THE "PRE-EMBRYONIC" STATE OF THE AAVSO: AMATEUR OBSERVERS OF VARIABLE STARS IN THE UNITED STATES FROM 1875 TO 1911

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Abstract

For 35 years before the formation of the AAVSO, independent amateur variable star astronomers in the United States were making significant contributions to the field. Skilled, dedicated individuals like S. C. Chandler, E. F. Sawyer, and P. S. Yendell laid the foundation in variable star work that was expanded upon by Harvard College Observatory Director E. C. Pickering, under whose direction a new generation of enthusiastic amateur and professional astronomers continued to further the cause of variable star research. This paper is a survey of the contributions made by several independent amateur variable star astronomers, and it is also a chronology of the growth of a broader, more popularized, amateur involvement in variable star astronomy which led to the organization of the AAVSO in 1911.

1. Introduction

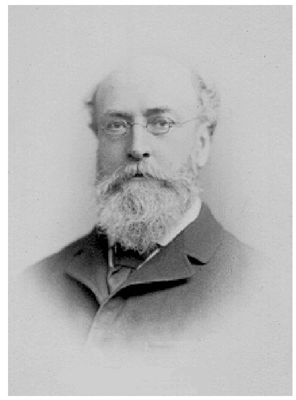
The German astronomer Friedrich Argelander is well-known in variable star histories as the "father of variable star observing." The professional astronomer Argelander in 1844 first brought to the attention of the astronomical community the phenomena of variable stars and the need for observations of them. His *Uranometria Nova* catalogue of the magnitudes of over 3,500 northern stars was a great boost to the involvement of amateur observers of variable stars in Europe. This catalogue was not widely available in America, hence the late start here in amateur variable star work. Historians of variable star astronomy tend to make a great leap from Argelander to Harvard College Observatory (HCO) Director Edward C. Pickering in discussing variable star work in late 19th and early 20thcentury America. And, if the subject of amateur involvement happens to come up at all, there occurs another great leap from Pickering to the AAVSO co-founder William Tyler Olcott. This paper will attempt to fill in the gaps by surveying the involvement of amateurs in variable star astronomy in the United States prior to the organization of the AAVSO in 1911.

Friedrich F. W. Argelander

A small number of highly capable amateur astronomers in the United States were making variable star measurements in the 1880's. The most notable of these amateur astronomers were: Seth Carlo Chandler, Jr. of Cambridge, Massachusetts; Edwin Forrest Sawyer of Brighton, Massachusetts; John A. Parkhurst of Marengo, Illinois; William E. Sperra of Randolph, Ohio; and Paul S. Yendell of Dorchester, Massachusetts. William Tyler Olcott later noted that "these men became internationally famous for their discoveries of variable stars" (Olcott 1937). Other accomplished amateur variable star astronomers at this time were John H. Eadie, of Bayonne, New Jersey; Henry M. Parkhurst, of Brooklyn, New York.; and Arthur C. Perry, of Brooklyn, New York. Chandler is best known today for his early variable star catalogues. Eadie contributed several hundred variable star observations to HCO between 1880 and 1911. Arthur Perry discovered Z Puppis in 1897. Of this group, Yendell and J. A. Parkhurst also contributed observations to the AAVSO once it was formed. Yendell became a Charter Member of the AAVSO when it was incorporated in 1917, and J. A. Parkhurst (who became a professional astronomer at Yerkes Observatory) was named an Honorary Member of the AAVSO (AAVSO archives; M. Mayall 1976).

2. Benjamin A. Gould: Argelander's American disciple

The discoveries and comments of Chandler, Sawyer, Yendell, and other accomplished amateurs appeared in the U.S. mainly in *The Astronomical Journal*, edited by Benjamin Apthorp Gould, and published in Boston. Gould (born in 1824), was a professional astronomer who, according to Chandler, was "a powerful moulding influence upon the development of American astronomy" (Chandler 1897).



Benjamin A. Gould

Gould was the first American astronomer to receive part of his training in Germany (Ashbrook 1971; Herrmann 1971). Gould, by his own initiative and at his own expense, traveled to Europe in 1845 to learn from all of the great astronomers of the time. He became a pupil and friend of Encke, Gauss, Struve, Argelander, and others. And he became associates of the younger astronomers Winnecke, Schönfeld, Auwers, and others. During the same period, Gould also associated with such important American scientists as Bache, Pierce, Coffin, Chauvenet, and Winlock (Chandler 1897; Furness 1915). Of particular importance for Gould's work was his acquaintance with, and the influence of, the German astronomer Friedrich Argelander.

Gould returned from Europe in 1848. In the summer of 1849 he began publication of *The Astronomical Journal*, which he deliberately modeled after the respected German astronomy journal, the *Astronomische Nachrichten*. Gould sought to stimulate important astronomy research in the New World by providing a journal of similar quality (see Herrmann). Among his first contributors was Argelander himself, who, in 1855 and 1856 published articles and notes on the variable stars Algol and T Cancri. In 1855 and 1856 numbers of *The Astronomical Journal*, Gould appealed for observations of variable stars from observers in the United States. Refering to Argelander's contributions, Gould remarked: "it is to be hoped that some interest may have been awakened for the investigation of the strange and striking phenomena of the variable stars; and that observers may be found wherever there is a love for astronomy, and a disposition to labor for its advancement" (Gould 1856).

The first amateur astronomer in the United States to answer Gould's call was Stillman Masterman, of Weld, Maine. Masterman's observations appeared in Gould's journal between 1857 and 1861. A promising astronomy career was cut short when Masterman died at the age of 32. With the onset of the Civil War, but also due to lack of funds, Gould postponed publication of the journal. He resumed publication in 1885.

In the meantime, Gould undertook his primary astronomical work, the *Uranometria Argentina*—a photometric catalogue of the southern hemisphere, published in 1879. He meant his catalogue to be a continuation of Argelander's *Uranometria Nova*, extended to stars of southern declination. From his compilation of the magnitudes of southern stars Gould recognized the need to monitor the stars in his catalogue that showed variability. Between 1871 and 1874, when he compiled his catalogue, he and his assistants discovered 12 new variable stars. At the conclusion of his project he estimated that at least half, if not most, of the stars within the magnitude limits of his catalogue would show some kind of variability over time, and they would have to be measured if for no other reason than to ensure the usefulness of this and other catalogues (see Gould *UA* 1879). As Gould stated in the introduction to his catalogue:

> Another inadequately executed part of my original plan was the determination of the limits of magnitude and laws of fluctuation for all the most marked variables.... Still I trust that something may yet be done here in this direction. (Gould *UA* 1879)

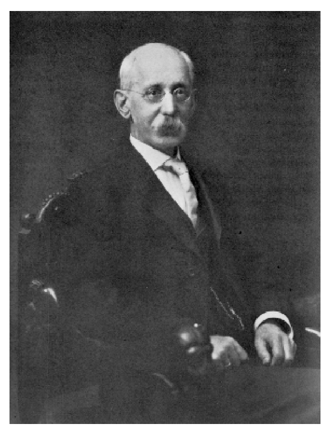
Argelander's work was the primary foundation for Gould's catalogue. In the introduction to his own catalogue, Gould acknowledged his indebtedness to Argelander:

> During all the stages of this undertaking, and the not small discouragements which have attended it, I found incentive and support in looking forward with hopefulness to the approbation of the great master in this department of astronomy. The coveted privilege has not been granted me, to lay at his feet the finished work. But, in justice and in gratitude, I desire to record my obligations to him for counsel and encouragement, direct and indirect. To Argelander, living, I desired to inscribe this work, which but for his *Uranometria Nova*, might never have existed. Now I may only dedicate it to his honored memory. (Gould *UA* 1879)

From Germany and from Argentina, Gould brought his interest in variable stars to the United States where he supported the variable star work of several important amateur astronomers. The most notable of these amateurs was S. C. Chandler.

3. Seth C. Chandler, Jr., and his influence on the growth of amateur variable star astronomy in the U.S.

Seth Carlo Chandler, Jr. was born in Boston in 1846. After graduating from Boston English High School in 1861, Chandler worked for Gould on United States Coast Survey longitude determinations. From 1863 to 1869 Chandler worked for the Coast Survey as an aide. Chandler was an accurate and tireless computer and a skilled mathematician who also became experienced in the use of precision measuring instruments. Chandler co-discovered the nova T Coronae Borealis in 1866 (Ashbrook 1971). In 1869 he declined an opportunity to join Gould in astronomy work in Argentina. He remained in the U.S., married in 1870, and worked as an actuary for 15 years (Anon. 1898; Yendell 1914; Bailey 1931).



Seth C. Chandler, Jr.

In 1874–75, Chandler made comparative observations of stars selected from Argelander's *Uranometria Nova*, using Argelander's step method (Pickering *et al.* 1885).

From 1881 to 1885 Chandler worked for Harvard College Observatory as a volunteer observer and research assistant, receiving only a nominal salary (Searle 1914). Here, between 1881 and 1883, Chandler made visual observations for correlation with Pickering's photometric observations being compiled for his photometric catalogue (Pickering *et al.* 1884). Pickering also used Chandler's unpublished compilations of suspected variables, which Pickering describes as: "a collection, from the whole available field of astronomical literature, of references to the probable or suspected variability of stars not yet included among the known variables" (Pickering *et al.* 1885).

After 1885 Chandler continued astronomy work as an independent amateur astronomer. He became especially interested in variable stars, and soon became a recognized authority on the subject both professionally, through his publications in the U.S. and abroad, and popularly, through his lectures on variable star theory and discoveries given to the Boston Scientific Society and elsewhere, summarized or reprinted frequently in the Boston papers in the late 1800's (see Anon. 1898; Yendell 1914; AAVSO Archives).

Chandler, with John Ritchie, Jr. and others, organized the Boston Scientific Society, a group of amateur and professional scientists from many disciplines who met regularly to discuss the latest developments in their fields. Chandler made many presentations about variable stars to this group through the late 1800's. It was through the Society that Chandler and Gould met Sawyer and Yendell and encouraged them to take up variable star work.

In 1878, Chandler published a series of three articles in the *Science Observer* (published by the Boston Scientific Society), "On the Methods of Observing Variable Stars" (see Chandler 1887). These articles, with an introduction by Gould, were reprinted as a booklet by *The Astronomical Journal* in 1887 (see Chandler 1887).

In 1888, Chandler published his first catalogue of 225 variable stars, based mainly on the earlier compilations of Schönfeld (Chandler 1888). This was followed by a second catalogue (cumulative) of 260 stars in 1893, and a third catalogue (cumulative) of 393 stars in 1896 (Chandler 1893, 1896). All three catalogues were published in Gould's *Astronomical Journal*. Pickering relied on information from Chandler's working versions in making his own compilations (see Chandler 1888; Pickering *et al.* 1885).

In 1891 Chandler received an honorary LL.D. degree from de Pauw University. In 1895 he was awarded the gold medal of the National Academy of Sciences in the United States for his researches on the Variation of Latitude, and he became Editor of *The Astronomical Journal* after Gould's death in 1896. In 1901 he received the gold medal of the Royal Astronomical Society for his contributions to the knowledge of Variable Stars, and for other Astronomical work. After Chandler died on December 31, 1913, his fellow amateur astronomer Paul S. Yendell wrote of him: "Personally, he was wholly unpretentious and social ... always ready to aid and encourage any beginner in science whom he found to show an active interest in real work, as the writer well knows" (Yendell 1914).

Chandler is without a doubt the most important early link between amateur and professional variable star observing in the United States. He was among the first amateurs to publish his own observations, and he was the first to encourage other amateurs to take up the study of variable stars. His expertise, valuable contributions to the field of astronomy, and honors bestowed upon him notwithstanding, Chandler chose to remain an independent astronomer. Indeed, he preferred to be known as an "amateur" (Yendell 1914, King 1922).

4. Chandler's contemporaries

E. F. Sawyer, H. M. Parkhurst, and P. S. Yendell are three of Chandler's contemporaries who also published their variable star work in *The Astronomical Journal* during the 1880's and 1890's. They likewise are key figures in the growth of amateur involvement in variable star astronomy in the United States. I briefly summarize their accomplishments here.

Edwin Forrest Sawyer was born in Boston in 1849. He started observing meteors at the age of 19, and earned a reputation for persistence and accuracy of observation. These are traits very suited to variable star observing, and Gould and Chandler took notice of him (Anon. 1898). (Sawyer himself stated in one of his notebooks that he had made "numerous observations" of delta Orionis as early as 1865 in an attempt to determine its variability (Sawyer, AAVSO archives.) Sawyer, who worked as a bank cashier for 64 years (!), joined the Boston Scientific Society in 1876 at the age of 27. It was here that Chandler convinced Sawyer to turn his observing skills to variable star work (Anon. 1898; Sawyer 1932).

Edwin F. Sawyer

Between 1882 and 1890 Sawyer determined visual magnitudes of 3,415 stars selected from Gould's *Uranometria Argentina*. To do this he observed nearly every star 3 to 4 times or more, making a total of 13,654 observations. During this work, Sawyer discovered eight variable stars, and 51 suspected variable stars (Sawyer 1893). Sawyer published his results in 1893 as the *Catalogue of the Magnitudes of Southern Stars*. Yendell praised Sawyer's catalogue, calling it "one of the most valuable works of its kind in existence"; he considered Sawyer to be "one of the best living observers of variable stars" (Yendell 1894a, 1896). Sawyer was made a fellow of the American Academy of Arts and Sciences, and, in 1890, he was made a life member of the Astronomische Gesellschaft (Anon. 1898).

Henry M. Parkhurst was born in New Hampshire in 1825. He died in Brooklyn, New York, in 1908. Parkhurst was the first American "phonographic" court reporter (stenographer), and he was the first to introduce women to the profession of stenography. From 1848 to 1854 he was Chief Official Reporter for the U.S. Senate, and later he was reporter for the New York Superior Court for 20 years. He was also an inventor, musician, linguist, and social reformer.

Henry M. Parkhurst

H. M. Parkhurst was interested in astronomy since he was a child. He was seriously interested in astronomy from the age of 17, when he invented a type of elongating lens, and when, at eighteen, he computed the orbit of the comet of 1843, gaining national acclaim. He independently discovered Donati's comet in June 1858. He invented a star mapping device, and several kinds of photometric instruments, one of which he described in the *Annals* of HCO (Parkhurst 1890).

Parkhurst began making photometric observations of long period variable stars in 1883. The results of 10 years of observations (1883–93) were published by HCO (Parkhurst 1893). These were observations of 96 variable stars, and measurements of 3000 comparison stars. From 1884 to 1890, he collaborated with John H. Eadie in making regular observations of variables. They had an arrangement whereby Eadie would observe a star when bright, using his 3-inch refractor, and Parkhurst would take over the observing with his larger telescope when the star became faint. In later years, H. M. Parkhurst collaborated with A. C. Perry. From 1893 on, Parkhurst regularly published his work in "Notes on Variable Stars" in *The Astronomical Journal*. Pickering used the observations of Parkhurst in his own compilations (see J. A. Parkhurst 1908).

Paul S. Yendell, born and educated in Boston, was a store clerk, a soldier, a bank clerk, a draftsman for a wood engraver and, later, for the Massachusetts topographical survey. He also was a member of the Boston Scientific Society, and he began variable star observing in 1887 at the suggestion of Gould and Chandler (Anon. 1898).

Yendell probably devoted more time and effort to the observation of variable stars than any of the other early amateur astronomers in the U.S. Yendell certainly did more than any of the others to write about variable star observing and history with the intention of introducing the subject to amateur astronomers. Between 1894 and 1906 he published over 140 pages of articles on variable stars in *Popular Astronomy*.

Yendell's own experience in variable star work gave him a keen appreciation for the efforts of other amateur astronomers who never achieved fame but who nonetheless worked diligently and carefully to make variable star measurements. In 1900, Yendell published an obituary of an unknown amateur observer, David Flanery, and titled it "A Faithful Worker." Although Flanery took up variable star observing late in his life, Yendell was impressed with the 4,000 observations Flanery made over five years:

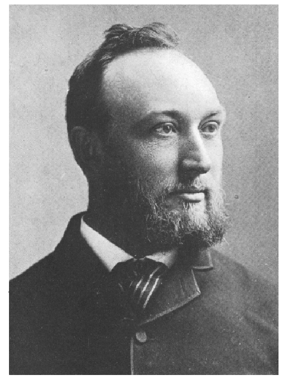
> An examination of these notes shows that the observations were made with very great care, and the notes are carefully and minutely kept. He was very solicitous in securing the best information accessible to him as to positions and magnitudes, and in taking every possible precaution against avoidable errors of observation.
>
> Mr. Flanery received little attention or encouragement from the regular astronomers; what he did receive he repaid with a great gratitude and appreciation.... In spite of all discouragements and difficulties, and the occupations of a busy life, he secured valuable lines of observations of a number of variable stars.... (Yendell 1900)

Although these early amateur variable star astronomers worked individually, not as an organized group, they did not work in isolation. Chandler received communications from amateur and professional astronomers regarding variable star discoveries, positions, magnitude determinations, etc. Yendell, in particular, sent Chandler letters that were filled with meticulous calculations, but also never failed to include some warm and humorous greeting. Yendell continued this correspondence with Chandler into the 1900's, and probably until Chandler's death in 1913. Similarly, Yendell received correspondence about variable stars from amateur and professional astronomers to ask him to confirm some point or another about a star. William E. Sperra, of Ohio, and Zaccheus Daniel, of Pennsylvania, were among these correspondents. When John A. Parkhurst (having become a professional astronomer) published his *Researches in Stellar Photometry*, he acknowledged "the kind assistance of P. S. Yendell, of Dorchester, Massachusetts, who with great patience gave the instructions needed by a beginner and corrected the errors into which one was so likely to fall" (AAVSO Archives; J. A. Parkhurst 1906).

Also indicative of the spirit of shared interest between these amateurs: a copy of Chandler's booklet was given to Sawyer, in which Sawyer (probably at a later date) noted "from his friend and tutor Dr. [*sic*] Seth C. Chandler 1887"; a small photographic portrait of Gould is inscribed to "Edwin F. Sawyer Esq with kind regards of B. A. Gould 1891"; and another copy of the Chandler observing booklet (the inscribed year is smudged, but it was probably presented about 1910) was presented "to William Tyler Olcott with Mr. Yendell's compliments" (AAVSO Archives).

5. Edward C. Pickering and the idea of "Cooperation"

Harvard College Observatory (HCO) Director Edward C. Pickering became interested in variable stars in the early 1880's. His interest was a by-product of his attempt to obtain photometric magnitudes of north polar stars. Like Gould, Pickering recognized the need to monitor stars thought to be variable if his standard star measurements were to be of any use. At the time he became HCO Director in 1877 there were about 200 known variable stars. By the time of his death in 1919, his retinue of HCO staff and volunteer observers had discovered about 3,400 variable stars (AAVSO 1920; Ashbrook 1971).



Edward C. Pickering

In 1882 Pickering published "A Plan for Securing Observations of the Variable Stars" in which he proposed enlisting the help of volunteer observers. Although he is primarily addressing his professional colleagues, this 15-page pamphlet describes a method for observing variable stars that is meant to be undertaken by amateur astronomers (with the reductions to be performed by professional astronomers):

> It is on the amateur and student of astronomy that we must depend largely for the success of the plan here proposed. Many such persons spend evening after evening at their telescopes without obtaining results of any permanent value. Either no publication is made and the results are therefore valueless, or time is spent on objects that can be much more usefully examined with a larger instrument. Most commonly the observer has no special plan and spends many hours without result, while the same time might have been employed with equal pleasure to himself and results of great value collected. Those who have not tried it do not realize the growing interest in a systematic research and the satisfaction in feeling that by one's own labors the sum of human knowledge has been increased. (Pickering 1882)

Pickering envisions the casual sky gazer turning his or her interest to the service of science, but he does not actually propose the establishment of a formal organization of amateur observers. Pickering's thrust is simply that individual amateur observers are capable of submitting their observations to an observatory in a standardized way, and are requested to do so.

William Tyler Olcott later recognized the importance of this proposal (notwithstanding Chandler's 1878 publication of "how to observe" articles, and Gould's appeals to amateurs in 1855 and 1856) when he wrote that Pickering "was the first to place before the amateur astronomers of this country the opportunity afforded them for accomplishing valuable and scientific work in the observation of Variable Stars" (Olcott 1937).

In 1882, *The Sidereal Messenger* (the only astronomy publication in the U.S. at the time), edited by William Payne, the Director of Carleton College Observatory in Northfield, Minnesota, noted the release of Pickering's "Plan." In 1883, Payne published excerpts from it, and offered to send the complete pamphlet to anyone interested (Payne 1882, 1883).

In 1887, *Popular Science Monthly* reported on a paper by Pickering, titled "The Extension of Astronomical Research," in which he proposed the establishment of a central astronomical agency to which research funds would be sent for distribution to observatories and researchers. Like his specific plan for efficiency in collecting variable star observations, this broader proposition seeks to make the best use of observatory time, equipment, personnel, and other resources (Youmans 1888). This idea of administrative efficiency is a recurring theme throughout Pickering's career and should be considered an important non-scientific motivation for his encouragement of amateur involvement in astronomy (see, for example, his 1915 paper "Aid to Astronomical Research").

Another glimmer of popular interest in the subject of variable star observing appeared in the May 1891 issue of *The Sidereal Messenger*:

> *How to Observe Variable Stars*. We have asked one or two of the best observers of variable stars that we know of in this country to give suggestions for amateur work in this direction. Some useful work will be mapped out next time. (Payne 1891)

Nothing further on the subject appeared in *The Sidereal Messenger* other than ephemera lists and the occasional report of a variable star discovery. In 1892 the journal changed its name to *Astronomy and Astro-Physics* (co-edited by the eminent George Ellery Hale), took on a more technical slant, and featured articles (many by Hale and by Pickering) on stellar spectroscopy more than on general astronomy (see Payne and Hale 1892–93).

In September, 1894, amateur astronomer Paul S. Yendell published "Suggestions to Observers of Variable Stars" in W.W. Payne's new, "untechnical" publication, *Popular Astronomy*. This is, perhaps, the article Payne had in mind for his 1891 issue of *The Sidereal Messenger* (see Payne 1893 concerning the inauguration of *Popular Astronomy*). Yendell begins:

> It is gratifying to note the signs of an awakening of interest, among our amateur observers, in this field of work; a field in which the laborers have up to the present been few, although it especially commends itself to the amateur of modest equipment, as the one best suited to his means, and in which he may most confidently hope to achieve results of value to science.... (Yendell 1894a)

This article was quickly followed by the four-part series "On the Variable Stars of Short Period" beginning in the December, 1894, issue of *Popular Astronomy*. Speaking of the short period variables, Yendell says:

> So far as is known to me, I have been for some years past almost the only observer that has made a practice of keeping a watch on them, and it is very desirable that others should take up the lines of observation which are being crowded out from my own list by the pressure of other work of greater importance. (Yendell 1894b)

Although he is aiming for an audience of amateurs, and these are meant to be introductory articles, Yendell does go into considerable detail. He does not only provide a list of positions of 18 short-period variables, but he also provides for most of them the elements of variation, a finder chart, a table of comparison stars and light steps, and a light table of mean values made from his own reduced observations, as well as a brief observing history of the star from its discovery to the findings of its most recent observers. Yendell followed these articles with many more in *Popular Astronomy* in the years to come.

6. "Undoubted authority" or "high authority": the visual/photographic controversy

In the introductory remarks to his "Third Catalogue of Variable Stars" of 1896, Chandler makes a point of remarking on "the degree of uniformity and completeness" of variable star observations made to date, noting that:

> this harmonious development has been attained without any concerted scheme of "cooperation," but by the free will and independently planned efforts of individual volunteers, each discriminatingly directing his work in accordance with his means and situation. Such a satisfactory result could hardly have been reached so effectively by a formal organization of work, directed from headquarters prescribing and circumscribing the operations of each participant, and destroying, by its benumbing influence, the enthusiasm which springs from the individual initiative of the observers themselves. (Chandler 1896)

Chandler's defiant remarks are the culmination of several years of feuding between the experienced variable star amateurs and the professionals. Chandler is aiming his remarks at Harvard College Observatory, where many photographic and spectroscopic discoveries of variable stars and suspected variables were being made. Some of the other established visual astronomers, as well, expressed their distrust of the growing reliance on the new astrophysical and photographic methods.

In the remarks of his "Second Catalogue" of 1893, Chandler stresses the strict principles by which a star considered to be variable is included in his catalogue. He cites as his models of visual observation "the critical and conscientious care of Argelander" and of Schönfeld. He concludes by saying:

> No star should be inserted, no matter how high the authority on which its variability is declared, without independent verification on undoubted authority and evidence. Otherwise the result will be chaos. (Chandler 1893)

It is hard to say exactly when and how the seeds of this controversy were planted. It could have begun with the publication of Pickering's 1882 "Plan" for recruiting inexperienced amateurs in variable star work. It could have started with Pickering's 1886 *Investigation in Stellar Photography*, which includes a description of how photographic stellar spectra are obtained, or with the publication of the *Henry Draper Memorial* in 1890 and 1891. But it is clear that by the mid 1890's, there were two extremes of thought on what type of variable star observations really mattered.

Between 1890 and 1892 there occurred a series of miscommunications and disagreements between Pickering, on one side, and Chandler, John Ritchie, and Gould, on the other side, concerning how astronomical discoveries were being announced. This matter took on serious proportions in 1894, when Chandler publicly criticized the Harvard photometry program. Pickering admitted that there were some errors, but that these were to be expected in such a large project, and that this did not justify Chandler's blanket condemnation of the work. The strained relations between Chandler and Pickering were thoroughly healed by 1899 (see Jones and Boyd, 331–345).

In *Astronomy and Astro-Physics* of October, 1893 (two months after Chandler's "Second Catalogue" appeared), HCO assistant M. Fleming published an article entitled "A Field for Woman's Work in Astronomy." In her article, Fleming describes the new scientific work opportunities opening for women in astronomical photography. By the end of the article, she apologizes for having gone off on a tangent in which she takes issue with the critics of the new photographic techniques in astronomy. Specifically, she is responding to Chandler's remarks in his "Second Catalogue" about the importance of visual observations. Fleming's remarks are worth quoting at length, since they give a good picture of the positions held by each side with almost religious fervor:

> You can obtain in one night what would represent years of hard labor in visual observation, and in the necessary computation involved in reducing and charting these same observations. Even when finished the visual observer's chart may be subject to various errors in the positions or in the brightness of the stars with which he has dealt, but the photograph cannot fail to be an exact and unquestionable record which can be consulted and compared with others years hence and thus serve to prove or disprove variations in light, changes in position, and in the case of the spectrum plates, changes, if any, in the constitution of the stars....
>
> In a catalogue of variable stars recently published and entitled "Second Catalogue of Variable Stars," a more correct title would be "Second Catalogue of Variable Stars discovered Visually," since in it no weight is given to photographic observations further than is necessary to enable them to swell the list of stars discovered visually. Stars discovered photographically which have been announced as variables, and have been proved beyond doubt to be variables, are here credited as "suspected." (Fleming 1893)

The arguments of Chandler and Fleming reverberate in articles by others through the rest of the 1890's. Yendell, who wrote many articles on variable star observing during this time, is a staunch defender of the traditional method:

> I would strongly insist on the necessity of careful, deliberate, and conscientious work; and that the beginner remember that quality is of infinitely greater importance than quantity; that a single well and thoroughly determined fact is worth more than pages of hurried and half-digested observations. It is due to a careful regard to this cardinal principle, that the names of Argelander, Gould, Schöenfeld, Chandler, and Sawyer, observers in this line of work, are known throughout the scientific world as the names of men whose statements may be implicitly accepted, with a full confidence that they will be borne out by the facts. Such a reputation is of unspeakably higher value than one based on no matter how great a quantity of crude and hasty work, and half considered deductions. (Yendell 1894a)

John A. Parkhurst expresses the most objective view. In an article of March, 1894, he acknowledges the recent emergence of photographic observation methods, and notes how photography can produce results for the fainter stars, especially when many plates of a region are made over a period of time. He also notes, however, that accurate photographic astronomy requires specialized equipment and techniques beyond the reach of most amateurs. "Besides," he adds, "the time required to expose and develop a plate and make the necessary measurements would suffice to observe a dozen stars visually."

He also acknowledges the controversy itself in an objective manner:

> A very animated discussion has arisen in regard to the weight to which these results [photographic discoveries of variable stars] are entitled, and the widest differences of opinion are expressed. It is perfectly proper that any new method of astronomical research should be subjected to the severest scrutiny in order that its weak points may be found and strengthened and its proper field assigned. (J. A. Parkhurst, March 1894)

Two years later, Yendell reaffirms his confidence in the visual method:

> Much work has been done of late years in the determination of magnitudes by measuring the photographic images of stars, and in some quarters exceeding accuracy has been claimed for these determinations. In view, however, of the character of the images, the influence of the colors of the stars on their relative sizes, the many varying conditions of atmospheric disturbance, possible lack of uniformity in films and emulsions, and different circumstances of development, the more one knows of these measures, the less he feels inclined to trust them. (Yendell, July 1896).

For Chandler and the other experienced amateurs, “high authority” and “undoubted authority” are not necessarily one and the same if the one is working from theory or new methods and the other relies on visual observation and precise measurement. Chandler and Yendell are justifiably proud of the accomplishments and discoveries that they and other skilled and dedicated amateur observers have made in the young history of variable stars. Yet Chandler himself goes on to state in the “Third Catalogue” that variable star observing “is a field affording ample room for more participants. In the southern hemisphere, particularly, the need for volunteers is pressing” (Chandler 1896). But Chandler undoubtedly is thinking in terms of highly skilled observers and computers, like himself and his amateur associates.

Chandler believed that the skilled amateur, acting as an independent observer, would ensure the highest quality of work. He feared that the mere proliferation of “discoveries” of variable stars would result in confusion and chaos. Pickering’s rationale for organization in variable star observing (noted later in the *Pickering Memorial*) was also to avoid chaos: he saw that individual, non-standardized efforts inevitably would result in confusion and errors, since most observers had their own sequences of comparison stars, and many times an individual’s star identifications would be questionable, rendering their observations useless (AAVSO 1920).

The visual/photographic controversy of the 1890’s was merely a symptom of inevitable change in the way variable star observations would have to be conducted in the future. The key to involving many more amateurs in variable star observing—while ensuring the quality and consistency of measurements—would be to provide standard sequences of comparison stars that have assigned magnitudes. For the novice observer, this would make variable star measurement a much simpler activity than having to follow the cumbersome step method, and it would do away with the laborious reductions needed to derive a light curve. It is perhaps enough to say that Chandler and Pickering, and their respective camps, both were aware of the rapidly expanding field of variable star research. They both agreed that more observations of these stars would be vital towards understanding them, and they both agreed that variable star work could be done by amateurs with modest means.

7. The fruits of "cooperation" in variable star research at HCO: the emergence of a new generation of enthusiastic amateur variable star astronomers

Between 1889 and 1899, a program of visual observation of 17 circumpolar variable stars was undertaken at HCO, under Pickering's direction. These observations were made mainly by Oliver C. Wendell, William M. Reed, and Annie J. Cannon, of the HCO staff, and by amateur astronomer Frank Seagrave, of Providence, Rhode Island. What distinguished these observations from others made elsewhere, Pickering noted, was that the stars were observed "throughout their variations of light," and that all observations were reduced "to a uniform photometric scale." Also, each of the variables had its own sequence of comparison stars (published in an 1891 pamphlet by E. C. Pickering, "Variable Stars of Long Period"), consisting of "stars differing from each other by about a third, or a half of a magnitude, the brightest being brighter than the variable at maximum, and the faintest fainter than the variable at minimum" (see Wendell and Pickering 1900).

The results of this survey, Pickering reported, "justified its extension to other stars." He soon followed it with a program of observations of 58 long period variables made between 1890 and 1901. Although Pickering continued to expand his collection and publication of variable star data, he still had to rely on an informal network of amateur and professional astronomers. The observations again were made mainly by HCO staff Wendell, Reed, and Cannon, and amateur astronomer Seagrave. Additional observations were made by Leon Campbell and other staff observers, and also the amateurs John H. Eadie, Zaccheus Daniel, and Manoel Soares de Mello (see Wendell and Pickering 1902).

In 1895, the Variable Star Section of the British Astronomical Association was formed. The VSS was the first group to use Pickering's standard sequences of comparison stars, adopted "practically *in toto*" Leon Campbell later reported (Campbell 1931).

In 1901 Pickering again called for "Co-operation in Observing Variable Stars," this time in the new, "untechnical" *Popular Astronomy*. This appeal had more urgency to it, as Pickering begins by saying:

> The number of known variable stars of long period is now so great, and is increasing so rapidly, that the observation of many of them has been greatly neglected. (Pickering 1901)

By 1901, the Variable Star Section of the British Astronomical Association must have seemed a good model of cooperation among amateur observers for Pickering and the amateur astronomers with whom he communicated. Pickering did a lot up to this time to encourage amateur observers, prepare and distribute charts and instructions, and determine comparison star magnitudes.

In *Harvard Circular* 112 of 1906, Pickering makes another appeal for observations of long period variables, stating that this type of variable is ideal for amateur observers who could observe them at infrequent intervals with small telescopes. Furthermore, because most of these stars have a large magnitude range, there is room for "moderate errors of observation." One important point in this circular is Pickering's description of a new method of making observations, "being substituted here for that of Argelander" by which the magnitudes of a sequence of comparison stars are entered directly onto photographic charts. The observation is made by comparing the variable directly with a brighter and a fainter comparison star, and matching or interpolating the variable's magnitude from the given comparison star values. It is the method commonly in use today (Pickering 1906; Furness 1915).

Between 1906 and 1910, Pickering reported, about 6000 observations of long

Caroline Furness

period variable stars were "kindly communicated by other astronomers." Among them were: Professor Anne S. Young of Mt. Holyoke College; Frank E. Seagrave of Providence, R.I., John H. Eadie of Bayonne, N.J., and several astronomers, assistants, and students at Vassar College, including Ida Whiteside, Helen Swartz, Psyche R. Sutton, Professor Mary Whitney, Professor Caroline Furness, and others. In addition, there were Henrietta Swan Leavitt, who joined the HCO staff in 1895, and by 1908 discovered nearly 1,800 variables in the Magellanic Clouds; Leon Campbell, who joined the HCO staff in 1899, and made thousands of observations; and other HCO staff astronomers, especially O. C. Wendell and Annie Jump Cannon. Also, the Variable Star Section of the British Astronomical Association was another important source of data for Professor Pickering at this time (see Pickering 1911).

Helen Swartz

The AAVSO archives show that Ida Whiteside, Helen Swartz, and Mary Whitney contributed over 3,200 variable star observations to Pickering from 1902 through October 1911. Ida Whiteside alone sent reports of at least 2,507 observations of variable stars to HCO between 1904 and 1909. Helen Swartz, of Norwalk, Connecticut (who became a high school mathematics teacher there), was later both a Charter Member and a Life Member of the AAVSO, and Caroline Furness was a Charter Member. Helen Swartz was also one of the first Council members of the AAVSO when it was formally organized in 1917 (AAVSO Archives).

8. Amateur to Amateur: William Tyler Olcott and the emergence of an American Variable Star Association

In 1909, William Tyler Olcott (shown at right) heard Pickering give a talk about variable stars at a meeting of the American Association for the Advancement of Science. Olcott, a gentleman (non-practicing) lawyer, became interested in astronomy in 1905, at about the age of 32, when a friend pointed out some constellations to him. By 1907 he had published *A Field Book of the Stars*, and in 1909 he published *In Starland with a 3-Inch Telescope*. He made his first variable star observation in February, 1910, and regularly sent his observations to Pickering from then on, joining the other dedicated and enthusiastic individual observers in the service of Pickering (Olcott 1937; Campbell 1931; AAVSO Archives).

William Tyler Olcott

In HCO *Circular No. 166* of June 1911, entitled "Cooperation in Observing Variable Stars," Pickering

Stephen C. Hunter

published a list of stars that needed to be observed, including a list of observers who were willing to participate in this project, some of whom are mentioned above (Pickering 1911). Leon Campbell later wrote that "right here, one might say, was conceived the embryo variable star association, which a year later took actual form as the 'A.A.V.S.O'" (Campbell 1931).

Anne S. Young

Actually, of the 10 individuals listed by name in Pickering's list (not counting Olcott and Campbell), five became Charter Members of the AAVSO in 1917, but only three of them continued to submit observations for more than 10 years after 1911. They were, S. C. Hunter (shown at left), of New Rochelle, New York; M. W. Jacobs, of Harrisburg, Pennsylvania; and Professor Anne S. Young (shown above right), of Mt. Holyoke College, Massachusetts. Hunter and Jacobs have over 2,900 observations each on record at AAVSO (over an observing lifetime of 23 and 26 years, respectively), and Anne Young submitted over 6,500 observations over a 33-year period. In addition to being an AAVSO Charter Member, Hunter was also a Life Member. Anne Young was also one of the first AAVSO Council members named in 1917 (AAVSO Archives).

In March, 1911, *Popular Astronomy* published an article by Olcott titled "Variable Star Work for the Amateur with Small Telescopes." Here, Olcott echoes Gould's 1855 and 1856 appeals, Pickering's 1882 appeal, J. A. Parkhurst's appeal of 1893-94, and the numerous appeals made by Yendell from 1894 to 1906, to casual star gazers to turn their eyes and instruments to a purposeful activity in the service of science, stating:

> ...it is a fact that only by the observation of variable stars can the amateur turn his modest equipment to practical use, and further to any great extent the pursuit of knowledge in its application to the noblest of the sciences. (Olcott 1911a)

But the real significance of Olcott's article is that, for the first time, a novice American amateur astronomer was addressing other novice amateur astronomers on the subject of variable stars in a general-circulation popular journal. Olcott's piece was not only an appeal for observations and an explanation of variables, not only a methodology carefully explained and laid out: it was also an invitation presented in a warm and friendly tone, with a number of simplified finder charts (provided by Pickering) and light curves, intended to be understood by novice amateur astronomers like himself who could be found amongst the public at large, anywhere in the United States.

There is an interesting side note to Olcott's encouragement of other amateurs. In the August, 1911, issue of *Popular Astronomy*, Frederick C. Leonard published a notice titled "The Society for Practical Astronomy." This, he stated, is "an association of astronomical observers" which he founded in 1909. The group only recently became well known, according to Leonard, when the latest issue of "The Monthly Register of the 'S.P.A.'" was given wider circulation. "It is our hope," Leonard stated, "to bind together in one strong society all of the astronomical amateurs in America and elsewhere, and in this way encourage and help to promote amateur work in general." The aim of the society would be "the advancement of, and cooperation in Practical Astronomy." Anyone who was a "fairly regular observer" was encouraged to join (Leonard 1911). AAVSO observers W. T. Olcott, of Connecticut, G. B. Lacchini, of Italy, and possibly others, were among the "rapidly growing" membership of Leonard's S.P.A. who contributed their observations to its variable star section. For a short time, between 1912 and 1913, Olcott even served as Director of the S.P.A.'s variable star section, but he resigned by mid-1913 due to his heavy work load as corresponding secretary of the AAVSO. By 1915, the many variable star observers left the S.P.A. to give their full attention to participation in the AAVSO (Williams 1998).

The final stage of the embryonic development of the AAVSO came in the same August, 1911, issue of *Popular Astronomy* in which F. C. Leonard's notice appeared. Immediately following it, in fact, was a notice titled "What an Amateur Can Do." Here, the editor, H. C. Wilson, asks: "Can we not have in America an association of observers with a 'Variable Star Section', a 'Jupiter Section', etc.?" (Wilson 1911) William Tyler Olcott answered this notice with one of his own, in the November, 1911, issue, offering to correspond with anyone interested in organizing to observe variable stars (Olcott 1911b). Now, with an organization envisioned, a handful of dedicated volunteer observers, and a worthwhile scientific purpose defined, the AAVSO was about to achieve "first light."

9. Conclusion

The future of variable star astronomy in the U.S. was based upon a foundation laid in the 19th century by the pioneering efforts of Benjamin A. Gould—who made the first appeals for amateur involvement in variable star work in America—and especially by the skilled and hard-working amateur astronomers Seth C. Chandler, Jr., Edwin F. Sawyer, and Paul S. Yendell, and others. Their work was utilized and expanded upon by Harvard College Observatory Director Edward C. Pickering, who favored the increased participation of much-needed variable star observers among amateur and professional astronomers. This participation was carried forward to a new level of popular engagement through the timely appearance of the novice, but enthusiastic, amateur astronomer William Tyler Olcott, who organized the growing body of variable star observers into the AAVSO.

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