

A Forgotten Nineteenth Century Mathematics Journal

ABSTRACT. *Scientiae Baccalaureus* was a scientific journal, mostly mathematics, published in Rolla, Missouri, USA in 1890-1891. Largely forgotten today, it nevertheless had the distinction of being the first to publish English translations of the principal works of Lobachevsky and Bolyai on non-Euclidean geometry. This paper provides a brief overview of *Scientiae Baccalaureus* and some of the people associated with it.

MSC 1991 Subject Classification: 01

Keywords: Missouri School of Mines, non-Euclidean geometry, G. B. Halsted, W. H. Echols

After it was extensively remodeled inside, the oldest building on campus, indeed the first building used by the school when it opened 130 years ago, recently became my department's new home. This was certainly not the first renovation since 1871, and I began to wonder what the original interior of the building had been like. While looking through our Library's collection of historical items, I found several old pictures of the building, both inside and out, but the most interesting thing I found was a copy of the first and only volume of a scientific journal, primarily mathematics, published at the Missouri School of Mines (M.S.M, now the University of Missouri-Rolla) in 1890-91. It was called *Scientiae Baccalaureus, A Quarterly Journal of Scientific Research* [13 1890-1891], was published under the auspices of the Missouri School of Mines, and was edited by "The Senior Classmen". Fewer than ten libraries now own *Scientiae Baccalaureus*, and even at its home institution it cannot be found in the regular stacks.

As I looked through the journal, two things caught my attention. First, undergraduates were encouraged to contribute. Sometimes we think that getting undergraduates involved in research is a new idea, but the notion clearly goes back at least to the nineteenth century. Second, *Scientiae Baccalaureus* was the first to publish English translations of two famous and important pieces of mathematics research. The translations will be discussed in detail later, but first let's

return to the purpose and intended audience of the journal. Here is an excerpt from the Prospectus:

"There is a considerable amount of scientific investigation going on at the present day which is of no contemptible order of merit, and which really deserves the name of research. This class of work is being done by the younger men, who are working earnestly and honestly ; for the love of their subject, and for the love of the work itself. These are the men upon whose shoulders, in the coming years, as the masters pass away their mantles fall. These are the men from whose ranks in maturer time, will be called those who are to inherit the mighty responsibility of developing scientific truth, to grope in the darkness further on, to feel the way to clearer thought, to show the way to higher reason, to throw light upon the mists of doubt and clear away the error.

"It is for this class of younger workers that this publication has its being, it is for them to give it success or let it fail. The selection of its name is not from pedantry, but because it has in its sense a twofold meaning. Its pages are open to work in Mathematics, Pure and Applied ; to Physics and to Chemistry, the exact sciences of the Bachelor's degree. On the other hand the name suggests the status of the workers, for it is not intended to be an undergraduate's plaything, nor yet does it aspire to the more powerful thought of the master workman.

"Its object is to encourage and foster the spirit of investigation and original thought. Its pages are to show research and originality in results which are new. The propounding and solution of questions, which by their novelty are interesting, is also invited."

Thus, as mentioned earlier, the niche for which this journal was intended included undergraduate mathematics and science, but not at the plaything level. Undergraduates were

encouraged to read and contribute to the journal, and some did, but the entire scientific community was invited to lend its support. The Prospectus concludes with this paragraph

"We hope and we also believe that the masters in scientific thought will not ignore us altogether ; but will encourage us from time to time by appearing in our modest pages, for the purpose of encouraging and suggesting lines of thought to younger men, whose earnestness and honest work commands respect, albeit they fall into error in their efforts and need correction : for younger hands must yet take up the torch and spread the light which older minds are now preparing."

As will be seen, in its short life, the pages of *Scientiae Baccalaureus* were indeed graced by the work of "masters in scientific thought", possibly to an extent beyond the most ambitious dreams of its founders.

The driving force behind the journal was William Holding Echols, Director of M.S.M from 1888-1891, and afterwards Professor and Chair of Mathematics at the University of Virginia, and editor of *The Annals of Mathematics*. Echols did not come to M.S.M. as a mathematician, but served one year as Professor of Engineering and Graphics and then three years as Director. While Director, he also held the chair of Civil and Mine Engineering, later renamed simply Engineering. Echols contributed seven articles to *Scientiae Baccalaureus*. In 1890 the Professor of Mathematics at M.S.M. was W. B. Richards, who was assisted by an Instructor, G. R. Dean, still a student at the time. Richards later became Director of the school, and Dean joined the faculty proper in 1897, replacing Richards as the Professor of Mathematics, a position he held until his retirement in 1935. Authors in the first number of *Scientiae Baccalaureus* were all from M.S.M., and one, Dean, was a student. Dean's paper was part of his senior thesis for the bachelor's degree Civil Engineer, which he received in 1890. He stayed an

additional year for another bachelor's degree, in Mathematics and Physics. Several other M.S.M. students contributed to the Exercises section. In the last three numbers, *Scientiae Baccalaureus* exhibited a wider scope, with contributions from William B. Smith and H. C. Williams of the University of Missouri, George B. Halsted of the University of Texas, Artemas Martin of Washington, DC, Levi W. Meech of Norwich, CT, Annie MacKinnon of the University of Kansas (a master's degree student). Contributors to the Exercises included Frank Morley, then at Haverford College, W. E. Heal of Marion, IN, G. H. Harvill, editor of the *Mathematical Messenger*, H. B. Newson of the University of Kansas, probably MacKinnon's mentor and an active supporter of women in mathematics (see [8 1994]), and William Hoover of Ohio University, who contributed problems and solutions to *The American Mathematical Monthly* for over 40 years.

The journal's greatest claim to fame came through Halsted. Vol. 1, No. 3 contains his translation of N. Lobatschewsky's [spelled here as in the journal] work on parallel lines, and Vol. 1, No. 4 contains his translation of J. Bolyai's famous appendix to the book written by his father. Their publication in *Scientiae Baccalaureus* was the first English language appearance of either of these seminal works on non-Euclidean geometry, in which each man, independently, showed that a consistent geometry was possible by negating Euclid's fifth postulate that exactly one parallel to a given line may be drawn through a point not on the line. E. T. Bell [2 1945] considers the work of Bolyai and Lobachevsky one of the major revolutions in all thought, comparable in significance to the ideas of Copernicus. Indeed, by the eighteenth and early nineteenth centuries, Euclid's geometry had taken on almost a religious authority and was widely considered the only possible mathematics of space. The Jesuit G. Saccheri, in 1733, published *Euclid Freed from Every Flaw* (see Smith[14 1920]), in which he believed that he had proved

Euclid's parallel postulate and thus had secured for Euclid's geometry the status of Truth, with a capital T. Actually, Saccheri proved several results in non-Euclidean geometry without realizing what they were, but this was not recognized until the 1880s. Bolyai and Lobachevsky demonstrated that geometric truth was not confined to Euclid, and neither knew of Saccheri's work.

Because of the short life and relative obscurity of the journal, and because Halsted later published his translations through the University of Texas, *Scientiae Baccalaureus* is not always given as a source for these translations by historians and in bibliographies. Smith [14 1920] credits Halsted with both translations in 1891, but does not specify where they appeared. Bonola [3 1899] lists Halsted's translation of Lobachevsky as "English translation by G. B. Halsted (Austin, Texas, 1891)." The translation itself appears as an appendix in the 1955 Dover edition of Bonola's book, and the Translator's Preface, identical to the *Scientiae Baccalaureus* version, is dated May 1, 1891. In that Preface Halsted claims, "Of the immortal essay now first appearing in English ...". The date of Vol. 1, No. 3 of *Scientiae Baccalaureus* is February, 1891. On the other hand, Sommerville's bibliography [16 1911] lists the May, 1891 Texas Univ. Bull. as the 2nd ed. of the English translation of Lobachevsky, and does cite the February publication in *Scientiae Baccalaureus*. The situation with Bolyai's paper is similar. In Bonola, we find, "See also the English translation by Halsted, *The Science Absolute of Space*, (Austin, Texas, 1896)." As with Lobachevsky, Halsted's translation of Bolyai is included as an appendix, but the Translator's Introduction in Bonola is quite different from the one in *Scientiae Baccalaureus*, showing evidence of much revision and updating. For example, in the revised version, Halsted says, "And even today, 1895, in the vast system ...", and at the end of the introduction, "In 1894 a monumental stone was erected on his [John Bolyai's] long-neglected grave ...". Clearly,

references to 1894 and 1895 were not possible in *Scientiae Bacculaureus*, the last number of which appeared in June, 1891. Also, in his Translator's Introduction in *Scientiae Bacculaureus*, Halsted states, "It is this Appendix which we now give for the first time in English.", a sentence which does not appear in the appendix to Bonola. The entry in Sommerville for John Bolyai cites *Scientiae Bacculaureus* as the earliest English source. As an additional check, we were able to obtain, through interlibrary loan, the earliest edition published in Austin of Halsted's translation of Bolyai, and it turned out to be simply a reprint of the *Scientiae Bacculaureus* article, complete with the journal name and volume information on the title page.

The works by Bonola and Sommerville are quite extensive, and were initially done within twenty five years of the time *Scientiae Bacculaureus* was published. Other late nineteenth and early twentieth century sources exhibit similar variation. For instance, in the *American Mathematical Monthly* article by Aley [1 1894], *Scientiae Bacculaureus* appears on his periodical list, and in the 1905 Yale dissertation of Withers [17 1905], both of the Halsted translations are recognized, but only the translation of Bolyai is attributed to *Scientiae Bacculaureus*. Most recent historians of mathematics, such as Boyer [4 1968] and Eves [7 1990], refer primarily to Bonola and to Smith on the subject of non-Euclidean geometry. In the anthology edited by Calinger [5 1995], a selection from Lobachevsky's *Theory of Parallels* is included, with the source given as the 1914 Open Court edition of Halsted's translation. In their 1962 bibliography on Bolyai, Pálffy and Pálffy [12 1962], refer only to the Austin publication. Thus, knowledge of even the existence of *Scientiae Bacculaureus* gets buried a little deeper as the years go by. Halsted himself wrote many articles which mention Bolyai and Lobachevsky, but he usually simply referred to "my translation(s)" without giving any specific source. All this supports the conclusion that Halsted did not intentionally ignore *Scientiae Bacculaureus*, but it is reasonable

to assume that when he was asked for reprints of his translations, he sent the ones published in Austin simply because those were the ones to which he had ready access. When Halsted died in 1922, his obituary notice in the *Monthly* [11 1922] pushed *Scientiae Baccaulaureus* even further into obscurity, saying,

"His most important work was the translation of writings on non-Euclidean geometry. Lobachevski's *Researches on the Theory of Parallels* and Bolyai's *Science Absolute of Space* were first published at Austin, Texas, in 1891, as parts of the "Neomonic Series." They are now published in Chicago."

As we have seen, the word "first" in this quote is in error.

The decision to discontinue publication of *Scientiae Baccaulaureus* was announced in an Editorial Note in Vol. 1, No. 4, June 1891, which was signed "W. H. E." Coincidentally, in the spring of 1891 Echols had decided to leave M.S.M. and return to Virginia, where he began a long career in the mathematics department at the University of Virginia. In fact, in both of his articles in Vol. 1, No. 4 of *Scientiae Baccaulaureus* give his affiliation as University of Virginia. Echols was 32 years old in 1891. Because the *Annals of Mathematics* was already being published at Virginia, there was little chance for him to be able to continue *Scientiae Baccaulaureus* there; in fact, he became an associate editor, and then, in 1896, editor of the *Annals of Mathematics*, a position he held until the *Annals* was moved to Harvard under the editorship of M. Bôcher in 1899. The full text of Echols' editorial note follows, and gives additional evidence of the primacy of the English translations of Lobachevsky and Bolyai.

"It has been decided to discontinue the publication of this Journal and its issue ceases with this number, which closes the first volume.

"We close the first volume and cease the publication with considerable regret, yet with no small degree of satisfaction, believing as we do, that as a Journal of Elementary Mathematics it has accomplished fairly well the object which it had in view.

"Had it done nothing more than to put into English words the papers of Bolyai and Lobatschewsky its life had been well lived. We believe that the time will yet come when the seed thus sown will bear its share of fruit in the advancement of sound geometrical teaching in America."

Even including the translations, which, after all, were of work sixty years old, the articles in *Scientiae Baccalaureus* were not at the cutting edge of mathematics research, but this was in keeping with the stated purpose of the journal, and the general quality of the articles was comparable to other journals of the time, such as *The American Mathematical Monthly* (which began publication in 1894 in Kidder, Missouri, a place even more obscure than Rolla). There were several expository articles, and also some articles which today would be called mathematical modeling. Geometry was prominent, and Halsted's article, "The Two-Term Prismoidal Formula" is listed in [15 1934] among the "more important" American papers in geometry during 1875-1900. The refereeing/editing process was not up to today's standards, but was typical for the time. One handicap faced by the journal was the isolation of Rolla, and the difficulty of checking on results using local resources. At least three articles were later either corrected, extended, or placed in historical context. In No. 4, Echols published an article correcting errors in his earlier article in No. 1, "The Railway Transition Curve". Halsted's prismoidal formula article in No. 3, mentioned earlier, is both a critique and an improvement of Echols' article on the same topic in No. 2, and mentions correspondence between the two men regarding the problem. In the article by Smith in No. 2, "A New Elementary Demonstration of

the Pythagorean Theorem", there is an editorial footnote discussing the claim of newness; more historical information, indicating that the proof was indeed not new, is given by Artemas Martin in No. 3. These examples are not given to belittle the editorial work, but rather to indicate that *Scientiae Baccalaureus* was actually read by a nontrivial subset of the American mathematics community.

Of the M.S.M students initially involved with *Scientiae Baccalaureus*, at least one, Dean, went on to have a respectable mathematical research career, and some of the others (see [6 circa 1892] and [10 1941]) taught mathematics at various levels. Also notable among the young contributors was Annie MacKinnon, a student at the University of Kansas and a teacher in the Lawrence schools when she contributed to *Scientiae Baccalaureus*. In 1894 she became the second woman to earn a Ph.D. in mathematics from Cornell University and the third American woman to get a mathematics Ph.D, see [8 1994]. Her dissertation [9 1894-1895], and a later paper as well, appeared in the *Annals of Mathematics*. The names of some of the other contributors to the journal, including Heal, Meech, Newson, and W. B. Smith are listed in the "Trend of Important Branches" section of [15 1934] for the period 1875-1900.

As true in 2001 as it was in 1891, being introduced early to research and scholarship, and thereby becoming acquainted with the work of leaders in the field is bound to foster the "spirit of investigation and original thought" and have a positive effect on "the younger men [and women], who are working earnestly and honestly". Almost forgotten today, *Scientiae Baccalaureus* advocated, and during its short life achieved, a purpose still considered desirable more than a century later.

Here are the tables of contents from all four numbers of *Scientiae Baccalaureus*, followed by a list of proposers and solvers of Exercises.

Vol. 1, No. 1

The Railway Transition Curve,	W. H. Echols
The Beginnings of Mathematics	W. B. Richards
Tallow Clays	W. H. Seamon
On the Continuous Construction of the Ellipse	W. H. Echols
On the Establishment of the True Meridian by Means of Observations on the Sun with the Engineer's Solar Instrument	George R. Dean
Exercises for Solution. 1–6	

Vol. 1, No. 2

Imaginarities in Analytic Geometry	William B. Smith
Our Belief in Axioms and the New Spaces	George Bruce Halsted
The Volume of the Prismoid and Cylindroid	W. H. Echols
The Beginning of Mathematics–II	W. B. Richards
A New Elementary Demonstration of the Pythagorean Theorem	William B. Smith
Exercises, 7–20	

Vol. 1, No. 3

Geometrical Researches on the Theory of Parallel Lines Translated by George Bruce Halsted	Nicolaus Lobatschewsky
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An Elementary Expansion of the Sine and Cosine in Terms of Circular Measure	W. H. Echols
The Two-Term Prismoidal Formula	George Bruce Halsted
Copy Multiplication Table	Levi W. Meech
The Transit of Mercury Across the Sun's Disk on May 9, 1891	H. C. Williams
Note on Stadia Measuring	W. H. Echols
Historical Note on "A New Elementary Demonstration of the Pythagorean Proposition"	Artemas Martin
Solutions of Exercises 4, 7, 8, 10, 11, 12, 13, 14, 15	
Exercises 21-27	

Vol. 1, No. 4

The Science Absolute of Space Translated by George Bruce Halsted	John Bolyai
Note on the Transition Curve	W. H. Echols
Number, Discrete and Continuous	George Bruce Halsted
Geometric Inversion	Annie L. MacKinnon
The Pneumatic-Hydraulic Sand-Lift	W. H. Echols
Editorial Note	W. H. E.
Solutions of Exercises 21, 23	
Exercises 28-37	

Proposers of Exercises: Geo. R. Dean: 4; W. H. Echols: 1, 2, 5, 6, 12, 13, 14, 15, 24, 25, 26; H.B. Hall: 33; Elmo G. Harris: 3, 11; G. H. Harvill: 23, 32, 35; Annie L. MacKinnon: 37; Sallie Millard: 27; Frank Morley: 7, 8, 9, 28, 31, 34; H. B. Newson: 30, 36; W. B. Richards: 29; T. U. Taylor: 21, 22; W. O. Whitescarver: 10; Selected Constructive Problems in Elementary Geometry: 16, 17, 18, 19, 20.

Solvers of Exercises: Frank Bolles: 7; Geo. R. Dean: 8; Charles P. Echols: 5; W. H. Echols: 1, 4, 6; G. B. Halsted: 27; G. H. Harvill: 23; Elmo G. Harris: 3; Wm. E. Heal: 14; George Herdman: 10; Wm. P. Holman: 8, 1; William Hoover: 21; J. C. Nagle: 21; Charles Puryear: 3; C. B. Spencer: 27; A. J. Stewart: 10; T. U. Taylor: 8, 11; W. O. Whitescarver: 3

REFERENCES

1. R. J. Aley 1894, Bibliography of the history of geometry; also a list of mathematical periodicals, *Amer. Math. Monthly* **1**, 42-47
2. E. T. Bell 1945, *The Development of Mathematics*, Second Edition, McGraw-Hill, New York
3. R. Bonola 1899, *Non-Euclidean Geometry* with a supplement containing the Dr. George Bruce Halsted translations of *The Science of Absolute Space* by John Bolyai and *The Theory of Parallels* by Nicholas Lobachevski, Dover, New York, 1955 reprint and translation of the original Italian publication
4. C. B. Boyer 1968, *A History of Mathematics*, John Wiley & Sons, New York
5. R. Calinger, ed. 1995, *Classics of Mathematics*, Prentice-Hall, Englewood Cliffs, NJ
6. *Catalogue of the Missouri School of Mines and Metallurgy*, Rolla, MO, circa 1892

7. H. Eves 1990, *An Introduction to the History of Mathematics*, Sixth Edition, Saunders, Fort Worth, TX
8. D. D. Fenster and K. H. Parshall 1994, Women in the American mathematical research community: 1891-1906, in *The History of Modern Mathematics*, ed. Eberhard Knobloch and David E. Rowe, vol. 3, Academic Press, 3 Boston, 229-261
9. A. MacKinnon 1894-1895, Concomitant binary forms in terms of the roots, *Ann. of Math.* **9**, 95-157
10. C. V. Mann 1941, *The History of Missouri School of Mines and Metallurgy*, Phelps County Historical Society, Rolla, MO
11. Notes and News 1922, *Amer. Math. Monthly* **29**, 187
12. I. Pálffy and M. Pálffy 1962, *Bibliographia Bolyaiana, 1831-1960*, Országos Széchényi Könyvtár, Budapest
13. 1890-1891 *Scientiae Baccalaureus*, Missouri School of Mines, Rolla, MO
14. D. E. Smith 1920, *A Source Book in Mathematics*, McGraw-Hill, New York
15. D. E. Smith and J. Ginsburg 1934, *A History of Mathematics in America Before 1900*, Mathematical Association of America
16. D. M. Y. Sommerville 1911, *Bibliography of Non-Euclidean Geometry*, Harrison and Sons, London
17. J. W. Withers 1905, *Euclid's Parallel Postulate: Its Nature, Validity, and Place In Geometrical Systems*, Open Court, Chicago