define the virus problem in contradistinction to the latter. The point of view that a true virus represents a distinct type of disease-producing agent has been presented and emphasized. To further assist in defining the virus field a classification of virus diseases based upon the presence or absence of inclusion bodies, transmissibility of the virus and filtrability of the infecting agent is presented for consideration.

THE ESTABLISHMENT OF PRIORITY IN SCIENTIFIC DISCOVERIES

By Dr. C. A. BROWNE

U. S. DEPARTMENT OF AGRICULTURE

A STUDY of the individual claims for precedence in making discoveries constitutes an interesting chapter in the history of science. The history of the discovery of oxygen and of other chemical elements is filled with controversial claims of this character and the opinions of the critics, who have weighed the evidence in these and other similar cases, have unfortunately been often influenced by feelings of national bias.

An interesting case of recent significance relates to the discovery of the missing element, Number 61, which was named Illinium by Harris and Hopkins in 1926, and Florentium by Rolla and Fernandes, who claim priority for the discovery upon the fact that they deposited a sealed note relating to their work with the Royal National Academy of the Lincei of Florence in 1924. The method of assuring priority by the deposition of sealed notes has been practiced for many years in various European countries. The *Chemiker-Zeitung* in Germany, for example, has conducted a bureau for this purpose since 1895, which gives their subscribers the right to deposit in its keeping sealed communications regarding work which is not yet ripe for publication. The date of the receipt of the deposition is registered and at any time upon request of the sender the sealed envelope may be opened and the dated communication published. The editorial office of the *Chemiker-Zeitung* is careful to inform its clientele, however, that, while the deposition of a sealed note may establish the intellectual ownership of a discovery (das geistige Eigentumsrecht), it does *not* provide for the vindication of patent claims.

Notwithstanding certain conveniences of the sealed deposition procedure, this method of establishing priority has been very generally and correctly frowned upon in English-speaking countries. If an individual, A, for example, deposits such a note, it simply indicates that at the time of the deposition A was not perfectly sure in his own mind of the validity of his discovery. If further work on A's part contradicts the statement in the sealed note, he orders it to be destroyed and is thus saved from the embarrassment of a refutation. It should be remarked, however, that if a rival investigator, B, makes a published announcement of the same discovery before A has completed the confirmation of his work, then B is entitled to the credit, as he anticipated A *in having confidence in the validity of his work.*

The official date of the publication of an article does not usually determine the time when a discovery was made. Months may elapse between the time when an article is received in an editorial office and the official date of publication. On the other hand, cases are known with journals, that were behind with their monthly issues, when the official date of publication of an issue preceded by many months the actual time when a discovery reported therein was made.

The date of receipt, which is usually attached to an article, is now usually accepted as the decisive index of priority. Yet cases are known where authors have inserted later discoveries in the proof sheets of an article that was previously submitted. In all such cases there should be a footnote regarding the date of such insertions. Charges of unfair preference in permitting the dating back of articles for the purpose of securing priority for favored contributions have been made against certain journals, but such unethical procedures, so far as the writer is aware, have never been confirmed.

Authors who are working in closely competitive fields are often anxious to indicate that their findings antedate the appearance of articles by rival investigators—a trait of human nature which Emerson once referred to as a "habit of saliency"—and hence we note the occasional attachment to articles of footnotes regarding the time of making a discovery, the date of a verbal statement or other matters irrelevant to the main subject of the paper. Personal remarks of this character can, of course, have no weight in the establishment of priority.

Some investigators are exceedingly cautious about drawing conclusions from their work, even when these conclusions may seem to be almost self-evident. Cases are known where a clever interpreter, after reviewing the publications of an over-cautious investigator, has foreseen the probable final outcome of an incompleted

research and rushed into print with an anticipatory article in the hope of reaping credit for something upon which he has expended but very little personal effort. The establishment of the premises, upon which the final conclusion is based, is, however, the question of most importance and the investigator who was the first to establish these premises by laborious research is entitled to the rewards of priority, although his caution always to verify the steps of his argument by every possible check may have caused him to delay the announcement of the almost obvious conclusion of his work.

An interesting example of the coincidence of published announcements of the same discovery is the recent publication of the constitutional formula of rotenone within the brief space of a few weeks by four wholly independent workers in America, Germany, England and Japan. The history of the investigation of this substance, which is finding increased use as an insecticide, discloses a number of interesting problems of priority.

In 1895, Geoffroy in France obtained from the stems of *Robinia* (now *Lonchocarpus*) *nicou,* a plant growing in South America, a crystalline substance which he called "nicouline" and which agreed in melting point and other properties with the substance afterwards called rotenone. Geoffroy should, therefore, probably be given the credit of having first isolated this compound in a state of purity.

In 1902, Nagai in Japan obtained from *Derris chinensis* a white crystalline compound melting at 163°, which he named "rotenone" because it was found to be a ketone and was derived from a plant called *"rohten"* in the Japanese language.

In 1911, Lenz in Germany isolated from *Derris elliptica* a crystalline substance which he named "derrin," and in 1916 Ishikawa in Japan isolated from the same plant a similar compound which he called "tubatoxin." These chemists were apparently ignorant of earlier investigations and therefore did not know that their crystalline materials were identical with the rotenone of Nagai or the nicouline of Geoffroy.

In 1923, Takei in Japan began a vigorous investigation of the chemical constitution of rotenone and in 1928 proposed for this substance the empirical formula $C_{23}H_{22}O_6$. In 1926, Butenandt in Germany entered the field and in his inaugural dissertation (Göttingen) of May 4, 1927, announced the formula $C_{23}H_{22}O_6$ that was later published by Takei.

In 1929, LaForge, Smith, Haller and Clark, of the Bureau of Chemistry and Soils, in their investigation of new insecticidal substances, took up the study of the active constituents of *Derris elliptica, Lonchocarpus nicou, Cracca toxicaria, Cracca vogelii* and other plants which had been used as fish-poisons by the natives of Asia, Africa and South America. In 1930, Clark isolated from the roots of *Derris elliptica* the three new compounds "deguelin," $C_{23}H_{22}O_6$, "toxicarol," $C_{23}H_{22}O_7$, and "tephrosin," $C_{23}H_{22}O_7$. Clark also found deguelin (an isomer of rotenone) and toxicarol to occur in the roots of *Cracca toxicaria,* and rotenone, deguelin and tephrosin to occur in the roots of *Lonchocarpus nicou.* He showed one half of the molecules of deguelin and tephrosin, as is the case with rotenone, to consist of derric acid and discovered the important fact that this portion of the molecule of the three substances yielded 2-hydroxy-4, 5-dimethoxy benzoic acid, thus establishing the orientation of the methoxyl groups in these compounds. Clark thus proved for the first time the remarkable similarity in constitution of the active principles of three different plants that were used as fish-poisons by natives in three widely separated sections of the world.

The work upon rotenone, deguelin, tephrosin and toxicarol was actively carried forward at the Bureau of Chemistry and Soils, and in the early part of November, 1931, the structural formula of rotenone was first definitely established by LaForge and Haller, their article upon the subject (No. XIX, in the Rotenone series) being received by the *Journal* of the American Chemical Society upon November 20, 1931, and published in this journal on February 5, 1932. Immediately following this work of LaForge and Haller upon rotenone was the provisional establishment by Clark of the structural formulas of the closely related substances, deguelin and tephrosin; the submission of his papers upon these compounds was postponed, however, for the completion of confirmatory analyses.

Meanwhile Butenandt, in Germany, was actively engaged in the continuance of the work upon rotenone, which he had begun in 1926. In an article submitted to Liebig's Annalen on February 10, 1932, and published on March 4, 1932, he submitted a structural formula for rotenone which is identical with that previously announced by LaForge and Haller. The *Journal* of the American Chemical Society of February 5, containing the article by LaForge and Haller, reached Butenandt while he was correcting the proof of his own paper. This coincidence, remarkable as it is, is paralleled, however, by an equally striking occurrence, which was the submission of an article by Robertson to the *Journal* of the Chemical Society of London on February 27, 1932, (only 17 days later than the submission of the article by Butenandt to the Annalen) upon the "Constitution of Rotenone, Deguelin and Tephrosin," in which the structural formula of rotenone, proposed by LaForge and Haller,

was also independently confirmed. Robertson adds in a footnote that his views were communicated privately to Professor R. Robinson, of Oxford, on January 20, 1932, before he had seen the publication by LaForge and Haller. Robertson's article (No. 2 of his series) was published in the *Journal* of the London Chemical Society for May, 1932.

Closely following the publication of Robertson's article was the appearance in the *Berichte* of the German Chemical Society for June 8, 1932, of a paper by Takei, Miyajima and Ono (submitted on May 21, 1932), who withdrew the structural formula of rotenone which they had previously proposed and submitted a new formula which was identical with the one first proposed by LaForge and Haller.

This announcement of the same discovery by four groups of chemists, working wholly independently of one another in four different countries, within so brief a space of time is probably without a parallel in the whole history of chemistry.[1]

With the establishment of the formula of rotenone, the structures of the closely related substances, deguelin and tephrosin, were deducible from the published articles of Clark, who, except for a few late experiments by Butenandt, has been the only chemist to conduct laboratory investigations upon these two derivatives, and was the first to point out the close structural relationships between rotenone, deguelin, tephrosin and toxicarol. Such deductions were in fact made by Clark, as previously stated, at the time of completion of the article upon rotenone by LaForge and Haller in November, 1931, but he deferred publication of the structures of deguelin and tephrosin until the completion of other confirmatory laboratory investigations. Clark's article upon the structure of deguelin and tephrosin was received by the *Journal* of the American Chemical Society on May 3, 1932, and published on July 6, 1932. His final laboratory investigations confirmed the formulas which he had previously assigned to deguelin and tephrosin in November, 1931, and which had been correctly deduced from his work by Butenandt in his article published in the *Annalen* on May 20, 1932, and by Robertson in his article in the *Journal* of the London Chemical Society for May, 1932. Inasmuch as everything that has been published concerning the constitution of deguelin and tephrosin is based upon the experimental work of Clark, the credit for having established the structure of these compounds belongs in greatest measure to him.

Provisional formulas for the structure of toxicarol have been proposed by both Butenandt and Clark. The suggested formulas however, are somewhat different and the final determination of its structure must await further research.

It is very apparent that the means for prompt publication are better organized in certain foreign countries than in the United States. Butenandt's paper, for example, upon the constitution of rotenone was submitted upon February 10, and published on March 4, 1932, whereas the paper of LaForge and Haller, submitted on November 20, 1931, was not published until February 5, 1932. Special consideration was probably given for the immediate publication of Butenandt's paper, as the average interval between the dates of submission and publication in the *Annalen* is greater than in this particular instance. It should also be noted that German chemists are favored by a greater number of journals in which publication can be secured.

As a means for shortening the delay between the submission and publication of a discovery, the writer would suggest the following procedure: When a piece of scientific work is completed the essential facts of the discovery are to be reported as soon as possible with the deposition of a copy of the paper, before the most convenient scientific society (academy, lyceum, local chemical society, etc.), the date of presentation to serve as the official date of announcement. Simultaneously, a brief abstract of the communication is to be submitted to the most available scientific journal (such as SCIENCE, one of the publications of the American Chemical Society, etc.) for prompt publication in a special section of "Comptes Rendus," or "Official Reports," which also shall give the date of the presentation before the local scientific society. These official abstracts must necessarily be of the briefest possible character and give only the essential part of the discovery. The date of announcement having been fixed, the publication of the complete paper can then await the usual course of events, without the necessity of giving impatient investigators the benefit of special consideration. In case there are no local societies available for the preliminary announcement, the prepared abstract can be sent directly to the desired scientific journal, but in this case the date of the receipt of the communication by the journal can be the only determining factor in the establishment of priority. It is believed that this plan, or some modification of the same, will help to solve some of the problems in connection with the establishment of priority in closely contested fields, of which the case of rotenone is only one example.

[1] I. Houben, of the Chem. Lab. der Biolog. Reichs-Anstalt, Berlin-Dahlem, in his recent article "Ueber insektentötende Pflanzenstoffe (Anzeiger für Schädlingskunde, V. 8 (1932) No. 7, pp. 83–88), gives a complete review and bibliography of the researches upon rotenone, deguelin, tephrosin and toxicarol. He also claims independent discovery of the constitutional formula of rotenone.