like this state. But what should one do! In fact, I would indeed prefer to withdraw to studying my favourite science. I realize, however, thanks to the reflections which were revived by your most recent letter that man does not live for himself alone; whether he be unhappy or happy, he is in need of others.

VIII My desire to become a famous warrior some day served only to direct my futile studies in

mathematics. Knowing just a few branches of this divine science, I wanted to start my brilliant career, spreading *terreur* among our enemies, putting them all to death for the salvation of my fatherland. But all these dreams are gone, sitting quietly in my room, I like to cultivate Archimedes's art and to appropriate its beautiful traits. How sweet it is then after some hours of study, to entertain oneself with Pascal, to admire together with him the works of the Almighty, and to get to know both the weakness and greatness of man!

IX Oh, how much I feel the enormous loss I incurred when I had to leave the country where the lives who explained to me with such goodness the difficulties which bogged me down in the course of my studies, who aided me and guided my efforts. To him, I owe everything. His image accompanies me so to speak everywhere, and tells me what I should do. How fortunate is he who has such a master! But how unhappy is he who is separated from him!

X During this time, I conversed with some other people versed in mathematics, and who have reconciled me to a certain degree with the German mathematicians.

XI Your memoir pleases here quite a lot, but that by Mr. Dandelin is not really understood according to my impression. Without doubt, the reason for this lack of understanding is that most of them just say that Gaspard Monge's descriptive geometry is nice—but nothing more. Oh, how stupid they are!

XII Recently, I had a little dispute with two mathematicians about the genius of Gauss and of Laplace. They absolutely insisted on granting preference to the former. I told them that while not having studied the works of either, it would seem to me, following the opinion of persons of renown in this, that the attempt at number theory is purely mental speculation of comprehensive and profound genius, and that the real uses drawn from the Celestial Physics of the French scholar by far surpasses the advantages gained from our German scholar; and that finally it is as difficult to develop an *Exposition du Système du Monde* as that of LaPlace as to realize a thousand different combinations of numbers in order to find their singular qualities. We did not speak at all about Gauss's astronomical works. My opinion is maybe wrong, I can even be blamed to wish to be the judge between two such terrifying geniuses; moreover, had they really read their immortal works? But I was unable to stand their complacency without being filled with extreme indignation at the fact that on the mere basis of their knowing how to write and to how count a bit, and about the periods of revolution, they have already become the judges of Gauss and LaPlace.

XIII Hence I find myself at the University of Heidelberg where I have followed the courses of philosophy and of logic and the lectures on geometry and on analysis (the latter were not really brilliant). Monsieur Schweins, one of the most eminent mathematics professors of this university, absolutely wants me to seriously study combinatorial calculus which I abhor, and which seems to me to be somewhat funny according to what this most famous professor tells me boastfully, and in what I have not the least desire at all to come involved.

XIV I beg of you therefore to communicate to me the subject which is the most convenient to be treated in the form of a doctoral thesis. For I would like to show this Schweins how wrong he is to speak with so little respect of French mathematicians. This individual has moreover placed two of his own disciples in posts at the university, and these two parrots screech even louder than their master. It is a bit bold of me, even blameworthy to enter into dispute with an old professor whose reputation seems acknowledged. But it is not detestable arrogance but rather generous appreciation, which obliges me to obtain my exam at this university. Alas, why do I have so much good will? And why so mediocre means? For the rest, I tell myself. Cheer up!, everything will go well.

XV I was so fortunate as to get to know the famous Gauss; he gave me several memoirs where he shows all the power of his amazing genius. I would have stayed with him at Göttingen, but the travels, which will begin next month made me prefer to go to Heidelberg. He agrees with

my project and he blames Mr. Schwein's weakness—who even dares to ponder over the respective merits of Gauss and of La-Place. Oh, vanitas, vanitas!

XVI I regret more and more to be have been born German. [...] Almost all German mathematicians are exclusively occupied with these calculi, which are so pernicious under all aspects. Please pardon the beginner for daring to speak too boldly. In vain Gauss, Bessel, and Thibaut and some other geometers apply all the power of their genius to invite them not to neglect the remainder of science. The malady has too strongly overcome their minds. Everyone obliged to pursue his studies at the university of the country to which he belongs must conform to the peculiar opinions of his professor if he has to have any hope of obtaining one day a post in his fatherland [...] Yes, I am obliged to occupy myself with a terribly voluminous volume of 774 pages, which deals only with this calculus. The result of all this scrupulous research is the discovery of nothing new at all. All what one is proving there is demonstrated [in French mathematics] hundred times more easily and more convenient to the character of the science. Whoever desires to study mathematics should never make it consist in handiwork.

XVII I announced to you, in my last letter, to dedicate myself entirely to mathematics, and that I hoped to have one day a post in my own country. By virtue of this laudable and maybe somewhat bold resolve, I should like to pass my exam as soon as possible to be free of this combinatory calculus […]. Monsieur Gauß told me at that time to take some less known integrals, to try to find them or at least to reduce them to those supposedly known. Moreover, I should like a topic where one might be able to apply a bit descriptive geometry, which is almost unknown to Germans. But a treatise governed by this beautiful science will be declared almost nil by the majority of the German mathematicians and in particular by my examiners. [...] For I tell you frankly that I should like at the same time to take my revenge for the disdain, which the professors here seem to feel for the French philosophers. Monsieur Gauß and others are not affected at all by this dangerous malady – it is to the contrary the greatest pleasure for a Frenchman to hear Gauß speak of Lagrange, of LaPlace, etc. The famous astronomer Bessel is soon expected to arrive here, whom you will surely know from reputation. He is the greatest enemy of combinatorial calculus.

XVIII At my recent call, for example, at Monsieur Schweins (he is, in his own lights, the most eminent geometer and the most capable analyst who ever existed, a judgment which thanks to common sense is only confirmed by his two disciples who are kind enough to laugh most forcibly at all of their arrogant master's snide remarks), where I intended to communicate him the excellent memoir by Mr. Dandelin, he seemed moreover to have a mind to make fun of this beautiful work, as is his practice, and of this sublime part of the science of which the immortal Monge is the fortunate inventor. I could no longer contain myself; Monsieur, I told him, you are not a friend of science, pardon me, you are a assiduous combinatorian—but the beauty and the sublime of this science remains hidden to you. He went furious, the two laughers found nothing to laugh at for the first time, and I chose to leave, bowing respectfully to all three of them. My response was admittedly two arrogant for a young man so little versed in mathematics, but I hope that the circumstances will be considered extenuating. At this occasion, I acted against all rules of common sense, since I forgot that this aimable threesome would probably become my examiners.

XIX My dear uncle lost a considerable part of his fortune by acting as a guarantor for one of his old friends. Surely, he still has some livelihood he would faithfully share with me; but knowing that he has been accustomed since his early youth to deny himself none of the commodities of life, and to satisfy his least desire, I resolved to look for any kind of employment to spare him feeling his loss due to the good things his infinite kindness would so to say compel him to do for me.

XX Guiding and abetting my feeble efforts, and clarifying the difficulties which incessantly appeared in the course of my readings and labours, and encouraging my ardent love for the most beautiful of all the sciences.

XXI My passion for mathematics has never been so strong; I work at least ten hours per day, as one must do it for picking some fruit of one's labours. [...] I believed to find paradise in Germany, but I found hell. In the sweet hope to be able to cultivate the first of the sciences near to him who made me know and love it.

XXII I had the pleasure since recently to know Monsieur Schmidt, a very distinguished mathematician, and generally renowned as the foremost physicist of Germany. He was the main interrogator at my exam, which took place at the University of Gießen and which was quite brilliant.

XXIII I am studying now a lot of theology, which charms me sometimes to such a degree that I believe to be in an otherworldly region. Every man intending to be worth this designation must not blindly believe. He must solve the important questions to be put both with regard to his God and to his own immortal soul. [...] Having attentively read several famous authors who all discuss these points which concern us so profoundly in different ways, and having seriously meditated on their various opinions, I eventually succeeded in being in agreement with myself and able to regulate all my projects with sense and judgment in the spirit of these important points. I would even dare to call man the asymptote of God. I seem to hear you laugh at this peculiar idea. But it is permissible to present things to oneself in one's own manner as long as this manner does not find itself in manifest contradiction with that which it is intended to represent. By virtue of my frequent reflections I am entirely convinced that man will continue to perfect himself by a series of other lives and to continually approach nearer to this infinite, unchangeable, eternal, truly immense and perfectly one and simple Being, whom I call God, without being ever able to attain it.

XXIV Since I left Brussels, mathematics and physics have been the principal subjects of my studies; I worked with such success that I became appointed in 1827 to regent of mathematics at the Normal School for the Grand Duchy of Darmstadt.

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