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THE

INFLUENCE OF PHYSICAL AGENTS

ON

LIFE:

BEING AN

INTRODUCTORY LECTURE

TO THE COURSE ON

CHEMISTRY AND PHYSIOLOGY,

IN THE

University of New-York.

BY

JOHN W. DRAPER, M. D.

SESSION 1850-51.

28361

New-York:
JOHN A. GRAY, PRINTER, 79 FULTON, CORNER OF GOLD STREET.

1850.

University of New-York, Medical Department,
October 30th, 1850.

Professor Draper,—

Dear Sir:—At a meeting of the students of the University Medical College, held October 28th, 1850, A. H. Nicholson, of Alabama, being called to the Chair, and F. H. Demeree, of Georgia, appointed Secretary, it was unanimously

Resolved, That a Committee be appointed to request of you a copy of your eloquent and instructive Introductory Lecture for publication.

The undersigned, having the honor to constitute the above Committee, in expressing the wishes of the class, add their solicitations that you will not refuse so unanimous a request.

Yours very respectfully,

Arthur Brown, *Maine.*
J. B. Woodward, *Vermont.*
D. W. Jones, *Massachusetts.*
W. H. Leonard, *Connecticut.*
G. Perry, *Rhode Island.*
T. C. Moffatt, *New-York.*
A. Young, *New-Jersey.*
W. T. Blackford, *Pennsylvania.*
A. C. Lobstein, *Maryland.*
W. N. Snodgrass, *Virginia.*
T. D. Haigh, *North Carolina.*
W. M. Hill, *South Carolina.*
W. P. McGehee, *Georgia.*
J. A. Davis, *Florida.*
D. C. Davis, *Alabama.*
W. L. Byrnes, *Mississippi.*
N. H. Prewitt, *Tennessee.*
W. C. Twyman, *Kentucky.*
J. W. Becker, *Illinois.*
J. Ebersoll, *Indiana.*
G. P. Hackenburg, *Ohio.*
W. B. Wilson, *Missouri.*
G. R. Giles, *Wisconsin.*
F. H. Vondy, *New-Brunswick.*
W. McAuley, *West Indies.*
A. H. Fraser, *Canada.*
A. Destruge, *South America.*
W. C. Moss, *England.*

A. H. NICHOLSON, *Chairman.*

F. H. DEMEREE, *Secretary.*

University of New-York,
Nov. 5th, 1850.

To Messrs. Nicholson and others of the Committee:

Gentlemen:—I have to acknowledge the receipt of your letter asking for publication, in the name of the Medical Class, my Introductory Lecture.

It gives me great pleasure to comply with this request, and to offer you my best wishes for your present and future prosperity.

Yours truly,

JNO. W. DRAPER.

LECTURE.

GENTLEMEN:—

Since the last Session a change has been made in the duties of my Professorship. To Chemistry has been added the important and interesting subject of Physiology.

I purpose to occupy your attention, this evening, with an exposition of the general principles which will be offered to you in this Course of Lectures, to illustrate the influence of external agents on life, and especially to point out the change which has taken place within the last few years in Physiology.

Men are too prone to stretch their knowledge to the farthest limit, and often make up in fiction what is wanting in reality. This is especially the case where pride or interest is involved. The three learned professions bear their appellation most justly. It is one thing to profess, and another to possess. The good old physicians of the last century, with their grave faces and gold-headed canes, were obliged, in the necessity of the case, to make people believe that they were quite familiar with everything pertaining to the animal functions, and that Physiology was the most perfect and best known of all the sciences. How else could they have pretended to set a machine in order, the nature and action of which they did not know? Here, in reality, was the great obstacle to the advance of the science. It was not the interest of the profession to permit changes to be made, nor even to acknowledge that any improvement was possible.

Yet, as there have ever been in the Church great theologians, and in the State great lawyers, who have risen above the prejudices or interests of their profession; so, from time to time, there have been great physicians who have recognized the path that ought to be taken. Among such I may mention the Italian, Sanctorio, who, foreseeing that the methods of Natural Philosophy were the only sure guide in Medicine, attempted to

do for it what Lavoisier subsequently did for Chemistry: to give it that exactness which alone can arise from determinations by measure and weight. Hence it is said with truth, that he literally lived in a balance, measuring with patience—according to the imperfect means of those times—the weight of the food, of the various excretions, and even of the insensible perspiration.

This was a great step in the right direction; it contrasted strongly with the wild and visionary speculations of that day. There had been theory enough; there was a want of the knowledge of facts. It had been better for Medicine, if the grave old doctors, with their white cravats and gold-headed canes, would have got into the scale-pan with Sanctorio. Even now we see the absolute importance of carrying out his views; and the first philosophers of the age occupy themselves with determining the physiological constants,—what should be the weight of the food, what of water, what of air, what of the various excretions; since, if these be not known, it is utterly impossible to say what is going on in the animal system.

The profession could not, or would not reconcile itself to the idea, that the principles of Natural Philosophy were to be looked to for the explanation of the animal functions. They fell back on the hypothesis, that a living being is totally emancipated from the dominion of such forces. But, by degrees, the rapidity with which all the great branches of knowledge, Mathematics, Mechanics, Chemistry, were advancing, caused things to be seen in their right proportions and right positions; and men at last began to suspect that the world is not governed by many systems of laws, or one part of it cut off and isolated or even at variance with the rest, but that there is a unity of plan obtaining throughout; and that whether things be living or inanimate, they are mutually dependent and equally obedient to the same rules, and are all the common offspring of one power, one thought, one God.

This noble idea, engendered in a few leading minds in the last century, has been slowly and silently working its way, gathering strength from every new philosophical and physiological discovery. A belief was gradually spreading, that the common laws of Nature would be applied to the elucidation of what were termed the vital phenomena; and that there is no mystery in animated beings, which time will not at last reveal.

The true peculiarity of modern Physiology, consists in its fully recognizing the relationship of an animated being to the world around; and in admitting, to the broadest extent, the control which external circumstances have over it. It teaches us not to regard an organized form as existing apart by itself and for itself, much less as resisting the general laws and powers of inanimate nature; but as assuming a relationship and obedience thereto. One would have supposed that so simple a condition would meet with universal acceptance, and yet with what reluctance we uniformly see new truths received. It matters not in what department of knowledge it may be, men cling to their ancient opinions until they can retain them no longer; they brood over their philosophical notions with as much self-complacency as birds do over their eggs, until at last the cherished treas-

ure bursts with its own intrinsic rottenness, and a new and living fact stalks forth and confronts them.

Why should it be thought improbable, that the same laws which govern the inorganic world are likewise employed for the government of the world of life? How is it that so many beautiful forms come into being? What is it that maintains them during their period of existence? The generations that are passed are gone for ever, no matter whether they were generations of flowers or of men. Where are they?

Such are the questions which it is the business of Philosophy and Physiology to answer. At every moment there are thousands of waves on the sea; no numbers can count all those that have ever been; they have disappeared, but the sea is still there. So, too, for every sound that reaches the ear, there are undulations in the air; and who can tell how many have been from the beginning of things? The sounds have died away, but the atmosphere exists. So, also, each one of the many colored rays of light, that pictures in the eye external scenery, is the result of wave-like motions in the universal ether. The light dies away, and the images of all the scenery and transactions from the beginning of the world disappear; but the ether endures. And thus, in whatever way you look, the same result arises,—material substances last for ever, and it is forms alone that perish.

In that most useful and most noble of all the pursuits of men—the art of Agriculture—what is it that we see? The farmer prepares his field, and takes from it his various crops in due rotation. It may be grain, or grass, or roots; he adjusts the succession duly, paying no particular attention to any individual plant that may grow on the land, but exerting such a general supervision over all, as to induce the highest development or greatest luxuriance. The harvest of one year he returns to the field as manure for the next; he converts the herbage into the flesh of cattle, and these again minister to the production of plants.

> "The forms that perish, other forms supply;
> By turns they catch the vital breath and die."

The end of his avocation is to procure the rapid production of organized from inorganic bodies. For this he ploughs, he sows, he reaps; and if his operations are conducted with intelligence, no matter with what rapidity one system of plants has succeded another, no matter what stock he has produced and killed; the land which has made it all has lost none of its fertility, but is as rich at last as it was at first.

It may be permitted to me, gentlemen, to liken the whole earth to the field I have described; for there is a great Agriculturist whose seed-times and harvests are not to be measured by the summer months, but reach over thousands of years. We, in our little way, farm our lands by the brief seasons; the geological epochs are His dates. He has called into existence, one after another, all those races of plants and animals that in succession have come and disappeared. To the variations that have

taken place in the constitution of the air, the temperature of the earth, the brilliancy of the sun, he has adapted the tribes of organization. The cold-blooded, slowly-respiring animals, that flourished in those dusky ages that preceded the deposit of coal, He replaced with the active, warm-blooded classes, as their respiration became possible by the removal of carbonic acid from the atmosphere. He works his farm by rotations, as we do ours. We deal with our animals and plants, and make each minister to the other; He does so too. The hoary centuries are the gleaners that pass through His fields, gathering in the harvest of plants and animals; yea, even of men. In vain we try to shun the inevitable fate before us. It is in vain for a blade of grass to remonstrate with the mower's scythe.

There is, in these thoughts, one fact which I desire to impress on your attention. Under this parable of the Farmer and his field, a great truth, the foundation of Physiology, lies. I wish you to see clearly that all organic forms come from the inorganic world, and return thereto. I wish you to see how the death of one tribe is the birth of another; and how, from a limited supply of inorganic matter, unnumbered races of beings may in succession arise; and after all is over there shall be no exhaustion, no impoverishment, but things shall be just as they were at first. We have already seen that material substances never change, they know neither decay nor annihilation; it is forms alone that are transitory and pass away. In this respect, the tribes of plants and races of animals are like the waves of a tempest or sounds in the air.

Why is all this? What is it that calls them forth and destroys them? Is there a more certain guide, to which we can appeal to enable us to come to a just conclusion on such a matter, than our own experience? And what is it we witness every year of our lives? Is there not a succession of organized forms that come into existence, and does not the dullest man recognize the power that external agents have in producing them? Are there not flowers that are proper to the spring, and others to the summer, and others to autumn? We see these beautiful creations arise true to their times, as with the precision of clock-work. Is it not the warmth of the sun that awakens the earliest comers, and his increasing ray that provides successors for them? And as we watch these frail generations marching onward to destruction, does any man doubt that the destiny awaiting them is due to the same natural causes? If he does, surely the repetition of the same event each following year, under precisely the same physical circumstances, should remove that doubt. In this, as in the world of lifeless matter, like causes will always produce like effects.

Uncertainties in the seasons often completely disturb the accustomed course of things. A long continued drought, or a long continued rain, is at once felt in the crops. Nor is it, as we all well know, an unusual thing for an entire failure to take place; and we, without hesitation, refer it to the proper meteorological cause. Again, there are years in which everything seems to favor the hopes of the farmer. His thankful heart with justice ascribes his well-filled granaries, and barns laden with the fruits

of the earth, to the Universal Giver of all good; but he is not so stupid as to suppose that there has been any direct or special interposition in his particular behalf. He refers the whole, in a subordinate manner, to the operation of secondary and natural causes. In his religious ceremonies and exercises, according to the custom of the age or the country he inhabits, he seeks by prayer or sacrifice for the favorable intervention of those secondary causes. From the beginning of the world until now, men, as their needs require, supplicate for refreshing rains or genial sunshines; but we might reasonably assert that no one has ever indulged in the preposterous hope that great harvests were to be vouchsafed to him on a sudden, as it were by miracle, and irrespective of the action of these natural agents. Everywhere it is admitted that, without a certain warmth and a due quantity of rain, the various produce of the earth cannot mature.

But the husbandman knows that, in a silent manner, great changes are effected over extensive regions of country by slow variations in the climate. Without hesitation he would admit that, if in the course of ages a temperature like that of the peninsula of Florida were to extend itself northward to New-York, the orange and lemon and other such tropical fruits would abound. So his whole art, both in theory and practice, is based upon a recognition of the influence of external agents upon life.

I have said that we may with propriety liken this earth to a farmer's field, and the management it has undergone—as proved by its ancient history or geological remains—to the gradual process we observe in converting a barren tract into fertile land; and just as there are in the course of a single year a variety of plants which follow each other according to the change of the seasons, and of insects that appear at different dates, or in the course of centuries gradations in the vegetable life proper to given countries; so also, in those longer periods of the ancient times, there have been mighty changes brought about by the gradual operation of variations in the physical condition of the world—changes not limited to the vegetable kingdom, but involving also animal life. For so intimately is the vegetable connected with the animal world, that it is impossible to touch the one without making an impression on the other.

The secondary causes which have been mainly involved in bringing organic nature to its present condition are two in number,—decline of the mean temperature, and change in the constitution of the air. A proper understanding of the mode of action of these, throws a flood of light on the former condition of animated nature; such as that, for example, before the deposit of the coal, slowly-respiring animals alone could exist. Refined organization and elevated intellectual powers are only possible for a quickly-respiring animal, and in an atmosphere abounding in oxygen gas. So in their due succession, as the relative quantity of that element increased in the air, there has been an age of fishes, an age of reptiles, an age of beasts and birds. Nor is the phenomenon more wonderful, if you leave time out of the consideration, than that the snowdrop and crocus, which come before winter is well over, are succeeded by the roses of spring, and these in their turn by the many-colored flowers of summer

and autumn. Yet why should you leave time out of the consideration? In the scheme we have now before us it is written, that "A thousand years are but as yesterday when it is past, or as a watch in the night."

We are too prone to measure the acts of the world by the duration of human life. King Henry, of England, stretched forth his arm and declared that that should be the standard yard, the basis of measure for all men. The threescore years and ten are always before us. In this we resemble, as has been justly said, the flowers in the Fables of Fontenelle: "Our gardener, said the roses, must be a very old man. When we first budded he looked just as he does now; he has never changed in the least, though we are nearly gone. We do not believe that he is liable to death; no, nor even to decay. The sunflower, who was here before us, tells us he thinks just the same."

Under such a system as we have been here contemplating, creation and destruction, life and death, go hand in hand. If provision is made that, as soon as physical conditions conspire, a given animated form may appear, provision is also made that, as events pass on in their course and new physical conditions are reached, that animated form is extinguished. So there is now scarce a tribe of animals surviving that was upon the earth at the period of the deposit of the chalk, a rock that is the latest of the secondary series. If there has been renovation, there has been destruction too; the death, not alone of individuals, but, reaching a higher element than that, the absolute death of races. Throughout, we see the traces of one of those fundamental laws which regulate the acts of Nature, from the smallest to the greatest. Every moment millions of the constituent cells of which our bodies are composed are dying, and new ones are coming in their stead. At longer periods, individual after individual submits to the same doom, and generations of descendants rise. A few centuries see empire after empire passing away; the Assyrian, Babylonian, Egyptian, Roman, are gone; and what are empires but the representatives of groups or families of men? Periods of some thousands of years are the terms of species. The hand of destiny presses on the North American Indian. The great elephant of his native woods—the mastodon—has preceded him. He, too, is preparing to join that melancholy caravan that travels to the land of shadows. Still higher the universal law rises, requiring only longer lapses of time. The thousands of animated forms utterly extinct, whose remains are dug from the bowels of the earth, are evidences that, from the beginning, it has never changed. Nay, more; what is it that astronomers say? Again and again they have witnessed stars disappearing from the heavens, and new ones coming in other places; and yet, in the midst of all this change, this creation and destruction, the universal aspect of nature remains unchanged. Well may we, therefore, accept the sentiment of one of our sweetest poets on the lost Pleiad:

"Why, who would talk of thrones or sceptres riven?
Bowed be our hearts to think of what we are,
When, from its height afar,
A world sinks thus, and yon majestic heaven
Shines not the less for that one vanished star."

And what now, gentlemen, is the commentary on all this? Turn which way you will; dig deep into the earth; survey the heavens; look through the pages of written history; take the knife of the Anatomist, or the microscope of the Physiologist, and penetrate into the mysteries of the living mechanism, what is the fact to which you must come at last? That the physical laws of the world are universal and unvarying in their operation; that they equally control the movements of the stars, and the vital processes of animated beings.

From the reflections I have thus presented to you, we may conclude that, in the management of the world,—both as respects its inorganic and living divisions,—Nature places an entire dependence on ordinary physical laws. The production and extinction of various tribes, both animal and vegetable, in long periods of time; the appearance and disappearance of successive genera of plants and insects, in the course of a year, so obviously depending on external forces, may satisfy us that these are the essential agents for carrying on the plan. With reason, therefore, we should expect to find the same principles in the details, and, indeed, throughout the history of medicine we trace the rudiments of these views. No one has pretended to deny that the eye is constructed upon the principles of optics, the ear on those of acoustics, the heart on those of hydraulics; or that, in general, the animal structure proclaims its own recognition that it is a mechanism on which external nature can act. There is a step, however, beyond which many physicians have been indisposed to go. Thus, though they will admit that the heart is purely a mechanical contrivance, they assume that the digestive organ, the stomach, acts by laws of its own, and in direct contravention to those of Chemistry; and that as soon as matter is submitted to its influence, it is lost to the action of the common laws of nature. And yet it is to be remarked that, though for years these have been the theories of medicine, its practice has been a practical denial of them. A man poisons himself with arsenic or oxalic acid; we at once consider what substance has the proper relations to combat their action. All toxicology, and the administering of antidotes to poisons, is a practical recognition of the great fact, that the organ of digestion cannot suspend the laws of Chemistry.

The time would fail me, were I to attempt a description of the mode of action of physical forces concerned in the various functions of life. The course of Lectures before us is devoted to that object. We shall see how the food undergoes digestion in obedience to the laws of Chemistry; one portion, the nutritious, being dissolved in the stomach; the other, the respiratory, in the duodenum;—by two different systems of absorbent vessels, the veins and the lacteals, acting on two different principles, the products of these digestions are introduced into the circulation, in the one by the great function of cell growth, in the other by physical absorption;—the circulation itself maintained partly by the hydraulic action of the heart and partly by the molecular relations of the blood to the tissues;—how, carried in this torrent, fatty matters are deposited in the adipose cells, nutrient matter in the muscular and nervous apparatus, as they

waste away by use, and combustible matters are burnt;—how the atmospheric air, finding access by the trachea, enters the cells of the lungs on the well-known principle of gaseous diffusion, and passing through the thin barrier that separates it from the venous blood, effects its arterialization;—how the air, thus introduced, performs a double duty, destroying the wasting tissues as they die away, and keeping up the temperature in man at 98°;—how the great glandular mechanisms come into play, the dead matters that are soluble in water being removed by the action of the kidneys, and the vaporous ones through the medium of the lungs.

No act of life can take place without the destruction of substance. If a muscle contracts, a part of its substance dies, as also does a part of the nervous material which brought the contraction on. It is the lot of every living part to die in producing its vital effect. Hence the enormous waste, both of muscular and nervous tissue, that is constantly going on; and hence the large amount required for keeping up the integrity of the mechanism. In a single year an adult man requires half a ton of solid food, and three fourths of a ton of water. This prodigious mass is wholly expended in carrying on the actions of life; and for its removal from the interior of the system, nearly half a ton of oxygen gas is required.

How completely do such considerations as these modify our views of the position and relation of animal beings, and illustrate their dependence on the external world. During their lives, all animals are employed in obtaining food, water, and atmospheric air. A thousand of the phenomena we witness in them, arise from the re-actions of these substances on each other. You will find that much of the time we have to devote to this course of Lectures, will be consumed in tracing out the chief features of these changes.

The vegetable creation, gentlemen, is emblematical of the life of man. It lives in a double world, and leads a double life. The oak tree spreads its roots in the earth, but its branches are in the skies, where there are sunshines by day and the unspeakable glory of the stars by night. We too have a double life; for if there be a world of fact, the scene of daily labor and disappointment, is there not also a world of thought, in which we hold communion with the illustrious of other countries and times,—poets, philosophers, soldiers, statesmen, the men of thought and men of action?

A few years ago it was more common than now for ladies to occupy their time in ornamental needlework. They could picture, in divers colored threads, scenes from the Bible or ancient history; or on their silken web set forth all the various actions of a man's life. The resemblance is even more striking than these innocent creatures intended or supposed; for a man's life, like their embroideries, has two sides: on one there is nothing but a confused maze of odds and ends, black, white, and of every shade; but turn it on the other, and all is harmonious, in its proper colors and just proportions.

With this double life, this world of realities and world of intellect, we bear a fixed relation. In the one we come in contact with things that are tangible and present; it is the scene of our struggles for physical existence.

Here obstacles have to be beaten down and difficulties overcome; here has to be the sweat of the brow, the fatigue of the body; and what, after all, is the slender reward; bread, and a little clothing! For this, alas! how large a portion of our race prolong their weary lives. The sun rises and sets; seed-time and harvest come. Physical necessity, the sternest of all taskmasters, is for ever present; his inexorable command is, work, work!

Oh! what would life be worth, if this were all? If a man, like a beast, must eat only to repair the waste of his muscles, and keep himself warm! If, living as it were in a circle, he must work to eat, and only eat to work!

Well then is it for us, that there is another world,—the world of intellect, full of old recollections and existing pleasures! In this the man of cultivation comes in contact with the wise and good of former times; in this, in common with his humblest fellow, he shares the sweetest sentiments, the pleasant recollections of childhood, and the thousand charms that gather around maturity, the endearments of friends and home! The gifts of fortune are here spread forth with equality; the dweller in the cottage is on a level with the lord of the castle. Here no invidious distinction is possible; the blessings are given in secret. No man can say, "I am richer than thou!"

What is it that establishes our relation with this, by far the choicest part of existence? Is it for Physiology or Chemistry to deal with that master work of God, the human brain? What is the meaning of the periodicity of its functions, awakening by day and reposing by night? Is it, too, subject to dilapidation and wear by use? Does it require perpetual renovation and repair? How does it come to pass that, by so many means its action is disturbed, overset by the fumes of alcohol in the drunkard, and excited to tenfold activity or stunned into stupidity by fever? The Turk chews opium, and a thousand fanciful dreams flit before him; the Chinese smokes it, and what a world he enters! When the poet Southey first breathed the protoxide of nitrogen, "It seemed," said he, "that I was come into the seventh heaven. I think that the atmosphere there must be made of that gas." The surgeon makes his patient breathe the vapors of chloroform or sulphuric ether; he relaxes the ties that hold him to the corporeal world, or even cuts him completely off from it; the man leads a purely mental existence,—that corporeal world fades away, and there is no more pain!

These facts, if properly considered, show what is the true domain of Physiology, and where her reliance on natural agents ceases. The principles of Natural Philosophy and Chemistry apply to all that relates to the organization and functions of the animal mechanism, but cease the moment you come to deal with the spiritual part. Nor does the one blend by insensible gradations into the other, for between matter and mind there is a great and impassable gulf. Without hesitation, therefore, you may reason as to the structure and working of the bodily frame. The same principles you find in the books to show that the bony skeleton is constructed on mechanical laws, the eye on those of optics, the heart with its valves on

those of hydraulics, you may extend to all muscular action, the waste and repair of the system, nay, even to the operation of the brain. But when all this is done, you will find that it is a machine alone that you have been describing, elaborately and most dexterously formed, in which there is scarcely a natural force not brought into action, and abounding in surprising instances of mechanical skill. And yet it is only a machine, dead and without action; a corpse without motion and feeling, like a steam engine without its fire. Well did the old authors speak of a vital spark; well does the common consent of mankind, the superficial observation of the ignorant, and the profoundest research of the wise, foresee that a prime mover is wanting, a something that can act, and feel, and think,—a something which, indeed, employs the body for the establishment of its relations with natural events, and makes it the channel of communication with the external world; but which, nevertheless, maintains an existence absolutely independent.

It is for you, in the profession you have chosen, to repair the accidents and defects of this delicate machine. How shall you be ready for your task if you are ignorant of its structure, or unacquainted with its mode of action? Impressed with the belief of the influence of physical agents on life, you will with enlightenment not only prepare to combat disease in the individual, but also in communities; or, better still, prevent it. Believing that death from any cause, except old age, is unnatural and may be avoided, the deleterious agents which surround us will awaken your attention, whether they be found in densely populated towns, or the sparse settlements of the country. To die, it is true, is the lot of us all; but the human race anticipates its doom. Look at the statistics of mortality and the investigations of Sanatory Commissions: poverty, wretchedness, the want of fresh air, impure water, bad food, the filth of cities, the effluvia of crowded places, contagions, miasms,—these are the agents that decimate our race, the shadowy spectres that reach forth from the grave their giant cloudy arms to seize their prey. The science of the good physician is already expanding; it looks to a higher duty than in former times—to prevent disease, rather than to cure it; to deal with communities rather than with the individual.

Permit me to offer you my best wishes, and, in their humble way, my best services for your advancement in these noble studies; and to hope that the ensuing session may be pleasant and profitable to you all.