which, fortunately, may now be found; these should include either one or both of the new towns west of Yuma, Calexico and Mexicala, together with Caborca, the westernmost town in Altar District, Sonora (to which the Mexican government telegraph line has recently been extended), and Hermosillo, the capital of Sonora. Doubtless cooperative stations might be established at these points; at the latter two perhaps in accordance with the law authorizing observations at points outside of the United States on Gulf of Mexico and Caribbean Sea. It would be well, too, to establish a record station on Rio Colorado between Yuma and Parker, and if practicable also at Quitobaquito (or Humboldt post-office) on the international boundary, some ninety miles east of Tinajas Altas. Records at these points would serve both to determine the limits and define the nature and influence of the vapor zone above the Californian Gulf.

W J McGee.

A SYMPOSIUM ON CHEMISTRY REQUIREMENTS.[1]

That charming and discerning essayist of to-day, Samuel M. Crothers, in a recent issue of *The Atlantic Monthly,* calls our attention to the delightful ease with which one may cultivate a good crop of fallacies by employing a heavy mulch of statistics. "The best way," he suggests, "is to prepare circulars containing half a dozen irrelevant questions, which you send to several thousand persons—the more the better. If you enclose stamps, those who are good-natured and conscientious will send you such odd bits of opinion as they have no other use for, and are willing to contribute to the cause of science. When the contributions are received, assort them, putting those that strike you as more or less alike in long straight rows. Another way, which is more fanciful, is that of arranging them in curves. This is called 'tabulating the results.' When the results have been thoroughly tabulated, use them in the manner I have described for the protection of your favorite arguments."

And yet it is less Crothers that speaks than his Scholasticus, a rather prosy, old-fashioned gentleman whose evident aversion for the times in which he lives and for the manners of those times forbids our taking him too seriously.

The symposium method may, I think, like any other method under the sun in the wide field of thought-husbandry, be made to stimulate and protect the growth of sound arguments as well as of fallacies. Of what kind it has brought forth on this occasion I must leave it to my patient hearers to determine.

It is both trite and untrue to assert that the south is backward in methods, but rather in lack of money to execute and realize methods. By careful inspection of the curricula of a list of southern institutions, even the smaller fresh-water colleges, we shall find that mention is nearly always made of the laboratory and of the library. Besides, a majority of these colleges are manned by competent instructors—young men educated after the most approved orthodox modern methods in American and European universities. This is especially true in the departments of the natural sciences, and particularly in chemistry. The crux of the situation is the poverty of all of our colleges, including state institutions, private foundations, and church colleges alike.

Of the three requisites for a good college, competent teachers, eager students and adequate equipment, naming them in the order of their importance—I take it that

[1] Paper read at the meeting of the American Chemical Society at New Orleans, December 30, 1905.

southern colleges possess the first two in a liberal degree. In our poverty, however, we have been consuming time in applying the first law of nature, that of self-preservation; and have often chosen to do those things which we should have preferred to alter or forego.

With a desire to contribute towards bringing about a better understanding and feeling among the teachers of chemistry in the south, I recently sent out a number of inquiries, the answers to which should form a symposium on chemistry requirements. The results have been most gratifying. Of the forty-four teachers of chemistry concerned, forty made prompt, candid and interested replies.

The list of questions by no means covers the ground, but enables us to form some idea of the general trend of work done in the more important southern colleges.

In order that the replies may be discussed systematically, I have here arranged the several queries *seriatim*, as in the circular, with their corresponding replies.

1. *Should chemistry be taught in preparatory schools?*

Of the forty replies, twenty are affirmative, fifteen negative and five doubtful. My object in asking the question was to secure some justification of the decision of the Committee on Chemistry Entrance Examinations for the Association of Colleges and Preparatory Schools of the Southern States. The committee is made up of Dr. Cameron Piggott, Sewanee; Dr. F. P. Venable, University of North Carolina, and myself. The majority of the committee were opposed to the study of chemistry in preparatory schools, and asked to be excused from service on that account. But at the earnest solicitation of the president of the association, the committee remained intact and submitted a list of college entrance questions. From the replies to question 1 of the circular, it seems that the majority of southern chemistry teachers differ with the committee, and approve of the study of chemistry in preparatory schools.

2. *Does your first course in chemistry precede, accompany, or follow that in physics?*

The replies show that in ten colleges chemistry precedes physics; that in eight it accompanies physics; and that in twenty-two, it follows physics. These figures, however, are probably not expressive of the ideals of the respondents, but form rather a simple statement of facts and conditions as they find them. In many cases neither subject is required for entrance and both are postponed until after college is entered. In nearly all cases chemistry is begun in the college. In a large number of cases physics is begun in preparatory schools.

I believe, personally, that physics should invariably precede chemistry. Elementary physical phenomena are more easily observed and interpreted than those of chemistry; and, besides, while very few physical problems involve chemistry, nearly all chemical problems require some physics for their solution.

Another consideration to be reckoned with is that a beginners' course in physics may be conducted more successfully and satisfactorily with limited equipment than a course in chemistry. In fact, I am rather strongly persuaded that the study of chemistry should never be undertaken in any of our southern preparatory schools. The time spent in such schools should be devoted to the humanities and the mental disciplinary studies, such as literature, language, pure mathematics, and sufficient nature study to give diversity and recreation. When students begin chemistry, their minds should be able to grasp such

abstractions as the atomic theory, Avogadro's hypothesis and so forth.

3. (*a*) *State your ratio of hours devoted to lectures and laboratory in general chemistry.*

(*b*) *Should individual laboratory work invariably be required in connection with the study of general chemistry?*

The replies to (*a*) show general uniformity in ideal and application. The theory seems to prevail that about equal time limits be afforded lectures and laboratory. In most cases the practise conforms to the theory. There are some extremes which, when paired, do not affect the average. One college gives the ratio three lectures to nine laboratories; another reports five lectures to one laboratory.

I was glad the answers to (*b*) were made *in absentia,* for a majority were very emphatic in their affirmative replies—so much so that italics and exclamation points were in evidence. I should have been embarrassed had I asked the question of an audience of chemists, and had their replies been as vociferous as I am led to suspect they would have been. The interesting feature of the symposium is that some answered directly in the negative, and other few in a modified affirmative. Dr. Caldwell, of Tulane, writes: 'Some laboratory work is advisable; but laboratory work is, in my opinion, often overdone'; Dr. White, of the University of Georgia: 'Not invariably'; Dr. Wait, of the University of Tennessee: 'We do not require laboratory work.'

I am afraid we have made a fetish of laboratory work. The pendulum has swung too far. Twenty-five years ago some good chemistry was taught by masters to students who did the minimum of laboratory work. At that time Harvard, Yale, Princeton, Virginia and other similar and smaller colleges gave courses in general chemistry with practically no laboratory work. It might be said that those times of laboratory ignorance could be winked at, but that now all chemists everywhere should be expected and urged to require laboratory work.

In the evolution of chemistry teaching we are facing the same problem which, in language teaching, provoked a wordy wrangle among the German universities fifty years ago. Leipzig placed grammar before literature; Berlin placed literature before language.

We must not lose sight of the fact that chemistry, while an experimental science, possesses likewise a large deductive value. Undoubtedly, we should require laboratory work in general chemistry; but if I were forced to accept an alternative, illustrated lectures without laboratory, or laboratory without lectures, I would choose the former, the lesser of the two evils.

4. *Does your course in qualitative analysis accompany or follow that in elementary general chemistry?*

For the most part the consensus of custom everywhere, including the south, is to let qualitative analysis follow general chemistry. I presume that in the case of this question I am also open to criticism from those who consider no other place for qualitative analysis. The object in asking the question was twofold: First, to emphasize the fact that many text-books include impossible and out-of-place courses. Just why qualitative analysis should be mixed with general inorganic chemistry I can not understand. The short references to the subject are nothing more than an outline, and I have never known a teacher to use them in actual practise.

The second purpose was to make a plea for legitimate qualitative analysis. The subject has been abused, it is true, and often authors and teachers have degraded

the science of chemistry to the art of detecting and separating acids and bases. In their over-ardor for brevity and tabulated schemes, they have emphasized the empirical and minimized the rational aspect of the subject, to its detriment as a factor in liberal education. The subject has a peculiar virtue if taught with the end in view that it is not technical but pure chemistry. By devoting periodical hours to the interpretation of the chemistry involved, no branch of the science offers such delightful and profitable employment to students.

I am aware that my view may possibly be regarded as old-fashioned, and that there is an effort to displace this subject from the college curriculum. Dr. Arthur Lachman, in a recent address before the American Chemical Society, referring to qualitative analysis, said: "The chemists of the U. S. Geological Survey never carry out qualitative analyses of the rocks they investigate. * * * The assayer never makes other than a quantitative analysis of gold and silver ores. For the food analyst, all is grist that comes to his mill—moisture, fats, carbohydrates, proteids and ash. Where then is our boasted art of qualitative analysis?" Evidently the speaker has misinterpreted or forgotten the aim and genius of qualitative analysis. As an art it is useful only as a handmaid to the science. It is not technical chemistry, and I doubt whether Liebig or Fresenius ever considered it in that light. The mineral analyst does not rethresh old straw by investigating the constitution of the positive and negative ions he discovers. This he learned in general chemistry. Nor does he waste his time in making a qualitative analysis of the average specimen; for experience has taught chemists that most minerals are composed of only a few basic and acid radicals. The argument for the condemnation of qualitative analysis would apply with equal force to general chemistry.

The object of qualitative analysis is not so much the detection of certain ions in 'unknowns,' but rather a systematic study of the chemistry involved in a well selected and progressive set of facts. I use the word 'progressive' advisedly, for though the arrangement is not that prescribed by Mendelejeff, it is the most practicable known. Nor do we follow the periodic table in the study of general chemistry, for the apparent reason that oxygen, hydrogen, nitrogen and chlorine are more accessible and tractable than either lithium at the one end, or fluorine at the other end of the table.

5. *What number of hours do you devote to qualitative analysis?*

The average time calculated from these replies is six hours a week for one term or semester. I am glad to learn that there seems to be no desire nor expectation of limiting or abandoning qualitative analysis.

6. *What number of hours do you devote to quantitative analysis of typical compounds before attempting technical analysis?*

The language here is somewhat obscure, but as yet I am unable to formulate a sentence more clearly expressing my thought. Hardly any two authors or teachers would give identical lists of typical compounds for courses in quantitative analysis; though probably all would include in their lists a dozen or more common types.

It is not surprising that a great diversity of opinion and practise is shown in these replies. After all, the *desideratum* is a thorough drill in gravimetric and volumetric methods. Familiarity and practise with the balance and other essential apparatus, including calibration of graduates and preparation of reagents, are funda-

mental, but are attained by various individual methods.

7. (*a*) *Do you begin the study of organic chemistry with a lecture course merely, or with one combining lectures and laboratory work?*

(*b*) *What number of hours do you devote to organic chemistry?*

I happened to know of several southern colleges which give lecture courses in organic chemistry without laboratory work. I was anxious to learn how general this practise is in the south; and accordingly used this opportunity of taking a census of southern colleges on this subject.

Those which give no parallel laboratory work, though in the minority, are more than I had supposed. Just what the trend in this method of teaching organic chemistry is I have not been able to learn. Whether the large number of lecture courses without laboratory is a protest against what some regard as a laboratory mania, or whether the majority of teachers following this practise have not adequate laboratory equipment or assistance, I am not prepared to say. I suspect, however, that the latter is true, though the list includes several small colleges and a smaller number of universities and well-equipped schools of technology. The following are some of the institutions which offer organic chemistry lectures without laboratory: Tulane, Sewanee, Washington and Lee, University of Louisiana, University of Tennessee, University of North Carolina, Clemson College, A. and M. College of Texas.

What was said regarding general chemistry without laboratory may also, I think, be said in part of organic chemistry without laboratory. It is better in most cases to have the laboratory course, but often the deductive may precede the inductive with fair results. Another factor to be taken into consideration is the stage of the student's chemical education when the subject is begun. If introduced early, before he has acquired the quantitative habit, I think that laboratory work should invariably accompany lectures, the idea being to reinforce theory with practise. If the student has had considerable training in both theoretical and practical inorganic chemistry, it seems reasonable to believe that he could assimilate lectures on organic chemistry without the laboratory.

The average number of hours devoted to organic chemistry is three hours for lectures and two hours for laboratory a week for one term.

8. (*a*) *Do you offer courses in chemistry for graduate degrees?*

(*b*) *If so, please state the degrees.*

The majority of the institutions represented offer graduate work in chemistry for the M.S. degree. This is noticeably characteristic of the southern state universities. The most significant, and I think hopeful, development from the investigation is the very small number of southern universities offering the Ph.D. degree. Of the forty institutions heard from, only the following offer the doctor's degree: University of Virginia, Washington and Lee, University of North Carolina, Vanderbilt, University of Mississippi, Tulane, University of Missouri, Washington University. Of this number, four, while still offering the degree, indicate their intention of abandoning it. The small number is hopeful, I think, in that it means a growing desire among our southern colleges and universities to accomplish only that work they are best fitted to do. Many have been pretending to do work for which they were not adequately equipped. The cause is less one of vanity or dishonesty than of history. Before the civil war, nearly every southern state had well-equipped

state and church colleges. Many of them were legitimately named universities and did what was then regarded as university work. The war destroyed their endowments and buildings, and left most of them with only one asset, their names. When they were reopened, after the war, it was hard for some of the universities immediately to become colleges, and for the colleges to become preparatory schools. In many instances their ante-bellum titles carried with them grants, franchises and endowments, rendering it practically impossible for them to assume more modest and significant names. I am quite sure that the authorities of a majority of the so-called universities of the south would prefer that their institutions be called colleges; but for the reasons assigned and others, they have been largely powerless to change the titles. Furthermore, some institutions, which enjoyed merited reputations before the war have tried to justify their pretensions by indulging in the hope that they may come into their own again.

But whether we praise, apologize for or blame our institutions, the south is in this matter justly criticized, though pretence is rapidly disappearing, and most southern colleges are honestly trying to live up to their published standards. Some, however, still continue to publish courses which either are not taught, or are conducted in a perfunctory manner. I shall not call any names, but I am venturing the statement that ten of the forty institutions on the list publish courses in their catalogues different from those given in the circular now under discussion.

I have already digressed, but must ask leave to wander a little farther yet.

There are too many colleges in the south. It is a mistake to substitute quantity for quality. It were better for the south to have fewer, well-equipped colleges than so many with inadequate appointments. It is too late and impracticable now for each state to focus all of its higher state institutions into one common plant. The present generation is not responsible for the mistakes of the past, and can not correct some of them; but it is responsible for the future. There should be no more dissipation of our educational forces, and all future enlargement should be added directly to the central university. Probably no state in the south makes more liberal appropriations for higher education than Georgia. Two sets of schools and colleges for the two races must necessarily be supported. We believe that this is fundamental and should be maintained at all hazards. But is it educationally economical for Georgia to provide seven separate, unarticulated institutions, so situated that students from no one of them can have access to the instruction and equipment of the others? Other states, especially those in the west, are consolidating their public institutions into great university systems.

9. *What are your requirements in inorganic preparations?*

10. *What are your requirements in organic preparations?*

Eight of the list of colleges require both organic and inorganic preparations additional to their elementary courses in these subjects; three of them, organic preparations only; and two, inorganic preparations only. One of the largest universities in the south, Tulane, has no formulated prescription for either organic or inorganic preparations. Dr. Dudley, of Vanderbilt, writes, 'I never could see the necessity for inorganic preparations.'

Why so few southern chemistry teachers carry on research themselves, much less offer courses, is patent, when we consider their situation. They are so overloaded

with instruction or executive duties that they can not carry on original work in their own specialties. Nor are they supplied with adequate library or laboratory facilities for advanced students.

11. (*a*) *Do you offer technical courses in chemistry?*

(*b*) *If so, which do you emphasize?*

There are more southern colleges offering technical work than I had anticipated. Twenty-four of the list give technical courses in some form or other. Usually the special kind of technical work is controlled by local demands and natural supplies. For example, all of the colleges receiving the Morrill fund make a specialty of fertilizer, soil and food control; the Louisiana colleges offer courses in sugar chemistry; the Alabama colleges, iron and coal analysis; and so forth.

I consider this both pedagogical and profitable. While the study of chemistry should be considered fundamental, and should not be side-tracked for technical work too soon in a student's chemical education, even from an educational viewpoint some technical application is helpful in reinforcing previous theoretical training. The same principle obtains in language study. Literature emphasizes and strengthens the technique of grammar and rhetoric. Then, too, technical training is materially profitable. The reason why the familiar national trade-mark, 'Made in Germany,' is a valuable asset is because German manufactories are worked and superintended by graduates technically trained in the great universities. It is possible that the *Germanophobia* indulged in by our British cousins is caused by commercial rather than political jealousy. The two antipodal economic practises account for the apparent industrial decadence of Great Britain compared with the ascendency of Germany. Oxford and Cambridge—despite their admirable history of light and leading—have had little share in the affairs of the great industrial centers of Birmingham, Manchester and Sheffield. These industries have been developed by the apprentice system. Under this system young men become skilled in the manipulation of old methods, but have no opportunity of contact with the new. In one German pharmaceutical plant alone, there are employed two hundred university graduates, who by their superior skill and education not only perfect old methods of preparations, but are earnestly devising new processes. Although Great Britain and America manufacture more iron, and consume more coal, Germany, a less favored nation in these raw materials, converts the by-products from our coke ovens and gas plants into antipyretics and coal-tar colors, and returns the finished products to us.

President Remsen in his inaugural address at Johns Hopkins said: "It is generally accepted that the reason why Germany occupies such a high position in certain branches of industry, especially those founded upon chemistry, is that the universities of Germany have fostered the work of investigation more than those of any other country. * * * In Germany the chemical industries have grown to immense, almost inconceivable, proportions. Meanwhile, the corresponding industries of Great Britain have steadily declined."

Once the American universities were replicas of the British system, but now the German university sets the standard.

It is this shifting of method and manner that affords us of to-day, in the matter of the practical virtue of our courses in science, an assured guarantee of commercial and industrial progress.

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