BULLETIN

of the

American Association of Jesuit Scientists

Eastern Section
Founded 1922

Published at

WESTON COLLEGE
Weston, Mass.

Vol. XIX MAY 1942 No. 4

NOTICE

Concerning the Annual Meeting of the American Association of Jesuit Scientists.

BECAUSE of the conditions which prevail in our schools at the present time, it has been deemed advisable not to hold a meeting of the Association in the usual manner this coming summer, 1942. In its place the Maryland-New York Province will hold its own meeting, and the New England Province will hold a separate one. In order that as many as possible may attend in each case, one day meetings will probably be held. Plans for both these meetings are now being formulated, and information concerning them will be distributed as soon as possible.

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EASTERN STATES DIVISION

Vol. XIX MAY 1942 No. 4

THE EDITOR'S PAGE

With the publication of the May - June Issue, we bring to completion another Volume of our JESUIT SCIENCE BULLETIN. The success or failure of any work of this nature depends upon the cooperation of many individuals. It is a pleasure, therefore, to express gratitude to all who have made the publication of the BULLETIN successful this year. First, we thank our contributors for making it possible to maintain the size and standard set by our predecessors. Special gratitude is felt, and hereby expressed, to the Theologians in science at Weston College for generously taking over practically all the detail work connected with each issue, and also many hidden tasks which were by-products of publication. Without their assistance in proof reading, mailing and other correspondence, drudgery would have taken away much of the pleasure of the editor's work. A word of appreciation is due, also, to our printer, Mr. Joseph Sullivan of Lowell, Mass., for his very generous spirit of cooperation.

Perhaps a linking thought between this year and our next issue is carried by the following quotation from an eminent Scientist of a former day. What is said of Chemistry is true in an even broader sense of science in general. The personal conviction and spread of the thought contained is the only "ratio sufficiens" of a Jesuit Scientist.

> "Chemistry, therefore, is highly worthy of our attention, not merely for its own sake, because it increases our knowledge, and gives us the noblest display of the wisdom and goodness of the Author of nature; but because it adds to our resources by extending our dominion over the material world; and is therefore calculated to promote our enjoyment and increase our power.
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> "No study can give us more exalted ideas of the wisdom and goodness of the Great First Cause than this, which shows us everywhere the most astonishing effects produced by the most simple, though adequate means; and displays to our view the great care which has everywhere been taken to secure the comfort and happiness of every living creature."

A System of Chemistry by Thomas Thomson

Published in 1818

Introduction, Page 18.

SCIENCE AND PHILOSOPHY

TELEOLOGY IN THE PHYSICAL WORLD

Rev. Joseph P. Kelly, S.J., Weston College

Since Francis Bacon denied to final causes the right of "scientific" consideration, teleology has had little weight either in the Physical Sciences or in the concomitant philosophy of Materialism. But now that "materialism and determinism, the household gods of the nineteenth century . . . must be discarded by modern science"[1], the notion of finality is once more being introduced into present-day interpretations of the universe, (surreptitiously, says Meyerson). The Aristotelians maintain that the surest knowledge comes through the four causes. Not all may agree with this theory. But no one can deny that in the pursuit of knowledge, the "why" of things is our objective. Children and grown-ups are quite alike in this matter. We are not satisfied with facts, we want to know *why* things are as they are. The citizens of the nation are not content to know that they are at war; they ask the reason for it, our war aims. This spirit of inquiry is a sign of that "metaphysical distress" generated by the lack of sufficient knowledge in those cases where we realize that further information is possible. For, the human intellect possesses a "metaphysical impulse" to seek that which lies behind the things perceived. The ancients called it a "natural appetite" to know. It is as natural as the desire for food and life.

This is as clearly manifested in the Natural Sciences as in any other intellectual field. In most books of science, we read that the scientists are dealing with facts. They are trying to discover "how things happen and what attributes things have." It is not our object to judge the value of these limitations. They may or may not be purely arbitrary. The fact remains that most of the scientists accept them, at least in theory. Actually, they are not content to remain within the established boundaries. For, how else can we explain the phenomenon, evident as it is, that so many eminent authorities, e.g., Planck, Heisenberg, etc., have ventured so widely into the realms of philosophy? How else can we solve the paradox, that men, who profess the axiom: "physics beware of metaphysics", do not hesitate to philosophize about the material world? And despite the repeated rejection of philosophy, Jeans insists that "the old philosophy ceased to work at the end of the nineteenth century and the twentieth century *physicist* is hammering out a new philosophy for himself."[2]

(1) Eddington. "New Pathways in Science." c.f.Ch. IV.

Editor's Note. This is the first of a series of two articles on the problem of Finality. The next paper will discuss some opinions of the scientists on the teleological aspect of the world.

(2) Jeans. "New Background of Science." p. 2 (Italics ours).

Granted, then, these limits to the Physical Sciences, it follows that teleology is not a scientific problem. It is essentially metaphysical. For, it is not a measurable phenomenon; it cannot be tested on a spring balance or in a test tube. It is an "irrational" in science. Certainly, in the pursuit of a final goal, an individual may perform actions which have a *quantitative* aspect, which are subject to observation and measurement. But these do not constitute finality in itself. Just as thought or emotion may be accompanied by physical changes in the body, but these modifications do not constitute thoughts. Hence, the investigation of final causes does not belong to the scientist as such. There is nothing either in his principles or method that justifies him in introducing this question into a scientific discussion. No more can he pass judgment on the justice of a law suit *according to the principles and method of the Physical Sciences*. These matters are simply outside the limits of science. As Meyerson asserts: "finality will remain irrefutable from the scientific point of view."[3]

FINALITY IN RATIONAL ACTIVITY

In its formal sense, finality pertains only to rational beings. It is that intentional or purposive aspect of actions done precisely for the attainment of a proposed end. It is found, e.g., in the orderly direction of the activity of a scientist who sets out to prove experimentally a scientific theory. That it is a common factor in daily life, no one would deny. It is equally true in science. "Even the most violent opponent of teleological explanations, even the most thoroughgoing determinist, would hardly be flattered if his writings and other activities were described as guided by no aim and devoid of purpose."[4] The greater part of human actions are guided by purpose. Our present, national crisis is a striking example of the reality and influence of final causes. Victory and all the blessings that it represents are the final cause. We may describe it in various ways: the defeat of the Axis powers, the Four freedoms, the American Way of Life, they all represent something good and desirable which here and now is exerting a profound influence on our present mode of life. Although it does not yet exist, it is visualized as an attainable end. At the same time, it has the power to give order and direction to our activity and to determine us. The desirable object attracts the intellect and will of man; it moves us to choose and order our actions for the accomplishment of this good. The final cause is the good proposed. Final causality consists in that influence by which we are moved to act for this end. On the other hand, we are conscious that without this goal, the sacrifice of so many comforts and necessities of American life would not be made.

One does not need any profound reflection to realize that final causes or finality are realities in human life and that they exert very definite influences on men. To deny this would be an open contradiction

(3) Meyerson. "Realitie et Identite." p. 364.
(4) Wolf. "Essentials of the Scientific Method." p. 124.

to our lives and actions. It would destroy the "raison d'etre" of our educational institutions, scientific laboratories and student councillors. Perhaps we do not fully understand how a non-existing object, or rather, an object as yet existing only in the mind, can actually determine us to action, but we cannot reject that fact. We do not refuse to accept electrical phenomena because the nature of electricity is not fully understandable. We do know that we choose one course of action rather than another and direct our activities in one channel rather than another, precisely because we desire a particular goal. This is teleological activity.

TELEOLOGY IN THE MATERIAL ORDER

From the above exposition, final causality offers relatively little difficulty in human affairs. It becomes more complicated when applied to the world of Physics, Chemistry, etc. We must bear in mind that the question is *not a choice between efficient and final causes.* In too many scientific books, the problem is proposed that way. The reason being that the scientists recognize, in science, only mechanical, efficient causes. They are observable and measurable and thus fall within the scope of the Natural Sciences. Finality is non-scientific and the scientist rightly refrains from considering it, according to his principles. The Philosopher, on the contrary, investigating a much wider field, is not so limited in his outlook. He justly considers *all* causes. Hence in his mind, the problem is: can we legitimately admit final causes, *together with efficient causes*, in the interpretation of the material universe? Does the activity of natural bodies manifest a teleological aspect as well as an efficient? Scholastic Philosophy has always held that there is efficient causality in physical beings. Physical Determinism and its application to the material world is quite consistent with the tenets of Scholasticism. We hold, however, that the Principle of Physical Determinism is not a strict, philosophical principle but a Principle of Methodology.[5] It is evident that in human activity, the notion of purpose does not exclude efficient causality. Our final cause, (or goal) at present is victory. We know that we will accomplish this by our own actions, by our efficiency. The two causes stand side by side. One does not exclude the other. So also, our use of finality in the physical order does not deny anything that has been proved regarding the efficient causality of these beings. It is a misunderstanding of the problem to reduce it to a choice between final and efficient causes.

Further, as we have indicated, finality in its formal concept, can be predicated only of deliberate, human actions. For, this demands a knowledge of the end or purpose. Man alone has that cognition. Nonliving beings lack cognitive faculties. Consequently, any predication of finality in the material order must be understood in the analogous sense of the term. It is not a mere metaphor; there is a reality behind it

(5) Jesuit Science Bulletin. Dec. 1935. "Causality and Laws of Nature."

which justifies the interpretation. As the analogous application of the term LAW, to natural bodies, is justified from the similarity between the activity of Nature and human activity done according to law[6], so here, a similarity between the purposive actions of man and the activity of physical bodies gives us a solid basis for predicating finality of the material world. For, experience shows us that these bodies have a very definite mode of action and a fixed term or end product. Under similar conditions, similar actions are repeated. These actions are really intrinsic to the being and procede from the nature of the bodies. These regularities of activity are summarized in the Laws of Nature. From this fixity of being and actions follow the Order of Nature, scientific predictability and the possibility of Physical Science. If there were no regularities of this type in Nature, all would be chaos and life would become a tremendous hazard. Science would be impossible.

Hence, for the smooth and harmonious progress of the universe, it was necessary, "a parte ante" that each body should be so constituted in its nature and activities as to guarantee the subsequent realization of the Order of Nature. As in a machine, the preconceived design and the proper juxtaposition of parts are the "a priori" warrant of the proper functioning of the machine. Each part must have its particular role and, at the same time, be consonant with the whole. In the analysis of the machine-like concept of the universe, as proposed to us by the scientists, we must inevitably come to the same conclusion, viz: that each part plays a determined role by itself and also, must be in harmony with the rest of the world. Chance is not admissible as a rational explanation of the universe. "The picture of the world as drawn in the existing, physical theories shows an arrangement of individual atoms and protons which if it originated by chance coincidence would be excessively improbable. The odds against it are multimillions to one."[7]

The interpretation of this "predetermined" aspect of the material order is teleological. It is something over and above the efficiency of physical bodies, just as the rational conception of a machine involves more than its physical operation. Its fixed action and its determination to the production of a definite effect indicate the fulfillment of a purpose and intention on the part of a designer. Its tendency toward its own goal is the counterpart of man's tendency towards his final cause. Behind the regularities and uniformities which are the basis of Physical Laws, we must recognize in physical bodies, natures and potencies, as principles and origins of these activities. This follows from the Principle of Sufficient Reason. Anterior to all action, there is and must be a recognized "predetermination" of material beings which is the guarantee, in the ontological order, of the uniformities of Nature. The extrapolation of a Physical Law into regions not yet explored by experimentation, the prediction of future phenomena, the construction of

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(6) Jesuit Science Bulletin. Dec. 1933. "Laws of Nature in Science and Philosophy."

(7) Eddington. Op. Cit. p. 59.

ships and armament, all these constitute a rational procedure only on the supposition of this "predetermination" in the physical world.

Thus, there is an evident similarity between man's purposive tendency to a definite goal and the action of material bodies tending toward a determined effect, omitting the knowledge of the end in the latter. This objective similarity forms the legitimate foundation for the teleological interpretation of the universe. The analogy is undeniable. It furnishes us with a reasonable answer to the question *why* things are thus determined. It has been empirically established that a ray of light follows the shortest path from one point to another. That is the fact. Why is it so? The longest or the medium path would equally well satisfy the physical law, if such were the fact. Water reaches its maximum density at 4° C. Why not at 7° C., or at 1° C? To these and many other questions, Science offers no response. Many hold that it is not within the province of Science to treat of such problems. Others tell us that they are "meaningless questions" to the scientists. The human intellect is not and cannot be content with these replies. It is evident that if water attained its greatest density at a much lower temperature, our water-ways would soon become filled with ice, navigation would cease and marine life be destroyed. Accepting the scientific explanation of "how" this phenomenon takes place, our intellect suffers no shock in adding the teleological notion that water has its maximum density at 4° C., precisely to preserve aquatic life and to prevent the icy congestion of rivers. There is nothing in this to contradict scientific data. Likewise, it seems quite just to hold that the gravitational attraction of material bodies is to preserve our solar system and all that dwell therein. For, one can readily picture the mad, chaotic rush of stars and planets into space, if the force of gravity were suddenly to fail. On this principle, we can say for all material bodies, that each one has its own determinations and actions precisely for the effect that it produces and for the general good of the universe.

INTERPRETATIONS

In a discussion of the Law of Snellius, Planck declares: . . . "the protons behave like rational beings, choosing from all possible curves at their disposal always the one on which they will reach their goal in the shortest possible time."[8] And again: "All we want to do is to state that theoretical physics in its historical development, yielded a formulation of physical causality, which has a distinctly teleological note."[9] Meyerson, rejecting such a shocking anthropomorphism, claims that "it is a point of view, foreign to the (scientific) spirit."[10] but is willing to admit that "empirical laws themselves, in so far

(),[8] ([9]) Planck, in "Die Natur, Das Wunder Gottes." c.f. Jesuit Science Bulletin. March 1942. p. 118-119.

([10]) Meyerson. Op. Cit. p. 361.

as they cannot be explained by causality, may be conceived as ruled by finality."[11] We would not agree with Planck in his too close comparison between protons and rational beings. Yet, as we have insisted, there is a notable resemblance in the two types of activity. Scholastic Philosophy has always avoided over-likeness between human actions and those of material beings, being careful not to attribute to these more than is due. Suarez suggests that it is better to say that "non-rational beings are *directed* to their goals" rather than to say that they act for purpose.[12] This places the real notion of finality in a being outside the material objects themselves, as we might maintain that the finality of a machine is in the maker rather than in the machine itself. We call this "material finality" and not formal finality. In this case, we hold that there is a real teleology although not in the full sense, because formal finality demands that the one acting for a purpose should have knowledge of that end. In its adequate concept, finality comprises God, as the Creator of the universe, its First Cause. As an Intelligent Being, He acts with reason. In His Infinite Wisdom, God bestowed on each creature, all its powers and potencies, all its qualities and activities. They act according to the capacities of their natures. They have within themselves, the Laws of Nature, which are the principles of the observed regularities and uniformities and are the objective basis of Physical Laws. Through these inherent potencies and powers, material beings act efficiently to fulfill the purpose of creation. Primarily finality pertains to the Creator; secondarily and materially, to physical bodies. Although we say that material beings are "directed" to their ends, this is not to be understood in the same sense that an arrow is directed to a target by an archer. We all recognize the difference between the inherent action of heat that expands metals, under proper conditions, and the action of a man who throws an object at a target. The former is a natural activity, having its origin in the nature or potencies of the body itself. The latter is from something extrinsic to the beings and, of itself, does not belong to it. In natural bodies, the teleological direction is essential and intrinsic to them.

CONCLUSION.

Teleology is a true aspect of Nature. It is non-scientific in the sense already explained. Hence, it does not come within the ordinary investigations of the Natural Sciences. At the same time, it is in no way contrary to the Sciences. Rather, it is complementary to it, for it satisfies that spontaneous demand of the human mind for the reason of things. Science may rightly show us "how" bodies act, but does not give us reasons "why" they act as they do. Rational knowledge cannot be limited to the mere "how" of natural phenomena. It is true that we

(11) Meyerson. Op. Cit. p. 364.

(12) Suarez. "Disputationes Metaphysicae." Disp. 23. Sect. 10. No. 5.

do not and cannot know why each and every being acts. We cannot state the specific purpose of all physical bodies. But it is not at all unreasonable to accept teleology in a general sense or in the more specific meaning that has been proposed for the maximum density of water or for the gravitational attraction of material bodies. With this we must be content until further data is uncovered to permit us to extend this type of explanation to other elements of the physical world. Despite the rigid following of principles and methods in the strict, scientific order, we believe that most men of science will agree with Eddington in the assertion that: "the type of knowledge after which physics is striving is much too narrow and specialized to constitute a complete understanding of the environment of the human spirit. A great many aspects of our ordinary life and activity take us outside the outlook of physics . . . Any discussion as to whether they are compatible with the truth revealed by physics is purely academic; for whatever the outcome of the discussion, we are not likely to sacrifice them, knowing as we do at the outset that the nature of Man would be incomplete without such outlets."[13] Teleology is one of those interpretations which helps man to a more complete understanding of the world in which we live.

(13) Eddington. Op. cit. p. 316.

BIOLOGY

TRANSFUSION FLUIDS

Whole Blood and Blood Plasma

JAMES J. DEELEY, S.J.

An increasing interest is being evidenced in the substitution of blood plasma for whole blood as a transfusion fluid. This concept is now new, but represents a culmination of the developing processes of thought concerning the mystic healing and restorative properties of blood which have occupied men's minds since the beginning of civilization.

Ancient and modern literature has always exhibited a keen interest in the most important of all carriers, the blood. The term "life's blood" has become almost sacrosanct. As a term it is all-embracive and indicative of the importance of blood in the maintenance of life itself. Among the ancients blood was the ingredient to which they attached paramount importance in their medicinal preparations. The less robust of the Romans were accustomed to drink the blood of dying gladiators, that they might partake of some of their strength. The American Indians often drank the blood and ate the heart of some captive whom they had slaughtered, in order that they might be like their victim in courage. It is recorded, and we stand to be corrected by the historians, that in 1490 when Pope Innocent VIII lay dying, he was given the blood of three young boys to bolster his failing strength. These and similar instances might be cited as examples of ancient oral transfusions, although the moderns of the medical world might rightly question their efficacy.

Actual transfusion was first suggested by Cardamus in 1556, but little progress was made until the announcement in 1628 by William Harvey of his discovery of vascular circulation. With a physiological basis thus established, further interest was aroused, and in 1654 Francesco Folli performed the first transfusion to animals. In 1667 Jean Deny successfully transfused lamb's blood into a man and was the first to note the presence of hemoglobin in urine. Because of Deny's startling and dramatic success transfusion suddenly achieved a wide vogue, but due to the number of resulting deaths the procedure was banned by law or fear for over a hundred years.

In 1818 James Blundell by means of silver and bone cannulae transfused blood directly from man to man. Seventeen years later, in 1835, the indirect method of blood transfusion was first employed by Bischoff, who employed defibrinated blood. Various improvements and changes followed in rapid succession. . . . Buchner demonstrated the hemostatic effects of transfusion; glass cannulae were used by Higinson, Aveling, Gasellius and Leisrink; Landois used tubing and cannulae from vein to vein; Prevost explained the danger of transfusion between species on the basis of the hemolysis of the red cells of one species by the serum of another.

As yet transfusion was an extremely hazardous procedure and recommended by most authorities only as a last resort. Adverse reactions were the rule and the mortality rates were high. Consequently transfusions were little used until an explanation of the frequent and devastating reactions became apparent with the discovery of isoagglutinins by Landsteiner and Shattuck. In 1902 human blood was divided into three groups with respect to isoagglutinins and the following year Decastello and Sturli discovered evidences of a fourth group.

The Blood Groups

As a result of the work of several investigators at the turn of the century, i. e., Landsteiner, Jansky and Moss, it has been definitely established that the blood of any person falls into one or the other of four well defined groups according to its agglutinating properties. These groups are usually designated by the Roman numerals I, II, III, and IV. According to the classification of Jansky, which is most commonly used, although it was originally published only in Bohemian and did not immediately receive any wide attention, the groups will exhibit reactions shown in the table below. The alternative classification of Moss (1910), is sometimes employed. In this classification Group I corresponds to Jansky's Group IV and Group IV to Jansky's Group I.

CORPUSCLES	SERUM			
	I	II	III	IV
I	Minus	Minus	Minus	Minus
II	Plus	Minus	Plus	Minus
III	Plus	Plus	Minus	Minus
IV	Plus	Plus	Plus	Minus

N. B.— Plus indicates incompatibility of corpuscles and serum resulting in coagulation.

Minus indicates compatibility of corpuscles and serum resulting in non-coagulation.

The table shows that serum of Group IV (vertical row on extreme right) is compatible with corpuscles of all other groups, i. e., non-agglutination of the corpuscles of any donor should occur when the recipient belongs to this group. It will be noted that the cells of Group IV (lowest horizontal row) are agglutinated by the sera of all other groups when tested outside the body. It might therefore be thought that this reaction would occur in the blood of the recipient but as a matter of fact, when a patient belonging to Group IV is transfused with the blood of any group agglutination of the corpuscles does not usually occur. The reason for this is not clear, unless it is that the serum of the injected blood is diluted excessively by the patient's serum. Whatever the explanation, the fact remains that the reaction of the donor's corpuscles to the serum of the recipient is the important factor, and that the agglutinating property of the donor's serum is not generally evident.

It will be seen from the table that the corpuscles of Group I, (uppermost horizontal) are not agglutinated by any serum. Members of this group are therefore called "universal donors" since agglutination does not, as a rule, occur when this blood is transfused into a member of any of the other groups.

Though in general use, the terms "universal donor" and "universal recipient" are dangerously misleading. Severe and even fatal reactions may occur from the transfusion of Group I into a subject of one of the other groups. Similarly it cannot be taken for granted that a subject of Group IV can be transfused with impunity with the blood from any of the other groups. Such procedures are especially hazardous in the case of children. Therefore, the blood of the same group to which the recipient belongs should always be employed unless it is unobtainable and the emergency does not brook delay.

Theoretically and practically then, whole blood is the ideal transfusion fluid. Improvements and simplification of technique and the advance in our knowledge of blood incompatibilities have made transfusion immeasurably safer and have rendered blood available under circumstances which hitherto would have been insuperable. The older method of transfusion involving direct anastomosis is no longer employed, it having been replaced by the indirect method, which involves the drawing of blood from the median basilic vein of the donor by means of large glass syringes and the injection of the same into the corresponding vein of the recipient. Nothing is added to the blood, its transfusion is carried out before clotting has time to occur.

In recent years stored blood has come into use in clinics throughout the world. Blood collected from the dead has been used in Russia, but cadaver blood has not found general favor. Placental blood or blood removed by venesection from cases of congested heart failure may be employed but blood from healthy donors is preferable. The blood is preserved at a temperature of 1 degree C. and rendered incoagulable by the addition of sodium citrate or heparin. Kept in this way blood is usable for a week to ten days or perhaps longer. These so-called blood banks have the obvious quantitative advantage of blood supply and the immediacy of procurement.

However, the difficulties of this method of transfusion and preservation became immediately evident during World War I. Inadequate supply of donors, insufficiency of laboratory facilities, necessity of typing, all presented difficulties which at times resulted in the death of the patient who could have been saved if the essential elements of time and quantity and quality had not intervened to slow up the treatment.

Captain Gordon R. Ward of the Royal Army Medical Corps in a letter to the editor of the British Medical Journal first suggested the possibility of substituting blood plasma satisfactorily for whole blood. Unfortunately the suggestion was not acted upon in time and whole blood or a modification of the same continued to be used in the treatment of war injuries. Experience garnered from the last war and the knowledge of the extreme rapidity of movement of the present has brought the realization that all injuries resulting should primarily be considered as cases of extreme shock. Thus adequate means must be made available for the immediate treatment of shocks and related conditions incident both to warfare and peaceful civil life. Investigators during recent years have emphasized this approach and with few exceptions plasma has been found to be a satisfactory substitute for whole blood, and in the treatment of many conditions it has been found to be definitely superior.

Transfusion of whole blood is often misused and its promiscuous use may cause disastrous effects. It is recommended that it be limited to cases of severe hemorrhage, certain blood dyscrasias, especially those with hemorrhagic tendencies, acute poisonings affecting the hemoglobin such as carbon monoxide and nitrobenzol, and finally as a palliative in various forms of hypoplastic anemias. On the other hand numerous studies have shown that plasma is more effective in the treatment of

1) Shock, unless accompanied by extreme blood loss.

2) Severe infections as a means of supplying specific and non-specific antibodies.

3) Various conditions associated with hypoproteinemia, v. g., ulcerative colitis.

4) Blood dyscrasias characterized by hemolytic tendencies or fibrinogen deficiency.

5) Cerebral edema resulting from various injuries and toxemias.

6) Emergency treatment of acute hemorrhage until whole blood becomes available.

Several practical considerations can thus be seen in the use of plasma. It has been shown that because of the high osmotic pressure exerted by the plasma proteins, plasma does not diffuse from the circulation because of capillary permeability as do crystalloid solutions; consequently it can be used to effectively regulate the volume of circulating blood. One of its most practical advantages is that it may be used immediately and simply administered under the most adverse conditions since no complicated transfusion apparatus or special assistance is required. Finally, and a note of prime importance, it does not cause further hemoconcentrations, a condition usually present in cases of severe shock or burns. However, it possesses several characteristics which militated against its usefulness under mobile conditions, namely it must be stored and used under refrigeration, consequently requiring special handling, and it must be used usually while in a semi-refrigerated state. In addition, the stability of the complement prothombin, and antidodies in liquid plasma is relatively transient.

Of the many procedures that have been studied in the attempt to obviate these difficulties, one of the most effective, since it evidences no detectable change in the plasma solids, is the method of desiccating the plasma from the frozen state under high vacuum. The lyophile modification is an embodiment of this precedure. This unique method of rapid freezing and vacuum dehydration from the frozen state, which at times has been referred to as the lyophile process, represents a revolutionary advance in the preservation of biological substances. The process gives practical application to the fact that chemical and physical changes are reduced to a minimum in desiccated substances. A mere drying of the biological substance results in such a definite change that the full therapeutic value and efficiency is not retained.

Lyophilization of Human Blood Plasma

Connected with the lyophilization of human blood plasma, several points of interest may be indicated. The blood is obtained from healthy donors, who have undergone a complete physical examination and been found free of infectious disease and in good nutritional condition. Needless to say serological tests with respect to venereal diseases must be negative.

The blood is collected directly in bottles containing sodium citrate, an aseptic technique being rigidly exercised. The blood is then centrifuged in the same containers at two to four degrees C. in order to separate the plasma from the cellular elements. The plasma of a number of bleedings is then pooled.

Pooling, the first important step, obviates the necessity of classifying the plasma with regard to the blood groups. Typing and crossmatching are unnecessary because the agglutin titer of the pooled plasma is low and no erythrocytes are present which might lead to agglutination in the blood of the recipient. After passing safety and sterility tests the plasma is filled into individual containers and lyophilized. When the process is completed the material is sealed under vacuum until required for use. It is then immediately usable by the addition of a suitable quantity of pyrogen-free distilled water.

Plasma thus desiccated retains its therapeutic value and remains stable for at least five years. The content of the specific and non-specific antibodies, complement, and coagulating elements together with three-fifths of the platelets, is essentially the same as that of the original fresh plasma.

In the treatment of shock and hypoproteinemia, where rapid restoration of plasma protein is required, the lyophilized plasma may be restored to a concentration of one-third or one-fourth its original volume. Following intravenous injections, a rapid restoration of plasma protein occurs, which, if sufficient, prevents the loss of further protein from the blood stream.

Plasma is usually administered intravenously although the intramuscular route may be used if the intravenous is not available. No definite dosage is indicated, as the elements of sex, age, weight, condition and response of the patient must be considered. In general an amount equivalent to the dosage of whole blood may be used. Plasma should be used and administered as frequently and in such quantities as are necessary to meeet the emergency of the individual case, in order to balance all losses and supply sufficient additional protein to meet metabolic requirements. If it is desired to quickly raise the plasma protein concentration, as in cases of hypoproteinemia, concentrated plasma is particularly recommended. In these circumstances concentrations three or four times the normal, in amounts as high as 200 to 300 cc. will rapidly restore the normal plasma protein concentration.

Throughout the country medical agencies are collecting blood through the medium of voluntary donations. Much interest and sympathetic cooperation has been accorded the plan to build up reserve stores of preserved plasma. It is through the application of this process of preserving human blood plasma that such a military and civil program has been made possible, that will have such far-reaching effects on the lives and well-being of the armed forces and civilians in the present emergency. Thus once more fundamental physical principles have been made to serve the needs of man, as it was foreordained, and medical achievement and skill has added to the welfare of mankind.

GENETICS AND THE GUINEA PIG

PAUL A. EICHORN, S.J.

The changes brought about in the life of modern man through the study and application of the principles of heredity are indeed varied and wide-spread. It might almost be said that these principles with all the results of their application in agriculture, stock raising, etc. have played a major role in providing man with many of the amenities of modern living. The influence of heredity is seen and felt wherever we turn, whether it be in the agricultural, the economic or medical sphere, at our own dinner table, in our garden or countryside.

Ever since the rediscovery of the principles of heredity some forty years ago, tremendous discoveries in animal and plant life have tumbled forth in an endless stream upon an amazed world. And the end of these discoveries and possible application is still nowhere in sight. Indeed the scope of heredity seems to grow daily until it has come to the stage where experts are able to predict, breed and obtain forms and varieties that were heretofore unknown and thought impossible of attainment. In spite of these great advances there still remains the very difficult and necessary field that the heredity of human beings and of other organisms of high chromosome content presents. It is true that great strides have been taken in these fields, but it is also true that a far greater amount awaits discovery.

What of the future in this field? Are advances to be made? Are the broad extensions of unknown but badly needed and desired facts to be narrowed down? Are we to leave the greater part of such work and its benefits to other universities and deny work in this field to our students? Of necessity the answer lies with us and with our students. And it is only by constant work, study and *experimentation* that we can make a satisfactory answer. Indeed, science without experimentation is a very sterile occupation and rarely yields fruit. It is as true in biology as in any other science that it is only when theories and studied knowledge have been practically applied in experiments that the real understanding and solutions of problems are grasped and mastered.

For such schools and colleges where modest allowances provide for but little expansion or equipment it is difficult to see how much practical experimentation can be carried on in heredity. It is true that most places make use of the fruit fly as a subject for lab work and it is fully agreed that its relatively simple chromosome complex, distinct hereditary characteristics, rapid multiplication, and the slight expense and space required for its use render it an almost perfect subject for introductory courses in heredity. But a knowledge of the principles involved in the breeding of the fruit fly does not by any means solve the whole problem of inheritance.

It may be objected that a thorough knowledge must be first obtained of simpler organisms and through them the solution will be laid clear to the higher ones. By all means a sound grasp should be had of the fundamentals and the study of the fruit fly is one of the best subjects for such a knowledge. But we should not stop here as, it would seeem, is often the case. For we cannot apply the narrow results afforded by a four chromosome organism to an animal possessing twenty or more chromosomes. Too many other factors enter into the question to allow merely a mathematical progression from a relatively simple complex to the solution of more complicated phenomena as witneessed in other animals or plants.

The fundamentals of heredity were revealed by Mendel and the later discoveries, but had knowledge and experimentation stopped here, very few of the modern applications which are now so valuable would have been made. In like manner, the study of the fruit fly although it is very practical and necessary, is still only a stepping stone to work and experimentation in more complex systems.

The experimentation on the type of animals which the tenor of this paper indicates might receive a reasonable objection in the practical consideration of expense, upkeep and space required. After all, the keeping of such animals as horses, cattle, sheep, dogs, chickens and the like is an expensive proposition no matter how advantageous or desirable the knowledge to be gained from them is. In brief, the answer to such an objection is that, one doesn't need one or any of them. Instead, we actually have a much smaller, decidedly less expensive and very apt subject in the guinea pig. For many years, especially those following immediately after the discovery of Mendel's laws, the guinea pig was employed extensively in this work, but during the past few years the highly desirable but very limited fruit fly has in great part taken its place. Many reasons may be alleged for this forsaking of the guinea pig, not least of which is the ability to illustrate fundamental facts by the fruit fly, but this should by no means be responsible for abandoning work with more complicated animals.

In the guinea pig we have not only an inexpensive animal as regards procuring, housing and upkeep, an organism with a high chromosome complex, but also a source for a host of other experiments and observations ranging from embryology, comparative anatomy, zoology to pre-medical work. That these assertions are not exaggerations has been adequately proven by past experiments. But these are beside the point at issue. As a subject for heredity the guinea pig with its complicated array of hereditary phenomena advances the student from the relatively simple and fundamental principles characteristic of the fruit fly. In the course of his study the student further applies the principles which he has learned from the simpler animals. They become for him something real and practical in all phases of life and not merely a process common to insignificant flies and plants. The student also begins to appreciate the tremendous obstacles which must be dealt with when working with more specialized organisms. Of particular advantage is the fact that any results he may obtain from his study will be more directly applicable to such subjects as more specialized animals, plants and human beings which field is naturally more pertinent to him.

As regards the actual experiments which may be applied to the guinea pig in the line of heredity, there is no specially designated procedure. A reasonable method, however, would be to try and obtain pure-bred animals, and, starting with fundamental and easily predicted experiments, to gradually increase the complications of the crosses by backcrossing, cross-breeding, following up variations and so forth.

For a student sufficiently familiar with the facts and laws of heredity the following experiment should prove to be deeply interesting and at the same time enlightening. It also serves as an excellent means for reviewing and applying his knowledge of heredity.

Instead of starting with animals of known stock, use animals of unknown parentage and of varied colors, preferably ones with solid coats which may also include albino animals since more often than not they possess latent colors. After first breeding these animals together as pairs, then amongst the other pairs, and after backcrossing and interbreeding the young, the student is asked to determine what color factors are possessed by each of the original animals, which of the chromosomes in each animal is responsible for each of the colors or patterns that it passes on. From this data, then, he should be able to predict what would be the approximate average of phenotypes that these original animals could produce. Of necessity, this experiment will cover at least a yeear, but since the actual work entailed does not require much time it may be easily carried on as a side interest.

In itself the experiment involves many of the attractions of a game, as results are often totally unexpected and conclusions may be reached only by a strict adherence to known facts and laws. In speaking of conclusions that may be drawn it may be well to mention that this is the one place where caution is to be employed since the number of young and their phenotypes are necessarily limited and do not often allow for a definite conclusion due to the numerous possible combinations of genes which are characteristic of a high chromosome complex. This fact, too, should impress on the observer the tremendous difficulties that are involved in working with such material and the realization of just how limited our data is about them at present, and the caution with which any statements in this field must be made.

By the use of an experiment of this type a good check can be made on the usable knowledge of the student. In most of his work he has followed for the most part, type experiments, the results of which are frequently known before he begins his work, or can be easily obtained from some textbook. But in the experiment just outlined he is "thrown on his own", has no means of finding out the answers to his problem and must apply his own knowledge of facts and laws.

For anyone who might be interested in such an experiment or even for general work with guinea pigs the following bibliography though by no means comprehensive should serve as a guide.

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CHEMISTRY

TEACHING THE IDEAL GAS LAWS

Rev. Bernard A. Fiekers, S.J.

Many of the modern elementary chemistry texts derive each of the gas laws separately but tend to omit an algebraic derivation of the combined mathematical statement for both laws. They substitute the so-called "inspection method", the "common sense method" or some mnemonic device for solving problems in combined pressure, volume and temperature data. However, there is something to be said for the algebraic method. It recurs so often in the undergraduate curriculum, there comes a time it must be treated. Possibly it could be clinched on first encounter. Postponing its use is probably due to certain apparent difficulties.

At constant temperature the relation between pressure and volume is given by:

$$P\,V = K_t \qquad (1)$$

At constant volume the relation between pressure and temperature is given by:

$$P = K_v\,T \qquad (2)$$

And at constant pressure the relation between volume and temperature is given by:

$$V = K_p\,T \qquad (3)$$

The combined interrelation of pressure, volume and temperature is given by:

$$P\,V = K\,T \qquad (4)$$

Now these might be called general equations, for the terms bear no explicit relation to other data whose constant relation is expressed.

Particular equations might be written to correspond to these. In such equations the data are tagged. The constant temperature relation is then given by:

$$p_1v_1 = p_2v_2 = p_3v_3 = \text{etc.} = k_t \qquad (5)$$

and the constant volume relation by:

$$\frac{p_1}{T_1} = \frac{p_2}{T_2} = \frac{p_3}{T_3} = \text{etc.} = k_v \qquad (6)$$

and the constant pressure relation by:

$$\frac{v_1}{T_1} = \frac{v_2}{T_2} = \frac{v_3}{T_3} = \text{etc.} = k_p \qquad (7)$$

The combined interrelation has the particular form:

$$\frac{p_1v_1}{T_1} = \frac{p_2v_2}{T_2} = \frac{p_3v_3}{T_3} = \text{etc.} = k \qquad (8)$$

It has proved of value to keep this distinction between particular and general forms of the statements for the ideal gas laws clearly in mind. For if the general forms are mishandled algebraically, difficulties are encountered. One such difficulty that seems worth treating, since it has been mentioned in the literature (1, 2), is the apparent difficulty of the "squared temperature term".

"Why cannot equations (2) and (3) be combined in such a way as to give:

$$P\ V = K\ T^2 \qquad (XX\ 9)$$

instead of equation (4)?" the student might ask[1]. The easier answer is to show the absurdity of the proposition the question implies. The answer is that T could not be squared unless it had the same absolute value in both equations. Having such a value, the temperature would be constant, so that equations (1) and (5) would suffice. There would be no need for further derivation. Moreover, on solving for T in both equations and equating, the constant temperature statement would be given by the equation:

$$\frac{P}{V} = \frac{K_v}{K_p} = K_t \qquad (XX\ 10)$$

which contradicts the experimental facts stated by equations (1) and (5). McCulloch (2) offers the more rigid answer.

The topic is treated well then if the development is carried from general to particular forms right at the beginning of the derivation. The procedure can go stepwise through a stage that is intermediate between initial and final data. This is illustrated in the following which is taken essentially from Deming (3).

At temperature T_1, let the pressure and volume change from:

$$p_1v_1 = (\text{to})\ p_2v_2 \qquad (5a)$$

Then p_2, v_2 and $T_{1=2}$ determine the new state. At constant volume, this time $v_{2=3}$, let the pressure and temperature change from:

$$\frac{p_2}{T_{1=2}} = (\text{to}) \frac{p_3}{T_3} \tag{6a}$$

or

$$p_2 = \frac{p_3 T_{1=2}}{T_3} \tag{6b}$$

Substituting for p_2 in equation (5a):

$$p_1 v_1 = \frac{p_3 v_{2=3} T_{1=2}}{T_3} \tag{8a}$$

or

$$\frac{p_1 v_1}{T_1} = \frac{p_3 v_3}{T_3} \tag{8b}$$

for which equation series (8) is the fuller expression.

Now for one mol of gas, standard conditions determine the temperature and pressure, and Avogadro's law the volume. One of the terms in equation (8b) becomes constant, the other general; equation (4) results. Given the proper units, this takes the form:

$$P\ V = R\ T \tag{11}$$

for one mol; and for n mols:

$$P\ V = n\ R\ T \tag{11a}$$

In advanced courses and in many foreign texts (4, 5), the following form might appear:

$$P\ V = P_0 V_0 (1 + \propto t) \tag{12}$$

but here the relation to other standard forms is generally given.

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ORIGINAL EXPERIENCES IN BREATHING NITROUS OXIDE, AS CONTAINED IN THE WORKS OF SIR HUMPHRY DAVY.

GERALD F. HUTCHINSON, S.J.

Beginnings are always interesting. If it is true, as so many believe, a prize is due the one who first swallowed an oyster, the personal report of one who first breathed nitrous oxide, a pioneer in the field of anesthetics, should be interesting to us. The work of Sir Humphry Davy in this field is contained in a volume of some three hundred and forty pages. It is one of the nine volumes of his works published by his brother, John Davy, M.D., in 1839. The book contains a great many interesting and humorous passages recording the experiences of those who breathed the gas for him. The ones recorded here exemplify both the valuable data and the humor. We may note, too, one of the earliest extensive uses of the experimental method. Davy was completely absorbed in the experiments he was conducting, even to the disregard of himself and his own health. He was extremely cautious, nevertheless, in drawing conclusions from the data his experiments furnished.

"In April, I obtained nitrous oxide in a state of purity, and ascertained many of its chemical properties. Reflections upon these properties and upon the former trials[1], made me resolve to endeavour to inspire it in its pure form, for I saw no other way in which its respirability or powers could be determined[2].

"I was aware of the danger of this experiment. It certainly would never have been made if the hypothesis of Dr. Mitchill had in the least influenced my mind[3]. I thought that the effects might be possibly depressing and painful, but there were many reasons which induced me to believe that a single inspiration of a gas apparently possessing no immediate action on the irritable fibre, could neither destroy nor immediately injure the powers of life.

"On April 11th, I made the first inspiration of pure nitrous oxide; it passed into the bronchia without stimulating the glottis, and produced no uneasy feeling in the lungs.

"The first inspirations occasioned a slight degree of giddiness. This was succeeded by an uncommon sense of fulness of the head, accompanied with loss of distinct sensation and voluntary power, a feeling analogous to that produced in the first stage of intoxication; but un-

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1. Made the previous month with impure nitrous oxide.
2. He did not use experimental animals "because they die nearly in equal times in non-respirable gases, and gases incapable of supporting life and possessed of no action on the venous blood."
3. Dr. Mitchill attempted to prove from some phenomenon connected with contagious diseases, that dephlogisticated nitrous gas which he called oxide of septon, was the principle of contagion, and capable of producing the most terrible effects when respired by animals in the minutest quantities, or even when applied to the skin or muscular fibre.

attended by pleasurable sensation. Dr. Kinglake, who felt my pulse, informed me that it was rendered quicker and fuller.

"This trial did not satisfy me with regard to its powers; comparing it with the former ones[4] I was unable to determine whether the operation was stimulant or depressing.

"I communicated the results to Dr. Beddoes; and on April the 17th he was present, when the following experiment was made.

"Having previously closed my nostrils and exhausted my lungs, I breathed four quarts of nitrous oxide from and into a silk bag. The first feelings were similar to those produced in the last experiment; but in less than half a minute, the respiration being continued, they diminished gradually, and were succeeded by a sensation analogous to gentle pressure on all the muscles, attended by a highly pleasurable thrilling, particularly in the chest and extremities. The objects around me became dazzling and my hearing more acute. Towards the last inspirations, the thrilling increased, the sense of muscular power became greater, and at last an irresistible propensity to action was indugled in; I know that my motions were various and violent.

"These effects very soon ceased after respiration. In ten minutes, I had recovered my natural state of mind. The thrilling in the extremities, continued longer than the other sensations.

"This experiment was made in the morning; no languor or exhaustion was consequent, my feelings throughout the day were as usual, and I passed the night in undisturbed repose.

"The next morning the recollections of the effects of the gas were very indistinct, and had not remarks written immediately after the experiment recalled them to my mind, I should have even doubted of their reality. I was willing to attribute some of the strong emotion to the enthusiasm, which I suppose must have been necessarily connected with the perception of agreeable feelings, when I was prepared to experience painful sensations. Two experiments, however, made in the course of this day, with scepticism, convinced me that the effects were solely owing to the specific operation of the gas."

"I found that I could breathe nine quarts of nitrous oxide for three minutes, and twelve quarts for rather more than four. I could never breathe it in any quantity, so long as five minutes. Whenever its operations were carried to the highest extent, the pleasurable thrilling at its height about the middle of the experiment, gradually diminished; the sense of pressure on the muscles was lost; impressions ceased to be perceived; vivid ideas passed rapidly through the mind, and voluntary power was altogether destroyed, so that the mouth-piece generally dropped from my unclosed lips.

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4. Referring to trials with Hydrogen and carbonic acid gases.

"Whenever the gas was in a high state of purity, it tasted distinctly sweet to the tongue and palate, and had an agreeable odour. I often thought that it produced a feeling somewhat analogous to taste, in its application to my lungs. In one or two experiments, I perceived a distinct sense of warmth in my chest.

"I never felt from it anything like oppressive respiration; my first inspirations became deep in proportion as I breathed it longer; but this phenomenon arose from increased energy of the muscles of respiration, and from a desire of increasing the pleasurable feelings.

"Generally when I breathed from six to seven quarts, muscular motions were produced to a certain extent; sometimes I manifested my pleasure by stamping or laughing only; at other times, by dancing round the room and vociferating.

"After respiration of small doses, the exhilaration generally lasted for five or six minutes only. In one or two experiments when ten quarts had been breathed for near four minutes, an exhilaration and a sense of slight intoxication lasted for two or three hours.

"The power of the immediate operation of the gas in removing intense physical pain, I had a very good opportunity of ascertaining.

"In cutting one of the unlucky teeth called dentes sapientiae, I experienced an extensive inflammation of the gum, accompanied with great pain, which equally destroyed the power of repose and of consistent action.

"On the day when the inflammation was most troublesome, I breathed three large doses of nitrous oxide. The pain always diminished after the first four or five inspirations; the thrilling came on as usual, and uneasiness was for a few minutes swallowed up in pleasure. As the former state of mind however returned, the state of organ returned with it; and I once imagined that the pain was more severe after the experiment than before."

The following testimonial from one of Davy's close friends, shows us why so much interest and enthusiasm should be aroused by this new experiment.

"Having seen the remarkable effects produced on Mr. Davy, by breathing nitrous oxide, the 18th of April, I became desirous of taking some. A day or two after, I breathed 2 quarts of this gas, returning it back again into the same bag; after two or three inspirations, breathing became difficult, and I occasionally admitted common air into my lungs. While the respiration was continued, my sensations became pleasant. On taking the bag from my mouth, I staggered a little, but felt no other effect.

"On the second time of making the experiment, I took nearly 4 quarts, but still found it difficult to continue breathing long, though the air which was left in the bag was far from being impure.

"The effects, however, in the case, were more striking than in the former. Increased muscular action was accompanied by very pleasurable feelings, and a strong desire to continued the inspiration. On the removal of the bag from my mouth, I laughed, staggered, and attempted to speak, but stammered exceedingly, and was utterly unable to pronounce some words. My usual state of mind, however, soon returned.

"On the 29th, I again breathed 4 quarts. The pleasant feelings produced at first, urged me to continue the inspiration with great eagerness. These feelings, however, went off towards the end of the experiment, and no other effects followed. The gas had probably been breathed too long, as it would not support flame. I then proposed to Mr. Davy, to inhale the air by the mouth from the bag, and to expire it from the nose into another. This method was pursued with less than 3 quarts, but the effects were so powerful as to oblige me to take in a little common air occasionally. I soon found my nervous system agitated by the highest sensations of pleasure, which are difficult of description; my muscular powers were much increased, and I went on breathing with great vehemence, not from a difficulty of inspiration, but from an eager avidity for more air. When the bags were exhausted and taken from me, I continued breathing with the same violence; then suddenly starting from my chair, and vociferating with pleasure, I made toward those who were present, as I wished that they should participate in my pleasure. I struck gently at Mr. Davy; and a stranger entering the room at the moment, I made towards him and gave him several blows, but more in the spirit of good humor than of anger. I then ran through different rooms in the house, and at last returned to the laboratory somewhat composed; my spirits continued much elevated for some hours after the experiment, and I felt no consequent depression either in the evening or on the following day, but slept as soundly as usual.

"On the 5th of May, I again attempted to breathe nitrous oxide, but it happened to contain suspended nitrous vapour which made it non-respirable.

"On the 7th, I inspired 7 quarts of pure gas mingled with an equal amount of common air; the sensations were pleasant, and my muscular power much increased.

"On the 8th, I inspired five quarts without any mixture of common air, but the effects were not equal to those produced the day before; indeed there were reasons for supposing that the gas was impure.

The report of one case among many, taken from the section headed,

"Of the Effects of Nitrous Oxide upon Persons Inclined to
Hysteria and Nervous Affections.";

may be of special interest. Davy evidently considered women quite different from men, as subjects of experiment.

"A young lady who never had hysterical attacks, wished to breath the gas. I informed her of the disagreeable effects it had sometimes produced, and advised her, if she had the slightest tendency to nervous affection, not to make the trial. She persisted in her resolution.

"To ascertain the influence of imagination, I first gave her a bag of common air, which she declared produced no effect. I then ordered for her a quart of nitrous oxide mingled with two quarts of common air; but from the mistake of the person who prepared it, three quarts of nitrous oxide were administered with one of common air. She breathed this for near a minute, and after the experiment, described her sensations as unpleasant, and said she felt at the moment as if she were dying. The unpleasant feelings quickly went off, and a few minutes after, she had apparently recovered her former state of mind. In the course of the day, however, a violent headache came on, and in the evening after she had taken a medicine which operated violently, hysterical affections were produced, followed by great debility. They occasionally returned for many days, and she continued weak and debilitated for a great length of time."

After citing another instance, Davy says,

"These phenomena have rendered us cautious in administering the gas to delicate females. In a few instances, however, it has been taken by persons of this class, and even by those inclined to hysterical and nervous complaints with pleasurable effects."

MATHEMATICS

A SEQUENCE OF HISTORICAL RANDOM EVENTS: DO JESUITS DIE IN THREE'S?

By J. Solterer
Georgetown University

Editor's Note: In the following article Dr. Solterer, Head of the Department of Economics of the Georgetown University Graduate School, brings to a definite statistical conclusion an investigation on which preliminary reports (contributions) appeared in the May and October, 1940, issues of the BULLETIN. It is here reprinted by kind permission of the Author and of the Editor of the JOURNAL OF THE AMERICAN STATISTICAL SOCIETY, in which it was originally published (Dec., 1941, Vol. 36, pp. 477-484).

The article has attracted favorable attention in several scientific quarters. It was quoted in a recent meeting of the Statistical Society; and in a letter to the author a national authority on statistics (who holds the post of Mathematical Adviser to the Bureau of the Census) wrote as follows: "I have not seen so clever an exposition of the subject of the distribution of rare events. I have profited greatly by reading it, and have noted it very definitely in mind for use in my teaching hereafter. Your explanation of just what happens when the interval of time is described is exceedingly cleverly expressed."

Amongst the men of the Society of Jesus there exists a persuasion that they die commonly in groups of three. Such tradition or as some would call it, superstition, is not limited to this Society nor to grouping of deaths alone; in fact, there are even proverbs in different languages which point to relatively high frequencies of groups of three within series of historical random events, or at least to a prevalent tendency toward bunching in such sequences.

The Rev. E. C. Phillips, S. J., of Georgetown University examined in this respect[1] the 597 deaths which had occurred in this century (1900-1939 inclusive) in the Maryland-New York Province of the Society of Jesus. These forty years, including leap years, contain 14,609 days, spanned by 596 intervals between successive deaths; hence the mean interval between two successive deaths is 24.5 days and 49.0 days between the first and third of a group of three deaths.

[1] Rev. E. C. Phillips, S.J., "Do Deaths Come in Groups of Three", **Bulletin of the American Association of Jesuit Scientists** (Eastern Section), Loyola College, Baltimore, Md., vol. XVII, no. 4, pp. 196-199 (May, 1940).

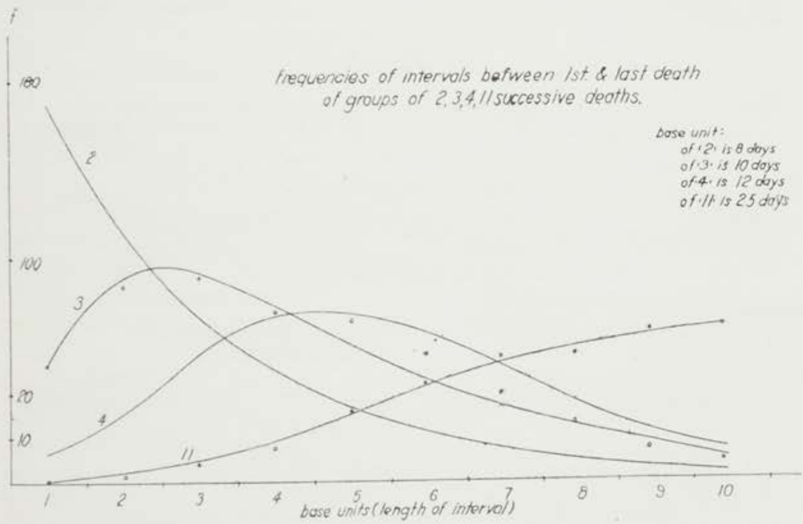
The original data upon which this discussion is based, were taken from the official annual necrologies, issued for private circulation among the members of the Jesuit order. These lists give only the calendar date of each death, and hence the intervals could not be determined in units of less than one whole day.

Father Phillips found that there were 68 groups of three deaths occurring in intervals of 17 days (i.e. in one third of the mean interval) or less, and 28 further groups of three within 18 to 25 days; a total of 96 groups of three deaths which occurred in intervals equal to or shorter than one half the mean interval of 49 days. In some of these short intervals there were more than three deaths following each other. This was particularly noticeable during an epidemic of flu when there were ten deaths in 31 days, from September 26 to October 26, 1918.

Father Phillips concluded that the persuasion in question has a solid foundation in fact. Out of the total of 597 deaths, containing 199 triplets, there are in fact 96 such close groups whence it follows that more than 48 per cent of all deaths occurred in groups spanning at most 25 days. The fact of grouping was taken to be established but the nature of the fact was left conjectural with the added suggestion that the phenomenon was one of chance.

Rev. J. T. O'Callahan, S. J., of Holy Cross College, presented a further investigation of the National Science Convention of the American Association of Jesuit Scientists.[2] He arranged the time intervals elapsing between the first and last death of groups of two, three,

CHART I



[2] Rev. J. T. O'Callahan, S. J., "Deaths of Jesuits in Groups of Three; The General Grouping of Random Historical Events," **Bulletin,** vol. XVIII, no. 1, page 52, (October, 1940).

four and eleven deaths in frequency distributions and showed that they constitute a related series of the general statistical curve, Type III of Pearson. In the case of doublets the curve is L-shaped, the shortest doublets having the highest frequency. The larger the group, the less does the frequency distribution depart from the approximately normal curve, observed in the case of groups of eleven deaths. These curves, adapted from an unpublished diagram prepared by Father Phillips, are shown in Chart I. This seems to be the first published concrete case in which the frequency distribution of a single series of observations changes from an extreme non-normal form to a normal form as the unit of grouping is varied.

Father O'Callahan concluded from the goodness of fit that the skewness of the distribution, i.e. the prevalence of short intervals or the grouping effect, is due to chance and is characteristic of all random series of historical events. The frequency of observed short interval quadruplets is relatively so small as not to attract attention. The short interval doublets are very numerous but they very frequently combine in observation with the next death and so form a short interval triplet. Thus, the random series gives rise to the persuasion that events occur in groups of three only.

This analysis rests essentially on the notion of goodness of fit of empirical curves to observed data and, furthermore, on the fact that large groups falling within short intervals are scarce. The test of goodness of fit, however, is not sufficient to establish the nature of the function required. At best, such tests can establish the randomness of the deviations from the curve. What is needed first is an hypothesis on general theoretical grounds; this may later be tested for goodness of fit.

The higher frequency of closely spaced deaths when compared with more widely spaced ones is to be expected in case each death is a random event. If we chose a sufficiently short observation interval, the probability of a certain death falling within it is less than that of falling without. Consequently, the distribution of deaths per short observation interval must be skewed. For an extremely short interval this distribution will be L-shaped, the distribution of rare events. If the observation interval is indefinitely long the normal distribution will be approached. The impression we get from the observation of a historical random series obviously depends on the length of the observation interval. A long interval will leave us with the conviction that deaths are more or less evenly spaced, a short one that they occur in spurts or particular, characteristic groups.

For each observation interval there will be a particular modal value for deaths per interval. If among all possible intervals for any series of observations there would be one, enforced by Nature on all observers alike, then the respective modal value for deaths per interval would determine what grouping effect we observe.

It is quite clear that for many fortuitous time series this observation interval is habitually or arbitrarily short. The result is the impression of bunching. Series of automobile accidents per week or month in our cities, fire hazards and the like are good examples. The influence on bunching of profits of the variation of the accounting or fiscal period may also be mentioned in this connection. Actually, many governments have discovered empirically that it is possible to reduce the irregularity of some of their revenues by increasing the corresponding fiscal period. Of course, it is not asserted that such bunching might not also be the consequence of systematic causes; nevertheless, an old rule of wisdom advises us to look at events *sub specie aeternitatis.*

The distribution function of deaths per observation interval is the same as that of the Brownian motion without the so-called probability after effect.[3] The usual way of observing the Brownian motion consists of fixing the attention on a square formed by a net of mutually perpendicular, equidistant lines on the bottom of a shallow vessel, containing a colloidal solution, and counting the particles contained within this square from second to second or in any other chosen interval. Our vessel is the Maryland-New York Province, our solution consists of all men in this province, and our particles within the square are the deaths occurring in this province. We neglect the following five factors: (1) the flu epidemic 1918-1919; (2) the variation in the population in the province from year to year during the forty years considered; (3) the change (increase) in life expectancy during this time; (4) the difference in length of months; (5) the seasonality of mortality. The Chi-square test employed later justifies this neglect.

The Brownian probability after-effect results from the relation between the average velocity of particles and the size of the square as well as the observation interval. Only small changes in the number of particles in the square can be expected to occur in intervals not large relative to the velocity. In our case, however, the number of deaths in any one interval is independent of the number in any other, with the exceptions just noted above.

If all the observed deaths, numbering N, were equally spaced throughout all time T, a certain number v would be found in each observational interval t. This is the mean number of deaths per observation interval.

$$\frac{v}{N} = \frac{t}{T} \text{ or } v = N\frac{t}{T} \tag{1}$$

The probability of a certain death falling within t is: $P_t = t/T$.
The probability of a certain death not falling within t is:

$$p_{T-t} = \frac{T-t}{T}.$$

[3] Cf. Von Mises, **Probability, Statistics and Truth,** pp. 261, 262.

The probability of n deaths falling within t is:

$$P_{n(t)} = \frac{N!}{n!(N-n)!}\left(\frac{t}{T}\right)^{n}\left(\frac{T-t}{T}\right)^{N-n}.$$

Substituting v from (1) we get:

$$P_{n(t)} = \frac{N!}{n!(N-n)!}\left(\frac{v}{N}\right)^{n}\left(\frac{N-v}{N}\right)^{N-n}.$$

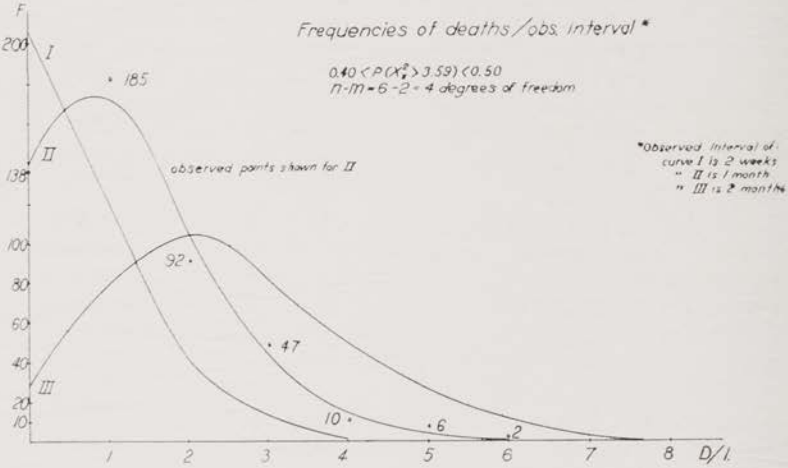
and for large N we get Poisson's distribution:

$$Pn(t) = \frac{vn}{n!}e-v.$$

Chart II gives the respective curves for the observation intervals of two weeks, one month and two months. The corresponding v's are:

$$v_{\mathrm{I}} = 0.6 \text{ death}$$
$$v_{\mathrm{II}} = 1.2 \text{ deaths}$$
$$v_{\mathrm{III}} = 2.5 \text{ deaths.}$$

CHART II



These curves, similar to those used by Father O'Callahan tell us indirectly that successive deaths occur in differently spaced groups since the empty or sparsely populated intervals are of ever greater frequency the smaller the observation interval. However, in both procedures the grouping effect depends on an arbitrary choice of either the size of the observation interval or the size of the observed group.

Popular observations, supporting the belief of deaths in three's, are independent of such choices since they may take any number of deaths as a group and, also, need not use any constant observation interval. The procedure will be to begin observation with any death, observe intervals between successive deaths, and derive from their relative lengths the impression of a pattern of the sequence. Correspondingly, we need the distribution of intervals between successive deaths. It will then be easy to determine the probability of any combination of different successive intervals because each interval is an independent event.

The function required has been derived by physicists in connection with their study of emission of α particles (scintillation).[4]

The different intervals observed between two successive deaths may be thought of being made up of a number of equal elementary intervals following each other. These elementary intervals are so small that none of them contains more than one death. If there are M such intervals and μ is the probability that a particular interval contains one death, there will be $M\mu$ deaths in all, and $M/M\mu=\lambda$ will be the average interval between two successive deaths. μ and λ are reciprocal. The probability that, starting from a certain death, there will be a series of τ elementary intervals without any death, followed by a death within a very small interval $\delta\tau$ is

$$(1-\mu)^{\tau}.\mu.\delta\tau=\left(1-\frac{1}{\lambda}\right)^{\tau}\frac{1}{\lambda}\,\delta\tau.$$

If $\mu\to 0$, $\lambda\to\infty$. r and dr are numbers of elementary intervals and approach ∞ also. The ratios τ/λ, $\delta\tau/\lambda$, however, remain finite and are independent of the unit in which τ and λ are measured. Then the required probability will be:

$$\frac{1}{\lambda}\,e^{-\tau/\lambda}. \tag{2}$$

From this expression we see that the shorter the interval r, the more frequent its occurrence. The preponderance of short intervals leads to the group impression. The latter is intensified if λ is large, i.e. if the mean number of deaths occurring in any fixed interval is small. We know this already from our previous discussion.

From (2) can be deduced an expression for the probability of an interval between two successive deaths falling within a particular finite range of values of r. Integrating 2), the probability of an interval being between τ_1 and τ_2 is:

$$\int_{T_1}^{T_2}\frac{1}{\lambda}e^{-\tau/\lambda}\delta\tau.$$

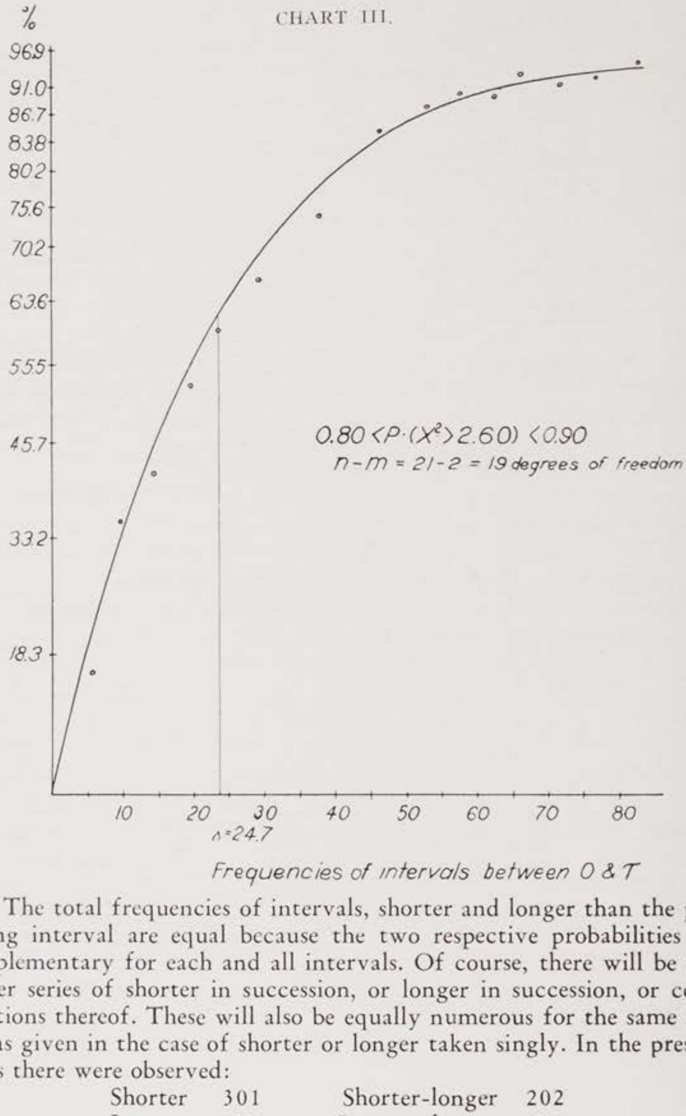
$$=(1-e^{\tau/\lambda}) \tag{3}$$

gives up the probability of an interval between zero and r. Chart III shows this function and the corresponding observed values.

Any grouping of intervals presupposes classification into either short or long intervals, or intervals longer or shorter than the preceding one, if the latter classification be chosen, we note the following:

[4]Cf. W. N. Bond, *Probability and Random Errors*, p. 19

CHART III.



The total frequencies of intervals, shorter and longer than the preceding interval are equal because the two respective probabilities are complementary for each and all intervals. Of course, there will be also longer series of shorter in succession, or longer in succession, or combinations thereof. These will also be equally numerous for the same reason as given in the case of shorter or longer taken singly. In the present series there were observed:

Shorter	301	Shorter-longer	202
Longer	287	Longer-shorter	200
Equal	7		

Shorter-longer-longer-shorter	44
Longer-shorter-shorter-longer	56
Shorter-3 successive longer-shorter	14
Longer-3 successive shorter-longer	11
Shorter-4 successive longer-shorter	2
Longer-4 successive shorter-longer	2

This classification, however, does not lead us to any outstanding group impression as the one we are attempting to explain. We turn to the second of the classifications mentioned before, viz. classification of intervals into short and long. This requires a definition of short and long. Our function (3) has only one parameter, λ. Choosing any other value as the dividing value between short and long will introduce arbitrary elements. If, for instance, we should take the median value (17 days) of the interval series for this purpose, the chances would be equal that any interval, whether long or short, would be followed by either short or long. It would be observed very soon that by adopting such classification, intervals would be called long which are only slightly longer than the median and yet occur very frequently. So the norm interval would be lengthened. If an interval longer than the mean should be taken as the norm, the opposite result would ensue. The only classification free from this difficulty is the one which calls any interval short which is less than the mean interval (25 days), and long any interval more than that.

From function (3) we notice that any such short interval is followed by another short one in about 64 cases out of a hundred, because successive intervals are independent events. The observer of the interval series will not only be impressed by the predominance of short intervals but also by the fact that any short interval tends, in the majority of cases, to be followed by another short interval. He will notice the pattern of the death triplet.

The probabilities of any other larger combination may be derived from the expansion $(p + p)$ where p, p are 0.64 and 0.36, and n the number of intervals in the desired group. The respective pure short combinations are always the most frequent. This fact extends the impression of bunching from triplets to even larger groups.

In the present case there were 377 shorts (375 required theoretically), and 258 groups of two successive shorts (240 required theoretically).

We may conclude that the persuasion in question, a supposed superstition, that Jesuits die in three's is confirmed by the series observed and, furthermore, has been shown to be the recognition of an important trait of all random historical sequences.

METEOROLOGY

JESUIT CONTRIBUTIONS TO METEOROLOGY

A. R. Schmitt, S.J.

The first weather observers were, of course, Adam and Eve. To have provided perfect contentment the Garden of Eden must have had its variations of weather even on an unspoiled Earth, and our first parents must have made conversation about these and, like their subsequent children, have done nothing more about them. To copy the current mode of understatement, there followed a considerable period of relative inactivity and the situation, in general, remain unchanged. Anno Domini 1540 there were still no new developments on the meteorological front. Even the irreducible minimum of equipment in the way of a thermometer came only about 60 years later and the earliest specimen of the more important barometer some 40 years after that. But even at this embryo stage the first Jesuit contributions to meteorology, at least in the instrumental division, were made by two contemporaries of Galileo and Torricelli. The differential air thermometer devised by Fr. Gaspar Schott (1608-1666) did not find much later application but the use of mercury as the expanding liquid in the thermometer first applied by Fr. Athanasius Kircher (1601-1680) is still happily with us. Serviceable thermometer scales were found by Fahrenheit and Celsius (1742) only during the first half of the following, or 18th century. Instruments, however, were developed a bit sooner than was the knowledge of what to do with them or their indications. The science of meteorology could not really get under way until at least some body of fundamental laws had been discovered and formulated and this was sufficiently accomplished only during the course of the 18th century.

It is obvious, therefore, that prior to the suppression of the Society of Jesus in 1773 there were not many contributions of Jesuits to the nonexistent science of meteorology. Nevertheless, it should be noted that the Old World's first information about the climates of many foreign lands came through reports made to their European superiors by Jesuit missionaries. Beginning with the establishment of the first Jesuit mission in Canada by Father Brebeuf in 1633 (after an earlier attempt in 1625), nine years before the death of Galileo and the birth of Isaac Newton, descriptions of Canadian climate are scattered throughout the *Jesuit Relations*. In their place there might have been precise scientific data if the science of physics itself had been sufficiently advanced. This surmise seems to be justified, at any rate, by comments in the *Jesuit Relations* like the following. This was written by Fr. Guiseppe Bressani in the relation which he prepared for Cardinal De Lugo in 1653.

"I do not dispute whether the cold of new France is more intense than that of countries which are under the same latitude; certain it is, that it is much more acute, and accompanied with much snow and ice, which keep the rivers frozen five and six entire months. But all this may be an effect of the dryness, which is necessary for the snows and ice,—it being a very well-founded opinion that even very intense cold is not sufficient to make ice; otherwise water—which naturally never freezes except under the greatest cold, as may will have it, or at least under a highly intense cold, as no one denies—would in its natural state be frozen, contrary to its destined use, which is to serve for washing and as drink for men and animals. But, because cold alone, although intense, is not sufficient without either some little body, or exhalation, or dry quality, therefore water, even in its natural state, would be fluid; and where dryness prevails, although the cold is not greater than elsewhere, it contracts or expands itself into snow or ice."

These are quaint notions to us now, but the quotation shows that in the case of Father Bressani, and I may add in that of many of his fellow missionaries, the mind was quite willing but science itself was very weak.

At the time of the restoration of the Society of Jesus in 1814 the science of meteorology was still learning to walk; this was true in Europe and to a greater degree, in the much younger United States. In the absence of information to the contrary I am attributing the earliest Jesuit contribution to the science of meteorology and, for that matter, the first official cooperation with an agency of the United States government, to two great missionaries among the American Indians, Fr. Peter De Smet and Fr. Felix Verreydt at their mission at Council Bluffs, Iowa. Joseph N. Nicollet, in the service of the Corps of Topographical Engineers of the United States of America was exploring the upper reaches of the Missouri River in 1839, after having in the previous year made his way to the source of the Mississippi. With instruments furnished by him Frs. De Smet and Verreydt kept a daily record of temperature and atmospheric pressure from May 17 to September 17, 1839. It was just a little summer project but Nicollet was highly pleased with the result and incorporated the Jesuits' data in his official report.

It was three years after this, in 1842, that our nation took the first step toward the establishment of an official weather service by the appointment of James P. Espy as meteorologist to the United States government.

The now venerable Jesuit College of Stonyhurst, in England, began its famous observatory in 1838 under the direction of Fr. Charles Irvine. The original equipment was only for work in astronomy, but with the installation of meteorological instruments in 1845 Stonyhurst became the first Jesuit observatory devoted to the study of weather phenomena. For a number of years it was an official station of the

British weather service and received some subsidy from the government and although this arrangement, together with the subsidy, was later discontinued it still remains a cooperative station. Stonyhurst is best known for its studies in stellar spectroscopy, for the many eclipse expeditions it has conducted or participated in and for its investigations in terrestrial magnetism. But while the chief interest of its distinguished directors, Frs. Joseph Perry, Walter Sidgreaves, Aloysius Cortie and others (Fr. E. D. O'Connor was director in 1931) lay in these fields the meteorological records of Stonyhurst Observatory have been carried on and published without interruption for 95 years. It may surely be said, then, that Stonyhurst Jesuits have contributed to the progress of meteorology according to their means. (Stonyhurst College —George Gruggan, S.J. and Joseph Keating, S.J.—Kegan Paul, Trench, Trubner and Co., Ltd. London 1901.)

In the year 1857 two more meteorological observatories were founded by Jesuit institutions. One of these was at St. Joseph's College, Bardstown, Kentucky. But to the loss of our science St. Joseph's College was discontinued in 1861 and its instruments were transferred to St. Louis University.

The fortunes of the other Jesuit observatory which was founded in 1857 have been much happier. The name of Belen Observatory, Havana, Cuba, is forever associated by weather scientists with man's victory over West Indian hurricanes, insofar as warnings to get out of their way or lie low can win the fight. But the mention of Belen immediately recalls the like accomplishment against the same type of tropical storms over in the Orient by the Manila and Zi-Ka-Wei observatories and, on a reduced scale perhaps but with no less local importance, in the Indian Ocean by the Observatory of Tananarive (Ambohidempona), Madagascar. In recounting this biggest, combined Jesuit contribution to meteorology it hurts to be constrained by the limitations of time to give little more than a synopsis of the story and I particularly regret that, while introducing the principal actors, I cannot let these speak their own generous commendation of all who participated with them as well as before and after them.

The Observatory of Belen was founded in 1857. Fr. Benito Vines, who is chiefly responsible for its fame, was appointed director in 1870 and continued in this office until his death 23 years later. He was succeeded by Fr. Lawrence Gangoiti and the present director is Fr. Mariano Gutierrez-Lanza. At Manila another Spanish Jesuit Fr. Frederick Faura took charge of the observatory in 1865 and directed its salutary operation for over 30 years. The name of his immediate successor, Fr. Jose Algue, is probably more widely known, but anyone who tries to decide which was the more distinguished will probably find that in this they were twins, although not identical ones. Across the China Sea at the Shanghai suburb of Zi-Ka-Wei, Jesuits of the Province of Paris began their meteorological station in 1872. Fr. Marc Dechevrens was its director from 1876 until ill health forced his return to France in 1887. To him Zi-Ka Wei credits its early rise to recognized standing in the meteorological world, a position uniformly maintained and enhanced by his successors. The Observatory of Ambohidempona at Tananarive, Madagascar is also conducted by French Jesuits. Meteorological work was begun in 1887 and reorganized on a larger scale by Fr. E. Colin in 1889. The handsome observatory building, devoted to astronomy, seismology, and terrestrial magnetism as well as to meteorology suffered tragic destruction during a war between the French and the native governments in 1895 but was rebuilt and scientific work resumed in 1898.

The founders of these four observatories were missionary priests and the foreign lands in which they were laboring were all periodically laid waste by the scourge of tropical storms. On the same principle of "prius est vivere" (you have to keep a man alive while you are trying to convert and save him) they sought some method of preventing the immense loss of life and property on land and sea. Before very long Frs. Vines and Faura had found in cloud formations and movements, combined with observations of pressure and of wind directions, a reliable method of discovering the birth of the storms and of forecasting their paths, intensity and time of approach. Early in their campaigns these observatories established chains of auxiliary stations as necessary aids in getting previous and more complete information of the storm center's whereabouts, Belen and Manila in the neighboring islands, Zi-Ka-Wei along the China coast and Tananarive in various parts of Madagascar, which is almost of the same size as our large states of California and Oregon combined, 228,000 square miles with over four million inhabitants.

Fr. Vines began his long series of successful forecasts in 1875 and Fr. Faura a few years later (1879). Of the warnings issued by Fr. Faura on 53 typhoons in the three or four year period, 1879-1882, only three were not completely verified. The laying of a cable between Manila and Hong Kong in 1880 enlarged the sphere of Manila's beneficent protection and naturally increased the efficiency of Zi-Ka-Wei's vigilance in behalf of the China coast and of the Japanese islands. Fr. Faura's cyclonometer and Fr. Algue's barocyclonometer, which I have no time to describe, were blessed aids to mariners in the eastern seas for many long years, but they have been rendered largely unnecessary by the development of radio communication, just as the latter has been a providential means of increasing the efficiency and completeness of the observatories' forecasts. The heightened importance of the four observatories with the development of flying needs no further comment here.

How many thousands of lives and what fortunes in property have been saved and are being saved from destruction every year through the devoted efforts of these four observatory staffs in tropical storm areas no one can estimate. This inestimable contribution, which is appreciated by high and low alike because it is so practical, is the direct application of what they have themselves largely added to the sum of meteorological theory as evidenced by their publications. All four observatories began these publications in the first years of their existence and have continued them ever since. Manila observatory, as we are all aware, is at the head of the official Philippine Weather Bureau, since 1901. If I am not mistaken, Tananarive has a somewhat similar position in Madagascar, and Zi-Ka-Wei has had its meteorological, time and lighthouse services subsidized by the Chinese government although its security for the future is, in this respect, very uncertain. When the first Cuban government was formed it passed by the opportunity of taking into its service an institution of thirty years' experience and of world-wide recognition in favor of the wasteful duplication of nursing a newborn National Observatory. The only subsidy ever received by Belen Observatory in Havana has come in the shape of modest gifts from grateful owners of ships and plantations.

After many years of careful and intense planning Father Ricardo Cirera inaugurated his Observatory of the Ebro at Tottosa, Spain on September 8, 1904. While in chage of the section of terrestrial magnetism at Manila (1890-1894) he had dreamed of a geophysical observatory which would give particular attention to the investigation of the influence which cosmic phenomena, especially those of the Sun, exert upon our globe. That his hopes have been amply realized is attested by the universal acknowledgment of Tortosa's standing in scientific circles. Fr. Cirera was succeeded as director by Fr. Louis Rodes in 1920. During the war of extermination of Spain's extensive fifth column he continued the direction under obvious difficulties and toward the close of hostilities the observatory was disorganized and partly destroyed. But it is again happily in operation under Fr. Antonio Romana who succeeded Fr. Rodes on the latter's much regretted death on June 7, 1939.

The Observatory of Cartuja, Granada, Spain, has also been given back into its rightful hands under charge of Fr. Antonio Due, and it is hoped that its meteorological work, begun in 1902, has again been resumed.

What is planned to be a duplicate, at least in general purpose and aims, of the Observatory of the Ebro was begun five years ago in a suburb of Buenos Aires, Republic of Argentina, by Fr. Ignacio Puig who for some years was assistant director at Tortosa. The first unit of the Observatory of San Miguel, devoted to meteorology, atmospheric electricity and earth currents, has been in successful operation since 1935.

I humbly regret that my information about Jesuit contributions to meteorology in South and Central America is so meager. Jesuits conducted an observatory at Quito, Ecuador, (1870-1875) and another in Mexico at Saltillo, beginning in 1884. Both fell victims to political storms.

The observatory of the Roman College, which had been given back to the Society of Jesus on the latter's restoration, met the same fate of confiscation in 1870. Fr. Angelo Secchi was its director at the time, having been appointed to this position in 1850 after his return from a year's exile at Georgetown University.

Best known for his original work in astronomy Fr. Secchi was also one of the eminent meteorologists of his time. If for nothing else, his name will be well remembered for his meteorograph, an assembly in a single, massive cabinet of recording instruments for atmospheric pressure, temperature, humidity, rainfall and the direction and velocity of the wind. Copies of it were in use in many observatories, and some of them are still in operation.

Just outside of Rome, at Frascati, there is the meteorological observatory of the College of Mondragone, founded in 1880 by Fr. Felix Ciampi who had preceded Fr. Vines at Belen and was later an assistant to Fr. Secchi at the Roman College.

At Feldkirch, in Austria, the Observatory of Stell Matutina, in operation since 1889, has recently passed from Jesuit into Nazi hands. This may also be the fate which awaits, if it has not already overtaken, Jesuit observatories at Valkenborg (1901) and Ouderbosch in Holland and another on the island of Jersey (1894). In Jersey Fr. Marc Dechevrens had continued his valued researches after his return in ill health from Zi-Ka-Wei and from there he had published a number of valuable treatises on the general circulation of the atmosphere and on the dynamics of cyclones.

In Hungary at Kalocsa, on the Danube, Jesuits have been conducting an astronomical and meteorological observatory since 1879 when Fr. Karl Braun was appointed its first director. The meteorological work was considerably expanded by Fr. Jules Fenyi who took charge in 1885. Smaller stations are also operated in Hungary at Presburg and Szatmar.

High up in the Lebanon, not far east of Beirut, Syria, is the Observatory of Ksara, dating from 1906, its meteorological section from 1908.

Far south of this in the province of Southern Rhodesia, South Africa, Jesuits have been recording daily weather data since 1897 at their Observatory of Bulawayo and at a few other mission stations.

But much farther along in Australia at Riverview College near Sydney, meteorological records have been continued since 1907 when they were begun by Fr. Edward F. Pigot who had spent some years at the Observatory of Zi-Ka-Wei.

Returning to our own country once more we take what must be an all too brief notice of the further contributions of American Jesuits. At Woodstock a long succession of priests and scholastics has been keeping an uninterrupted record of weather phenomena for the past 70 years. Father Aloysius Valente was responsible for the inauguration of the station which was practically synchronous with the start of organized government activity in the same field. The Woodstock station has seen the evolution of our national weather service from the Smithsonian Institution through the Signal Service of the Army into the United States Weather Bureau.

At Weston College observations were begun at the close of 1924 and cooperation with the Weather Bureau in 1928. Woodstock and Weston results are published in the "Climatological Data" of their respective localities.

All of us in this section of geophysics gratefully cherish the memory of Fr. Frederick L. Odenbach, the founder and for almost 40 years the director of the Angelo Secchi Observatory of St. Ignatius College, now the John Carroll University, of Cleveland, Ohio. Beginning in 1894 he had soon developed an unusually well-equipped station not only for standard weather observations but for further investigations as well. He designed an original and very efficient form of lightning recorder or "ceraunograph", as his colleague Fr. James A. Kleist named it, as well as apparatus for the study of earth currents. At the request of the Director of the United States Weather Bureau he cooperated in the International Cloud Study in 1896 and during the following year in the Bureau's kite studies. He was not only tireless in maintaining the trying routine of his own observatory, but was keenly interested in initiating and fostering Jesuit endeavor in his own and other fields of science. His pioneering in establishing the Jesuit Seismological Association is adequately told elsewhere. Long before the buildings on the modern site of John Carroll University had been completed Fr. Odenbach had put much of his equipment into operation in his new observatory, but within a year he was called to eternal rest from labor on March 15, 1933.

For some years Fr. Odenbach had the capable and devoted assistance at Cleveland of Brother George E. Rueppel. Brother Rueppel later began an observatory at St. John's College, Toledo, in 1903, and operated it until he was transferred to St. Louis in the summer of 1908, when he was succeeded by Fr. Joseph J. Horst. Not long after Fr. Horst's departure, a year later, the observatory regrettably surrendered all rights to further mention here. But Brother Rueppel, in spite of his 76 years, or is it because of them, is still contributing to the sum of our knowledge of what the atmosphere is doing and how it does it.

Just a little over a month ago (July 31, 1940) the St. Louis University Meteorological Observatory published a 25 year summary of local weather data covering the period 1911-1935. The present observatory dates from 1910 when Fr. John B. Goesse became its first director and Brother Rueppel its very active meteorologist. Long before this time the University had had a weather station at its old location which was in operation from 1860 until 1874 when it was discontinued. The present observatory has been under the direction of Fr. James B. Macelwane since Fr. Goesse's death in 1923 and Brother Rueppel, with total experience of almost 40 years, is still the meteorologist in charge.

Out in California the Observatory of the University of Santa Clara is now in its 40th year. Fr. Jerome S. Ricard was its founder and its director until his death in 1930. He will always be well remembered as an ardent investigator of the correlation between sunspot activity and types of weather on our globe. His weather predictions, based on the acceptance of such correlation and made for the purpose of checking what he thought was the exact relationship, met with much verification in some areas. A fuller and more definite statement than this must wait for the publication of a complete account of Fr. Ricard's work. Dr. Albert J. Newlin, Fr. Ricard's former assistant and now director of the observatory, has this much-desired work in gradual preparation.

In my attempt to give some notion of what Jesuits have contributed and are still adding to the science of meteorolgy I have presented little more than a catalog of observatories. I have been able to find only one complete catalog with detailed descriptions and histories of all Jesuit observatories of every kind. This was published in Volume 9 of the Revue des Questions Scientifiques (Brussels) in 1906. It will bear freshening up. I hope that I have shown, at any rate, that Jesuits are gathering first hand data on the spot of most types of weather which this Earth has to offer, even if they are unable to do any more about them than Adam and Eve could in the first place.

PHYSICS

A VACUUM TUBE MILLIVOLTMETER

THOMAS L. CULLEN, S.J.

The theory and applications of vacuum tube voltmeters has been well treated by Rider[1], who gives in addition copious references to the literature. The present circuit, recently completed at Woodstock, is, in all but a few details, that of Brunetti and Harrison[2], with a voltage regulator of Bousquet[3], somewhat modified in accord with the theory of Hunt and Hickman[4]. Two commercial instruments are on the market. The General Radio instrument ($165) has five ranges with full scale values from 0.1 to 150 volts and measures within 3% up to 100 megacycles[5]. Ballantine's ($245) has five ranges from .01 to 100 volts and measures within 3% up to 100 KC. The present circuit, without the meter, costs less than $50 to build.

The main advantage of vacuum tube voltmeters is their high impedance which means a negligible current drain from the source being measured. Another advantage of the circuit under discussion is its sensitivity and wide range. The circuit has six scales on the lower range running from .005 to 1. volt, and on the higher range from 1 to 25 volts. A shunt across the meter enables us to read up to 150 volts. Lastly, the meter has a wide frequency range. Using the 955 as a rectifier the response, according to Brunetti and Harrison, is linear up to 15 KC.

Two disadvantages may be noted. First, when making d.c. or low frequency measurements in low impedance circuits, ordinary meters are more convenient because of their simplicity, and often are of greater accuracy. It is in high impedance circuits the vacuum tube voltmeter reigns supreme. Second, linearity is not an easy thing to obtain. Generally, only the higher four-fifths of the scale should be used. For lower readings it is necessary to switch to a lower scale.

The circuit comprises three parts: an A.C. amplifier; a diode rectifier; and a D.C. vacuum tube voltmeter.

The d.c. voltmeter is an amplifier of the degenerative type whose

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1. Rider, John F. *Vacuum Tube Voltmeters,* New York, Rider, 1941.
2. Brunetti, Cledo and Harrison, Chas., "The Design of a Diode Millivoltmeter", *Communications,* Jan. 1941, p. 26.
3. Bousquet, A. G., "Improving Regulator Performance", *Electronics,* July 1938, p. 26.
4. Hunt, F. V. and Hickman, R. W., "Electronic Voltage Stabilizers", *Review of Scientific Instruments,* Jan. 1939, p. 6.
5. General Radio, *Experimenter,* Vol. XI, No. 12, May 1937.

performance is controlled by a bleeder from plate to ground, used for grid bias, and a degenerative resistance which is fed step by step into the cathode circuit. When the grid bias is raised the current in the plate circuit tends to increase and this in turn causes an opposing voltage drop across the cathode resistance. The net change in grid voltage is the difference between the two. The larger the resistance the smaller the current required to develop a rise equal to the rise in grid voltage. As the bias is increased and the cathode resistance is increased we return to almost the same portion of the Ip-Eg characteristic, with these results: the sensitivity is made practically independent of tube constants; the grid circuit is made capable of handling voltages hundreds of times higher than the normal cut-off bias; and the meter within very close limits responds proportionally to the d.c. voltage introduced on the grid. The sensitivity of the device is changed by a change in the cathode resistance. With ten times the resistance, only one tenth of the change in current would be required to develop a given opposing voltage and ten times the voltage could be applied to give a full scale deflection of the meter.

Since the diode is so connected as to decrease the positive bias on the grid of the 6SF5, the signal causes a decrease in plate current. The meter, consequently is inserted with reversed polarity. A potentiometer at the end of the bias bleeder is used as a source of bucking e.m.f. to balance out the plate current through the meter when no signal is being applied.

In the diode section either of two tubes are in general use, the 6H6 and the 955. The latter, an acorn type tube with a plate-cathode capacitance of .6 micromicrofarads is linear through a greater frequency range. Two things must be cared for in the diode: first that the ratio of rectification, i.e. the ratio of d.c. output voltage to the peak value of the a.c. input voltage, be as close to unity as possible; second, that the diode be stable in operation.

The ratio of rectification is close to unity for large values of impressed voltage but drops off considerably for smaller values. This is remedied to a certain extent when we decrease the zero-signal current—the current flowing through the diode due to the high velocity of the electrons leaving the cathode—by increasing R_6. We have changed this R from 1 to 3.5 megohms.

It is found that the 6H6 and the 955 are more stable in their operation when run at 5 volts instead of the rated 6.3. The effect of instability would appear as a drift in the meter.

The resistance coupled A.C. amplifier provides us with a more sensitive set of ranges. The coupling resistor is variable, so that once the degenerative and bias resistances are set for the unpreamplified ranges, convenient full scale values for the low ranges may be obtained by adjusting the attenuator, The formula for the sensitivity of the meter for any scale is given by Brunetti and Harrison:

$$\frac{di}{de} = (G'Rt)b \frac{G}{1+RG}$$

where de is the impressed voltage, di the change in current necessary to produce a full scale deflection of the meter, R the total resistance in the plate circuit of the d.c. voltmeter, G' and G the transconductance respectively of the 6J7 and the 6SF5, and b the ratio of rectification. Rt is a resistance factor of the preamplifier.

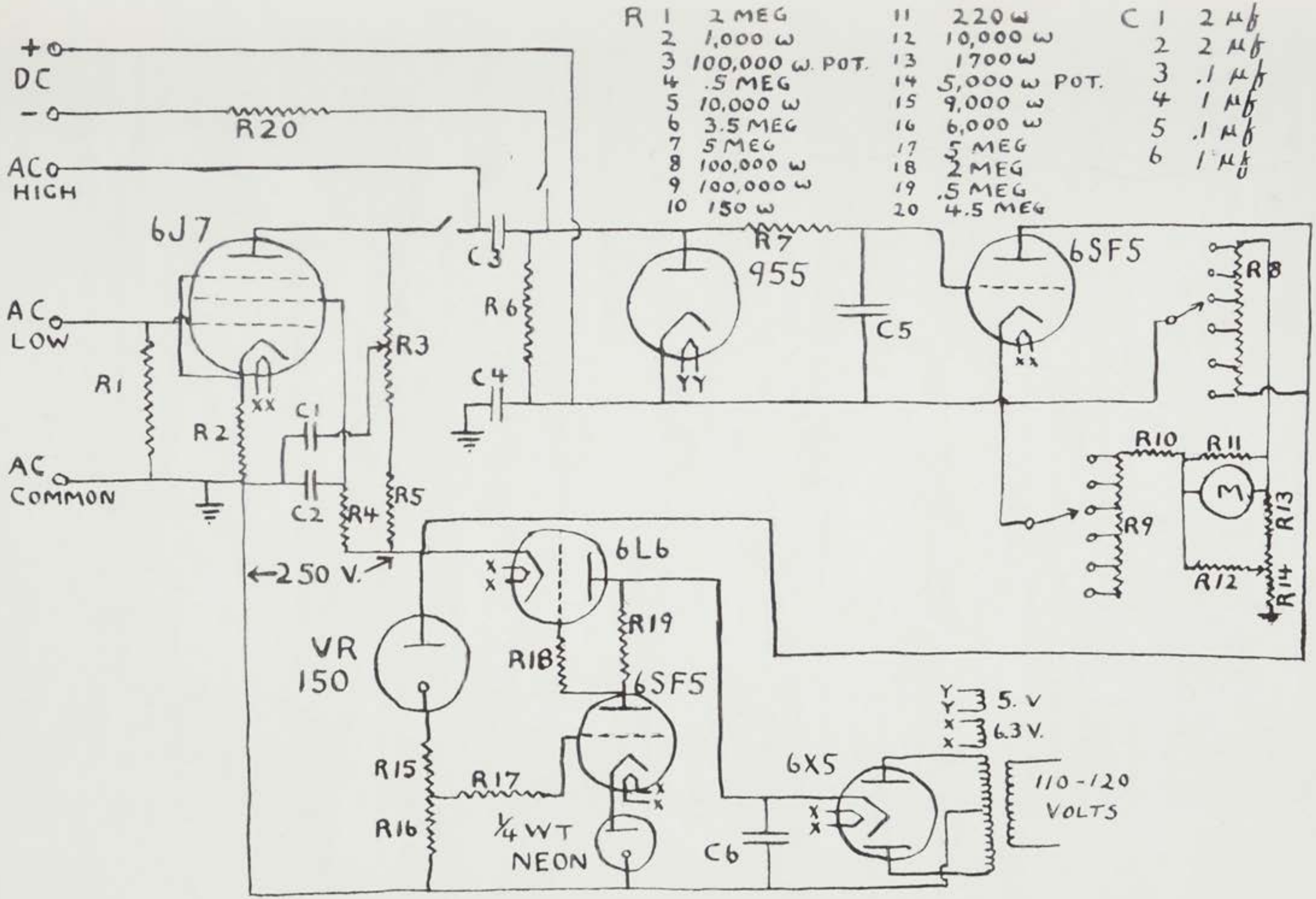
$$Rt = \frac{R'r}{r+R'}$$

where r is the plate resistance of the tube and R' the effective plate load resistance.

Several changes were introduced into the original circuit. A 6SF5 was used in place of a 6F5 for its slightly lower capacitance and for greater mounting convenience. R_6 was increased from 1 to 3.5 megohms with a betterment of rectification. R_{11} when switched in reduces the meter current to one tenth of its value and has to be calculated for each meter. Leads were also brought to the diode so that the meter may also be used to measure d.c. voltages. R_{20} is so chosen that the desired full scale readings are of the same order of magnitude as on A.C.

A Weston type 600 meter (50 microamps, 2000 ohms) is employed in the present circuit. A meter with smaller resistance would be preferable. First, it would decrease the degenerative resistance considerably. Secondly, a greater portion of the change in plate current would flow through the meter. Because of the high resistance of the meter the minimum cathode resistance R_{10} was reduced from 500 to 150 ohms, R_{13} was likewise reduced from 2000 to 1700 ohms.

For the purpose of calibration a circuit was set up in which a constant voltage was maintained, alternately a.c. and d.c., and measured by a dynamometer type voltmeter accurate within .5%. A portion of the IR drop with d.c. voltage was measured by a d.c. millivoltmeter corrected to within 1% and the same portion with a.c. voltage was then measured by the vacuum tube voltmeter. The greatest percentage error for the upper three fifths of the scale was 3% for the highest four ranges. The lower two fifths could always be read better by switching to a lower scale. The lowest two ranges on the unpreamplified range can be read on the preamplified range with an adjustment of the attenuator. The lowest two scales of the preamplified range because of their non-linear characteristics, require the use of a calibration curve.


R 1 2 MEG
2 1,000 ω
3 100,000 ω. POT.
4 .5 MEG
5 10,000 ω
6 3.5 MEG
7 5 MEG
8 100,000 ω
9 100,000 ω
10 150 ω
11 220 ω
12 10,000 ω
13 1700 ω
14 5,000 ω POT.
15 9,000 ω
16 6,000 ω
17 5 MEG
18 2 MEG
19 .5 MEG
20 4.5 MEG
C 1 2 μf
2 2 μf
3 .1 μf
4 1 μf
5 .1 μf
6 1 μf
+ DC -
R20
AC HIGH
AC LOW
AC COMMON
6J7
R1
R2
XX
C1
C2
R3
R4
R5
C3
R6
C4
R7
955
YY
C5
6SF5
XX
R8
R9
R10
R11
M
R12
R13
R14
←250 V.
6L6
X X
R18
R19
6SF5
X X
VR 150
R15
R16
R17
1/4 WT NEON
C6
6X5
X X
Y Y 5. V
X X 6.3 V.
110-120 VOLTS

HIGH SCHOOL SCIENCE AND MODERN TRENDS

Stanley J. Bezuszka, S.J.

In 1820, six years after Pius VII issued the Bull 'Sollicitudo Omnium Ecclesiarum' restoring the Society of Jesus to its former status as an Order in the universal Church, the Twentieth General Congregation assembled in Rome. The most pressing problem confronting these men at that time, was the reconstruction of their previous educational work, and raising their schools to the former degree of usefulness and excellence. Consequently, in response to the numerous petitions sent in from various sections of the Society to have the Ratio Studiorum adapted to the scholastic requirements of the times, the Congregation instructed the General (working with a selected committee) to supervise the revision. The task was begun immediately and in 1832, Father John Roothan sent a letter to all the Provincial Superiors of the Society introducing the revised Ratio Studiorum. This document has since become a classic commentary in educational history and characterized as one of the lasting ordinances issued by leading men in education.

However, the characterization applied to the Ratio in this last sentence requires a clarifying distinction. It has been and will continue to be a 'lasting' declaration of educational principles. But it will not be the 'last' or final effort of the Society to meet the varying and restricted demands of education in particular social groups or secular crises. Perhaps no definite need will arise for a Congregational restatement, but the policy of localized and constant vigilance with specific adaptations, is an inherent necessity for all educational organizations. On this assumption, the present critical American situation will require all the experience, the talent, the sound and analytic fruit of past years of watching and waiting. And though some of the immediate aims will of necessity be dictated to us by increased governmental requirements, the method and success must be attributed to our efforts alone.

The obvious danger of hurried reforms during any unsettled period, especially during a war of such tremendous proportions, is a commonplace immediately evident. Therefore, the groups which can now produce a seasoned method with established success, or new techniques qualified by long trial to produce results, will have the predominating voice on the scholastic front. This perhaps accounts for the interest and attention bestowed upon the recent report made by Dr. Wilford M. Aiken of Ohio State University to the North Central Association of Colleges and Secondary Schools. Essentially, the plan embraces a separation from the standard and conventional High School education and favors the 'Progressive' system. Whatever deficiencies the plan may have, yet its main strength today lies in the fact that eight years of trial have produced results which are considered satisfactory by many accredited colleges and universities in the United States. This single evidence of some necessity for an increased and serious consideration of the scientific and mathematical curricula in our High Schools is not an exception.

The Committee on Physics Teaching Central Association and Mathematics Teachers, in its report submitted to the Physics section at Cleveland, tersely characterized the curricular needs of High School Physics to meet modern demands by one word: *Revision!* In their estimation, the physics curriculum at least, should satisfy the requirements of the group of students who finish their education with the completion of High School without interfering with the fundamental preparation necessary for future work in this field. To paraphrase their main objectives:

1. the student should acquire a thorough understanding and appreciation of the fundamental concepts at the foundation of the sciences.
2. the student's understanding should be enriched and the appreciation of his information developed by applications to every day life.
3. the student should establish sound habits of thinking, reflection and show definite ability to follow the progressive solution of problems in his subject.

None of these objectives are foreign to the spirit or the purpose of the Ratio Studiorum. How these aims could be realized in concrete cases in our schools needs the critical judgment of those teachers whose long experience has prepared them for just such an analysis. Some such attempt at this was made by the above Committee in its advice for greater concentration on basic concepts rather than a scattering of attention on numerous and often unrelated topics. In their typical scholarly thoroughness, the assignment was divided among the members so that definite suggestions could be made on:

4. an outline of the subject matter to be included in each course, and a few sample presentations.
5. an assembly of lists of all types of aids for the teacher for presenting the course.
6. a preparation of problems and test exercises to check accomplishment.

This at least ought to stimulate and provide a model for imitation in our own drafts and discussions of curricular changes and adaptations.

The year following this Committee's report, a more concrete evidence of work along the lines discussed came from E. Burdette Chrisman who made a study of class scientific coordination with the current social needs of individuals.[1]

Though the survey has its restrictions, it offers another method whose adaptability warrants examination and consideration. The reference given will detail the Author's procedure. Only the result of the research is given below. The data from newspapers, articles and selected

1—Chrisman, Burdette E., Master's Thesis Research Problem—State College of Washington—**School Science and Mathematics**, Vol. 42, No. 1. (January, 1942).

group opinions were averaged and expressed in terms of school weeks. When compared with current and standard textbooks, the following table was drawn up showing the relative treatment in weeks given in texts and the week-demands of social living:

	Mech.	Mod. App.	Heat	Light	Sound	Elec.
Average	9.9	8.7	3.1	4.9	3.6	5.7
Texts	11.4	3.6	4.8	4.6	2.6	9.0

An analogous tabulation could be made in chemistry, biology and mathematics with a special model presentation of a selected class topic in any of these subjects.

Recently there appeared the Progress Report of the Subcommittee on Education for Service of the War Preparedness Committee of the American Mathematical and the Mathematical Association of America. The list of activities and curricular recommendations proposed by the committee concentrated special attention on the High School science and mathematics courses. In order to compare just how our present high schools qualified in the light of these new requirements, the following list of science courses compiled from 10 Jesuit High Schools was made.

School		
	1st year	2nd year
Xavier High School New York	Elem. Algebra.	Intermed. Alg. Greek or Biol.
	3rd year Pl. Geom. Grk. or Chem.	4th year Trigonometry Solid Geom. Grk. or Phys.
Regis High School New York	The prescribed courses prepare the student primarily for admission to liberal arts colleges rather than for entrance to specialized technical, scientific or professional schools. Three years of mathematics and one year of laboratory science.	
	1st year	2nd year
Loyola High School Baltimore	Algebra	2nd. Alg. Grk. or Biol.
	3rd year Pl. Geom. Grk. or Chem.	4th year Gen. Science Grk. or Phys. or Trig.
	1st year	2nd year
Boston College High Boston	Algebra	Algebra
	3rd year Pl. Geom.	4th year Trig. or Grk. or Phys.

	1st year	2nd year
Cranwell Prep. School	Algebra	Algebra
Lenox, Mass.	Grk. or Gen. Science	Grk. or Biol.
	3rd year	4th year
	Pl. Geom.	Trig. and Solid Geom.
	Grk. or Chem.	Grk. or Phys.
	1st year	2nd year
St. Peters College High School Jersey City, N. J.	Algebra	Algebra
	3rd year	4th year
	Classical course:[2]	*Classical course*:
	Intermed. Algeb.	Physics
	Trig.	Elective:
	Scientific course:	Solid Geom.
	Chemistry	Adv. Algeb.
	Elective:	*Scientific course*:
	Intermed. Algeb.	Physics
	Trig.	Solid Geom.
		Adv. Algebra
	1st year	2nd year
Canisius High School	Algebra	Algebra
Buffalo	Physiology and Hyg.	Grk. or Biol.
	3rd year	4th year
	Pl. Geom.	Grk. or Phys.
	Grk. or Chem.	Trig. / Solid Geom. } Opt.
Jesuit High School	*Honors course*	
New Orleans, La.	1st year	2nd year
	Algebra	Pl. Geom.
	3rd year	4th year
	Algebra	Phys. or Chem.
	Academic course	
	1st year	2nd year
	Algebra	Pl. Geom.
	3rd year	4th year
	Algebra	Mod. Language or Mathematics
	Science	Science
	General course	
	1st year	2nd year
	Algebra	Pl. Geom.
	3rd year	4th year
	Algebra	Chem. or Phys.

2. In this course, the two subjects are electives.

St. John's High Shreveport, La.	*Latin-English course*	
	1st year	2nd year
	Algebra	Pl. Geom.
	3rd year	4th year
	Algebra Solid Geom. or Trig.	Phys. or Chem.
	English-Commercial course	
	1st year	2nd year
	Arith.	Algebra or Mod. Language General Science
	3rd year	4th year
	Pl. Geom. or Mod. Language	Science
St. Joseph's High Philadelphia, Pa.	1st year	2nd year
	Algebra	Algebra Grk. or Biol.
	3rd year	4th year
	Grk. or Chem. Plane Geom.	Grk. or Phys. Solid Geom. Trig. Chem. (Classical students)

A cursory glance at the Table shows that there are but slight variations in the courses so that the objection of regional requirements at least for the High Schools does not exist for this widely scattered group. Furthermore, the texts, class hours and laboratory periods specified in teaching the science courses (esp. Biology and Physics) are quite uniform. It must be understood however, that these are just superficial similarities. As yet we have no detailed account as to the treatment accorded each subject in the matter of time allotment to individual topics, methods, outside reading, project plans, etc.

In the light of the above outline, we can better examine the report of the Subcommittee on Education. Members of the Committee reviewed or inspected extensive lists of books and pamphlets in mathematics, made contacts with various branches of the Army, Navy, C.A.P., and vocational directors. Their summarized suggestions and observations are:

1. The past peace-time economy of the country has minimized the fact that important branches of military service are mathematical in nature. Consequently, there is a real need for mathematics in the present courses.
2. In order that an individual may be able to use effectively any particular body technique (mathematics, science), his preparation should progress a reasonable distance in advance of the level of difficulty at which he will apply the technique.

This last point, though pedagogically sound, will find reluctant approval from officials whose present demand for man power is willing to compromise for just the minimum formal preparation required for an approach to the technique.

A. Recommendations concerning mathematics for those in non-military activities:
   1. Substantial secondary mathematics through computational Trigonometry and an acquaintance with the fundamentals of solid geometry.

B. Mathematical requirements of the Army and Navy (in the light of the emergency situation and which will not be fulfilled unless special efforts are made by *High Schools*, Colleges, etc.
   1. Algebra, Plane Geometry (with construction problems), use of coordinate systems, acquaintance with notions of probability and statistics, solid geometry, spherical trigonometry, physics.

This minimum schedule was set up with great concern expressed for those whose education will end with high school graduation. In the final set of recommendations, the committee urged that:

1. trigonometry, solid geometry and spherical trigonometry be given in the High Schools, and emphasized that they could and should be studied efficiently
2. some socialized form of mathematics be given to all
3. time for spherical trigonometry can be found by omitting a few sections of solid geometry
4. they strongly recommend that a single set of courses be used in any high school for students of appropriate ability in attaining desired ends relating to industry, military service or future collegiate education. They recommend this single treatment rather than separate curricula, some designed to fit men for industry or military service and some planned for those who will delve more deeply into mathematics and related fields in college. They advise curricular division based on the intelligence of the students.

With the exception of spherical trigonometry, our Jesuit High Schools amply satisfy the recommendations of the Committee. But there cannot be too much emphasis placed on continual interest and encouragement for mathematics, chemistry, biology, and physics in the High Schools. The drop in the enrollment of science courses in the colleges, and the constant complaints of students, center on the fact that colleges and universities ignore the science taught in High Schools. The one answer to this criticism is an extensive program of constant check and recheck with the varying demands of the time. To see what was actually being done on this point, the Jesuit Science Bulletin for the last six years was examined. However, beyond a few scattered remarks on High School science or mathematics, no specific treatment of this class of training appeared. The same remarks could stand repetition for the three volumes of the Jesuit Educational Quarterly.

The final and latest information on High School science courses comes from the recent convention of the American Physical Society and the American Association of Physics Teachers. At the conference, Dr. Irvin H. Solt, of the United States Office of Education, and representatives of the Office of Scientific Research and Development in Washington, stressed the urgent need of the armed services and other government agencies for men trained in physics. The following joint resolution of the committees was sent by the American Institute of Physics to all State Superinendents of Education:

"The present emergency demands that an appeal should be made to the nation's high schools to urge in every proper way qualified students to prepare themselves in the fundamentals of mathematics and physics. Our country has been caught desperately short in the supply of such men because careers in physics have not been brought adequately to the attention of *High School Students.*"

COLLEGE PHYSICS, 3RD EDITION

By WILLIAM T. McNIFF

Fordham University Press. 1942

This textbook of college physics by an Assistant Professor of Physics at Fordham University combines the two volumes of former editions into one. Its appearance is made attractive by the symbols on the cover, and especially by the remarkably clear and readable print, uninterrupted by that bane of most students, sections in fine prints. Generously sized, clear, and frequent explanatory diagrams are also worthy of note here.

Intended for all types of college courses, this text accordingly supposes apt selection, stress, and amplification by the teacher. Realistically, it presupposes mathematics only through trigonometry and then includes (as an appendix) a review of mathematics. A rather lengthy list of references and suggested readings precedes the well-arranged and ample index.

The concluding chapter on modern physics is rightly calculated to provoke thought and further investigation by the student. Particular attention, even to the extent of two special chapters, is also devoted to the connections between physics and medicine. Sound, the stepchild of physics, is given only a single chapter, but this, it must be admitted, is well done. Each chapter is followed by problems, and there are also many solved problems in the text itself. In a sentence, we have here a thoroughly up-to-date, attractive, well-written and comprehensive textbook of college physics.

M. F. GREENE, S.J.

NEWS ITEMS

HOLY CROSS COLLEGE—PHYSICS DEPT.

At the present date (April 1, 1942) there are 95 Freshmen enrolled in the Naval R.O.T.C. There are 22 Seniors and 30 Juniors in the V-7 Class U. S. Navy.

The data on the Fall and Spring Program of the Civil Pilot Training (C.A.A.) is not complete as yet. The following is a summary of the previous programs:

Program	No. of trainees completing program
Fall, 1940	10
Spring, 1941	17
Summer, 1941	17

Seventeen of these trainees went on to the advanced program (C.A.A.). Twenty trainees (including a few who started the primary program without completing it) have entered the U. S. Army and Navy. With a few exceptions, they are in the Air Corps.

Starting May 5, 1942, the E.S.M.D.T. (Radio Technicians Training) course will be given jointly by Worcester Polytechnic Institute and Holy Cross College. The lecture course will be given at Holy Cross College, and the laboratory course at Worcester Polytechnic Institute. The course will last eighteen weeks.

A few months ago, Fr. James K. Connolly was elected a member of the Acoustical Society of America and an Associate in the Institute of Radio Engineers. Fr. Thomas H. Quigley received his Ph.D. (Physics) John Hopkins University in June, 1941.

The following summary will give an estimate of the extra work done in Physics and Mathematics during the Winter Term of the current year. These courses are over and above the courses given in the regular curriculum, e.g. B.S. Physics, A.B. Mathematics, etc. The figures refer not to those who signed up for the courses, but to those who have persevered in the courses up to the present date (April 1, 1942).

Course	Number of Students
College Algebra	167
Plane and Spherical Trigonometry	303
College Physics (Duff & Masius)	80
Morse Code	147
Elementary Radio	53
Navigation	9
Engineering Electricity	9

Acknowledgment should be made of the generous cooperation of Fr. Harold C. Kirley, Fr. Thomas F. McDermott, Fr. Timothy J. O'Mahony, Fr. James J. Devlin, Fr. Joseph A. Martus, Mr. Gerald A. Kinsella and Mr. John V. O'Connor, who came to the assistance of the Department of Physics and Mathematics in the present emergency.

JESUIT SCIENCE BULLETIN

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