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General Drift of Education at the Land-Grant Colleges.

BY

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GENERAL DRIFT OF EDUCATION AT THE LAND-GRANT COLLEGES.

By J. K. PATTERSON.

The law of Congress approved July 2, 1862, which made provision for the establishment, endowment, and maintenance of agricultural and mechanical colleges, set forth in section 4 of the act that "The leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

In this section certain lines of work are made obligatory, viz, "military tactics," those branches of learning "related to agriculture," and those branches of learning "related to mechanic arts." Of these three it may be conceded that, while all are obligatory, "agriculture and the mechanic arts" are relatively of primary importance and "military tactics" of secondary importance. There are certain other lines of work which are permissive, viz, "the scientific and classical studies." It is, I believe, a fair interpretation of the two groups that the obligatory is considered the more important and the permissive the less important, so far as the purposes of the act are concerned. The intent is set forth in the concluding lines of the section, viz, "to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

It will be observed that it is within the exclusive competency of the legislatures of the respective States to determine whether the colleges established under the act shall be limited and bounded by the obligatory features of the act or whether they shall, in the exercise of a wise liberality, make provision for the inclusion of "other scientific and classical studies;" also, if they adopt the latter alternative, then the institutions founded under the act make their instruction liberal as well as practical.

It may not be inappropriate to consider for a few minutes how far the intentions of the founder have been realized.

Many of the institutions founded under the act have large incomes, accruing partly from the interest on the proceeds of the land grant, partly from liberal appropriations from the respective States. In some instances State aid surpasses the income from the legislation of Congress.

In a meeting in Washington in 1885, when I expressed the conviction that compliance in good faith with the organic law required daily instruction in military science and daily drill I was met with a storm of dissent from every quarter of the house. The idea of daily military drill and instruction was scouted and ridiculed. After a few years military instruction grew somewhat more in favor. Some colleges had military instruction twice each week; some three times; some every day. The college which I represent has maintained the principle of daily drills and military instruction, and has required every man during his college connection to do military service.

The good results of military instruction in the land-grant colleges were apparent during the war with Spain and the military operations subsequently in the Philippines. Every State in the Union was able through its agricultural and mechanical college to provide the necessary number of officers for the contingent which it fur-

nished for the increase of the Army, many of them quite as well educated and quite as capable as graduates of West Point. The wisdom of Senator Morrill's forecast was thus justified by results.

Irrespective of providing an educated military reserve, I believe that military instruction in these colleges is a good thing in itself and in its relations. It is a valuable element in physical training; it inculcates promptitude and exactness, promotes grace and dignity of movement, and, above all, enjoins and compels obedience and submission to wholesome discipline and restraint—one of the most important lessons to be learned in any country and especially in our own, where the coordinate ideas of liberty and authority are but imperfectly understood. For these reasons, but briefly expressed, I believe that every land-grant college in America ought to make the military feature of coordinate obligation in dignity, and should endeavor to make the military instruction as thorough and comprehensive as the act of 1862 intended that it should be.

When the statute of 1862 was passed the country was in the throes of a great national crisis. Military considerations were paramount. There was abundance of material out of which to make soldiers, but the material when listed, or later on drafted into the service, was raw and undisciplined. The officers elected by the regiments and subsequently confirmed by the States and by the War Department were as little fitted for command as the men whom they were appointed to lead. The majority of them knew nothing about the requirements for a good soldier; they could not drill the men; they could not instruct them in tactics; they knew nothing about strategy. Senator Morrill saw the necessity of providing officers, and that too out of all proportion to the ability of the Military Academy to supply. Officers who would be thoroughly drilled and able to command on the field; officers who should be well versed in the modern science of warfare. The thought suggested to him the propriety of making the colleges founded under the act military schools, schools for making soldiers as well as schools for scientific agriculturists and scientific mechanicians. The country could not afford to keep a standing army of half a million men with the proper complement of officers under arms, but it could afford at inconsiderable expense to provide for the military instruction of all who matriculate in these colleges and thus have thousands and tens of thousands of men ready at the call to arms and capable of shaping into companies, and regiments, and brigades, and divisions, and corps, and armies the volunteers and conscripts of future days. Thus the military feature was engrafted on the land-grant colleges and made a coordinate and obligatory feature of their organization. But a reaction set in after the close of the war. Men were wearied with civil strife. After four years of continuous warfare they were ready to sheath their swords and devote themselves to the ways and arts of peace.

The military feature of these colleges became generally unpopular and the amount of military instruction was reduced to a minimum, if not eliminated altogether. Between 1885 and 1897 there was a gradual revival of interest in military matters in these colleges. The War Department held out prospects for promotion to students who had graduated with honor in military science and the governing boards of the colleges and universities gradually became conscious of their duty under the law. The consequence of this awakening was that when the Spanish American war came on hundreds of educated men, well drilled in the manual of arms, familiar with tactics and strategy, were available for officers, not only in the volunteer, but in not a few instances for the Regular Army. In discipline, in aptitude, in knowledge of military science, in all that goes to make an able, intelligent, and capable officer, the graduates of land-grant colleges were able to hold their own with the best West Point men. I say this, and I say it with pride, not to disparage the graduates of the Military Academy, but in justice to our own men.

It may be well in this connection to say that by judicious and cooperative effort there is a strong probability that an appropriation can be had from the Government for establishing schools for marine engineering in connection with the existing schools of mechanical and electrical engineering which will enable the land-grant colleges to educate men for this branch of the naval service and thus to do for the Navy what they are now able to do for the Army.

Of the two objects in the mind of the author of the act of 1862—namely, the scientific development of agriculture and the application of science to the mechanic arts by providing instruction in those branches of learning relating thereto the mechanic arts seem, as measured by ultimate results, to attract more students and to graduate more students in full and relatively complete courses in the ratio of 4 or 5 to 1. In many of these colleges students in the application of science to agriculture can not be had for long courses of study. These latter have been abridged from four years to three, from three to two, from two to one, from one year to a few months or even weeks. These

truncated courses of study, necessarily meager and partial, supply some practical knowledge, but do little in the way of either scientific instruction or education. I have had occasion to collect college statistics for other purposes and find that of 20 or 30 representative colleges the number of those who completed regular courses of study which led to the bachelor's degree in agriculture and in engineering in 1900 were about 126 in the former and 620 in the latter. This seems to show that the trend of education in the land-grant colleges, so far as the purpose of the founder was concerned, is in the direction, not of agriculture, but of the mechanic arts. In some of these colleges the graduates in classics and in other scientific studies outnumber both the one and the other. This seems to indicate that though agriculture is encouraged by farmer's institutes and all the machinery which ingenuity can devise for its upbuilding and growth, farmer's do not care to educate their sons in agriculture, or the sons object to the kind of education specially provided for them. Farmers in most parts of the country, I think, prefer when they send their sons to college, to educate them for professional life, as lawyers, clergymen, physicians, engineers, or anything, indeed, but farmers. On the other hand merchants, bankers, professional men, gentlemen of fortune and gentlemen of leisure prefer for the most part a liberal education for their sons, though many place them in engineering schools.

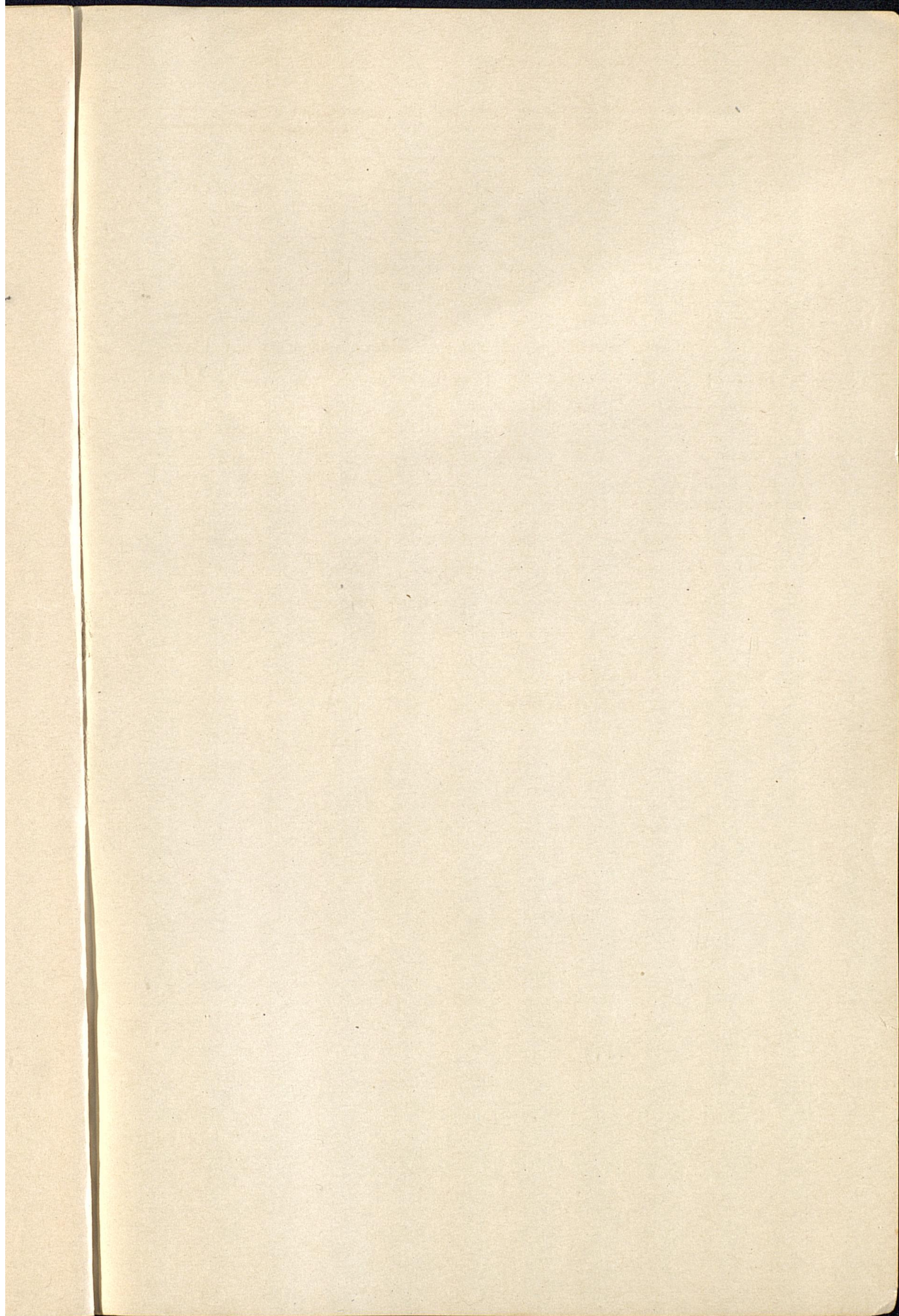
The aggregate agricultural productions are large, but few farmers are rich. They are not rich in the sense that merchants and contractors and manufacturers and iron-masters and railroad magnates are rich. Many of them are, it is true, well off. But of the thousands of millionaires and multimillionaires in America how many of them became rich by farming? This I imagine is the main reason why the agricultural side of the land-grant colleges do not flourish as the mechanic arts and scientific branches and classical and philosophical subdivisions do. If then I were to sum up the work of the colleges outside of the experiment stations, I should say that engineering and classical education and philosophical training take the lead, and that agriculture follows, oftentimes with a halting, limping gait and considerably behind. From many points of view this is to be regretted. I can not but look on the agriculturist as the mainstay of the country, and that upon his education and intelligence and patriotism the perpetuity of free institutions depends. An approximately correct diagnosis may lead to a remedy.

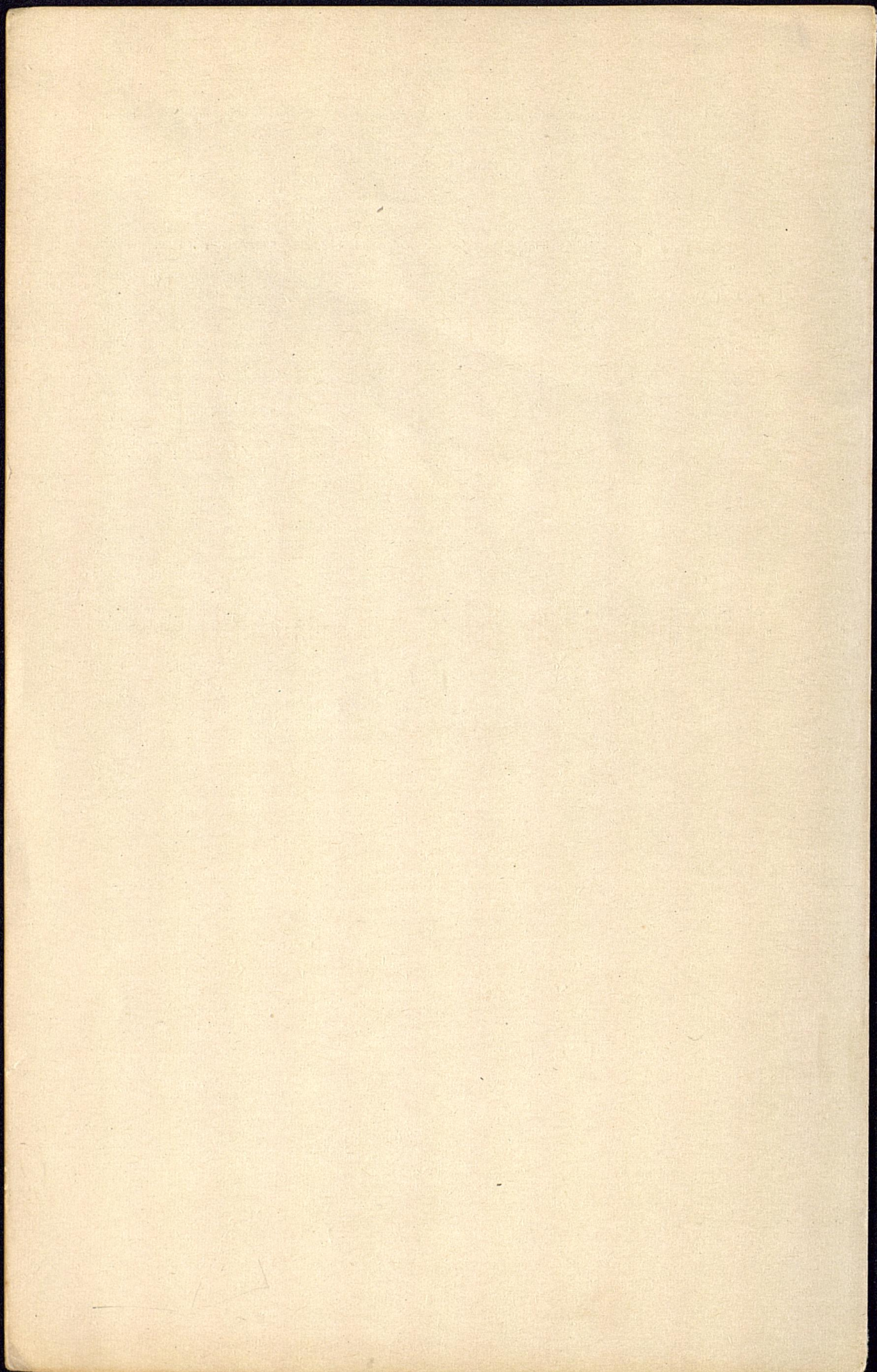
The scientific instruction in these colleges outside of agriculture and the mechanic arts has had a great and gratifying development. Those sciences which deal with matter and with life in their broadest extent have been cultivated for their own sake and not because of their relation to agriculture and the mechanic arts. The boundary lines between the known and unknown have been pushed back from year to year, enlarging the domain of realized knowledge to a degree which could not have been anticipated a generation ago. The far-reaching generalizations of Darwin and the practical discoveries of Pasteur, with their manifold applications in theory and practice, gave a notable impulse to discovery based upon observation and experiment. In these the land-grant colleges have taken the lead in America. They have, moreover, been largely instrumental in stimulating increased attention to natural science in many of the older institutions of the country. Harvard and Yale and Princeton and Columbia have followed the example, though somewhat reluctantly at first, of the colleges established under the act of 1862, and have spent large sums of money in equipments for physical, chemical, and biological instruction and research. They have not, however, been able to keep pace with the State colleges and universities in scientific investigation and instruction. These latter institutions, drawing largely from the liberality of their respective commonwealths, have had resources at their command which even the best of the old universities with their princely endowments were unable to equal. The effect has been to liberalize and widen the scope of university work, and to modify the character of the old scholastic training by the introduction of a much-needed leaven drawn directly from the daily operations of nature in her own great laboratory. While the land-grant colleges have given a wholesome stimulus to scientific investigation and discovery in the older colleges and universities, these latter have been instrumental in causing the State institutions to introduce a large element of liberal culture into their courses of study. Philosophy, literature and classics, and modern languages and comparative philology, Aryan and Semitic, find adequate recognition in most of the higher institutions founded under the act of 1862. These are permitted by the organic law, and in connection with the scientific courses afford educational facilities unsurpassed on the Western Continent. Classical and philosophical training have held their own for centuries. The natural sciences have not superseded them, nor are they likely to do so. As a means of mental development and of mental discipline, of the cultivation of the mind as an instrument for the perfection of thought, Latin, Greek, logic, and metaphysics have no superior, and it is doubtful whether they have or will have an equal.

The roots of our modern civilization go back to the language and literature and philosophy of the "dead but sceptered sovereigns who still rule our spirits from their urn." It is impossible to dissociate ourselves from the civilizations of the distant past. And in this age of intense devotion to material things, to the multiplication of the products of the field and the forge and the loom, to the improvement of the facilities for intercommunication; in this age of steamships and railroads and telegraphs; of manufactures and commerce reaching out to the ends of the earth and seeking new spheres of influence and new fields of enterprise; in this age of intense devotion to the accumulation of wealth, it is well that the desire should exist to educate and develop the intellect on lines that do not stimulate and impel its possessor to transform his brain into a mint for the coinage of gold and silver. For this purpose classics and the liberal arts—the humanities, as they were very properly designated—provide the necessary conditions and supply the proper counterpart. The bread and butter sciences are needful, nay indispensable, but "man does not live by bread alone."

To build machinery for agriculture, for manufactures, for locomotion, is well. To breed poultry, to fatten pigs, to develop beef in cattle and speed in horses, to multiply the return from the fields of wheat and corn and cotton and cane, increase the comforts and conveniences and well-being of life. These are the material conditions of civilization and refinement, but these are not ends in themselves; they are means to the attainment of a higher end. They should rightly subserve the development of the intellect, the growth of intelligence, the discipline of the mental faculties, the quickening of the moral powers, the cultivation of the æsthetic powers, to the end that the true, the beautiful, and the good should find symmetrical and harmonious growth. Then would we understand and live for the sublime truth that "on earth there's nothing great but man, in man there's nothing great but mind." Then would be realized the ideal of the founder to provide an education at once practical and liberal "for the industrial classes in the several pursuits and professions in life." Culture and refinement and intelligence and humanity and an enlightened patriotism will then be possible in the homes of the masses as well as in the stately mansions of the classes. In the former rests the hope of the future, and not in the wealthy few whose accumulated fortunes are counted by tens and hundreds of millions.

"Ill fares the land to hastening ills a prey
Where wealth accumulates and men decay.
Princes and lords may flourish or may fade;
A breath can make them as a breath has made.
But a bold peasantry—their country's pride,
When once destroyed can never be supplied."





COMMENCEMENT ADDRESS

TO THE
FACULTY AND STUDENTS
OF
HANOVER COLLEGE, INDIANA



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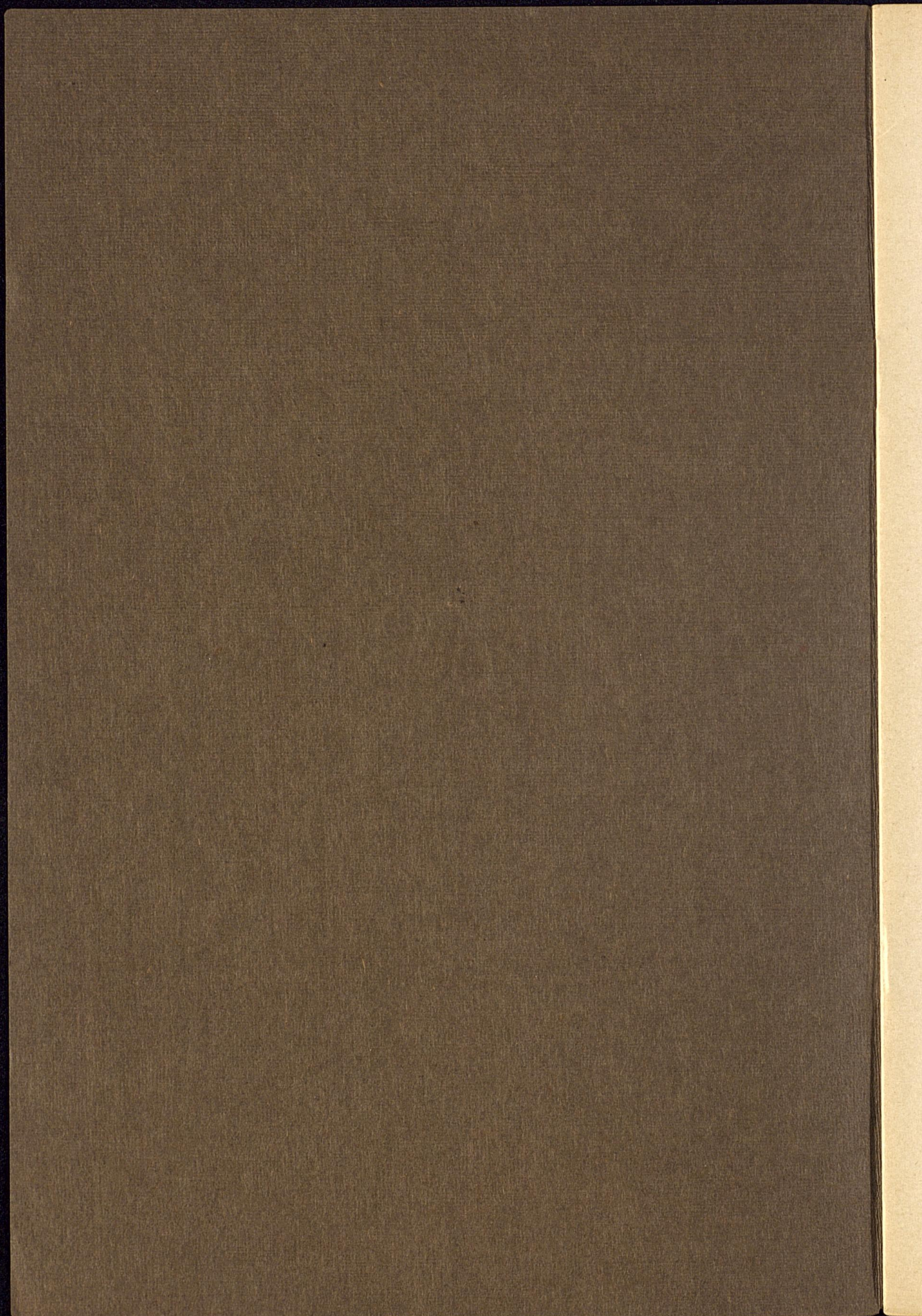
"Influence of the Bible Upon Civilization"

BY

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PRESIDENT EMERITUS KENTUCKY STATE UNIVERSITY

JUNE 7, 1911

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COMMENCEMENT ADDRESS

TO THE

Faculty and Students of Hanover College, Indiana

BY

JAS. K. PATTERSON, Ph. D. LL. D., F. R. Hist. S.

"Influence of the Bible Upon Civilization"

T has been well said that mankind, preceding the advent of the Saviour, had been subjected to discipline and culture on a variety of converging lines. Finite as we are, no single individual and no single race could suffice as the vehicle and embodiment of the manifold and varied preparatory work which conditioned the fullness of time. Each of the great historic races of the pre-Christian world had its time of development and its appropriate office in the education of mankind. The Eastern Aryan, who left his Central Asiatic home ages before the dawn of history and who, passing the Himalayas and the Indus, spread over the fertile lands of India, lost his original monotheism in the deification of the forces of nature, and gave a divided allegiance to Indra and Dyaus and Varuna. While unity of cult and unity of religious belief were lost, free scope was given to the play of the imagination and the Eastern Aryan became the type of the bold thinker, unchecked by logical sequence or ethical consequence. Pure thought, the form of thought apart from the matter of thought, the science of logical processes, whose analysis surpassed that of Kant and whose generalizations rose higher than those of Aristotle, moved on, while imagination held the reins, to elaborate, establish, assail and destroy systems which the Academy and the Porch, the Idealism of Berkeley, the Nihilism of Hume, the Pessimism of Schopenhauer and the Pantheism of Spinoza but repeat and reproduce. The dominant philosophies of the classic age and of the modern era were anticipated hundreds of years by our dusky kinsmen on the Ganges and the Jumna, and nothing in these latter ages has been better said than by the sages of Hindustan three thousand years ago.

But with all in grandeur of thought and its great riches of speculation, there is a grotesque side to Hinduism, from which the classicism of Greece is free. Greece had her polytheism also, a polytheism which, there is reason to believe, followed and supplanted a monotheism equally grand and simple with that which Hindu and Greek alike derived from a common source, a polytheism fostered by, if it did not grow out of, the

physical conditions of hill and mountain, rock and river, fountain and sea which made Greece of all lands the loveliest and of all homes the most beautiful. The beauty of nature around him evoked the idea of the beautiful in his soul, kindled the creative genius within and enabled him to realize conceptions in poetry, in marble and in canvas which became the priceless heritage of mankind. Science perfected art and art beautified and adorned science.

The Roman had neither the imagination of the Oriental, nor the sense of beauty which prevailed in his Hellenic kinsmen. Rude in speech, rugged in thought, stern in demeanor, owing and rendering an allegiance to his country beyond that which Hindu or Greek with rare exceptions had ever conceived, the civic virtues shone in him with a lustre which dwarfed and eclipsed all others. The Roman was an organizer of men and his mission was to teach men how to obey. With resistless energy and untiring zeal he gathered into one Commonwealth all the nations of the Old World and held them in obedience for centuries to the city on the Tiber. He gave an external unity to the fierce Cherusci, the fiery Numidian, the polished Greek and the dreamy, languid, imaginative recluse of the Orient. He welded into one all the historic nations which preceded him and infused into them the new blood and the new life of the barbarian Gaul and Frank and Burgundian and Goth.

To the Hebrew was given a grander mission than to any kindred stock. Possessing neither the logical power, the metaphysical subtlety and the vivid, unrestrained imagination of the Hindu, nor the exquisite conception of the beautiful and the power to project its ideal of the Greek, nor the exalted civic virtues, the unbending force of will and the genius for organization of the Roman, to the Hebrew was given a sense of all-pervading Deity, in the universe but above it, conditioned by no limitations of space or time, personal, holy, beneficent, the creator of all, to whom is due the allegiance of all, unbegotten, self-existent and eternal. With this ideal exalted and exalting, was given the cognate one of personal devotion, through acts of worship, service not fitful, transient, occasional and formal, but the service of a heart whose duty it was to essay justice, purity, holiness and beneficence. The essential ideas forming the center around which all others clustered, were the unity of God and service acceptable to him through a life of personal purity and obedience.

For two thousand years the scriptures of the Old Testament traced the development and growth of these ideas. The sense of sin and the sense of ill-desert formed the dark background to the ideas of God and the necessity of personal purity in the human soul, and the problem thence emerged of how to reconcile man to himself and with God. This problem also confronted the Aryan sage on the Hydaspes and the Ganges; it loomed up before the Zoroastrian in the plains of Media and Iran and though perceived with less distinctiveness by the Socratic and the Peripatetic, its shadow fell across the Porch and the Academy and shrouded in mysticism and gloom the speculations of the later philosophy of Greece. The questions ever recurring, but never answered: "How shall man be

just with God?" and "If a man die, shall he live again?" found authoritative response neither from Brahmin nor Buddhist, Pyrrhonist nor Stoic.

How, during these twenty centuries and more, the Hebrew learned and forgot this lesson, adored Jehovah and worshipped Baal, flung himself repentant upon the earth in dust and ashes and again sold himself to the unhallowed orgies of Ashtoreth, these grand old Hebrew scriptures faithfully portray. And when on these converging lines the fullness of time came and God was manifest in the flesh, justified in the spirit, seen of angels, preached unto the Gentiles, believed on in the world, received up into glory, the scriptures of the New Testament declare with equal simplicity, fidelity and truth.

In comparison with the sacred books of the great ethnic religions of mankind, the Bible stands alone. It is not a difference in degree merely, but in kind; it is not that it stands first and they second, but like the Olympian Jove of Horace, all the minor deities stand at a distance so immeasurable that no one is second to him or like him. Its thought, its expression, its authoritative utterances, all commend themselves as above men. We read and we yield unconstrained acquiescence. The human soul accords an instinctive response and whether it has declared the whole counsel of God or not, consents that it is holy and just and good. Its analysis of the weakness and greatness of man, its recognition of the schism within him made by the consciousness of guilt and his longing for higher and better things, its clear deliverance on the immortal destiny which awaits him and his responsibility to a power above him, all find corroboration and proof in his own consciousness. How trivial the cosmogonies of Greek and Roman, Hindu and Zoroastrian, compared with simple yet sublime utterances in Genesis: "In the beginning God created the heavens and the earth." "God said, Let there be light, and there was light," "The Lord God formed man out of the dust of the ground and breathed into his nostrils the breath of life, and man became a living soul." The Vedic hymns, beautiful though they be, awake no such sense of the fatherhood of God as the Twenty-third Psalm: "The Lord is my shepherd; I shall not want," no such sense of his goodness as the One Hundred and Third: "Like as a father pitieth his children, so the Lord pitieth them that fear Him," no such sense of his love as the utterance which forms the burden of the New Testament: "God so loved the world that He gave His only begotten Son that whosoever believeth on Him should not perish, but have everlasting life." The hymns to the Maruts, among the sublimest in the Veda, have no such lofty grandeur as the Eighteenth Psalm: "He bowed the heavens and came down and darkness was under his feet. He rode upon a cherub and did fly; yea, he did fly upon the wings of the wind." Neither in the Vedas nor in the Zendavesta nor in the Koran is found any such lofty conception of the Majesty and Infinity and Omnipotence of God as in the 11th chapter of Job: "Canst thou by searching find out God? Canst thou find out the Almighty unto perfection? It is as high as Heaven; what canst thou do? Deeper than Hell; what canst thou know? The measure thereof is longer than the earth and broader than the sea."

The parables of Buddhagoshā contain maxims of worldly prudence and of personal and social ethics which have justly excited the admiration of scholars, but place them side by side with the proverbs of Solomon and the Sermon on the Mount, and we see at once that they are of the earth, earthy, not heavenly treasures in earthen vessels, but treasures and vessels of identical mould.

We can hardly say that even the greatest among the sages of the classical world had any well-defined belief in immortality. It was a hope, rather than a belief, a yearning inspired by a sense of incompleteness, a desideratum of philosophy, rather than a religious conviction, an aspiration of the Schools, rather than an ethical fact regulative of human life,

"An infant crying in the night,
An infant crying for the light,
And with no language but a cry,"

but in the Gospel, it is the ground-work of the Christian system. The wisest of uninspired men, in that solemn scene recorded by Plato, after drinking the cup of hemlock, discourses on the immortality of the soul in language which Cato and Cicero regarded as the glory of philosophy, but Socrates lays him down upon his couch and composes his stiffening limbs with no clear vision of the future, and enjoins one of his faithful companions to sacrifice a cock to Aesculapius. Compare this with the words of Jesus; with whom Socrates is sometimes compared: "I have glorified Thee on the earth; I have finished the work which Thou gavest me to do. And now, O Father, glorify me with thine own self, with the glory which I had with Thee before the world was. Father, I will that they also whom Thou hast given me be with me where I am, that they may behold my glory."

Homer relates in the *Odyssey* how Ulysses, in his journey through the realm of shades, came in succession upon the heroes whom he had known, and who were now doomed to a cheerless existence in the nether world. Meeting Achilles, the bravest of the Greeks, he adverted in terms of compliment to the precedence accorded him, and received this reply:

"Say me not death in praiseful words, noble Ulysses.
"I would sooner be a bonded serf,
"The laborer's tool to ply,
"To some small cotter on the heath,
"With wealth exceeding small,
"Than be the lord of all the shades,
"In Pluto's gloomy hall."

How different this from the language of St. Paul at the close of his ministry, with the axe and the block before him: "I am now ready to be offered and the time of my departure is at hand. I have fought a good fight; I have finished my course; I have kept the faith. Henceforth there is laid up for me a crown of righteousness which the Lord, the Righteous Judge, shall give me at that day, and not to me only, but to all them also that love his appearing."

Responsibility to one God, the author and sustainer of all, alienation from God by reason of sin and inability to make expiation therefor, atonement and reconciliation through the God-man, the fatherhood of God and the brotherhood of man—these were the distinctive features of the Christian system as the outgrowth and complement of Hebraism and these were the doctrines which, when accepted, revolutionized the religion and the morals of the Roman world. As a corollary to these, devotion to a personal Saviour, intense zeal for his service, love for the author of our being, humility, forgiveness, mortification of self, charity, unselfishness, became the springs of a new activity, the essence of a new morality, the inspiration of a new life, the lever and the fulcrum by which the potencies of humanity should be brought into play for the regeneration of mankind. Virtues which found no place among the philosophies of the time, or had been relegated to a subordinate place, now rose into prominence and came to the front.

The new doctrine spread rapidly, first among the lower classes, then among the middle, and lastly reached the highest strata of society, until in a little over three centuries, its adherents, though persecuted, proscribed, banished, despoiled of goods and oftentimes called to seal their testimony with their blood, became a majority of the Empire and the first sovereign of the new Rome on the Bosphorus acknowledged his allegiance to the once despised Nazarene. And much mankind needed the infusion of the new leaven. In all the annals of the world, there have been no such boundless bogs of moral corruption and social rotteness as the historians and satirists of Rome chronicle and denounce. From the cottage to the throne throughout the whole expanse of Roman dominion, and among the one hundred and twenty millions over whom the imperial city bore sway, mankind, degenerating from year to year and from age to age, was perishing, through venality, rapacity, dishonesty, and abominable lust. The shameless, nameless vices which polluted the imperial palace and were quenched only by the cup of the poisoner or the dagger of the assassin threatened to banish love and reverence and charity from earth and transform it into a pandemonium. In another and more awful sense the fullness of time had come.

But silently, steadily, resistlessly, the new faith entered on its mission of transformation. In spite of the corruption which abounded, a deep anxiety, a restless longing, a painful unrest pervaded the souls of men. But the fatherhood of God, the brotherhood of man, reconciliation through a Redeemer, purification of self, the depression of the ignoble elements of human nature and the elevation of whatever good existed, these, through devotion to a personal Saviour, infused new hopes, created new ideals, awakened new impulses and lifted all who accepted them to a higher plane and to a healthier atmosphere.

Long before the fall of the Western Empire, its great dependencies had accepted the Christian faith, and Gaul and Syrian, Iberian and Greek, Italian and Numidian bowed before the cross. The highest magistrate and the humblest citizen, the master and the slave, the poor peasant receiving the scanty earnings of his daily toil and the great proconsul

whose broad acres covered rich provinces, met and worshipped on equal terms under the same roof. They sat at the same sacramental board, united in ascriptions of praise to a common Father and a common Saviour, chanted the same penitential psalms and looked forward with hope and trust to the same resurrection from the dead. We of this age who have never known otherwise, cannot, without an effort realize the mighty transformation wrought by the Gospel. It was a transformation from the stench and corruption of the charnel house to the freshness and verdure of the summer landscape, lighted by the sun and overhung by the gladsome sky. It was a lifting from the valley of the shadow of death to the mountain summit, sparkling in the sunlight and revealing on the not distant horizon the Paradise of God and the city of the redeemed. Not extinction, not oblivion, not the gloomy abode of the shades and the shivering throng on the banks of the infernal river awaiting each his time for that grim ferryman to cross the melancholy flood to the regions of perpetual night, were ever present to depress and terrify; but release from the bondage of sin, union and communion with Christ and with God, cheered through life and gave to the adherent of the new faith a placid quiet and a triumphant death which the greatest of the sages of heathenism could never know.

And when the Northern races, moved by that mysterious impulse which precipitated them upon the frontiers of the now tottering Empire, flung themselves with resistless force upon its defences, holy men issued from their cells and inspired with a burning love for souls, met Goth and Hun, Vandal and Lombard, Burgundian and Frank, with open Bible and uplifted cross and led their conquerors captive to the Cross. The fierce warriors of the North bowed their heads at the baptismal font to do homage to the Saviour and to become his men. Many were the deeds of cruelty wrought by these imperfectly Christianized barbarians, rude were their conceptions of the Christian life, but the good seed sown in these iron hearts softened them in time and ample charities, holy lives, churches consecrated, idols overthrown and heroic Christian deaths, go far to relieve the turmoil and warfare of the ages which followed the fall of the Empire.

These fruits you and I behold today. THE GREAT FACTOR IN MEDIEVAL REGENERATION AND MODERN PROGRESS IS THE BIBLE. It has developed the rights of man, determined the relations of the governing to the governed, emancipated the human mind, broken down the barriers of caste and race, founded and endowed universities, built hospitals, ameliorated prison discipline and reared asylums for the unfortunate. It reforms the drunkard, reclaims the magdalene, curbs the passions, and by its exemplar of one perfect man in the annals of our race, presents the sublimest ideal and the loftiest standard of excellence for imitation. It inspired the great Apostle of the Gentiles to brave perils by land, perils by water, hunger, nakedness, the dungeon and the axe. It animated St. Francis Xavier in his weary wanderings over the mountains and rivers and plains of India and China in his zeal to bring souls to his

master. It gave fortitude to Ridley and Latimer at the stake and rent for them the clouds for a vision beyond the skies. It kindled the ardor of Knox to consecrate his people to Christ's covenant and crown and made the hills and vales of his country vocal with the prayers and praises of the gallant men and devoted women who sealed their testimony with their blood. These fiery trials gave hardness to the bone and toughness to the sinews and strength to the brains of a people once the poorest in Europe, but whose influence in the development of civil and religious freedom, in the diffusion of sound moral and religious principles, in philosophy and literary industry and self-reliance, has been out of all proportion to its population. In the language of another:

"Paul stamped his image upon Augustine, Augustine upon Calvin, Calvin upon Knox, Knox upon Scotland, and Scotland upon universal protestantism."

I may add: "Protestantism, with its open Bible, rules the world today."

And now a few words in reference to our own authorized version, the ter-centenary of which has excited so much enthusiasm and religious feeling in Great Britain and in America. Rev. F. W. Faber, a former member of the Episcopal Church, but latterly in the Roman Communion, speaks of the Authorized Version as follows:

"It lives on the ear like a music that can never be forgotten, like the sound of church bells which the convert hardly knows how he can forego. Its felicities often seem to be almost things, rather than mere words. It is part of the national mind and the anchor of national seriousness. The memory of the dead passes into it; the potent traditions of childhood are stereotyped in its verses. The power of all the griefs and trials of a man is hidden beneath its words. It is representative of his best moments and all that there has been about him of soft and gentle and pure and pertinent and good speaks to him forever out of his English Bible. It is his sacred thing, which doubt has never dimmed and controversy never soiled. In the length and breadth of the land there is not a Protestant with one spark of religiousness about him whose spiritual biography is not in his Saxon Bible."

George V. of England, replying to a deputation which on the 21st of March presented him with a copy of the ter-centenary edition of the Authorized Version of 1611, said:

"This glorious and memorable achievement, coming like a broad light in the darkness, gave freely to the whole English-speaking people the right and the power to search for themselves for the proofs and consolations of our faith; and during three hundred years the multiplying millions of the English-speaking race, spreading ever more widely over the surface of the globe, have turned in their need to the grand simplicity of the Authorized Version and have drawn from its inexhaustible springs of wisdom, courage and joy."

The only version of the Scriptures which can be compared with the Authorized Version in point of influence is the Vulgate of St. Jerome. This Latin translation has for sixteen centuries been familiar to scholars

and to the better educated among the Roman clergy, but has been in the main a sealed book to the masses. Not so the Authorized Version. It became accessible to every person who could read and familiar to those who could not read through the weekly ministrations of the pulpit. It permeated every stratum of society. Its lessons and the language in which they were conveyed became household possessions. The life of the people became saturated with its all-pervading sanctity and with its divine authority, its incomparable message of life and hope, it was not the heritage of the few but the possession of all.

When the English colonist left his native shores, he carried this precious treasure with him. This was the bond that bound him to the home of his fathers and united him with all who thought his thoughts and spoke his speech. To the Protestant colonist it was an indissoluble bond of union with those he had left behind him. The ordinary layman who left France or Spain had no Authorized Version to carry with him. The Roman hierarchy kept the Scriptures in their own hands, for the use of the clergy, but the Bible was for the most part to the layman a sealed book. I make bold to say that the Bible is the great unifying influence which binds the English-speaking stock together in one, giving them today precedence in the arts of peace, leadership in civilization, invincible prowess on land and on sea, and a preponderating influence in the dissemination of Christianity and in the councils of the nations.

That phase of Christianity which Hanover College represents has been prolific of important results to mankind. The Bible provides us with a perfect rule of faith and practice. In the standards of the Presbyterian Church, its Confession and Catechism, is found, in my opinion, the most scriptural and the most complete of all creeds, a system of theology as perfect as human wisdom can devise. To one of its aspects only I desire for a brief space to call your attention.

Its political cult has given freedom to the English-speaking race. It recognizes the essential equality of all men. It sketches in bold outline the distinction between those who govern and those who are governed, as well as the reciprocal rights and duties of equals. The most philosophic body of systematic theology in Christendom, it is logically perfect and metaphysically impregnable. The germs of freedom had been brought into Britain by the Angles and the Saxons from their primeval home in the Teutoberg forest on the banks of the Saale. They had been struggling for centuries to obtain and to secure permanent recognition when indubitable support and sanction came to them from Christianity. "Whether the democracy of later centuries had its roots in the guilds and brotherhoods preceding the Reformation and its appearance in the sixteenth century is to be regarded as a revival, rather than a birth, matters little."* Borgeaud says: "Modern democracy is the child of the Reformation. To make the religious revolution lawful, it was necessary to proclaim these two principles, viz: Free inquiry and the priesthood of all believers, which contain in them the germs of the political

* Lobengier.

revolution." In Geneva as early as 1540, "the Small Council, the Council of Sixty and the Council of Two Hundred contain the essentials of the Scottish League and Convent and of the American Constitution. The enactment of the organic law, its discussion, submission for popular approval, ratification and adoption, are all found therein"[†] Knox carried these principles with him to Scotland, made them the foundation of his ecclesiastical polity and his successors during the Puritan Rebellion made the solemn League and Covenant the basis and the condition of their co-operation with England. Calvin's theocratic state contains the essential elements of all civil and religious freedom, by recognizing the equality of all orders of men, both in church and in state. Transplanted to Scotland, it has formed the ground-work of civil and religious freedom, in the British Isles, in the United States of America, and throughout the colonial dependencies of the British Empire. That the people are the ultimate source of law and that the Presbyterian and old Puritan stock were the depositories of this sacred trust is the inheritance bequeathed to us by John Calvin and John Knox.

"The solemn league and covenant

"Gave Scotland blood, gave Scotland tears,

"But it sealed freedom's sacred cause.

"If thou'rt a slave, indulge thy sneers."

Froude says that Scotland saved Protestantism once and may have to save it again, and James Bryce, author of the "American Commonwealth," than whom there is no higher authority, says:

"Someone has said that the American government and constitution are based on the theology of Calvin and the philosophy of Hobbes. This at least is true, that there is a hearty Puritanism in the view of human nature which pervades the instrument of 1787. It is the work of men who believe in original sin."

Large numbers of Scotch were among the early settlers of Pennsylvania and though they were far outnumbered by the Germans, exerted a political influence out of all proportion to their numbers. In the Carolinas they were controlling factors in government. In the period from 1650 to 1750, more than three hundred thousand Scots from Scotland and from Ulster emigrated to America, most of whom settled in Virginia and the Carolinas. These for the most part were saturated with the principles of the Covenant and boldly applied them to the political organizations which formed its counterpart. "The chronicles and diaries of the period" show how keenly they resented and how steadily they resisted any encroachment by the colonial government on their freedom of thought and action. The "Regulators' Movement" in North Carolina in 1768, the "Wautauga Compact" of 1772 in East Tennessee, and the "Mechlenberg Declaration" of May 31, 1775, preceded by one to eighty years the more famous and more articulate Declaration of July 4, 1776. And when the colonists had by formal act severed their allegiance to

[†] *ibid.*

the British crown, the Scots of the Middle States, of Virginia and of the Carolinas formed the back-bone of the army of the Republic. It was not the Puritans of New England, nor the Cavaliers of the South, nor the Patroons of New York that won independence, but the strong arm and resolute heart of the Presbyterian Scot, with the Covenant in one hand and the sword in the other. The bloody battle of King's Mountain, in the Carolinas, was no less decisive of the ultimate issue than Saratoga, and made the surrender of Cornwallis at Yorktown inevitable.

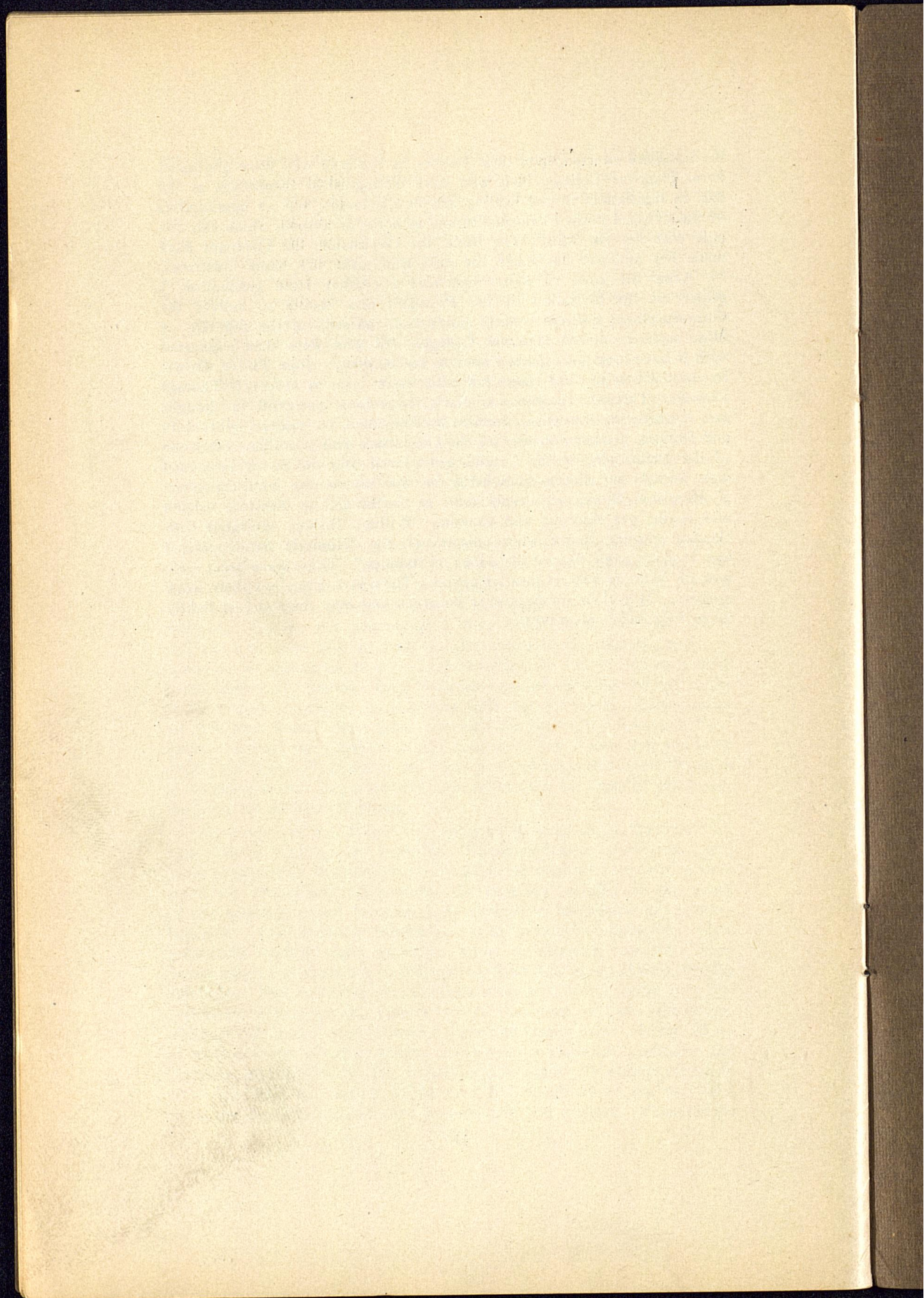
Happily after more than a century, the wounds left by the Revolution are healed and bitter memories of the unfortunate cleavage obliterated. Community of interest in common ideals, identity of race, language, laws, literature and religion, have brought the two great branches of the English-speaking stock together in a sense that can be affirmed of no other nations. All outstanding differences have been adjusted and the treaty of arbitration now pending will, when adopted, provide the basis of lasting friendship and co-operation. Their united influence and example may in the no distant future bring about the era of universal peace for which all Christians of whatever name and creed earnestly hope and pray.

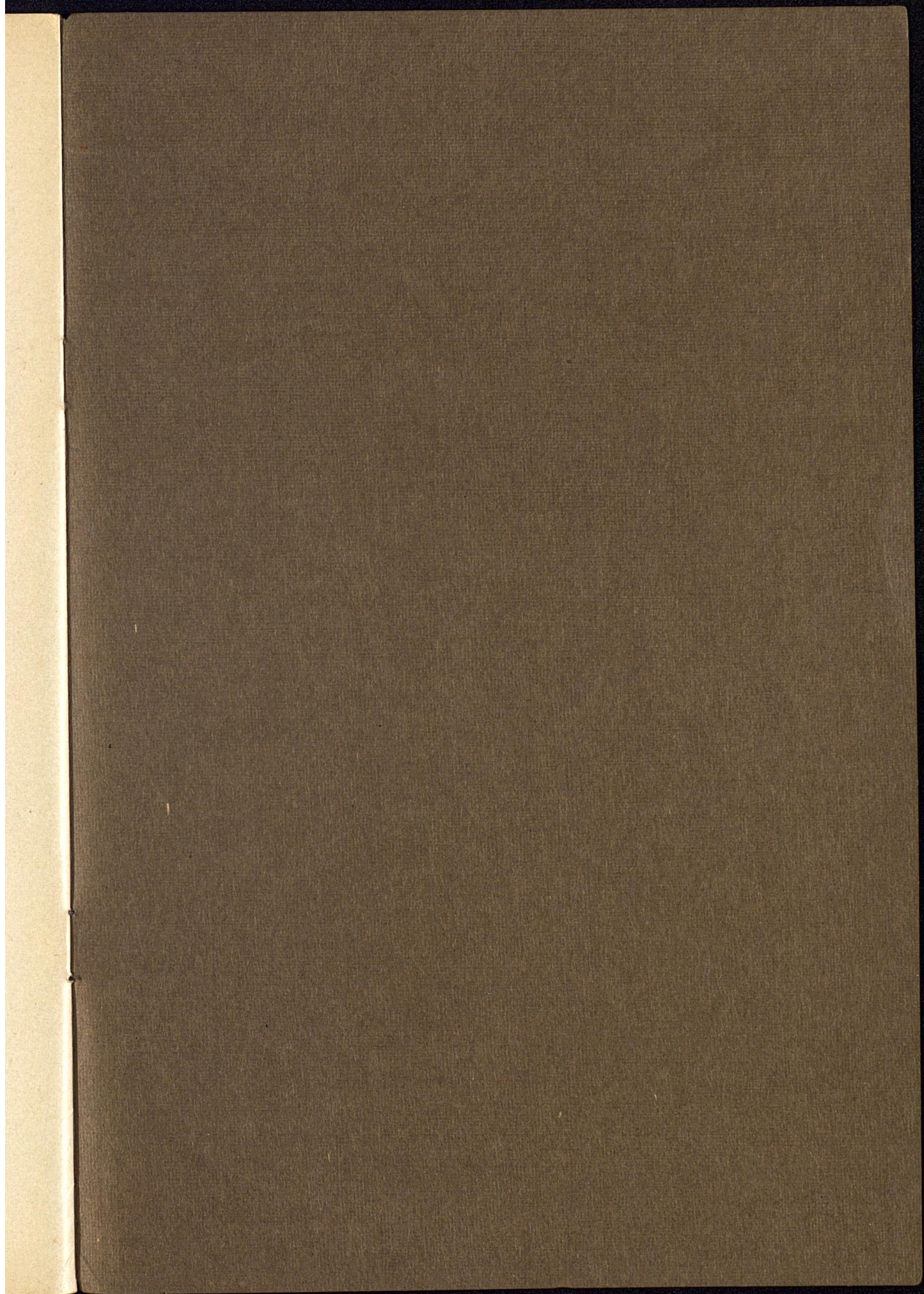
The Bible, the Confession, the Covenant and the parochial schools made the Scots. They moulded his character, civil and religious, and when these emigrants came to the colonies, they were not less careful than their Puritan contemporaries of New England to found schools and colleges. Modest and unpretending they often were, but they made scholars who were able to read the Scriptures in the original texts, to interpret the standards of their faith intelligently and to maintain their tenets against all comers. They made scholars who understood the rights of man, their obligations no less than their duties. George Buchanan in his "De Jure Regni" more than two centuries before the American Revolution, defined the relations of the subject to the crown and set forth clearly the limits of allegiance and obedience. With a passionate devotion to Christ's crown and covenant, they cherished an equally passionate devotion for political freedom.

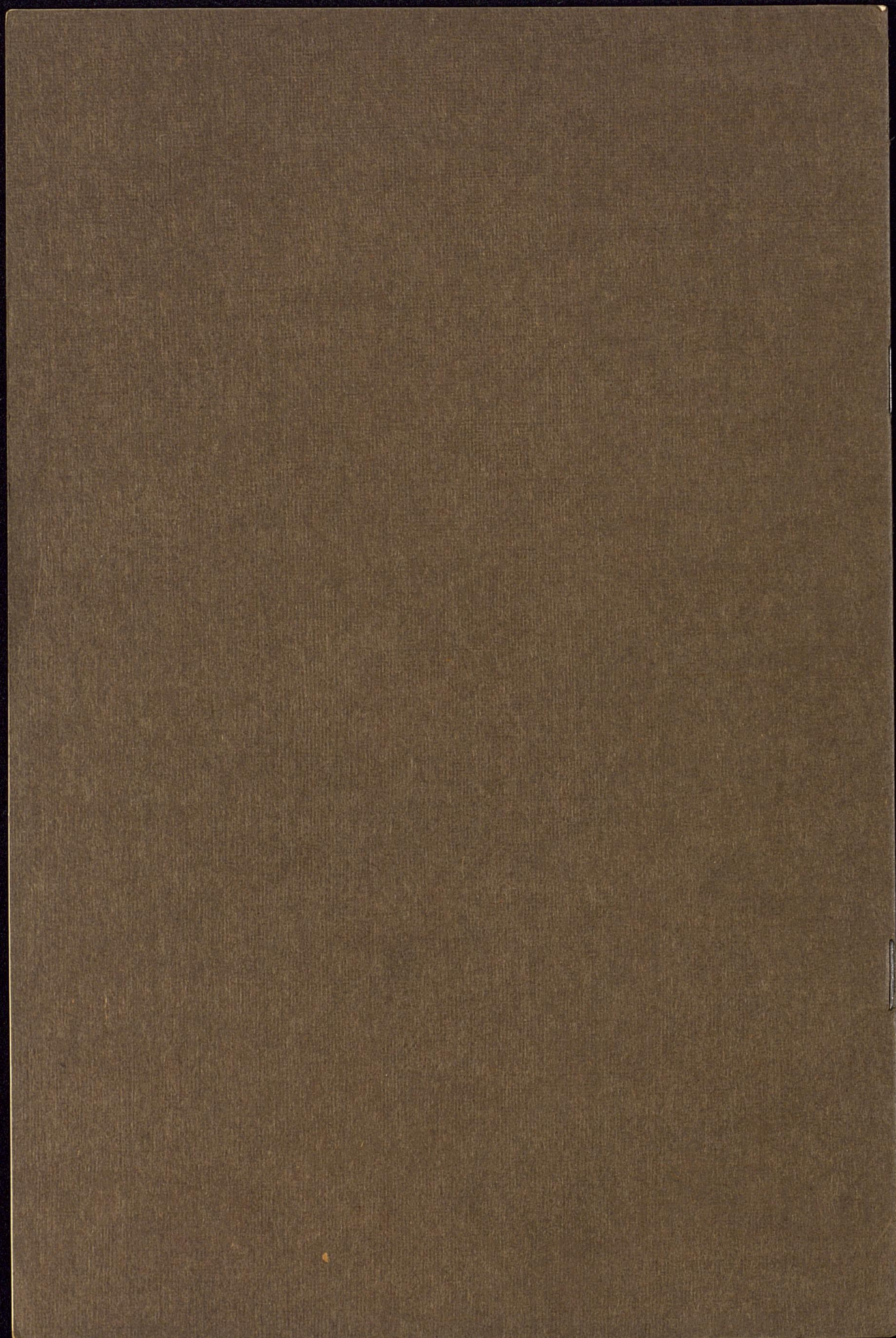
Princeton College, Miami University in its early days, Hanover College, Centre College in Kentucky, Hampden-Sidney, LaFayette, and other Presbyterian institutions of like grade throughout the country have stood for Evangelical Christianity, the religious training of the youth of the country, sound learning and wholesome submission to salutary restraint. The tendency nowadays is to secularize education. State institutions rightly claim immunity from ecclesiastical control. They cannot claim and must not be allowed to claim exemption from Christian influences. The relatively small college must still be the home of piety, associated with classical culture where the lamp of an enlightened religious cult is kept burning with a clear and steady flame. It can afford to hand over the scientific studies which require elaborate apparatus and expensive equipments, to the control of the State. It cannot afford to allow the State to dispense to the sons and daughters of the men who made the Republic an education materialistic and godless. Measured by

the influence exerted upon their fellows by the men who have graduated from Hanover College, men who have distinguished themselves at the bar, in legislation, in the healing art, in the pulpit, and as missionaries of the Cross, I know of no institution, at home or abroad, which can dispute with her the palm. The Bible, the Confession, the Covenant have made her and she has made the men who make her name illustrious.

After the lapse of more than half a century from graduation, I return on the invitation of the President and faculty to deliver the Commencement address. Sixty years have passed, on the 5th day of May, since I entered Hanover College. All who were then connected with it have long since passed over to the majority. John Finley Crowe, its founder, saint and sage, tall and erect even at seventy; Thomas Ebenezer Thomas, vigorous, scholarly, imperious, powerful in thought and eloquent in expression, dreaded by Freshmen, but adored by Juniors and Seniors, a stout defender of the Confession and a brilliant expositor of the Philosophy of the Conditioned; Jared Merwin Stone, immersed and versed in science, delightful in his intercourse with classmen; S. Harrison Thompson, deeply read in Euclid and in Newton, urbane and gentle, yet rigorous and exacting; William Bishop, saturated with classical culture, under whose inspiration the "Homeric battle clanged and Pindar's eagle flapped his wings of thunder." These were great men, men of faith, as well as men of action. They have gone, but their work remains. May their memory ever be green and may the sod rest lightly upon their hallowed graves.







July 22, 1905

"Peat Briquets vs. Coal

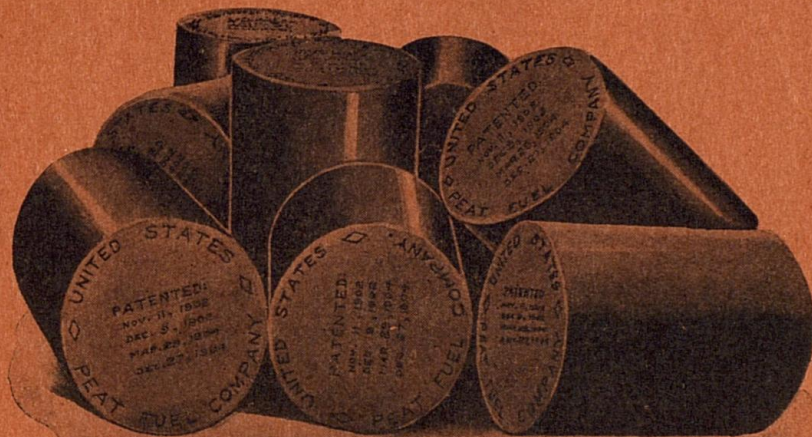
...AS A...

Smokeless Steam Producer"

A LECTURE BEFORE THE
National Association of Engineers

BY

J. CAMPBELL MORRISON, C. E.



PEAT BRIQUETS MANUFACTURED BY THE PATENTED PROCESS
AND MACHINERY CONTROLLED EXCLUSIVELY
BY THE

UNITED STATES PEAT FUEL CO.

Fort Dearborn Building

Suite 1006-7-8 and 9

CHICAGO, ILL., U. S. A.

The "Seared" Peat Briquet

As described by Mr. Morrison in his lecture, is the only fuel made from peat that has any real commercial value. It, in fact, is in all ways the most perfect fuel in the world to-day, and the discovery and successful development of the "seared" briquet lifts peat fuel from the plane of dirty, spongy, cumbersome, fragile and tinder-like mud brick fuel, and places it in a class by itself, the safest, most efficient and economical fuel obtainable.

It is as clean and dense as marble and as tough as granite. It requires no more care in storing, shipping and handling than anthracite coal and is fully as efficient under all conditions.

The United States Peat Fuel Company owns and controls the patented process and machinery that makes possible the "seared" peat briquet, which in reality is nothing more nor less than a sulphurless, smokeless, clinkerless, sootless coal. The company is prepared to erect plants for its manufacture in any part of the United States or the world, and will contract with responsible persons for the organization and management of subsidiary companies in unoccupied territory.

Peat Briquettes vs. Coal—The Great Smokeless Steam Producer of the Future.

BY J. CAMPBELL MORRISON, C. E.

A Lecture before the Robert Fulton Association of the National Association of Engineers.

The members of this association are all so well acquainted with the general characteristics of the standard fuels of today to need no special leading remarks from me in making the comparisons and deductions which, after some years of study and experience, I have been able to arrive at upon the subject of our paper this evening. I will therefore confine myself to such facts, figures and practical elucidations and demonstrations as will place my subject within easy grasp of my hearers, so that the details that I shall attempt to bring forth may be criticised, if desired, so clearly that the question of fuel combustion, for industrial and domestic purposes, shall at least no longer remain the terra incognita it has arrived at in this age of "preventable smoke" and "impossible smoke-preventing ordinances."

The materials commonly used for fuel today in the United States are coal, wood, and oil, either in their natural state or modified by special treatment to fit them for the purposes they are required for. The abundance of a good fuel in any country or state must always constitute a principal source of wealth, especially since steam has become the motive power of manufacturing industry, as well as the great agent in locomotion. Therefore, while I intend to consider those three elements as steam producers, I will confine my remarks more particularly to coal and peat as steam producing fuels, merely referring to the others briefly by way of comparison.

To every thinking man it must be apparent that the industrial development of the United States has increased so rapidly within the last four

years that today there is a growing demand for special kinds and forms of fuel, hitherto not required or available, and while our coal mines may never be exhausted, the cost of transportation to points at long distances from the mines will always make coal an expensive power producer.

This is particularly true of our western states, where the awakening trade with Hawaii, Alaska and the Orient has developed a manufacturing future for the Pacific states if the problem of cheap fuel can be solved.

The technicalities of heat measurement are not familiar to most commercial men, but it is a well known fact among engineers that it is impossible to separate laboratory science from boiler-room practice.

The heat units obtained from chemical analysis and calorimetric tests do not agree with conditions in the boiler-room and probably never will. Therefore, taking incomplete combustion as the principal cause of this discrepancy in the burning of coals, deductions show that a loss of heat (or efficiency) may occur from two reasons, viz.: too much air being admitted to the fire-box as well as too little. By admitting a large quantity of cold air (or oxygen), the temperature of the fire is lowered to such a degree that perfect combustion can not take place, as the temperature of the fire must be at least 1500° centigrade to produce perfect combustion. On the other hand, when too little air is introduced, the third element, oxygen, is absent, hence the carbon and hydrogen do not come into combustion but are driven unconsumed up the smoke stack.

These conditions can be readily ob-

served by watching a train in operation; it will be noticed that when the fireman opens the fire-box door, dense clouds of smoke issue from the stack, due to the gases being cooled by the introduction of cold air. The same condition will occur when fresh coal is put on the fire and will continue until the temperature of the fire is sufficiently high to bring the elements into proper combustion.

Different boilers with many different methods of drafts and stoking devices produce entirely different results with the same quality of coals, and while probably the most valuable and useful mineral known, coal is of no use as coal, but as it ceases to be coal by chemical transformation in the process of combustion, the chemical change consisting in the union of the carbon and hydrogen of the coal with the oxygen of the air producing the chemical compounds, carbon monoxide, CO , or carbon dioxide CO_2 and hydrogen monoxide (common water) H_2O .

The direct results of the chemical action referred to above are the withdrawal of the oxygen from the air, and the production of energy in the form of heat. An examination of coal shows only two oxidizable substances, carbon and hydrogen, and upon the percentage of these elements present depends the commercial value of coal and has given us the "heat of formation" measured by heat units, but it is a well-known fact that more attention has been paid by engineers to the economical use of steam than to the efficiency and cheapness of its production.

We have two kinds of heat units, the caloric and the British Thermal Unit (B. T. U.); the caloric is the amount of heat required to raise the temperature of one gramme of distilled water from 0° to 1° centigrade and is used in scientific work only. The British Thermal Unit is the amount of heat required to raise one pound of water to 1° Fahr., and is the unit used in engineering work.

The Standard Dictionary defines

coal as "An Amorphous" substance derived from the vegetation of prehistoric ages, consisting of various kinds of hydrocarbons. In burning soft coal, aside from the loss of hydrocarbon gases driven unconsumed from the top of the fire before combustion takes place, there is an additional loss, from the fact that the carbonic acid gas formed in the bottom of the fire in passing upwards takes up a further amount of carbon, forming carbonic oxide; the carbon thus taken up being entirely wasted, for while sulphur is a combustible element, the heat derived from it is more than counterbalanced by the damage done the metal of the boiler surfaces.

Then again the fine coal fluxes on top of the fire and the clinker and ash obstructs the draft below (preventing the introduction of sufficient oxygen to produce proper combustion). To remedy this condition the fire-bed must be broken up, so that in either case there is a great loss of hydrocarbons up the chimney. Taking into consideration that there is expended annually for coal in the United States about \$275,000,000, and we only get in actual efficiency from 20 per cent to 27 per cent in steam-raising from every ton of coal, some idea can be formed of the great loss to individuals and the public annually, to say nothing of the nuisance caused by the volumes of smoke from the chimney and the removal of clinker and ash.

Coal Briquets.

For the last few years considerable attention has been given toward many experiments made to utilize the slack or screenings of coal at the mine by compressing them into briquets with a binder of coal tar, pitch, or resin, but the combustible elements of the slack and binder were so dissimilar that the binder not only ignites but is also consumed before the coal comes into combustion, and the mass either fell through the grate bars unconsumed, or fluxes on top of the fire excluding the oxygen necessary to

produce combustion, thus defeating the object for which the briquets were made.

In Germany the briquetting of coal and lignite has received the attention of some of the most eminent engineers—they are greatly in advance of this country. In Leipzig a large plant makes briquets from coke; the coke being reduced to 1 millimeter in size and mixed to a paste in a concentrated solution of resinic acid.

Another method is to use a thin solution of starch for a binder, the briquet being dried slowly at a moderate heat, but as the cost of the binder is from 60 to 80 cents a ton, none of the methods in use in Europe could be used advantageously in this country on account of the low prices of steaming coal.

Petroleum Oil.

Extensive experiments with liquid fuels in Germany, Russia, Italy, Sweden, and the United States have not been satisfactory. While the use of petroleum has its advantages, being smokeless, always ready and a quick heater, the many uses to which petroleum can be put, and the many by-products that can be obtained from it will always keep it from coming into common use for manufacturing purposes.

It is also found that in combustion the fumes or smoke form a deposit similar to asphalt on the flues and boiler surfaces, greatly retarding the steam-raising properties of the fuel by adhering to the surfaces, and while the caloric value of petroleum is given as 17,000 B. T. U., it has nothing like that efficiency in actual practice.

Coal Dust in Suspension.

The burning of coal dust in suspension has attracted the attention of some of our most eminent heating engineers in this country and Europe, and many patent devices have been invented, but none have proved satisfactory in continuous operation. The process is as follows:

The coal is ground to 90 mesh and fed into the boiler by a blower, brush (or fan); a sufficient amount of cold or superheated air being admitted with the dust, the object being to get as near perfect combustion as possible and avoid the *loss up the chimney* of the hydrocarbon gases which is so great in ordinary firing with steam coal. The objection to this system is that the particles of slate and other foreign substances flux in suspension, and the blast deposits them on the heated surface of the steel where they build up like coral, preventing the direct application of the flame to the boiler surface, and reducing the evaporating power of the fuel, also endangering the burning of the shell.

Another serious objection is that in grinding to 90 mesh the material heats in the rolls and considerable of the hydrocarbons are liberated, and the heat is so intense in front of the burners that it will burn out any boiler surface in a very short time.

With these facts before me and the knowledge that the cost of wood for heating purposes is becoming higher each year and almost impossible to get, and the demand for coal greater, as our manufacturing interests increase, my attention was called to peat as a substitute for all other forms of fuel, and after three years study of the art as practiced in Canada and Europe, I am pleased to present for your consideration the result of my observations and tests.

Peat as an Article of Fuel.

The general public in America have but a superficial knowledge of the character and properties of peat, beyond what they have gathered from hearsay, or the testimony of old country people in regard to the burning of dried turf, or sods cut from the surface of bogs and marshes. Peat, or turf, is formed by the slow decomposition or carbonization under water of a variety of accumulated vegetable materials. There are two species, one formed from aquatic grasses, the other from mosses.

The peat formed from grasses (or

sedges) is dark gray in color on the surface and black below and is nearly destitute of fibres. It flourishes in limestone districts, as it needs lime for its nutriment, and grows so rapidly that mosses can not live in the same vicinity; when dry it is hard and firm like clay.

The "Sphagnum moss" is reddish brown in color, fibrous in structure and is generally found in regions where the rocks are granite or silicious and where the surface waters are free from lime, and while the moss or Sphagnum flourishes in pure water it grows upward and continually dies away beneath, thus in the course of ages forming beds sometimes one hundred feet deep, the average bog, however, being from five to fifty feet deep, and is found in abundance in almost every portion of the United States, Alaska, Canada, and the South American republics.

The deposits of Great Britain and Ireland occupy an area of six million acres, and much more extensive beds are found in Germany, Russia, Norway, Sweden, Finland, France and other countries of Europe and Asia.

All European countries have for numberless years used peat in a crude form as fuel for domestic purposes. In Ireland and Germany its use is well nigh universal. The usual mode of preparation is to cut it out of the bog with an iron instrument called a "slane." These bricks are dried in the open air, and are then ready for use. Peat fuel in this form is too bulky to be a commercial success, hence the many and varied experiments to eliminate the moisture and reduce the crude peat mechanically to a product which would assure its use commercially in competition with coal.

Peat is the first stage in the formation of coal. Beginning with peat we pass to lignite (or brown coal), then to bituminous coal, and finally anthracite coal. In passing from the vegetable to the mineral state a large percentage of heat bearing properties of the peat are thrown off during the

transition in the shape of natural (or marsh) gas.

The tar, paraffin, light and heavy oils and other volatiles are eliminated by the load of strata over it which escapes and forms the natural gas belts and petroleum wells of this country. Peat as it goes below the surface naturally takes on the iron which changes its color from brown to black; the sulphur has a vulcanizing effect on the material, hence the hardness of the anthracite over the lignite and bituminous coal; *thus peat is embryo coal* (or coal deteriorated peat) which by the latest improved patent process is converted almost immediately into coal, retaining all the original heat-bearing properties, and none of the detrimental features of the coal, such as sulphur, phosphorus, and other foreign materials which produce gases so injurious to the boiler surfaces. Peat does not contain any slate or foreign substance to form clinker and residuum in the fire-box, as is usually found after burning either bituminous or anthracite coal.

Peat being a smokeless steam producer, is superior to all other known fuels, as by its use you get almost perfect combustion. Peat briquets give a long bright flame, and intense heat from the moment of ignition, leaving no soot, clinker, or cinder, and very little ash, the combustion being even and complete.

Peat being a gaseous (not a radiant) fuel, requires only half the amount of air (oxygen) to produce perfect combustion; it leaves no clinker to obstruct the flow of the air, and the briquet being cylindrical in form permits free passage of air between the pieces, consequently, the grate bars are always clean and the volatile gases are released and come into perfect combustion by the admission of a sufficient amount of oxygen, without lowering the temperature of the fire.

Coal can not be mined and marketed as cheap as peat, as peat is on the top of the ground and often in close

proximity to our large cities, making long hauls unnecessary by providing a market at the factory site, and enabling the manufacturer to supply the public direct in successful competition with coal.

The economic effects obtained by the use of peat may be grouped as follows:

1st. Production of direct results by combustion, warming, cooking, etc.

2nd. Production of indirect results through steam.

3rd. Production of indirect results through conversion into gas.

Previous Methods and Failures.

For centuries peat has been burned as an article of fuel; in Europe the primitive methods of preparing the fuel for use was by cutting it out in square bricks and drying it in the sun, but this fuel was bulky, friable, dusty, crumbled in handling, and required too much room for storage to make it a commercial success, with other fuels in abundance.

The next step looking to the utility of this natural material as fuel was a process whereby the peat was ground to a plastic mass, or formed in brick shapes, dried in the open air, or in a kiln till it became hard, but the product was a fissured block, the volatiles being liberated in the drying, and the block continuing to crack to such an extent as to unfit it for transportation.

Many patents have been taken out in this country and Europe for machinery to properly consolidate peat while wet, but they have all been comparative failures, as no permanency can be given to blocks that have to be dried after formation, the necessary solidity can not be imparted or maintained to prevent reabsorption of moisture.

Many systems of machinery have been patented for the production of a peat briquet by what is known to the art as the "dry process," which is the forming of the block after the material has been deprived of water (which is usually 50 to 75 per cent);

there are but three that I consider worthy of your consideration. After making an exhaustive study of every system in use in this country and Europe, they are as follows:

1st. A carbonized block of peat. The peat was partially dried and heated, then brought to the point of carbonization between hot rolls and pressed in a *hot mold* into a dense block. In heating the material, the tar and lighter volatiles were liberated and thrown off, thus reducing the efficiency of the fuel one-third, but producing a block extremely dense, which could be transported without injury.

Suitable machinery for carrying out this process was never built or perfected, owing to the death of the inventor.

2nd. Some ten years later patents were taken out for the production of a *cold pressed* peat briquet in reverse to the previous method (or carbonized block) by simply subjecting the peat to heavy compression in a *cold mold*, relying only upon the glaze imparted to the briquet in the mold for its waterproof qualities.

By compressing the material cold and raw, the full caloric efficiency of the peat briquet was maintained (no volatiles being thrown off by heat), but the result was a briquet loose in texture, which disintegrated with moisture or in the fire, also necessitating the drying of the crude material to the atmospheric degree, which operation was expensive. The briquet also required an extreme degree of compression, as there was no bond used.

While this style of peat briquets is an efficient steam producer and a smokeless fuel, it has to be transported in box cars and kept in dry places to keep it from reabsorbing moisture and disintegrating.

The "Seared" Peat Briquet.

3rd. The third system of patented machinery is for the production of what is known to the art as a "seared" peat briquet.

The "seared" block embodies every feature of value found in either or both of the above named systems is more economical in production than either, or any other form of pressed peat known to me. While it contains far more combustible matter than the first named or carbonized block, it is free from the serious objections of the plain, dry pressed block, which possesses no waterproof quality whatever, and is friable to such an extent to unfit it for favorable consideration in any market.

The "seared" block burns completely, gives an intense heat from the moment of ignition, is absolutely free from sulphur, has no clinker, soot, smoke, or ash, ignites easily, is easy to regulate, with no danger of asphyxiation, it being recommended by the highest medical authorities as a fuel for its hygienic advantages.

Professor Carpenter gives the caloric value of the best grades of Scranton (Pa.) anthracite as 13,805 B. T. U. against 13,330 in peat briquets (according to the German chemical testing station of Berlin), while Professor C. L. Norton, chief of the Experimental Station of the State of Massachusetts and Institute of Technology, Boston, says that, with the proper preparation and mechanical pressure, peat will average 12,000 to 14,000 heat units to the pound and equal anthracite coal as a heat producer; and while analyses show a much higher ratio of fixed carbon in coal than in peat, there is one important element that must be taken into consideration in actual boiler practice, viz.: the *volatiles* in the peat briquets, for while the fixed carbon in peat only runs 27 per cent to 35 per cent, the volatiles run from 56.20 per cent to 65.09 per cent, resulting in a high degree of temperature being maintained in the fire by the volatiles coming into combustion, and consequently the perfect combustion of the hydrocarbons. Many authorities quote peat as a low grade fuel on account of the small amount of carbon shown by analysis, but in

actual boiler tests made by myself I have proven the contrary.

Process.

The following is an outline of their process for the manufacture of the "seared" briquet:

The peat is dug from the ground by the excavating machine, which is very simple in construction and moves forward under its own power, propelled by a gasoline motor, where it is discharged on to a conveyor and carried to the expelling machine, where a preponderance of the moisture is thrown out by a patent automatic expeller.

In wet ground, where it is impossible to work the excavator, the material is taken out with a sand pump or suction.

From the expeller it proceeds to the disintegrator, where it is pulverized and passes on to the drier, which is a round cylinder five feet in diameter and thirty feet long, revolving on axles located at each end. Under this is a furnace, where heat is generated and applied to the exterior of the cylinder, the hot gases traveling the entire length and back through the interior of the cylinder to the point where the material is delivered.

At this end there is located an inverted fan, which sucks the wet vapors from the material and at the same time tends to draw the heated gases through the material. As the cylinder is set on an incline, the dried material passes through by gravity and is discharged at the lower end, with about 20 per cent of moisture.

It is then conveyed to the breaking machine, where it is pulverized to a powder and elevated to the hopper bin above the presses. In passing through the presses, the peat is first pressed into hard dense block and afterwards "seared" by liberating the tar and paraffin in the material by heat, thereby coating the exterior with a waterproof coating, making it impervious to moisture and spontaneous combustion.

The result of this process is to produce a smooth, oily and dense texture externally, so as to present the most inflammable constituents of the peat to the immediate action of the fire when igniting, to decrease the hardness and water-resisting qualities of the manufactured fuel, and while not depriving the raw material of any really valuable combustible constituents (for an extreme preponderance of the lighter volatiles only tends to unduly hasten the consumption), to render the block more lasting in the fire, and, consequently, more approaching to hard coal in value for steam-raising, domestic and other purposes where the maximum of the heat is to be produced with the minimum feed and replenishment of fuel.

Thus it will be seen that this process contemplates a continuous operation from the time the material is excavated from the ground till it is turned out by the presses a finished, marketable product.

All material used for generating steam and operating the different machines is furnished from the refuse or waste peat about the plant, and no skilled labor is required, with the exception of the engineer in charge of the engine room; thus the production of peat fuel by this improved method, in my opinion, solves the problem of furnishing a cheap, clean, uniform and reliable fuel for domestic and manufacturing purposes.

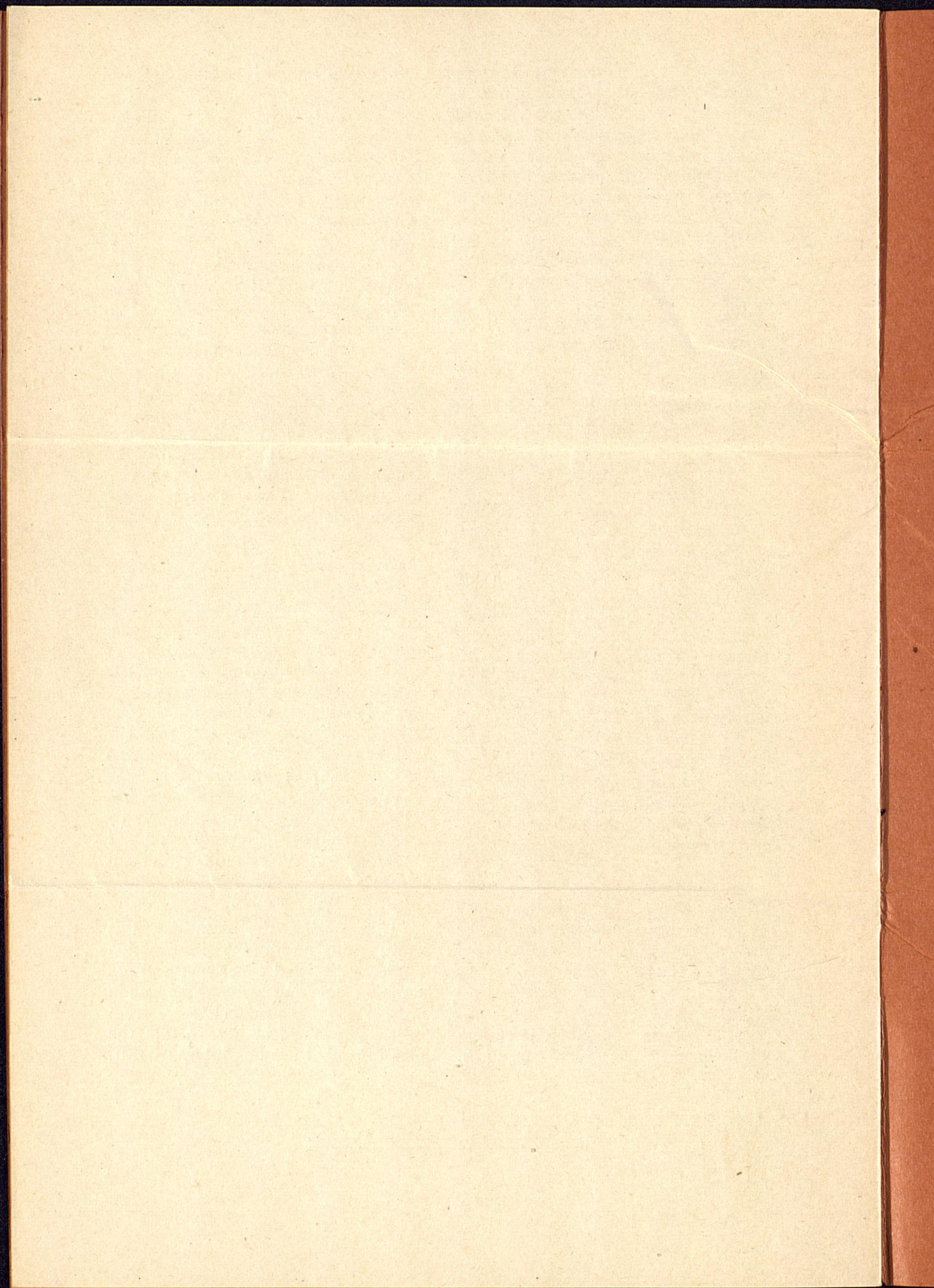
It is equally serviceable for grates, stoves, cooking ranges, boilers and furnaces, giving a long, bright flame and intense heat from the moment of ignition, and its durability being equal to coal in combustion, as the density of the "seared" block insures the retention of its original form until the last atom of the inherent carbon and volatile gas has been consumed.

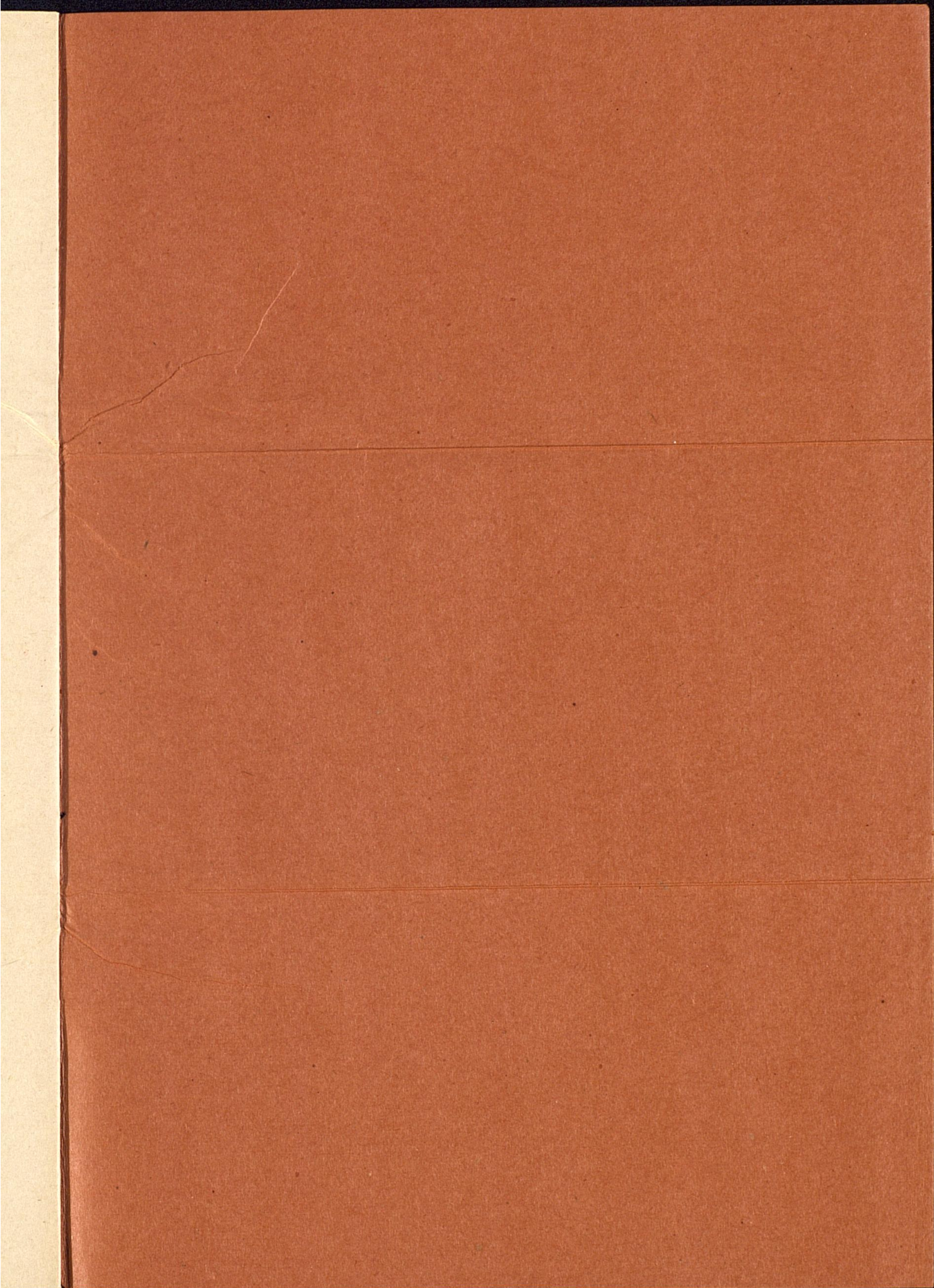
The combustion is so thorough and complete that no volume of free carbon or dilatorious vapor is allowed to escape, hence its hygienic and economic value over hard and soft coal. It will not absorb any undue amount of moisture or otherwise deteriorate in storage, is odorless, and clean to handle.

A company has secured the exclusive patents on their machinery and process for the production of a "seared" peat block and is at present constructing the machinery for the first plant to be erected in the state of Illinois, and it gives me pleasure to state that in the near future we may look forward to the end of the smoke nuisance and the dirt of coal firing, and I know that all engineers and firemen will gladly welcome the introduction of a clean, smokeless steaming fuel.

Before closing, I wish to state for the information of the gentlemen present that Russia produces annually 4,000,000 tons of peat fuel briquets and receives \$938,000 per annum for the leasing of the peat bogs. Germany produces 2,000,000, and Holland and Sweden each 1,000,000 tons of this fuel. Thus it will be seen that peat fuel briquets have passed the experimental stage and the subject is one of sufficient importance to command the most earnest attention of the business man and manufacturer, on account of its application to domestic purposes, manufacturing and the arts.

In compiling the data for this paper, aside from the information gained by personal experience and observation covering some three and a half years, I have quoted freely from several writers of ability, so that the facts presented are absolutely correct.



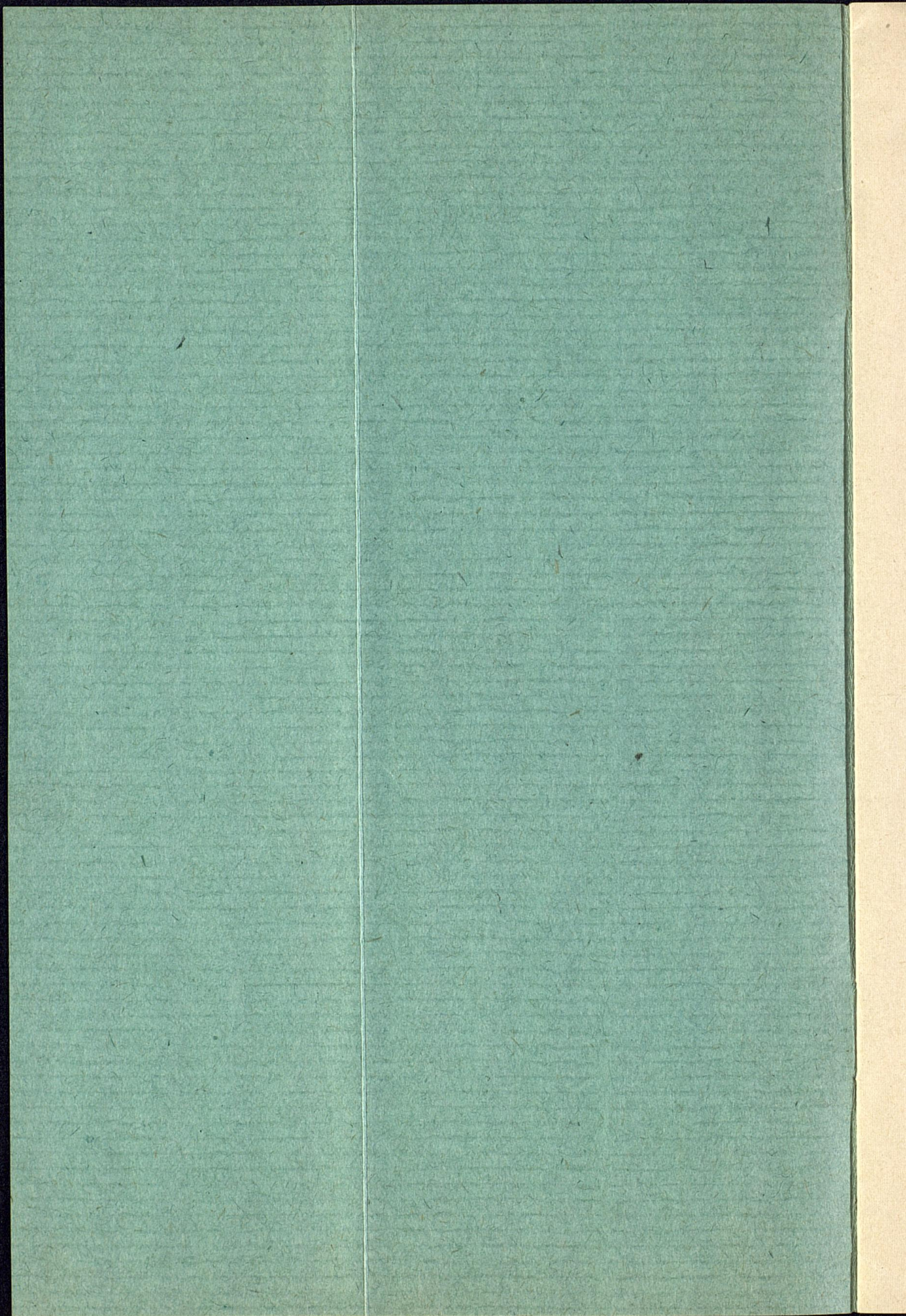


47-M-64

[Sep. 10, 1903]

BIENNIAL REPORT
OF THE
NORTH CAROLINA COLLEGE
OF
AGRICULTURE AND MECHANIC ARTS
1901-1902

RALEIGH:
E. M. UZZELL, STATE PRINTER AND BINDER.
1902.



BIENNIAL REPORT

OF THE

NORTH CAROLINA COLLEGE

OF

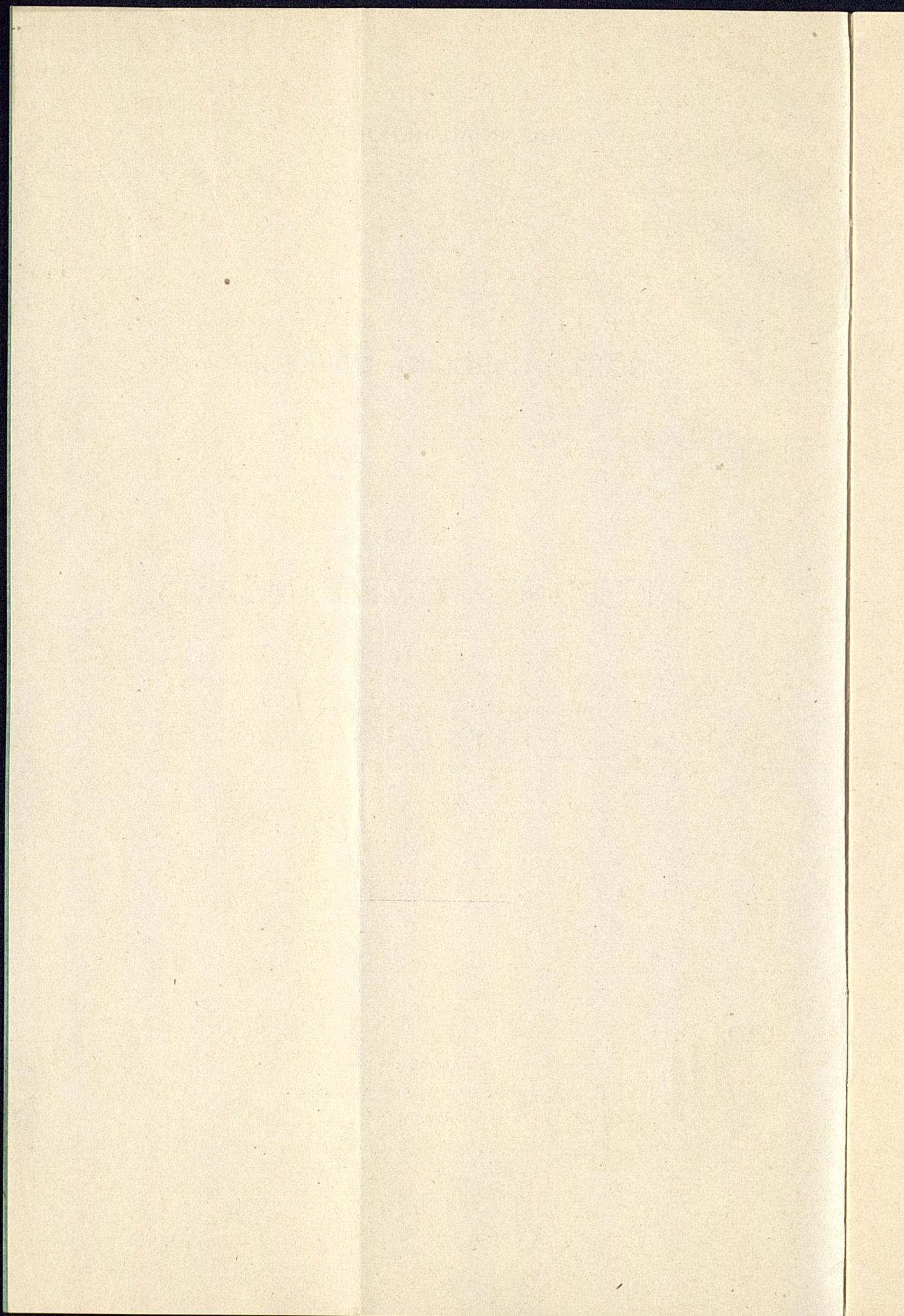
AGRICULTURE AND MECHANIC ARTS

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1902.



NORTH CAROLINA DEPARTMENT OF AGRICULTURE,

RALEIGH, December 20, 1902.

His Excellency, CHARLES B. AYCOCK,
Governor.

SIR:—I have the honor to transmit herewith through your Excellency to the General Assembly the biennial report of Dr. George T. Winston, President of the North Carolina College of Agriculture and Mechanic Arts, and also a Memorial by the Board of Agriculture, to be presented to the Legislature, and to ask their careful consideration.

Very respectfully,

S. L. PATTERSON,
Chairman Board of Agriculture in Charge of the College.

THE NORTH CAROLINA COLLEGE OF

AGRICULTURE AND MECHANIC ARTS,

President's Office.

WEST RALEIGH, December 26, 1902.

To His Excellency, CHARLES B. AYCOCK,

Governor of North Carolina.

SIR:—As required by law I have the honor to submit the following report of the North Carolina College of Agriculture and Mechanic Arts.

Very respectfully,

GEO. T. WINSTON,

President.

BIENNIAL REPORT.

The College has been full and overflowing since the opening of the session last September. The present enrollment is 450. By January it will exceed 500. The gain over last year is 150, or forty per cent. For lack of accommodations students have been rejected almost daily. Fully 100 have been kept away on this account. It is evident that the attendance would reach 1,000 if the College could receive them.

ITS GROWTH DUE TO INCREASING DEMAND FOR INDUSTRIAL EDUCATION.

The growth of the College is due to the increasing demand for industrial education. The College does not aim to be a literary institution, and does not confer the usual academic degrees. It stands for industrial education; and its instruction, its discipline, its inner life and spirit all look to this end. This is the secret of its growth and popularity; for industrial education is most useful to the average boy, and is most needful at this time for the development of North Carolina.

PRACTICAL CHARACTER OF ITS WORK. OVER FOUR THOUSAND DOLLARS EARNED BY STUDENTS.

The work of the College is both practical and theoretical. It runs along three general lines: (1) Agriculture, (2) Textile Industry, (3) Engineering and Mechanics. Every student is required to do manual work from two to six hours a day. If new students are unwilling to work, they are required to leave, and advised to seek literary education in some other college. The Freshman class this year numbers 250 students, each of whom is, according to his course of study,

required to work daily in the blacksmith shop, the lathe-room, the carpenter shop, the drawing and designing-rooms, the dairy, the barn, the greenhouses, or the field. There are book-studies besides in English, Mathematics, History, and Science. The Freshman year is one of testing. It also lays the foundations. Students in the higher classes also do practical work along special lines; in agriculture, or architecture, or electricity, or cotton manufacturing, or engineering and mechanic arts, or chemistry and dyeing, or drawing and designing.

Practically all the skilled work of the College is done by students or professors. The spirit of work is so strong that over \$4,000 was earned last year by students working at odd hours or on Saturdays; and this spirit pervades the College, inspiring even lads of wealth to work for wages by the side of fellow-students who are penniless.

A FIVE THOUSAND DOLLAR LAD CAPITALIZED AT FIFTY
THOUSAND DOLLARS BY INDUSTRIAL EDUCATION.

Two years and a half ago a young man of fine ability was graduated from the College after three years of study. His earning capacity when he entered was \$25 a month, or \$300 a year, being six per cent. on \$5,000. He is now earning \$3,000 a year, or six per cent. on \$50,000. Industrial education has capitalized a \$5,000 lad at \$50,000 in two and a half years' time. A lad of very ordinary ability, after two years of hard labor at \$15 per month, saved enough money to study and work in the College thirteen months, which enabled him to earn \$40 a month instead of \$15. A lad of fair average ability, earning \$20 a month, after spending two and a half years here, was employed at \$100 a month. The careers of all these lads have just begun; who can see the final goal? Who can estimate the effect of industrial education upon North Carolina fifty years hence?

TO PROMOTE AGRICULTURE.

The College recognizes agriculture as the chief interest of our people, and strives especially to promote agricultural education. For this purpose the following agencies are maintained:

1. A complete four years' course of Agricultural Instruction, with general culture.
2. A two years' course, devoted mainly to practical instruction in Agriculture.
3. A Winter Course in Dairying and Agriculture, for actual farmers and farm boys and girls.
4. A Summer School of Agriculture, Nature Study, and Manual Training for rural school-teachers and farm boys and girls.
5. Rural Science and Biological Clubs among the students for study and discussion of farm problems.
6. One hundred and twenty scholarships, conferring free tuition and room rent, exclusively for agricultural students.
7. Two thousand dollars annually to pay for student labor on the farm.
8. Special prizes for agricultural students doing the most work during the year.

These efforts to promote agriculture have been very successful. The number of students in agriculture has increased in two years from seventeen to ninety-two. By January it will probably be one hundred and thirty.

AGRICULTURAL BUILDING NEEDED.

The College is without a suitable building for agriculture. The present equipment is entirely inadequate. The barn and dairy are small, antiquated and worn-out. The Board of Trustees have unanimously requested that \$50,000 be appropriated for this purpose, and have prepared a Me-

morial on the subject to the General Assembly. Such a building will provide the College with equipment for agricultural instruction somewhat commensurate with the great agricultural interests of the State. A suitable site is available just opposite the State Fair Grounds. The College now owns sufficient land for its present farming needs. The Board of Trustees, with consent of the Governor and Council of State, have recently purchased the Crawford farm, a very desirable tract of land adjoining and jutting into the College farm. Notes for this purpose were given, amounting to \$10,900 on ten years' time.

A SEVENTY-FIVE THOUSAND DOLLAR TEXTILE PLANT
FOR THIRTY THOUSAND DOLLARS.

The appropriation of \$20,000 by the last Legislature for a textile building not being available from the State Treasury, the Board of Trustees, with consent of the Governor and Council, borrowed this amount and erected and partially equipped the Textile Building. A great many donations of textile machinery, heating plant, engine, belting, etc., have been received from manufacturers and others, until now the textile plant amounts to fully \$45,000. Other donations are ready to come as soon as the College is ready to receive them. An expenditure of \$10,000 additional on our textile department will equip it fairly well and enable it to receive additional donations amounting to \$20,000. In this case the total donations will amount to \$45,000, and the State will have secured at a cost of \$30,000 a textile building and equipment worth \$75,000.

SUMMER NORMAL SCHOOL FOR RURAL TEACHERS.

Recognizing the need of industrial education in all our schools, and especially the need of proper training for our

rural school-teachers in agriculture and rural science, the College has organized a Summer School mainly for rural teachers. The school will be held during the month of July. Board and lodging will be furnished at cost (\$10 for the month); tuition will be only \$5. The average cost to each teacher for traveling and all other expenses need not exceed \$20. Instruction will be given in the following lines:

1. Agriculture and Nature Study, especially for rural teachers wishing to teach agriculture.
2. Manual Training (iron and wood-working, drawing and designing, weaving and plaiting, decorating).
3. Public School Branches, for review and study of methods.
4. Model Practice School (Methods of Teaching and Government).
5. College Branches (Languages, Literature, Mathematics).
6. Child-study, Kindergarten and Nature Study in reference to Child-training.
7. Music, especially Sight Singing and Chorus.

The school is for both sexes. Separate dormitories with proper sanitary conveniences are provided for women.

A PERMANENT NORMAL DEPARTMENT.

As soon as possible there should be established in connection with the College a permanent Normal Department, designed especially for the training of rural teachers and for industrial training of city teachers. A few thousand dollars a year would provide such department, and thus would practically add another Normal School to the State's equipment for the training of teachers. Lack of competent teachers is the greatest drawback in our public school system; and this is a very practical and economical way to help supply them. Besides the general benefits that such a school would

produce, there would be especial good accomplished in the preparation of teachers along the new lines of manual training and rural science, and the introduction of this instruction into our public schools.

AN APPROPRIATION OF FIFTEEN THOUSAND DOLLARS
NEEDED.

The following extract from the report of the "Examiners of State Institutions," made after a careful detailed examination of the College budget, sets forth clearly the necessity for increased income to meet the growing needs of the College:

"The College most urgently needs an increase of appropriation for its annual support and maintenance. It already has an enrollment of 450 students, and by June the number will exceed 500. But the annual income is no larger than when the enrollment was below 200. To teach this large and continually increasing number of young men the present force of teachers is inadequate, and the supply of apparatus and teaching material is pitifully insufficient. For securing necessary and competent teachers and for the purchase of teaching apparatus and perishable material we consider that an additional appropriation of at least \$15,000 is absolutely necessary."

THE BURNING OF WATAUGA HALL.

On November 29, 1901, a disastrous fire visited the College in the middle of the night and destroyed its mess-hall, kitchen, and largest dormitory. About sixty students were forced to go home for lack of room. Facing this emergency, which threatened almost to close the College, the Board of Trustees resolved to rebuild Watauga Hall on the old foundations for exclusive use as a dormitory, and, as a protection against future fires, to erect a separate building, to be

called Pullen Hall, for kitchen, mess-hall and assembly hall. The Governor and Council of State authorized the necessary loans and contracts for this purpose and for replacing bedding and furniture destroyed by the fire. In accordance with this authority loans and contracts have been made amounting to \$46,500. Watauga Hall is now nearly completed, furnishing dormitory accommodations for 150 students, instead of 56 as before. Pullen Hall is in process of construction and should be finished by June. There will be needed about \$15,000 additional to complete, furnish, light, and equip these buildings, and provide the necessary repairs and rearrangements for the College heating system.

CAPACITY OF THE COLLEGE PRACTICALLY TREBLED.

By the rebuilding of Watauga Hall and the erection of Pullen Hall the capacity of the College is practically trebled. If the expenditure seems large, it is certainly economical, as the following considerations will show:

1. The dormitory capacity of the College is more than doubled.
2. A mess-hall is provided for 600 students, separate from the dormitories.
3. Much needed recitation-rooms, study-rooms for 150 students not living in the College, and a library-room have been provided.
4. An assembly hall for daily prayers, for lectures, and for commencement exercises has been provided.
5. An armory has been provided, as is required by the United States Government.
6. The Textile Building has been provided with heat, and made available for use, and \$25,000 of textile machinery protected from damp and rust.

URGENT NEEDS OF THE COLLEGE.

The most urgent needs of the College are summed up in the concluding paragraphs of the most excellent report of the Examiners of State Institutions, as follows:

"In conclusion, it gives us pleasure to testify that the affairs of this College have been administered economically, intelligently, and with an eye single to the interests of the State. The spirit of the College is admirable. The officers and teachers are faithful, hard-working, and harmonious. The students are well-behaved, industrious, and economical. The institution is, and deserves to be, the pride of the State. Nothing is needed except to develop it along the lines it is following. Our recommendations are:

"1. That the indebtedness which has been incurred by the Board of Directors, with the approval of the Governor and his Council, and of which we express our entire approval, shall be paid at once.

"2. That as soon as possible, this College be provided with the following improvements, which, in our opinion, are essential to its continued success.

"(a) Such increase in its annual maintenance as will make the State's appropriation thereto equal to that of the United States Government.

"(b) An agricultural building and equipment commensurate with the importance of the agricultural development of our State.

"(c) Additional dormitories capable to accommodate 500 students.

"(d) A central heating and power plant, and in connection therewith an ice plant and cold-storage room and steam laundry.

"(e) A suitable chemical building adequate to meet the requirements of this rapidly developing science."

THE AGRICULTURAL EXPERIMENT STATION.

The Agricultural Experiment Station, which is a department of the College, is conducted with the funds of the Hatch Act of the Congress of the United States passed in 1887.

Its work is to make experiments relating to the problems of agriculture in its various branches, with a view of aiding the farming interests by the development and introduction of better methods and practices on the farm. The work of the station has been enlarged to a considerable extent during the past year, especially with field crops and beef cattle. For a fuller account of the operations of the Station, attention is directed to the separate report of the Station for the past two years.

The main experiments conducted the past year and in progress may be briefly reviewed as follows:

Experiments with Cotton and Corn.—Forty-seven one-twentieth acre plats are devoted to experiments with each cotton and corn in testing flat as compared with ridge culture, and frequent in comparison with infrequent cultivation; in comparing a number of the varieties of cotton and corn as to productiveness, time of maturity, and with cotton the length and strength of the fiber; in growing these crops in a number of rotations with each other, the grains and leguminous crops, including peas, vetch and burr clover; in determining the yield of cotton and corn with similar total amounts of fertilizer, but with widely varying proportions of nitrogen, phosphoric acid and potash, and with varying applications, to see what is the most profitable quantity of fertilizer to use to the acre. Tests were also made of planting in different width rows and different distances in the rows.

Grasses and Legumes for Pastures and for Hay.—Ninety to one hundred different grasses and legumes and combinations of these for pasture and for hay are being tested on

small plats with a view to determining the ones best suited to our conditions, as well as the development later of best methods for growing and handling them.

Beef Production.—Past and present high prices of beef lend attractiveness to the beef industry. Last winter the Station obtained in Missouri thirty-nine head of thoroughbred and high-grade beef animals of the Aberdeen Angus breed, for the use of the Station, the Department of Agriculture, and for a number of farmers in the State. Sixteen head of these were kept by the Station as a nucleus of a beef herd. The interest attracted by these animals has made it necessary to obtain an additional lot of nineteen head during the present fall. These have been inoculated by the Veterinarian against the tick or Texas fever, and have been, or will be, sent to farmers in different sections of the State who placed orders for them in advance of their purchase. In this way the Station is performing an important service to the stock interests of the State by aiding in the introduction of a better class of animals. It is the purpose of the Station to make beef production and dairying and grass and forage plant production leading lines of its work.

Horticultural Work.—The main questions under investigation in this line have related to the growing of peaches, plums, pears, and apples, the Station having a considerable number of trees of the different varieties of these several fruits under experimental test. It has a large number of varieties of grapes and strawberries under tests, and has conducted experiments during the year with tomatoes out-of-doors and under glass, with potatoes, sweet-corn, etc. An effort is being made to introduce the culture of the newer and higher-priced kinds of bulbs into the eastern part of the State.

Chemical Work.—This phase of the Station's work is generally more technical than that conducted in the other

branches. Investigations of the past year have related mainly to the study of the rate at which nitrogenous fertilizer materials nitrify and become available for plant food in different soils and to the study of methods for use in agricultural chemical analysis.

The Veterinarian has given time to immunizing Northern-bred cattle against "tick" fever in the beef experiments.

During the year a biologist and a dairyman have been added to the working force of the Station.

LIST OF OFFICERS, INSTRUCTORS, AND EMPLOYEES,
WITH ANNUAL SALARIES.

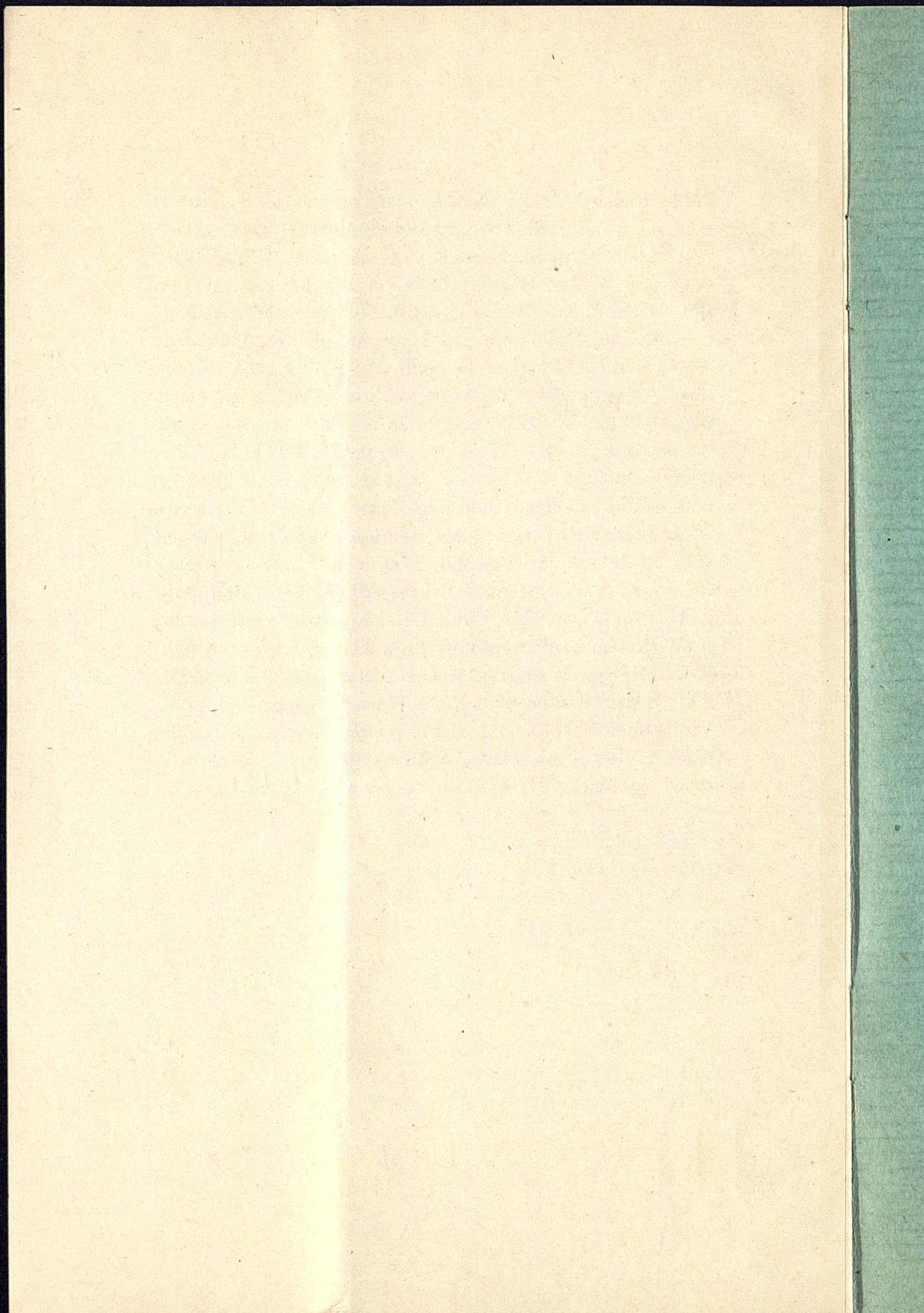
Geo. T. Winston, President of the College, \$2,500; B. W. Kilgore, Director of Experiment Station, \$1,250; W. F. Massey, Horticulturist of Experiment Station, \$1,200; Tait Butler, Veterinarian for Experiment Station, \$800; C. W. Burkett, Professor of Agriculture in College and Agriculturist of Experiment Station, \$2,500; F. L. Stevens, Professor in College and Biologist of the Experiment Station, \$1,800; W. A. Withers, Professor in College and Chemist of Experiment Station, \$1,800; D. H. Hill, Professor of English, \$1,800; W. C. Riddick, Professor of Mathematics and Civil Engineering, \$1,800; T. M. Dick, Professor of Mechanical Engineering, \$1,800; F. A. Weihe, Professor of Physics and Electrical Engineering, \$1,800; H. M. Wilson, Professor of Textile Industry, \$1,800; F. E. Phelps, Commandant of Cadets (no salary) and Instructor in History, \$300; C. K. McClelland, Assistant in Agriculture, \$1,200; J. C. Kendall, Instructor in Dairying and Dairyman to Experiment Station, \$800; Mrs. F. L. Stevens, Instructor in Biology, \$325; G. S. Fraps, Instructor in Chemistry in College and Assistant Chemist in Experiment Station, \$1,200; P. R. French, Instructor in Dyeing, \$1,200; B. S. Skinner, Farm Superintendent and Steward in the College and Experiment

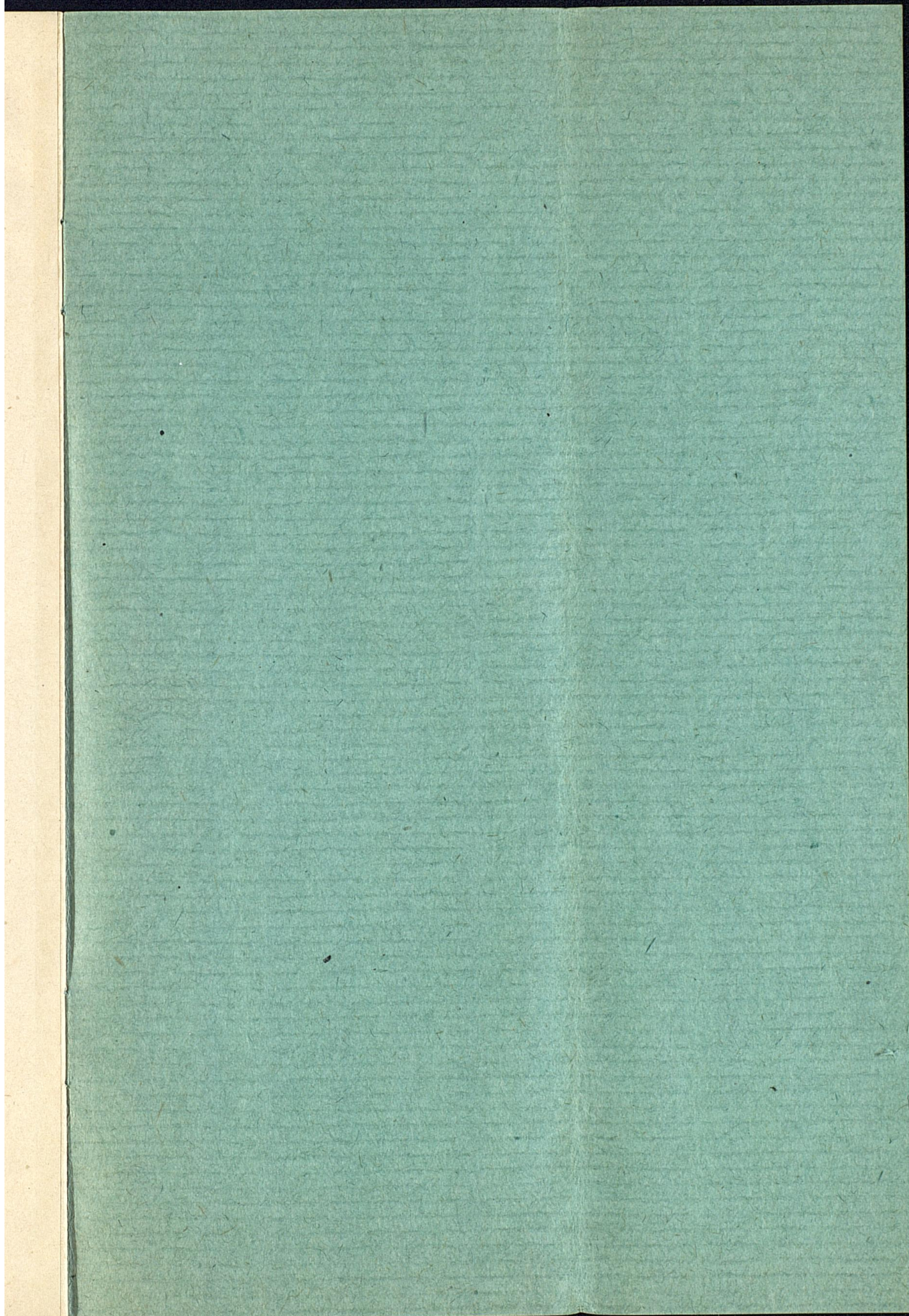
Station, \$1,200; W. A. Syme, Assistant Chemist, \$550; E. B. Owen, Assistant in English, \$700; R. E. L. Yates, Assistant in Mathematics and Civil Engineering, \$1,200; C. L. Fish, Assistant in Civil Engineering, \$750; A. G. Holmes, Assistant in Mathematics, \$650; C. L. Mann, Instructor in Mathematics, \$250; C. B. Park, Superintendent of Shops, \$1,200; T. A. Chittenden, Instructor in Drawing, \$900; S. E. Weber, Jr., Instructor in Drawing, \$650; Oliver Carter, Instructor in Forge Shops, \$500; V. W. Bragg, Instructor in Wood Shop, \$750; H. C. Walter, Instructor in Physics and Electrical Engineering, \$750; A. F. Bowen, Bursar in College and Experiment Station, \$1,000; F. E. Sloan, Registrar in College, \$900; Mrs. Daisy Lewis, Matron in College, \$300; M. DeL. Haywood, Librarian, \$500; Frank Baily, Night Watchman and Fireman in College and Experiment Station, \$365; E. T. Robeson, Instructor for Band, \$130; Phil. Broughton, Day Fireman, \$380; B. F. Walton, Assistant in Experiment Station Work, \$600; J. S. Cates, Stenographer and Clerk in Experiment Station, \$300; Miss A. C. Peddie, Stenographer and Clerk Experiment Station, \$240; S. W. Foster, Poultryman for Experiment Station, \$270; Allen Haywood, Janitor in College and Experiment Station, \$288; Joe Hardy, Janitor in Textile Department, \$240; Alonzo Shepherd, Janitor Experiment Station, \$90; Walter Mitchell, Janitor, \$180; E. M. Gunter, Dynamo-tender, \$150; Stephen Snipes, Servant, \$90; Bryant Taylor, Servant, \$90; Charles Debnam, Servant, \$90; Norman Snipes, Servant, \$90; Leah Hockaday, Servant, \$80.

BOARDING DEPARTMENT EMPLOYEES.

W. H. Billings, Housekeeper, \$405; W. J. Smith, Baker, \$405; Joe Stover, First Cook, \$225; Christopher Simmons, Second Cook, \$225; Moses Williams, Dining-room Servant,

\$108; Richard Green, Dining-room Servant, \$108; Hubert Debnam, Dining-room Servant, \$108; John Hockaday, Servant, \$108; Joe Scarborough, Jr., Assistant Cook, \$126; Parthenia Wilder, Washer, \$196; P. W. Roberson, Waiter, \$36; W. C. Moore, Waiter, \$36; S. W. Foster, Waiter, \$36; B. A. Broom, Waiter, \$36; O. L. Bagley, Waiter, \$36; D. L. White, Waiter, \$36; G. F. Sedberry, Waiter, \$36; W. F. Brock, Waiter, \$36; T. White, Waiter, \$36; L. M. Oden, Waiter, \$36; W. G. Finch, Waiter, \$36; J. R. Smith, Waiter, \$36; P. H. Poindexter, Waiter, \$36; H. M. Lilly, Waiter, \$36; B. F. Gardner, Waiter, \$36; H. B. McIver, Waiter, \$36; O. H. Henderson, Waiter, \$36; C. L. Payne, Waiter, \$36; E. Cunningham, Waiter, \$36; J. H. Koonce, Waiter, \$36; A. L. Paschall, Waiter, \$36; A. A. Brown, Waiter, \$36; W. J. Clay, Waiter, \$36; L. Moore, Waiter, \$36; P. C. Lindsay, Waiter, \$36; J. B. Edwards, Waiter, \$36; W. W. Roseman, Waiter, \$36; T. A. Thornton, Waiter, \$36; C. W. Martin, Waiter, \$36; G. C. Hardesty, Waiter, \$36; L. V. Ewart, Waiter, \$36; R. H. Warner, Waiter, \$36; A. L. Niven, Waiter, \$36; L. R. Murr, Waiter, \$36; E. H. Barnes, Waiter, \$36; H. P. Foster, Waiter, \$36.





47-M-64

BULLETIN
OF THE
Agricultural & Mechanical College
OF TEXAS,

(Technical Branch of the University,)

COLLEGE STATION, BRAZOS COUNTY, TEXAS.

A REPORT
OF
EXPERIMENTS AND OBSERVATIONS
CONDUCTED AT THE COLLEGE.

(Issued from Time to Time as Results may Require.)

—No. 3,—

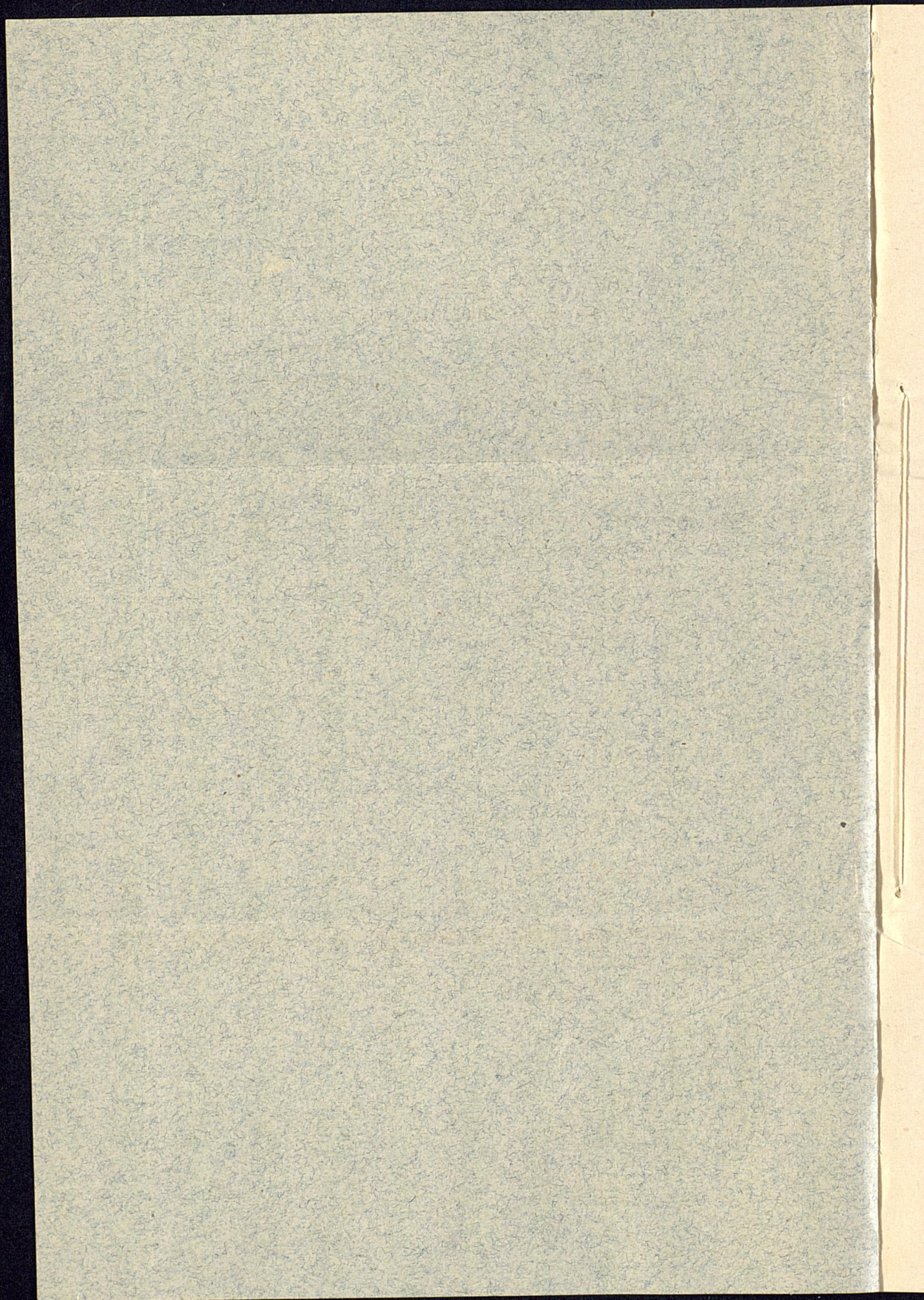
NOTES AND EXPERIMENTS,

June 1st, 1885.

HOUSTON, TEXAS:

J. J. PASTORIZA, PRINTER AND STATIONER, 89-91 CONGRESS STREET.

1885.



PREFACE.

OWING to changes made by the Board of Directors at their last meeting, several experiments which had been planned, with reference to calves and milk-cows, do not appear in this number.

Our main object in experimental work this year has been the starting of a series of experiments with fertilizers on corn—a synopsis of which appears on a subsequent page. The experiments with manures mentioned in BULLETIN No. 2, are not given in full, because of inaccuracy in carrying out results; we can only mention the fact, that wherever the manure was applied a wonderful influence was shown on vegetation.

Our experiments with pigs have an actual bearing on practical feeding, and the question of too much salt as a hindrance to fat production, should have much more extensive investigation.

We would call especial attention to the analytical work of Walter Wipprecht, a post graduate student in the Agricultural Department.

The fertilizers analyzed are in practical test now, as will appear from "Field Notes on Experiments," in this number.

Co-operation in all experiments connected with agricultural industry is heartily invited; and we desire to urge upon the farmers of Texas the vast good that may result from a system of co-operation in this direction. Let all who are willing to try experiments address us on the subject, that we may be able to formulate a plan of investigation to secure uniformity in results.

Respectfully submitted,

GEO. W. CURTIS,

Prof. Agr. and Hort.

Please

IN the following experiments the pigs were divided into two lots, one of which, for convenience, we designate "pen No. 1," the other, "pen No. 2."

In order that individual characteristics might be eliminated as far as possible from results, the different pens were fed in certain order for one week, at the end of which time, feed was *exactly reversed*, "pen No. 1" receiving the feed which "pen No. 2" had received in the first half of the experiment.

In all the experiments, the reader must bear in mind that a *rapid* gain was not only not desirable, but that such a condition would have vitiated results by bringing in more or less of individual peculiarity in regard to assimilation.

EXPERIMENT No. 8,

To Test the Value of House Slops in the Production of Pork.

Length of Experiment, Fourteen Days.

Feed per day and head—One-third pound bran, one-third pound cotton-seed meal, two-third pounds shelled corn, one gallon house slops. Bran and cotton-seed meal were mixed with slop and fed twice daily.

FIRST HALF OF EXPERIMENT	Weight in lbs.		Feb. 25	March 4	Gain	Loss	Net Total
	PEN No. 1.....	Pig No. 1.....	78.	86.	8.	.....	.....
		" 2.....	76.5	84.25	7.75	.....	.....
		" 3.....	77.5	81.5	4.	.....	.....
		Total.....	232.	251.75	19.75	.....	19.75
	Weight in lbs.		March 4	March 11	Gain	Loss	Net Total
	PEN No. 2....	Pig No. 1.....	79.5	85.5	6.	.....	.....
		" 2.....	111.5	122.25	10.75	.....	.....
		" 3.....	59.	63.	4.	.....	.....
		Total.....	250.	270.75	20.75	.....	20.75

Feed per day and head—same as above, except the one gallon of house slops was withdrawn.

SECOND HALF EXPERIMENT	Weight in lbs.		Feb. 25	March 4	Gain	Loss	Net Total
	PEN No. 2.....	Pig No. 1.....	79.5	79.5	.....	.....	.....
		" 2.....	110.5	111.5	1.	.....	.....
		" 3.....	59.25	59.	.....	0.25	.....
		Total.....	249.25	250.	1.	0.25	0.75
	Weight in lbs.		March 4	March 11	Gain	Loss	Net Total
	PEN No. 1.....	Pig No. 1.....	86.	85.25	.....	0.75	.....
		" 2.....	84.25	85.75	1.5	.....	.....
		" 3.....	81.5	81.5	.....	.....	.....
		Total.....	251.75	252.5	1.5	0.75	0.75

Fourteen days feeding with slops, gain, 40.5 pounds.

" " " " without " " 1.5 "

Making a net gain due to house slops alone of 39 pounds.

A fact which shows the full value of utilizing the waste portions of food from the kitchen; it also illustrates a frequent source of loss, where hogs are allowed to range at will and receive no benefit from what, in such cases, is thrown away.

To secure accurate results it was necessary to give a ration which should cause neither gain nor loss, and then add a selected amount of food, the value of which we desired to test. By examining the table we notice that "pen No. 2" *without* house slops gained a net total of only $\frac{3}{4}$ lb., and that "pen No. 1," under like conditions, gained exactly the same amount; hence, we conclude that a daily ration composed of $\frac{1}{3}$ lb. each of bran and cotton seed meal, and $\frac{2}{3}$ lb. of shelled corn with water, given freely, is approximately, a *maintenance fodder* for pigs 4 to 6 months old. Fourteen gallons of house slops, then produced 39 lbs. of pork; by a simple calculation 36 gallons would produce 100 lbs. of pork, worth at least \$2.00; or one gallon of *good* kitchen slop, has, for growing pigs, an actual cash value of $5\frac{5}{9}$ cents.

EXPERIMENT No. 9.

To Test the Comparative Values of Corn Meal and Cotton Seed Meal in Pig Feeding.

Length of Experiment, Fourteen Days.

Feed per day and head—One-third pound bran, one-half pound corn meal, one gallon house slops, two pounds shelled corn. Fed in same order as in Experiment 8.

FIRST HALF OF EXPERIMENT		Weight in lbs.	March 26	April 2	Gain	Loss	Net Total
	PEN No. 1.....	Pig No. 1.....	94.75	100.	5.25	.....	.....
		“ 2.....	95.	100.	5.	.....	.....
		“ 3.....	93.25	97.	3.75	.....	.....
		Total.....	283.	297.	14.	.....	14.
		Weight in lbs.	April 2	April 9	Gain	Loss	Net Total
	PEN No. 2.....	Pig No. 1.....	100.5	108.	7.5	.....	.....
		“ 2.....	138.5	150.5	12.	.....	.....
		“ 3.....	71.5	80.	8.5	.....	.....
		Total.....	310.5	338.5	28.	.....	28.

Feed per day and head—Same as above, except *corn meal* was changed for an equal amount of *cotton-seed meal*.

SECOND HALF EXPERIMENT		Weight in lbs.	March 26	April 2	Gain	Loss	Net Total
	PEN No. 2.....	Pig No. 1.....	97.25	100.5	3.25	.....	.....
		“ 2.....	133.5	138.5	5.	.....	.....
		“ 3.....	71.25	71.5	0.25	.....	.....
		Total.....	302.	310.5	8.5	.....	8.5
		Weight in lbs.	April 2	April 9	Gain	Loss	Net Total
	PEN No. 1.....	Pig No. 1.....	100.	113.75	13.75	.....	.....
		“ 2.....	100.	113.5	13.5	.....	.....
		“ 3.....	97.	97.	.....	.....	.....
		Total.....	297.	324.25	27.25	.....	27.25

Fourteen days feeding with corn meal, gain, 42 pounds.

“ “ “ “ cotton-seed meal, “ 35.75 “

Making a net gain in favor of corn meal of 6.25.

Assuming the above result as conclusive, and assigning to cotton seed meal a value of *one*, we find, by proportion, the value of cornmeal to be 1 3-17; or, to express it more clearly, cornmeal—*aside from the cost of either*—has 1 3-17 times the value of cotton seed meal in feeding pigs.

The pigs used in experiments Nos. 8 and 9 were of following breeds:

- Pen No. 1. { Pig No. 1, thoroughbred Essex sow.
 " " 2, cross-bred barrow, Essex and Jersey red.
 " " 3, low-grade Poland China barrow.
- Pen No. 2. { Pig No. 1, thoroughbred Essex sow.
 " " 2, cross-bred sow, Essex and Poland China.
 " " 3, low-grade Poland China sow.

An examination of the tables will determine any influence of breed which may have been potent in causing gain or loss.

For the purpose of comparison we present herewith a table, showing the average composition of the two fodders used; taken from the tables of J. Kuhn, as compiled by Henry P. Armsby, Chemist to Connecticut Agricultural Experiment Station:

COMPOSITION Per cent.	WATER	PROTEIN	FAT	NITROGEN FREE EXT.	CRUDE FIBRE	ASH	TOTAL
Corn meal.....	18.4	8	3	68.	1.4	1.2	100
Cotton seed meal	7	42.9	17.3	18.6	7.4	6.8	100

From these analyses it would seem that cotton seed meal would be the better of the two for feeding purposes; and, while the result of experiment 9 leads us to a reverse decision, yet we would urge further trial until disproved or established beyond a doubt.

EXPERIMENT No. 10.

To Test the Influence of Salt as a Hindrance to fat production.

Length of Experiment, Fourteen Days.

Feed per day and head—One pound bran, one-half pound chops, two pounds shelled corn; water given freely and small amount of salt in each feed.

FIRST HALF OF EXPERIMENT		Weight in lbs.	April 22	April 29	Gain	Loss	Net Total
	PEN No. 1.....	Pig No. 1.....	40.	43.75	3.75		
		" 2.....	50.	49.5		0.5	
		" 3.....	74.75	78.25	3.5		
		Total.....	164.75	171.5	7.25	0.5	6.75
		Weight in lbs.	April 29	May 6	Gain	Loss	Net Total
	PEN No. 2.....	Pig No. 1.....	101.5	107.25	5.75		
		" 2.....	73.75	75.5	1.75		
		" 3.....	50.	50.			
		Total.....	225.25	232.75	7.5		7.5

Feed per day and head—Same as above, *without the salt.*

SECOND HALF EXPERIMENT		Weight in lbs.	April 22	April 29	Gain	Loss	Net Total
	PEN No. 2.....	Pig No. 1.....	91.75	101.5	9.75		
		" 2.....	66.5	73.75	7.25		
		" 3.....	56.75	50.		6.75	
		Total.....	215.	225.25	17.	6.75	10.25
		Weight in lbs.	April 29	May 6	Gain	Loss	Net Total
	PEN. No. 1.....	Pig No. 1.....	43.75	46.5	2.75		
		" 2.....	49.5	50.25	.75		
		" 3.....	78.25	83.	4.75		
		Total.....	171.5	179.75	8.25		8.25

Fourteen days feeding *without* salt, gain, 18.5 pounds.

" " " " *with* " " 14.25 "

Making a net *loss* due to feeding salt of 4.25.

The pigs used in this experiment were considerably mixed as to breed, and their natural proclivities proved so hard to overcome as to somewhat weaken the result:

- Pen No. 1. { Pig No. 1, scrub sow.
 { " " 2, " "
 { " " 3, cross-bred barrow, Essex and Jersey red.
- Pen No. 2. { Pig No. 1, cross-bred sow, Essex and Jersey red.
 { " " 2, " " " "
 { " " 3, scrub barrow.

It will be noticed that "pig No. 3" in "pen No. 2" lost $6\frac{3}{4}$ lbs., when fed *no* salt; this resulted from his almost rigid abstinence from diet of any kind for the first four or five days. It may be confidently asserted that, but for this, the influence of salt in the fodder would have been much more marked.

WEIGHT OF CALVES,

Showing Growth and Gain.

		DUTCH FRESIANS, RECORDED IN VOLUME IV, D. F. H. B., OF AMERICA.				GALLOWAYS, RECORDED IN VOLUME II, AMERICAN G. H. B.		
Weight in lbs., 1885.		Raab (Bull), No. 486, D. F. H. B., dropped Feb. 29, 1884.	Metje, 2nd, No. 1653, D. F. H. B., dropped March 20, 1884.	Jessica, 2nd, No. 1654, D. F. H. B., dropped April 11, 1884.	Yentje, 2nd, No. 1446, D. F. H. B., dropped May 1, 1884.	Admiral Good (Bull), No. 1184, G. H. B., dropped March 7, 84.	Acume, No. 1188, G. H. B., dropped April 3, 1884.	Admiral, No. 1186, G. H. B., dropped March 15, 1884.
January	3.....	790	707.5	650	490	591	471	512.5
"	10.....	795	711	652.5	486	592.5	471	522.5
"	17.....	795	712.5	655	496	605	475	511
"	24.....	830	725	657.5	520	638	490	513
"	31.....	807.5	722.5	642.5	522.5	620	487.5	512.5
Gain for January.....		17.5	15	-7.5	32.5	29	16.5	.....
February	7.....	806	727.5	665	526	641	484	522.5
"	14.....	830	740	680	520	652	496	530
"	21.....	832.5	755	692	498	671	470	542.5
"	28.....	839	780	710	515	687.5	472.5	546
Gain for February.....		31.5	57.5	67.5	-7.5	67.5	-15.	33.5
March	7.....	830	751	702.5	508	693	472.5	542
"	14.....	845	795	737.5	545	707	486	550
"	21.....	872.5	807.5	732	570	712	495	552.5
"	28.....	892.5	792.5	720	572	731	502	550
Gain for March.....		53.5	12.5	10	57	43.5	29.5	4
April	4.....	908	830	762	617	737.5	527.5	575
"	11.....	917	832	762	621	749	535	575
"	18.....	915	839	767	645	740	538	580
"	25.....	975	873	805	668	767	561	594
Gain for April.....		82.5	80.5	85.	96	36	59	44
May	2..	977.5	863	802	677.5	777.5	577	608
"	9.....	1007.5	892	827	695	809	586	615
Gain two weeks in May...		32.5	19	22	27	42	25	21
Total gain 4½ months.....		217.5	184.5	177	205	218	115	102.5

These calves were imported from the North during the latter part of November last—the Dutch Fresians from Iowa, the Galloways from Kansas City, Mo.—and are *excellent* types of the breeds they represent.

A brief description of the two breeds may not be out of place here: The Galloway is a Scotch breed—*without* horns—color, black (in winter tinged with brown), hair, long, and more or less curled or shaggy; legs, short; body, long; neck, thick; outline typical of beef. They are excellent feeders and produce an excellent quality of beef.

The Dutch Fresians are, as the name indicates, from Holland, province of Friesland. They stand unrivalled in quantity or yield of milk, which, while not so rich in butter as that of the Jersey and Alderney, is still of *very good* quality. The globules, as seen under the microscope, are of a medium size, and *remarkably even*, adapting the milk admirably for cheese-making. The smallness of the globules necessitates a longer period for cream rising than required with milk of other breeds.

The DUTCH FRESIAN and the HOLSTEIN associations have always been kept entirely distinct; lately, however, the two associations have taken steps to effect a union under the name,

“HOLSTEIN-FRESIAN ASSOCIATION OF AMERICA.”

It is to be hoped that the efforts put forth to this end may reach an early consummation, as it would undoubtedly be for the best interests of all breeders of Holland or Dutch cattle.

The cattle are *pure* black and white in color—large sized—excellent feeders, and of the *typical milk outline*; frequently giving from 12,000 to 16,000 lbs. per year—a record of 9000 lbs. being required to admit a cow to entry in the main or advanced register.

GRASSES.

Thus far, we have found but few grasses that even promise well, the great trouble being the long drouth, which kills everything not extremely tenacious of life. From the peculiar conditions of our climate, we must soon see, that any chance to secure a forage plant which will thrive, must be limited to two classes of vegetation, viz:

1. Plants which send out strong vigorous roots, running far down below the influence of the scorching summer heat, or subterranean stems (*rootstocks*). Perennial plants of the most hardy and vigorous nature.

2. Plants which spring up in fall from the seed, grow most rapidly in early spring, and ripen seed perfectly before the drouth comes on. Seed of any kind remain perfectly safe and dormant during the long dry period, and spring up readily after the fall and winter rains.

Under the first class—perennials—nothing has given such marked satisfaction as TEXAS BLUE GRASS (*Poa Arachnifera*). Last summer (1884) was the most severe drouth known for years in this locality, yet the roots of the Texas Blue Grass seemed to derive renewed vigor from the summer's inactivity, pushing out a wonderfully fine growth for winter pasturage, and ripening an abundant seed crop about May 1. It seems to be rapidly spreading over a considerable portion of Central and Northern Texas, especially that portion between the Brazos and Trinity rivers. Specimens have been found in several of the lower counties, and in more northern counties—notably, Ellis and Johnson—it has already obtained a considerable foothold. As a hay crop, while not equalling Johnson Grass in quantity, it has certainly the recommendation of very fine quality; and as winter pasture it is unexcelled.

JOHNSON GRASS (*Sorghum halapense*) makes more hay to the

acre than any other grass grown in Texas; in quality it is rather coarse, and seems to be somewhat illflavored. As a pasture grass we do not consider it a success unless sown on poor, barren lands where other grasses would fail; it is so extremely tenacious of life that it will thrive where many other plants would die. The illflavor mentioned above belongs more especially to the growing crop, as when cut and properly cured it makes a very fair hay.

ALFALFA (*Medicago Sativa*), though not a grass, ranks under the class of hardy perennials.

We find, that on rich ground it will do remarkably well, making a *good* stand in one year; but on poor land the roots will not penetrate deep enough to withstand the drouth; some of the plants will live, but so scattered as to make anything like a reasonable crop an impossibility. If Alfalfa is to be raised for profit—as either pasture or hay crop—our ordinary lands must be well prepared by manuring; it seems to demand a soil containing a considerable amount of humus—in the low deposit lands along the rivers it grows with great luxuriance, a fact we may make use of by stating that well-rotted barn-yard manure will supply not only the fertility, but the humus so much needed in our stiff upland clays.

BERMUDA GRASS (*Cynodon dactylon*) is too well known as a summer pasture and lawn grass in Texas to need further mention here.

Under the second class — annuals — RESCUE GRASS (*Bromus unioloides*) is, perhaps, taking the lead. Its seed lies dormant all summer, springing up quickly and vigorously after fall and winter rains. Stock of all kinds are exceedingly partial to it, and coming—as it does—before the native wild grasses appear, it is recognized as most valuable for a late winter pasture. As a hay crop we see but one reason why it would not do well: being an annual, there is danger of weakening or destroying the stand by removing too much of the seed.

CANARY GRASS (*Phalaris Americana*) is another one of this class of grasses which will, sooner or later, be recognized as a valuable late winter annual. Its culms are tender, sweet and juicy, leafy almost to the summit, and eaten with great relish by all kinds of stock.

In this county (Brazos) it is multiplying rapidly, and bids fair to come into general favor.

THE MILLETS all do well here, but the cost and trouble necessitated by resowing every spring diminish their value quite materially.

Of the following grasses tested the past year (1884) we have to say—they are *failures* for this portion of our State:

Timothy (*Phleum pratense*), Kentucky Blue Grass (*Poa pratensis*), Orchard Grass (*Dactylis glomerata*), Sheeps Fescue (*Festuca ovina*), Red Top (*Agrostis vulgaris*) and Perennial Rye Grass (*Lolium perenne*).

Orchard Grass and Perennial Rye Grass we shall try again, hoping to have a better report on next trial.

JAPAN CLOVER (*Lespedeza striata*) is obtaining considerable favor in various parts of the State, especially Eastern and Northeastern Texas, but we are not prepared to make any statement—pro or con—without further trial.

ANALYSES OF FETILIZERS, BY WALTER WIPPRECHT,
Post Graduate Student.

	Per ct. total Ammonia	Per ct. free Ammonia	Per ct. Phos- phoric acid	Per ct. Potash
Columbus Fertilizer, manufactured at Columbus, Tex	3.98	1.21	14.5	2.97
Texas Phosphate, manufactured at Galveston, Tex.....	3.528	0.98	6.505	
Baugh's Bone Meal, manufactured at Galveston, Tex.....	3.92	.....	19.96	
Ammoniated Phosphate, manufac- tured at San Antonio, Tex....	1.568	0.196	8.78	
Cotton Seed Meal, from Schumaker's Oil Works, Navasota, Tex	9.408			

A brief synopsis of the methods used in the determinations may be of interest.

TO DETERMINE TOTAL AMMONIA

a known amount of substance burned in combustion tube, with soda lime—gases passed through known volume of sulphuric acid, requiring known amount of sodic hydrate to saturate. After com-

bustion, less quantity of sodic hydrate was required to saturate the sulphuric acid. This difference, then, represented the ammonia which was taken up by the sulphuric acid resulting from combustion of the known quantity of the substance; from the data thus obtained the percentage of ammonia is easily determined.

TO DETERMINE FREE AMMONIA,

known amount of substance placed in a dish and strong caustic potash solution poured over it, allowed to stand for five days in presence of sulphuric acid—requiring known amount of soda hydrate to saturate; at end of five days, required less amount to saturate—difference representing amount of *free ammonia* given off by substance and absorbed by sulphuric acid, from which percentage is obtained.

TO DETERMINE PHOSPHORIC ACID,

known amount of substance, fused with known weight of fusion mixture, and then dissolved in known quantity nitric acid of known strength, silica was removed by precipitating with ammonic molybdate—precipitate redissolved in warm ammonium hydrate, and the phosphoric acid precipitated by magnesia mixture; this, after being dried by ignition, and weighed, gives all data necessary for determining percentage of phosphoric acid.

TO DETERMINE POTASH—IN FORM OF THE OXIDE (K_2O),

known amount of substance ignited with nitrate of ammonia—dissolved in hydrochloric acid, silica removed—sulphuric oxide removed by chloride of barium, and filtrate reduced by evaporation. Added ammonic carbonate and ammonic oxalate—filtered—washed carefully, evaporated to dryness and ignited to expel ammonia salts. Ignited residue was dissolved in water containing few drops hydrochloric acid—filtrate evaporated to dryness and weighed. Residue again dissolved, perchloride of platinum added in excess and evaporated nearly to dryness over water at 75 degrees, centigrade; platinic chloride dissolved out by alcohol and ether—filtered—contents of filter dried and weighed, giving data for percentage determination.

These analyses are given here because of their intimate connection with the experiment on corn. Professor Dinwiddie will publish in full, results of investigations made in the chemical laboratory, as a separate bulletin, which we doubt not will prove of interest to the farmer.

FIELD NOTES ON EXPERIMENTS.

Each plat one half acre in extent.

Plat No. 1—Corn on *shallow plowing* even stand, not necessitating replanting; hence, shows up well as to size. Shallow plowing keeps from planting too deeply, hence prevents rotting in bad weather.

Plat No. 2.—Corn on *deep plowing* uneven stand; had to be planted in in places. Corn, healthy color, but looks badly on account of replanting.

Plat No. 3—Corn with *cow manure* also uneven. First planting strong, dark-green, large; second, or replanting, following rapidly.

Plat No. 4—Corn with *Texas phosphate*, good stand; *very* large; bright dark-green—ahead of all at this date, May 15.

Plat No. 5—Corn with *Baugh's bone meal*—planted later—fair stand, healthy color and good size. Bone meal shows up better the second year.

Plat No. 6—Corn with *ammoniated phosphate*, planted same time as No. 5, fair stand; bright-dark color; vigorous growth, larger than No. 5, and pushing more rapidly.

Plat No. 7—Corn with *cotton seed meal*, planted same time as Nos. 5 and 6, rather smaller, and not so good color as either.

Plats Nos. 8 to 28, inclusive—Small plats testing varying quantities of same fertilizers used on larger plats. The differences being so slight that we can hardly give any field notes which will be of value until later on.

As to mode of application and quantity applied, accurate data will be given when results are published in full.

Mr. J. C. Isbell, of Pankey, Tex., is also experimenting with some of the same fertilizers, and has promised to add his results for publication with those carried on here.

STOCK AND APPLIANCES AT THE COLLEGE CONNECTED WITH THE
AGRICULTURAL DEPARTMENT.

Thoroughbred annimals belonging to the following breeds:

Of cattle—Dutch Fresian, Galloway and Jersey.

Of hogs—Essex and Berkshire.

Windmill and force-pump, (supplying water at each barn); new barn for hay, stock and machinery, 40 x 86 feet, containing set Fairbanks' Standard Hay Scales; machinery of all kinds necessary to carrying on of farm work—among them, "Deere Rotary Drop Corn Planter," and wire checkrower for same. Horse hay-fork and carrier for unloading in new barn; the "Strowbridge Broadcast Seed Sower," manufactured by the Racine Seeder Company, Racine, Wis.

The latter instrument was received last year *on test*, and, we are glad to say, has given excellent satisfaction.

STOCK FOR SALE.

ESSEX Pigs, \$10, each; delivered boxed at express office.

All males have been sold of last litter, but another litter will be ready for shipping in about three months.

In a few years we hope to offer some very fine half-blood males, out of either Fresian, Galloway or Jersey bulls.

47-M-67

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS,

(Technical Branch of the University,)

COLLEGE STATION, TEXAS.

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PROGRAM

OF THE

Farmers' Institute

TO BE HELD AT

SHELBYVILLE, KENTUCKY,

Friday and Saturday,

April 7th and 8th, 1905

UNDER THE AUSPICES OF

The State Dept. of Agriculture

AND THE

Farmers' Club of Shelby County

J. A. STANLEY.....President
THOS. HORNSBY..... Vice President
C. M. HANNA..... Secretary

SHELBY RECORD PRINT.

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PROGRAM.

Friday, April 7—Morning Session.

(Begins at 9:30 o'clock.)

- Invocation Rev. H. D. C. Maclachlan
Welcome Address J. A. Stanley, President
Shelby County Farmers' Club.
Response Hubert Vreeland, Commissioner
of Agriculture.
Crop Rotation, with a view to maintain fertility
of the soil J. Sam Smith and R. C. Cren-
shaw, Ass't Commissioner of Agriculture.
Improved Methods of Corn Growing Prof. J.
N. Harper, Agriculturist, Ky. Ex. Station.
Some Fruit and Vegetable Pests Prof. H.
Garman, State Entomologist.
Forestry 'Squire B. B. Ross

Afternoon Session.

- Roadways--Construction and Maintenance
Judge B. F. Hill, Judge E. H. Davis, Judge
W. H. Tipton and C. M. Hanna.
Dairy Herds and Feeding Joseph E. Wing,
Mechanicsburg, O., and Prof. M. A. Scovell,
Director Agricultural Experiment Station.
Discussion--Three-Minute Speeches.
Fruits for the Farmer W. C. Cook, "Sage
of Rural Neck."

Evening Session.

- Invocation Rev. B. B. Bailey
Illustrated Lecture--Stereopticon Views
Profs. Harper and Scovell.
ADDRESS by Gov. J. C. W. Beckham.
Best Vocation for the Young Man Col. Harry
Weissinger.
How to Keep the Boys on the Farm Col. Jo-
seph E. Wing.

PROGRAM.

Second Day—Morning Session.

Prayer.....Rev. D. M. Sweets
Breeding and Raising Thorough-bred stock
 Joseph E. Wing.
 Discussion.
Beef Cattle..... R. M. Smith
Dairy CattleJno. A. Middleton
Hogs..... Frank G. Hogan
Alfalfa.....Joseph E. Wing and R. C. Crenshaw

Afternoon Session.

PrayerRev. O. J. Chandler
Burley Tobacco.....Prof. J. N. Harper
Purposes of State Organization....M. W. Neal,
 State Lecturer and Organizer; Hubert Vree-
 land, Com. of Agriculture; C. M. Hanna.

Each subject is open for discussion by any farmer or stock raiser.

School children are especially invited to attend the evening session.

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JUDGES	{	Tobacco—Dan Peed, Bourbon Co
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47-M-64

PREMIUMS.

TOBACCO.

For best sample of bright leaf, 1st premium, \$15; second, \$10; third, \$5.

For best sample of red leaf, first premium, \$15; second, \$10; third, \$5.

For best sample of twist wrapper, first premium, \$15; second, \$10; third, \$5.

For best sample of cigarette, first premium, \$15; second, \$10; third, \$5.

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For best sample of hemp, first premium, \$7; second, \$3; third, \$2.

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For best peck of clover seed, first premium, \$7; second, \$3; third, \$2.

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For best peck of orchard grass seed, first premium, \$7; second, \$3; third, \$2.

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For best half-bushel of calico corn, first premium, \$3; second, \$2; third, \$1.

Corn to be exhibited in the ear, and to become the property of the Farmers' Club.

HONEY AND ITS USES IN THE HOME

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HONEY is a sweet, old as the race, and always held in esteem. The flavor and aroma vary with the predominating kind of flower which the bees visit, and one can take advantage of this when selecting honey for the table, either to get a favorite flavor or to get variety by choosing different flavors.

Besides its uses for table purposes, honey is much used in cooking to replace all or part of the sugar called for by a recipe. A general rule in such cases is to use a cup of honey in place of a cup of sugar and to cut down the water or other liquid by one-fourth cup for each cup of honey used, to make up for the water in the honey.

The purpose which honey serves in the diet is like that of sugar—it is a source of energy in readily available form, and a flavor food which has many uses by itself and which adds to the palatability of other foods.

Besides discussing the nature and food value of honey, its place in the diet and related questions, this bulletin gives many suggestions and recipes for using honey in the home.

Beekeeping is an industry which is worthy of increased development, since it meets the growing demand for this palatable and wholesome food.

HONEY AND ITS USES IN THE HOME.

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INGREDIENTS OF HONEY.

IN THE DAYS before trade with the Tropics introduced cane sugar into temperate regions honey was by far the most common sweet substance available for human food. In very early times men discovered that the material deposited by honeybees in hollow trees and in the crevices of rocks was a valuable and agreeable food and learned to appropriate it to their own use. Such wild honey is still gathered in Palestine and in the less advanced parts of Africa, in Asia, and in South and Central America, that from Peru making an important article of export. Bee trees, which were considered a prize in pioneer times in this country, are still valued in some remote rural regions, and not infrequently people living in country or village take the comb from a colony of bees which has settled in a corner under the weatherboarding of a building or some similar place.

There are two kinds of natural honey, known as floral, or normal, and honeydew, or abnormal, the former being made from nectar, a sweet liquid secreted by flowers, and the latter from honeydew, a sweet substance deposited on the leaves of plants by plant lice and other insects. Unless otherwise stated, the term "honey" when used in this bulletin may be understood to refer to the kind made from nectar, or to that in which the quantity of honeydew is so small that it does not greatly affect the character of the product.

The chief materials that the worker bees bring to the hive are nectar, pollen, and propolis. They collect the pollen on the hairs on their bodies, place it in the so-called pollen baskets on their legs, and thus carry it back to the hive to be deposited near the brood cells. This pollen is rich in nitrogenous material and is important as food for the young and developing bees (larvæ). A few grains usually find their way into the honey cells. Propolis or bee glue is obtained from the gums exuding from trees and shrubs. It is taken to the hive in the same way as pollen and is used to make the hive water-

proof and sometimes to strengthen the edges of the comb. If any gets on the capping of the honey it tends to spoil the appearance of the combs; these traces of propolis are known as "travel stain."

Nectar is the material from which honey is made. The bees suck it out of the flower with their long tongues and swallow it into the honey sac where it undergoes some changes not yet well understood. It consists chiefly of sugar and water, the former constituting usually between one-fifth and two-fifths of the entire weight and the latter between three-fifths and four-fifths. With this substance are mixed small quantities of other materials, chiefly mineral matters, gums, and volatile bodies. To the latter the aroma and flavor of honey are chiefly due.

The changes by means of which nectar is transformed into the finished honey are technically known as "ripening." They take place partly in the honey sac of the bee, and partly in the cells of the comb, continuing even after the latter have been capped with wax. They consist mainly in removal of part of the water from the nectar, a task which the bees accomplish by warming the air of the hives and also by fanning the nectar in the cells, and in the change in the chemical nature of the sugars, which will be described later (see p. 7).

Wax is made in and secreted from special glands on the abdomen of the worker bee. Several pounds of honey are used in producing a pound of wax, and a high temperature must be kept up in the hive by the bees while it is being made. Because of the cost of wax secretion beekeepers usually try to arrange that the bees shall have little comb building to do except when comb honey is being produced.

FOOD VALUE OF HONEY.

So far as its food value is concerned honey may be roughly described as a sirup with a distinctive flavor and aroma made up of 4 parts sugar to 1 part water. There are several kinds of sugars present in honey, including cane sugar (sucrose), grape sugar (dextrose), and fruit sugar (levulose); the last two together being called invert sugar. Some dextrin is also present as well as a variety of other substances in very small amounts. Included among them are nitrogenous substances (protein), which occur in quantities too minute to affect the food value of honey for man. Some of the other substances present in minute quantity, namely, volatile oils, or other bodies of pronounced odor or flavor from the nectar, are valuable because they influence the flavor and aroma of the honey.

According to data gathered by the Bureau of Chemistry¹ honey, on an average, contains in round numbers per 100 parts 18 parts water, 78 parts carbohydrate (including 76 parts sugar and 2 parts dextrin), 0.2 part mineral substance, or ash, and nearly 4 parts of undetermined substances such as pollen grain, gum, bee glue, formic

¹ U. S. Dept. Agr., Bur. Chem. Bul. 110.

acid and volatile oils, and other flavor substances. These are average values, and there is, of course, considerable variation in individual honeys. For instance, the proportion of water varies from about one-eighth to one-fourth of the total weight of the honey, being influenced by the moisture in the air at the time the honey is produced and the dryness of the atmosphere in which the honey is kept afterwards. Samples of honey from conspicuously dry localities (the southwestern part of the United States, for instance) and honeys made in other localities in very dry weather have a relatively low water content.

Honey contains a small amount of mineral matter, including magnesia, lime, iron, and phosphoric acid. In this respect it resembles maple sirup and unrefined sugar rather than white sugar, from which the mineral substances originally present in the plant juices have been removed in the course of the refining process. These mineral substances do not exceed more than 1 part per 100 of the weight of the honey and for this reason do not contribute greatly to the total mineral matter of the diet even when honey is used freely. They are not, however, to be wholly disregarded, for mineral substances, particularly lime, are likely to run low unless the food materials of the diet are carefully selected. A very little vitamin has been found in honey but not enough to be significant in an ordinary mixed diet.

The percentage of the different sugars varies more or less, but under any circumstance the amount of cane sugar is small (some 2 parts per 100) and less than in the nectar from which the honey is made. The proportion of dextrose (grape sugar) and levulose (fruit sugar) making up the total invert sugar varies in honey as it does in the nectar from which it is made, but this is of no importance in planning meals. However, it is of practical importance for the reason that it determines the character and appearance of the honey. Honey will granulate easily if the proportion of dextrose is large, but this is not the case if levulose predominates. For example, alfalfa honey, which contains a high percentage of dextrose, often forms such a solid mass of crystals that it is sold in cakes. This may be an advantage sometimes. Thus, the solid alfalfa honey can be used for such purposes as filling for layer cakes, for which liquid honey would not be so suitable because it would run out. The proportion of dextrin present in normal or nectar honey is so small that it affects neither food nor cooking values. Abnormal or honeydew honey, however, contains so much dextrin that it requires special handling in cooking. This is a matter of interest to professional bakers rather than to housekeepers, as such honey is not commonly used in the home.

Since the principal ingredient of honey is sugar, it is obvious that it should be classed with the fuel foods which supply the body with the energy it needs for the various tasks it performs rather than

those whose function is to build and repair the body—that is, the “tissue formers,” as they are sometimes called. If honey contained no water its energy value would be practically the same, pound for pound, as that of cane sugar. However, since about one-fifth of its total weight is water, it follows that its energy value is one-fifth less than that of cane sugar, being 1,485 calories per pound.

In planning meals, particularly in hospitals, children's homes, and other institutions where large quantities are required, it is often convenient to have some quick and fairly accurate method of estimating the relative value of different articles of diet which are used in similar ways. For this reason it is worth remembering that an ordinary tablespoonful of honey weighs a trifle over an ounce and will furnish the body 100 calories. The same amount of energy would be supplied by five-sixths of an ounce of sugar, by $1\frac{1}{4}$ ounces of molasses, or by a little less than an ounce of preserves (such as orange marmalade).

FLAVOR OF HONEY.

Besides an intense sweet taste, honey retains enough of the perfume of the flowers from which it comes to have a distinctive flavor which has always set it apart as a food to be prized.

The flavor and aroma of honey depend largely upon the blossoms from which the nectar is obtained. The nectar of each kind of flower contains a distinctive combination of oils and other substances which gives the blossoms their special fragrance, and these substances are retained in the honey made from the nectar. It is practically impossible to prevent bees from visiting more than one kind of flower during a given period, and, strictly speaking, almost every kind of honey is made from a mixture of different nectars. Nevertheless, when the hives are situated near a large supply of one sort of blossom, its nectar usually predominates and its flavor and aroma can be easily recognized in the honey. It is perfectly correct, therefore, to speak of basswood honey, fruit-blossom honey, buckwheat honey, etc.

Different localities naturally produce different kinds of honey, and different kinds may be produced in the same locality at different seasons, according to the kinds of flowers which abound. Several famous European honeys, among them the choice French variety from Narbonne, owe their characteristic aromatic flavor to wild thyme and other flowers of the mint family. In orange honey from districts where orange blossoms abound the peculiar aroma and flavor of the flowers are very clearly marked. Sage and clover honeys are well-known American varieties in which the characteristics of the nectar are easily and pleasantly recognized.

Choosing between honey from different flowers is mainly a matter of taste; and taste in honey, as in many other things, seems to depend more on what one has been accustomed to than on any real supe-

riority. For example, it sometimes happens that a person who has always used buckwheat honey with its full-bodied, rather acid flavor, imagines that a mild, light honey with less of the characteristic "comby" taste must be adulterated, whereas a person who is familiar only with some such delicate honey as white clover or alfalfa may consider buckwheat very inferior, or even fancy that it is not genuine floral honey.

The relative abundance of different flowers and consequently the flavor of the honey vary so greatly in different seasons that beekeepers can not count on a regular yield of uniform honey, so one should not think it strange if the honey of one year is different from that of the year before. To overcome this difficulty many of the best wholesale dealers have recently adopted the practice of mixing several honeys to produce a blend. This process is like that adopted long ago in the case of teas. To blend honeys so that the mixture will be generally acceptable requires a great deal of skill, but when the consumer has found a blend which pleases him he is more likely to be able to get honey of that flavor season after season than if he depends on unmixed honeys.

WHOLESOMENESS.

That honey is a satisfactory and wholesome foodstuff is attested by its general acceptance as such wherever and whenever it can be obtained. Special properties and virtues have even been assigned to it in some cases.

Because the chemical change effected by the bee in the sugars of the nectar is the same as that effected by digestive ferments, and the principal sugars may therefore be considered to have undergone the first step of digestion, honey is often said to contain predigested sugar and to be more wholesome than cane sugar. There is no reason, however, to believe that the healthy human body is not equal to the task of digesting any sugar, so a special claim made for the wholesomeness of honey on this ground seems unimportant. It is generally believed that the energy from sugar is liberated for the use of the body more quickly than that from such other fuel foods as starch and fat. Hence it is said to delay the oncoming of fatigue during great muscular exertion. For this reason some form of sweet is included in almost all army rations and is often used by persons undergoing severe physical exertion, such as mountaineers and athletes. Although no experiments have been made to test the value of honey in this respect, it seems safe to say that it would have the same good effect as other sweets.

Everyone knows that eating too much ordinary sugar upsets digestion. The differences in the effects of too much honey and too much cane sugar are rather complicated, but it is safe to say that eating too much of either should be avoided, even by healthy people.

For some persons suffering from serious digestive disturbance honey may be a safer form of sugar than cane sugar, but with other forms of indigestion the opposite is true; it depends upon the particular form of disturbance, and such matters should be decided by a skillful physician for each individual case. For persons of very delicate digestion the particles of wax in comb honey may cause trouble, as it is believed that the digestive processes do not have any effect on them. For normal persons, however, the wax should be as harmless as are the particles of indigestible material contained in many other wholesome foods.

Honey is sometimes said to have a mildly laxative effect, and the statement is doubtless true, as it is of many other food materials, especially those of vegetable origin. If a person had to live on a very limited number of foods, especially if he had a tendency to constipation, it might be wise to use honey rather generally in preference to other forms of sweet; but the effect of such small amounts of honey as would be used in an ordinary diet would hardly be worth taking into consideration. Bran biscuits made with honey instead of sugar (see p. 16) would owe any advantage they might have over the ordinary bran biscuit to the laxative effect of the honey.

Other medicinal qualities have been claimed for honey, particularly in older writings, and it still finds use in medicinal preparations, but no doubt more because of tradition and of the flavor and texture it imparts than for actual medicinal properties. From the standpoint of the honey industry this is a matter of little importance, for honey is regarded by the vast majority of its users as a food and not as a drug product.

As a matter of fact, honey does not need the specific medicinal properties attributed to it to hold its place as a wholesome, useful foodstuff, well worthy of even more extended use than it already has, not only because it is agreeable and economical in itself, but also because it introduces a pleasing variety and thus makes the diet more appetizing, and consequently more wholesome.

ECONOMY OF HONEY AS FOOD.

In comparing foods for the purpose of determining which is more economical, it is necessary to take into account not only the relative prices per pound but also the amounts and kinds of nourishment they furnish. Honey, which contains little besides sugar, and is therefore useful chiefly as fuel for the body, can not be substituted in the diet for such foods as milk, eggs, and meat, which furnish not only fuel but also material for making body protein. The relative prices of honey and of milk, eggs, or meat, therefore, have little significance. Honey, however, can be used as a substitute for sugar and to a certain extent as a substitute for fat. Its fuel value per pound is about four-fifths that of sugar and nearly one-half that of butter.

Where honey is home-produced or very abundant locally at favorable prices, it can and does replace sugar for many household purposes. However, its distinctive flavor as well as its sweetening power and energy value are factors which should be kept in mind when comparing its relative cost, for in this respect it compares with maple sirup and maple sugar, which have a distinctive flavor, rather than with ordinary sugar.

The differences between the wholesale prices of comb honey and of extracted honey are much greater than those between the retail prices. A pound of extracted honey in a jar usually sells at retail for about the same as the average section of comb honey, which has a net weight of 14 ounces. On the other hand, the wholesale price of comb honey is usually about 50 per cent higher than that of extracted honey. The reason for this is that the producer of comb honey does far more of the work of getting his product ready for the final market than does the producer of extracted honey. As the sections leave his hands so they are passed over the counter to the housewife or other retail purchaser. Extracted honey, on the contrary, is sold by the producer to the bottler, not in pound lots but in 5-gallon cans or barrels. The bottler does the work of blending, liquefying, bottling, labeling, and packing. It is possible, therefore, for the consumer to save money by buying extracted honey at wholesale and avoiding the cost of the various kinds of work which prepare it for the retail market.

Where only small quantities of honey are used, the effort to buy in the cheapest market may cost more in energy than it saves in money. Where, however, large supplies are bought, the purchaser should try to get into direct communication with the producer and take advantage of the parcels post as a means of transportation. The names of dealers in his vicinity can often be obtained from the beekeepers' magazines, or by writing to the State inspector of apiaries. The names of State inspectors and often those of local dealers can be obtained by addressing the Bureau of Entomology of the United States Department of Agriculture.

Now that extracted honey is usually pure and of good quality, the advantage of comb honey lies chiefly in its attractiveness to the eye. Unless very great care is taken in extracting honey, some of the volatile bodies on which its flavor depends will probably be lost. Hence it often happens that the flavor of comb honey is really slightly superior to the same kind extracted. Many persons think that the presence of the wax gives the honey a more pleasant consistency for table use. Whether these advantages are worth the extra cost each consumer must decide for himself.

Comb honey is commonly graded according to finish and color. It is described as Extra Fancy, Fancy, No. 1, or No. 2, according to the evenness with which the sections are filled, the freedom of the product

from propolis or other stains, and the number of unsealed cells. It is graded according to color, as white, light amber, amber, and dark. From the point of view of food value alone, finish and color are not of importance, though dark honeys are usually of stronger flavor.

In order to comply with the Federal Food and Drugs Act, which applies to all goods shipped from one State to another, every section of honey and every package containing extracted honey must be marked with the net weight. In comb honey this is understood to be the weight of the comb and the honey and to exclude the weight of the wooden frame.

In choosing honey too much importance should not be attached to lightness of color, for some of the best varieties are dark; nor should granulation be thought to imply adulteration. The truth is that crystallization is more likely to occur in pure than in impure honeys, and some pure varieties, especially alfalfa honeys, granulate so easily that they are often sold to the consumer in solid form. The crystals can easily be dissolved by heating the honey, which should be done in a double boiler or other kind of water bath. If the temperature does not go beyond 160° Fahrenheit, there is little danger that either color or flavor will be affected.

Unless in a sealed package, honey should be kept in a dry place; otherwise it is likely to absorb moisture and spoil, for when dilute it will ferment or sour readily, as will any other similar sugar sirup. Heat and dryness are usually found together in the household, and ordinarily the safest places for honey are the warmest places; the least desirable is the refrigerator.

USES OF HONEY.

In its natural state honey is often served much as jelly, jams, and preserves are, and because of its delicate flavor and its sweet taste it is especially adapted for this purpose. This is only one of its many uses, however, for it can be combined with many other foods to form attractive dishes in great variety, and for this reason deservedly ranks as a staple food.

Honey is used both in its natural state and as an ingredient of cooked food. In this country it is more commonly used uncooked than cooked, and practically all comb honey is consumed in this way. Honey is much more commonly used in cookery in Europe than in America, though commercial bakers and confectioners in the United States use much larger quantities than many persons realize.

The simplest way of using honey is to serve it like jam or sirup with bread, breakfast cereals, boiled rice, pancakes, and other mild-flavored foods. As ordinarily used on bread, an ounce of honey "spreads" as many slices as an ounce of jam. When it is to be used in the place of sirup, some people dilute it by mixing it with hot water, which has the effect of making it not only less sweet but also easier to pour.

Honey or a homemade mixture of honey and sugar sirup can be satisfactorily used for sweetening lemonade and other fruit drinks. Sirup of any kind is more convenient for this purpose than undissolved sugar, and when charged water is to be added it has a further advantage since it has less tendency to expel the gas. It is the custom of many housewives to keep a homemade sirup for this purpose, particularly in hot weather, and variety can be secured by occasionally using honey.

Honey can be used in place of sugar for some kinds of preserving, and there is reason to believe that fruits cooked in it keep very well indeed. Bar-le-Duc currants, which form a very delicate and expensive article of commerce, are often made by cooking currants in honey. They are frequently served with cream cheese and crackers or other form of bread. A satisfactory substitute may be secured by serving honey and tart fruit, either cooked or uncooked, with cottage cheese and bread and butter. Three ounces of cottage cheese curd, two ounces of bread, two-thirds ounce of butter (either added to the curd or spread on the bread), two ounces of honey, and six ounces of strawberries or other watery fruit would make a reasonably well-balanced meal. Sometimes honey alone is served with cream cheese. Crisp crackers, spread with cream cheese and honey, form a good combination from the point of view of nutritive value and taste. Honey may be substituted for sugar in baking apples.

HONEY IN COOKERY.

Most housekeepers know that honey can be used in cookery, but not all realize in how many ways it can be served and of how many dishes it may form a part.

As a result of extended studies of honey and its place in the diet, some suggestions made for using honey and recipes are given for a variety of dishes in which it is used.

When used in cookery honey does not always produce the same effect as corresponding quantities of sugar or molasses, and the reasons for some of the differences between them are not well understood. Careful experiments with various types of honeys and honey recipes were therefore made as part of the experimental work on foods of the United States Department of Agriculture, in the hope of explaining such points, and all the recipes (pp. 15-26) were tested. Most of the facts stated in the following paragraphs were obtained in this way.

The fact that honey consists principally of sugar and water and is slightly acid suggests that it is a suitable substitute for molasses in cookery. As a matter of fact, it can be used in the place of molasses in all forms of breads, muffins, and cakes, and makes a more delicately flavored product. It contains less acid than molasses, however, and so requires less soda when it is substituted for molasses in recipes which do not include sour milk or other acid, and the cook

must be careful about the amount of soda used. Many trials were made with different kinds of honey in this laboratory which showed that the allowance of soda to a cupful of honey very generally ranges between one-fourth and one-half of a level teaspoonful. Unless the cook is thoroughly familiar with her honey, she would do well to mix and bake a small sample of dough before she decides on the amount of soda to be put into the main portion.

When honey is to be substituted for common sugar it is desirable to know not only how it compares in sweetness, but also how much allowance must be made for the water which it contains. Assuming a cupful of good honey to measure one-half pint, it should weigh about 12 ounces. Of this, 9 to 10 ounces, roughly speaking, is sugar. A cupful of honey, therefore, corresponds to a little more than a cupful of cane sugar. Hence it is safe to estimate that a cupful of honey will sweeten a dish just about as much as a cupful of sugar. Besides the sugars, there is about one-fifth of a cupful of water in a cupful of honey. Theoretically, therefore, in making cake one should substitute honey for sugar cupful for cupful, and for each cupful of honey use one-fifth cupful less of the milk or other liquid which the recipe calls for. For practical purposes, however, it is accurate enough to consider that the water in a cupful of honey is one-fourth of a cupful. This rule was found to hold good with a large number of ordinary cake recipes which were tested in this laboratory. These facts, if kept in mind, make special honey recipes unnecessary and enable the cook with very slight calculation to modify ordinary ones so that honey can be used in place of sugar. Besides slightly changing the flavor of the cake, honey used in the place of sugar makes it keep moist longer. A honey cake made with butter will keep its quality until the butter grows rancid, and one made without butter will keep fresh for months and even improve in flavor. What is true of the cakes is also true of the dough; it can be kept almost indefinitely. Evidently, then, honey is especially useful in recipes without butter. For this reason, most of the honey cakes experimentally studied in this laboratory were made according to the following formula which is typical of Honig Kuchen, or German Christmas cake: Three-fourths cup honey, one-half cup sugar, two cups or more flour, one-fourth teaspoon powdered ginger, one-half teaspoon powdered cardamom seed, one teaspoon cinnamon, one-eighth teaspoon cloves, a speck white pepper, a pinch salt, one-fourth to one-half teaspoon soda, one tablespoon water, and two ounces blanched almonds cut in small pieces or chopped.

The directions for making the honey cakes, not only in the older cookbooks, but also in many modern bakers' manuals, are extremely elaborate; one of the purposes of the experiments made in this

laboratory was to determine how many of the suggested precautions are necessary.

Recipes usually direct that the honey be brought to the boiling point and then skimmed and cooled. This must be done with great care, for the honey is very likely to boil over. Experiments with a large variety of honeys such as are ordinarily purchased in the United States for household use, showed that nothing rises to the top during the boiling which can not be easily stirred back into the liquid. It seems likely therefore that the custom of boiling had its origin at the time when honey, or at least the grades bakers use, was much less carefully prepared than at present and contained impurities of many kinds. A cake made by stirring flour directly into cold honey was found to be in no way inferior to those made with honey which had been heated.

Some recipes found in the older cook books, particularly those of foreign origin, direct that the spices be boiled with the honey and give as a reason for this that the heating brings out their flavor and makes them "go further." The weight of this argument is obviously difficult to determine, but the work carried out by the Department of Agriculture gave no evidence that the short heating at the beginning is of special importance in comparison with the long heating which the materials must receive while the cake is being baked.

The older recipes almost invariably direct that the dough be kept for a certain length of time, sometimes one day, sometimes more, before the soda is added. So reliable an authority as König says that this is because, owing to the presence of bacteria, the acidity of the mixture increases with time, and that therefore more soda can be used after the dough has stood. To test this point, dough was mixed in this laboratory and analyzed by the Bureau of Chemistry; it was found to have 0.0775 per cent of acidity immediately after being mixed, and 0.1 per cent after four days' time. Another sample increased in six days from 0.108 per cent to 0.117 per cent, and during the following six days to 0.125 per cent. It seems probable, therefore, that the acid does usually increase; but even so, the question arises whether there is not in the beginning enough acid to act on soda sufficient to raise the cake. In order to determine this, two samples of dough were mixed. To No. 1 the soda was added at once and baking followed immediately. No. 2 was kept for a week, when the soda was added and the cake was baked. The second was neither lighter nor in any way superior to the first.

It is frequently stated that the dough can be more easily kneaded if it is allowed to stand several days. In order to test this point, a dough was mixed which was stiff enough to hold its shape, but which stuck to the hands and the molding board. After a week's time it

could be molded freely on an unfloured board without sticking to it. This argument for keeping the dough seems therefore to be sound.

It is sometimes said that the reason why cakes made with honey keep soft for a long time is that they absorb moisture from the air. To test this point a cake made according to the recipe already given was weighed at different intervals during 7½ months. The weight of the dough was 526 grams, the weight of the cake on the day of baking, April 17, 1913, was 499 grams after it had been removed from the pan, and at the final weighing on December 2 of the same year, it weighed 469.7 grams. The loss of weight was continuous during all this time, with the exception that in the late summer there was a slight increase in the weight, probably due to unusual dampness of the air; this was followed by a relatively great loss. On December 2, when the cake was cut, it was in good condition, and had a fine flavor and the consistency of a soft cooky. The experiment was repeated with small honey cakes, and these also showed no increase in weight before softening. While these experiments are not sufficient for definite conclusions, they indicate that the increased softness of the honey cake is not due to the absorption of water.

Icing made with honey or with part honey and part sugar according to the recipe on page 25 has the same advantage that honey cakes have. Such icing made in this laboratory was found at the end of 10 months to be soft and in as good condition as when originally made. It would, therefore, seem to be suitable for cakes that are to be kept for a long time.

In most of the recipes in foreign cookbooks "potash" (potassium bicarbonate) is recommended for use with honey to raise the dough. This is very similar in its properties to ordinary baking soda (sodium bicarbonate) and seems to have no advantage over it for this purpose. Whatever may have been the conditions in earlier times in Europe, baking soda is a common kitchen commodity in most American homes, and the potassium bicarbonate is almost unknown for household purposes. Both the potassium bicarbonate and baking soda gave much better results in the honey recipes tested than did the baking powder, and naturally, since the acid honey calls for an alkali like soda rather than a mixture of acid and alkali such as baking powder. If baking powder were used it should be in addition to soda enough to neutralize the acid of the honey, not merely as a substitute for soda, just as housekeepers sometimes neutralize sour milk or molasses with soda and then add baking powder to raise the dough.

In the countries where honey cakes have come to perfection spices are used which are somewhat uncommon in this country, and it is reasonable to suppose that long experience has taught a good com-

bination of flavors. Cardamom seed, a rather old-fashioned flavor which is still sometimes found in candies, seems to combine more satisfactorily with the flavor of honey than some of the spices which are better known in our kitchens. It is best, however, to use it in combination with other flavoring materials. The following has been found to be a good combination:

Salt, 1 part by measure.	Ginger, 4 parts.
White pepper, 1 part.	Cardamom, 8 parts.
Nutmeg, 2 parts.	Cinnamon, 16 parts.
Cloves, 2 parts.	

These should be thoroughly mixed and can be made up in quantity and kept ready for use.

Aniseed and coriander seed are also often used in honey cakes in combination with other spices. The following mixture is recommended in a baker's handbook,¹ the amounts given being suitable for 10 pounds of dough:

2 ounces ground cinnamon.	1 ounce finely ground coriander
$\frac{1}{2}$ ounce ground cloves.	seed.
2 ounces aniseed.	

In considering the uses of honey in cookery, it is well to remember that it owes its flavor to bodies which are very volatile and that for this reason it should not be heated unnecessarily hot or unnecessarily long.

In order to learn how honey is used in cookery, standard cookbooks from many countries were examined and many persons familiar with honey cookery were consulted. Innumerable as the recipes were, it was soon found that they belonged mainly to only a few different types, such as breads made with honey, honey cakes made with or without butter, fruits preserved in honey, and sauces and candies made with honey. Many recipes were tested in this laboratory, and some of the more desirable ones were adapted for use in the United States and are published here.

BREAD AND MUFFINS.

Honey is not often used in bread making but there is no reason why it may not be used in yeast bread as food for the yeast plant or be substituted for molasses or sugar in varieties of bread which call for such sweetening. A few recipes are here given.

BRAN BROWN BREAD.

1 cup white or whole wheat flour.	$\frac{1}{2}$ cup honey.
1 teaspoon soda.	1 cup sour milk.
$\frac{1}{4}$ teaspoon salt.	$\frac{1}{2}$ cup raisins floured.
1 cup bran.	

¹ The Twentieth Century Book for the Progressive Baker. By F. L. Gienandt. Boston, 1913, p. 129.

Sift together the flour, soda, and salt, and add the other ingredients. Steam three hours or bake 40 minutes in a slow oven. If the amount of milk is increased by half, the bread is more delicate and has a somewhat higher food value.

STEAMED BROWN BREAD.

1 cup yellow corn meal.	1 teaspoon salt.
2 cups graham flour.	1½ teaspoons soda.
$\frac{3}{4}$ cup honey.	1 tablespoon boiling water.
2 cups sour milk.	1 cup seeded raisins.

Mix together the meal, flour, and salt; add the sour milk and the honey and then the soda dissolved in the boiling water; and the raisins. Steam three hours in covered receptacles, which should be not more than two-thirds full at the beginning of the cooking.

HONEY BREAD.

2 cups honey.	4 teaspoons powered cardamom seed.
4 cups rye flour.	2 egg yolks.
1 teaspoon soda.	$\frac{1}{4}$ cup brown sugar.
4 teaspoons aniseed.	
2 teaspoons ginger.	

Sift the flour with the spices and soda and add the other ingredients. Put the dough into shallow buttered pans to the depth of about an inch and bake in a hot oven.

HONEY AND NUT BRAN MUFFINS.

$\frac{1}{2}$ cup honey.	1 tablespoon melted butter.
1 cup flour.	1½ cups milk.
$\frac{1}{4}$ to $\frac{1}{2}$ teaspoon soda.	$\frac{3}{4}$ cup finely chopped English walnuts.
$\frac{1}{4}$ teaspoon salt.	
2 cups bran.	

Sift together the flour, soda, and salt, and mix them with the bran. Add the other ingredients and bake for 25 or 30 minutes in a hot oven in gem tins. This will make about 16 large muffins, each of which may be considered roughly to be a 100-calorie portion and to contain 2 grams of protein.

HONEY AND NUT SANDWICHES.

Mix the honey with pecan meats or almonds minced, and make into sandwiches with small baking-powder biscuits.

HONEY AND CREAM CHEESE SANDWICHES.

Mix honey with cream cheese and use as filling for bread or baking-powder biscuit sandwiches. Chopped nut may be added to the honey and cheese if desired.

CAKES, COOKIES, ETC.

By far the most general use of honey in cookery is for cakes. Of these there is an almost endless variety, from rich fruit cake in loaves or elaborate pastries with honey filling to simple cookies. As has been pointed out, the honey flavor combines especially well with spices. The presence of honey also makes the cakes keep fresh longer. These two facts probably explain why the honey cakes, which belong mainly to the general order of gingerbreads or spice

cakes, are so largely produced by commercial bakers. Many of these are rather elaborate to make, and for that reason some of the simpler kinds of honey cakes may be preferred by the busy housekeeper.

HARD HONEY CAKE.

$\frac{3}{4}$ cup honey.	$\frac{1}{2}$ teaspoon cloves.
$\frac{1}{2}$ cup sugar.	Speck white pepper.
$2\frac{1}{2}$ cups flour.	Speck salt.
1 egg.	$\frac{1}{2}$ teaspoon soda.
$\frac{1}{4}$ teaspoon ginger.	1 tablespoon water.
1 teaspoon cinnamon.	2 ounces blanched almonds cut into
$\frac{1}{2}$ teaspoon ground cardamom seed.	small pieces or chopped

Sift together the flour and spices, dissolve the soda in the water, beat the egg and combine all the ingredients. Beat or knead the mixture thoroughly. Cook a small sample. If it does not rise sufficiently, add a little more soda and honey; if it falls, add a little more flour. Roll out the dough to the thickness of about three-fourths of an inch and bake in a hot oven. When the cake is done glaze it with a thick sirup of sugar and water and allow it to dry in a slow oven or in some other warm place. While it is still warm, cut it into long strips. Or it may be left in one large cake, to be cut into very thin slices when served. This cake will become very hard on cooling and will not be soft enough to eat for several weeks, but will keep in good condition for an indefinite length of time.

BUTTER HONEY CAKE.

$1\frac{1}{2}$ cups honey.	$\frac{1}{2}$ teaspoon salt.
$\frac{1}{2}$ cup butter.	$1\frac{1}{2}$ teaspoons soda.
3 egg yolks.	2 tablespoons orange-flower water
5 cups flour.	(water may be substituted).
2 teaspoons ground cinnamon.	Whites 3 eggs.

Rub together the honey and butter; add the unbeaten yolks and beat thoroughly. Add the flour sifted with the cinnamon and the salt; and the soda dissolved in the orange-flower water. Beat the mixture thoroughly and add the well-beaten whites of the eggs. Bake in shallow tins and cover with frosting made as follows:

ORANGE FROSTING FOR BUTTER HONEY CAKE.

Grated rind 1 orange.	1 tablespoon orange juice.
1 teaspoon lemon juice.	1 egg yolk.
Confectioners' sugar.	

Mix all ingredients but the sugar and allow the mixture to stand for an hour. Strain and add confectioners' sugar until the frosting is sufficiently thick to be spread on the cake.

For the cinnamon in the Butter Honey Cake the following mixture of spices may be substituted:

$\frac{1}{2}$ teaspoon ginger.	1 teaspoon cloves.
2 teaspoons cinnamon.	$\frac{1}{4}$ teaspoon nutmeg.
1 teaspoon ground cardamom seed.	$\frac{1}{4}$ teaspoon white pepper.

Chopped citron or nuts may also be added.

This mixture may also be flavored with ginger, aniseed, or cardamom seed.

BUTTER HONEY CAKE No. 2.

1 cup honey.	3 cups flour.
$\frac{1}{2}$ cup butter.	$\frac{1}{2}$ to 1 teaspoon soda.
$\frac{1}{2}$ teaspoon ginger.	1 ounce candied orange peel.
$\frac{1}{2}$ teaspoon cinnamon.	1 ounce candied lemon peel, or
1 teaspoon ground cardamom seed.	1 cup seeded raisins.
3 eggs.	

Mix the honey and butter by warming slightly and stirring; add the spices and the yolks of the eggs unbeaten and beat the mixture thoroughly. Add the flour and the soda dissolved in a little water, then the whites of the eggs beaten stiff, and finally the fruit. Bake in a moderate oven.

NUT HONEY CAKE.

2 cups brown sugar.	$\frac{1}{2}$ teaspoon ground nutmeg.
2 cups honey.	$\frac{1}{2}$ teaspoon allspice.
6 egg yolks.	1 cup chopped raisins.
3 cups flour.	$\frac{1}{2}$ ounce citron cut in small pieces.
Speck of salt.	$\frac{1}{2}$ ounce candied orange peel cut in
$1\frac{1}{2}$ teaspoons soda.	small pieces.
3 teaspoons ground cinnamon.	$\frac{1}{2}$ pound almonds coarsely chopped.
$\frac{1}{2}$ teaspoon ground cloves.	Whites of 3 eggs.

Mix the sugar, honey, and the yolks of the eggs, and beat thoroughly. Sift together the flour, salt, spices, and soda. Combine all ingredients but the whites of the eggs. Beat the whites of the eggs till they are stiff and add them last. Pour the dough to the depth of about half an inch into well-buttered tins, and bake in a slow oven for one-half hour.

FROSTING FOR NUT HONEY CAKE.

$1\frac{1}{2}$ cups sugar.	$\frac{3}{4}$ cup water.
3 egg whites.	

Boil the sugar and water until the sirup forms a thread when dropped from the spoon. While still hot, pour the sirup over the well-beaten whites of the eggs, beating the mixture until it is of the right consistency to spread.

CHOCOLATE NUT HONEY CAKE.

To the above cake add 3 ounces of chocolate grated.

SOFT HONEY CAKE.

$\frac{1}{2}$ cup butter.	1 teaspoon soda.
1 cup honey.	$\frac{1}{2}$ teaspoon cinnamon.
1 egg.	$\frac{1}{2}$ teaspoon ginger.
$\frac{1}{2}$ cup sour milk.	4 cups flour.

Rub the butter and honey together; add the egg well beaten, then the sour milk and the flour sifted with the soda and spices. Bake in a shallow pan.

HONEY SPONGE CAKE.

$\frac{1}{2}$ cup sugar.	4 eggs.
$\frac{1}{2}$ cup honey.	1 cup sifted flour.

Mix the sugar and honey and boil until the sirup will spin a thread when dropped from the spoon. Pour the sirup over the yolks of the eggs which have been beaten

until light. Beat this mixture until cold; then add the flour, and cut and fold the beaten whites of the eggs into the mixture. Bake for 40 or 50 minutes in a pan lined with buttered paper, in a slow oven.

This cake can be made with a cupful of unheated honey in place of the honey and sugar sirup, but the quality is not quite so good.

HONEY POUND CAKE.

A good pound cake can be made by using equal weights of honey, sugar, eggs, flour, and butter. A little soda should be added because of the acidity of the honey, and a good flavoring is cardamom seed and orange-flower water. Or a cake similar to pound cake may be made as follows:

1 cup sugar.	$\frac{1}{2}$ teaspoon powdered cardamom seed.
$\frac{3}{4}$ cup honey.	$\frac{1}{2}$ teaspoon soda.
1 cup butter.	$\frac{1}{2}$ teaspoon orange-flower water.
4 eggs.	
2 cups pastry flour.	

Rub together the butter and sugar, and add the honey. Add the yolks of the eggs well beaten. Finally, add the whites of the eggs, beaten to a stiff froth, and the orange-flower water. Add gradually the flour sifted with the soda and cardamom seed. Beat the mixture for 10 minutes. Put the dough into a warm tin with high sides, and bake in a slow oven one hour.

RIBBON CAKE.

UTILIZING CANDIED HONEY AS FILLING.

$\frac{1}{2}$ cup butter.	$1\frac{1}{2}$ teaspoons ginger.
2 cups sugar.	$\frac{3}{4}$ teaspoon cinnamon.
4 eggs.	$\frac{1}{4}$ teaspoon cloves.
1 cup milk.	$\frac{1}{3}$ cup raisins, seeded and cut in pieces.
$3\frac{1}{2}$ cups flour.	$\frac{1}{3}$ cup figs, finely chopped.
5 teaspoons baking powder.	1 tablespoon honey.
$1\frac{1}{2}$ teaspoons ground cardamom seed.	

Rub the butter and sugar together and add the yolks of the eggs. Sift together the flour and baking powder and add them to the mixture, alternating them with the milk. Finally, add the whites of the eggs well beaten. Bake two-thirds of the mixture in two layer-cake pans. To the remainder add spices, fruit, and honey, and bake in a layer-cake pan. Put layers together with crystallized honey.

HONEY FRUIT CAKE.

3 cups flour.	$1\frac{1}{2}$ pounds currants.
2 teaspoons soda.	1 pound citron.
$3\frac{1}{2}$ cups honey.	1 pound candied cherries.
1 cup butter.	1 pound candied apricots.
6 eggs.	1 pound candied pineapple.
2 teaspoons cinnamon.	$\frac{1}{2}$ cup sour jelly, or
2 teaspoons ginger.	$\frac{1}{2}$ cup white grape juice.
3 teaspoons ground cardamom seed	2 teaspoons vanilla.
$\frac{1}{2}$ teaspoon cloves.	2 ounces candied orange peel.
3 pounds raisins (seeded).	2 ounces candied lemon peel.

Cut the candied fruit into small pieces, with the exception of the cherries, which should be left whole. Place the fruit in a large dish and sift over it one-half of the flour, mixing thoroughly. Sift the soda with the remainder of the flour. Bring the honey and the butter to boiling point and while still hot add the spices. When the mixture is cool, add the well-beaten yolks of the eggs, then the flour and grape juice or jelly and the well-beaten whites. Finally, add the fruit. The cake should be divided into three or four parts and put into buttered dishes covered with buttered paper tied closely over the tops. Steam for five hours, remove the paper, and bake in a very slow oven for an hour. This makes a very rich cake consisting chiefly of fruit. For the sake of economy, the flour can be increased to even twice the quantity without affecting the quality very much.

HONEY FRUIT CAKE No. 2.

4 cups flour.	$\frac{1}{2}$ teaspoon cloves.
3 teaspoons soda.	3 pound raisins (seeded).
2 cups honey.	4 ounces citron.
1 cup butter.	1 pound cranberries.
6 eggs.	1 pound canned pineapple.
2 teaspoons cinnamon.	1 pound dried apricots.
2 teaspoons ginger.	1 pound dried apples.
3 teaspoons ground cardamom seed.	

To prepare the cranberries, pineapples, apricots, and apples, cook each in honey till it is soft; remove from the honey and dry in a very slow oven. A little water should be added to the honey in which the cranberries are cooked, a good proportion of ingredients being equal weights of cranberries, water, and honey. To any honey left over from cooking the fruits add enough honey to make up the total amount called for by the recipe. Mix and cook the cake in the same manner as honey fruit cake No. 1.

HONEY DROP CAKES.

$\frac{3}{4}$ cup honey.	$1\frac{1}{2}$ to 2 cups flour.
$\frac{1}{4}$ cup butter.	$\frac{1}{2}$ teaspoon soda.
$\frac{1}{2}$ teaspoon cinnamon.	2 tablespoons water.
$\frac{1}{8}$ teaspoon cloves.	1 cup raisins, cut into small pieces.
1 egg.	

Heat the honey and butter until the butter melts. While the mixture is warm add the spices. When it is cold add part of the flour, the egg well beaten, the soda dissolved in the water, and the raisins. Add enough more flour to make a dough that will hold its shape. Drop by spoonfuls on a buttered tin and bake in a moderate oven.

YELLOW HONEY CAKE.

$\frac{1}{2}$ cup sugar.	$\frac{1}{4}$ teaspoon cinnamon.
2 egg yolks.	$\frac{1}{8}$ teaspoon cloves.
$\frac{2}{3}$ cup honey.	$1\frac{1}{2}$ cups flour.

Sift together the flour and the spices. Mix the sugar and egg yolks, add the honey, and then the flour gradually. Roll out thin, moisten the surface with egg white, and mark into small squares. Bake in a moderate oven.

HONEY COOKIES No. 1.

- | | |
|------------------------------------|---|
| $\frac{2}{3}$ cup honey. | 1 teaspoon allspice. |
| $\frac{2}{3}$ cup sugar. | 2 ounces finely chopped candied |
| $2\frac{1}{2}$ cups flour. | orange peel. |
| $\frac{1}{2}$ teaspoon soda. | $\frac{1}{4}$ pound walnut meats finely |
| $1\frac{1}{2}$ teaspoons cinnamon. | chopped. |
| 1 teaspoon cloves. | |

Sift together the flour, spices, and soda, and add the other ingredients. Knead thoroughly, roll out thin, and cut with a biscuit cutter. These cookies are very hard.

HONEY COOKIES No. 2.

- | | |
|--------------------------|--|
| $\frac{1}{4}$ cup honey. | $\frac{1}{2}$ teaspoon salt. |
| $\frac{2}{3}$ cup sugar. | 1 teaspoon ground cinnamon. |
| $\frac{1}{2}$ cup milk. | $\frac{1}{2}$ cup finely chopped almonds. |
| 3 tablespoons lard. | $\frac{1}{2}$ teaspoon soda or 2 teaspoons |
| 2 egg yolks. | baking powder. |
| 4 cups flour. | |

Bring the first four ingredients to the boiling point and allow the mixture to cool. Sift together the flour, cinnamon, and soda or baking powder. Combine all the ingredients. Roll the mixture out thin on a floured board. Cut out and bake in a moderate oven on tins which have been greased and floured. To prepare the tins properly, brush them over with melted butter and sifted flour, turn them over, and shake off as much as possible of the flour.

HONEY COOKIES No. 3.

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|------------------------------|------------------------------|
| $\frac{1}{4}$ cup water. | 1 teaspoon soda. |
| 1 pound brown sugar or 2 | 6 cups flour. |
| cups packed solidly. | 1 teaspoon powdered cardamom |
| $\frac{1}{2}$ cup lard. | seed. |
| 1 cup honey. | 1 teaspoon cinnamon. |
| $\frac{1}{3}$ cup egg yolks. | |

Heat the water, sugar, lard, and honey until the lard is melted. When cool, add the yolks of the eggs and the flour, sifted with the soda, and spices. Roll out on a floured board and cut into any desired shape. Place a small piece of citron in the middle of each cookie.

HONEY BRAN COOKIES No. 1.

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|---|--|
| 2 tablespoons butter. | $\frac{1}{2}$ cup flour. |
| $\frac{1}{2}$ cup honey. | 1 cup bran. |
| 2 eggs. | $\frac{1}{8}$ teaspoon powdered aniseed. |
| $\frac{1}{4}$ to $\frac{1}{2}$ teaspoon soda. | |

Rub together the butter and honey; add the eggs unbeaten and beat the mixture thoroughly. Sift together the flour, soda, and aniseed. Combine all the ingredients; drop from a teaspoon on to a buttered tin and bake in a moderate oven.

HONEY BRAN COOKIES No. 2.

- | | |
|---|----------------------------------|
| 3 cups bran. | $\frac{1}{4}$ teaspoon ginger. |
| $\frac{1}{2}$ cup sugar. | $\frac{1}{2}$ cup honey. |
| $\frac{1}{4}$ to $\frac{1}{2}$ teaspoon soda. | $\frac{1}{2}$ cup milk. |
| $\frac{1}{4}$ teaspoon cinnamon. | $\frac{1}{2}$ cup melted butter. |

Mix the sugar, cinnamon, ginger, and soda with the bran and add the other ingredients. Drop from a spoon upon a buttered pan and bake about 15 minutes.

ROLLED HONEY WAFERS No. 1.

$\frac{1}{4}$ cup butter.

$\frac{3}{4}$ cup honey.

$\frac{7}{8}$ cup flour.

$\frac{1}{4}$ teaspoon powdered cardamom or aniseed.

Mix together the butter and honey and add the flour, sifted with the spice. Spread out very thin with a broad long-bladed knife or spatula on a buttered, inverted dripping pan, or on flat tins made for the purpose. Mark off in 3-inch squares and bake in a slow oven until delicately browned. While warm, roll into tubular shape and hold until they cool and, if necessary, until they harden into shape. Honey wafers are not quite so tender as those made with sugar.

ROLLED HONEY WAFERS No. 2.

$\frac{1}{4}$ cup honey.

$\frac{1}{4}$ cup sugar.

$\frac{1}{4}$ cup butter.

$\frac{7}{8}$ cup flour.

$\frac{1}{8}$ cup milk.

$\frac{1}{4}$ teaspoon cardamom or aniseed.

Cream the butter; add the sugar, honey, and flour in the order named, and the milk very gradually. Cook as rolled honey wafers No. 1.

NOUGAT WAFERS.

$\frac{1}{2}$ cup butter.

1 cup brown sugar.

$\frac{1}{2}$ cup milk.

$\frac{7}{8}$ cup bread flour.

4 teaspoons ginger, or

2 teaspoons powdered cardamom or aniseed.

Rub together the butter and the sugar and add alternately the milk and the flour sifted with the spices. Spread in a very thin layer on the bottom of an inverted dripping pan or on flat tins made for the purpose. Mark off into pieces about an inch wide and 4 inches long and put together in pairs with honey nougat filling made as follows:

HONEY FILLING FOR NOUGAT WAFERS.

1 cup sugar.

$\frac{1}{2}$ cup honey.

$\frac{1}{4}$ cup water.

2 egg whites.

Boil the sugar, water, and honey together until the sirup makes a thread when dropped from a spoon, or until drops of it hold their shape when poured into cold water. Beat the eggs to a stiff froth, pour the sirup over them, put the dish holding the mixture in a place where it will keep warm but not cook rapidly, beat until it will hold its shape.

HONEY RISSOLES.

PASTRY COVERING FOR RISSOLES.

$\frac{1}{2}$ cup lard.

2 egg yolks.

1 egg white.

$\frac{3}{4}$ cup water.

$\frac{1}{4}$ cup brown sugar.

Flour.

Mix together all the ingredients but the flour and add enough of that to make a stiff dough. Roll out as thin as a knife blade, cut into round or square pieces, taking care to avoid the necessity of rolling out the second time, as this is likely to make the dough very tough. A honey filling is used with this dough and is made as follows:

HONEY FILLING FOR RISSOLES.

- | | |
|-------------------------------|-------------------|
| 1 cup honey. | Rye bread crumbs. |
| 2 ounces candied orange peel. | Aniseed. |

Bring the honey to the boiling point, remove from the stove, and add as much bread crumb as it will moisten while it is hot. Add the orange peel and enough powdered aniseed to give a decided flavor. Roll this filling into small balls and lay one in the center of each piece of pastry; fold the pastry over and press the edges together. Bake in a hot oven.

DESSERTS.

The following recipes suggest ways in which honey can be substituted for sugar or molasses in many common desserts. The ingenious cook with honey to spare can easily work out others if she remembers what was said on pages 11 and 12 about the sweetening power and water and acid content of honey:

BAKED HONEY CUSTARD.

- | | |
|--------------------------|---|
| 5 eggs. | $\frac{1}{2}$ teaspoon powdered cinnamon. |
| $\frac{1}{2}$ cup honey. | $\frac{1}{4}$ teaspoon salt. |
| 4 cups scalded milk. | |

Beat the eggs sufficiently to unite the yolks and whites, but not enough to make them foamy. Add the other ingredients and bake in cups or in a large pan in a moderate oven. The baking dishes should be set in water.

BOILED HONEY CUSTARD.

- | | |
|--------------|------------------------------|
| 2 cups milk. | $\frac{1}{2}$ cup honey. |
| 3 egg yolks. | $\frac{1}{2}$ teaspoon salt. |

Mix the honey, eggs, and salt. Scald the milk and pour it over the eggs. Cook in a double boiler until the mixture thickens. This custard is suitable for use in place of cream on gelatin desserts, or to be poured over sliced oranges or stewed fruit.

HONEY PUDDING.

- | | |
|--------------------------|--------------------------------|
| $\frac{1}{2}$ cup honey. | $\frac{1}{2}$ teaspoon ginger. |
| 6 ounces bread crumbs. | 2 egg yolks. |
| $\frac{1}{2}$ cup milk. | 2 tablespoons butter. |
| Rind of half a lemon. | 2 egg whites. |

Mix the honey and the bread crumbs and add the milk, seasonings, and yolks of the eggs. Beat the mixture thoroughly and then add the butter and the whites of the eggs well beaten. Steam for about two hours in a pudding mold which is not more than three-quarters full.

HONEY CHARLOTTE RUSSE.

- | | |
|-----------------|--|
| 1 quart cream. | $\frac{1}{2}$ cup delicately flavored honey. |
| 6 lady fingers. | |

Chill the honey by placing the dish containing it in a pan of ice water. Whip the cream and add it to the honey, mixing the two well. Line a dish with lady fingers and fill it with the honey and cream. Serve very cold.

HONEY MOUSSE.

- | | |
|---------------|--------------------------------|
| 4 eggs. | 1 cup hot, delicately flavored |
| 1 pint cream. | honey. |

Beat the eggs slightly and slowly pour over them the hot honey. Cook until the mixture thickens. When it is cool, add the cream whipped. Put the mixture into a mold, pack in salt and ice, and let it stand three or four hours.

HONEY ICE CREAM No. 1.

1 quart thin cream. $\frac{3}{4}$ cup delicately flavored honey.
Mix ingredients and freeze.

HONEY ICE CREAM No. 2.

1 pint milk. 1 cup honey.
Yolks 6 eggs. 1 pint cream.

Heat the milk in a double boiler. Beat together the honey and eggs, add the hot milk, return the mixture to the double boiler, and cook it until it thickens. Add the cream and when the mixture is cool, freeze it.

PRESERVED FRUITS.

CURRANTS.

Bar-le-Duc currants, an article of commerce often made with honey, sell for a relatively high price, in part no doubt because of the large amount of labor involved in preparing them. The seeds are removed from the currants by a method which mutilates the fruit very slightly; the fruit is then preserved in honey or sugar sirup. Those who wish to take the time to preserve currants in this way will find that a convenient way to remove the seeds is to cut a small slit in the side of each currant and remove the seeds by means of a needle. After this is done, weigh the currants and take an equal weight of honey. Bring the honey to the boiling point, add the currants, and allow them to cook at the boiling point for two or three minutes, or until the skins are tender, being careful not to let the mixture boil violently because this is likely to destroy the shape of the fruit. If the currants are so juicy as to liquefy the honey too much, they may be removed and the sirup reduced to the desired consistency, after which the currants may be replaced.

It is possible, of course, to preserve currants in honey according to the same recipe without the removal of the seeds, but the preserve thus obtained is not nearly so delicate as when the seeds are removed.

CRANBERRIES.

A very good preserve may be made from cranberries and honey which will remain in good condition for a long time. Take equal weights of cranberries, honey, and water. Cook the berries in the honey and water until the skins are soft. Remove the berries and boil down the sirup until just enough remains to cover the berries. Pour into glasses and cover as you would jelly. The appearance of the cranberries is improved if each one is pricked several times before cooking and if the cooking is slow at first. This gives the sirup an opportunity to penetrate the berries without destroying their form. A satisfactory method is to place all the ingredients in a double boiler and heat them very slowly. If this method is followed, the boiling down of the sirup is even more necessary than when the berries are cooked more rapidly.

STRAWBERRIES.

Take equal weights of strawberries and honey; mix the two and dry in the sun, or preferably in a warm oven; put into carefully sterilized glasses and cover with paraffin.

APPLES.

2 quarts apples cut into small pieces. 1 cup vinegar.
2 cups honey. 1 teaspoon cinnamon.

Heat the honey, vinegar, and cinnamon together and cook the apples, a few at a time, in the sirup until they become transparent. Pour the sirup which remains after all the fruit is cooked over the apples.

FRUIT AND HONEY JELLY.

A good jelly may be made from winter apples and honey, using a cupful of honey to each cupful of apple juice and proceeding as in ordinary jelly-making. Honey could probably be used with other fruits suitable for jelly, but no definite directions have been worked out in this laboratory. The more delicately flavored honeys are probably best for this purpose, alfalfa giving an especially spicy taste.

ICING, SAUCES, CANDIES, ETC.

HONEY ICING.

1 cup granulated sugar.
 $\frac{1}{4}$ cup water.

$\frac{1}{4}$ cup honey.
1 egg white.

Boil together the sugar and the water for a few moments and then add the honey, taking precautions to prevent the mixture from boiling over, as it is likely to do. Cook until drops of the sirup keep their form when poured into cold water, or to about 250° F. Beat the white of the egg until stiff, and when the sirup has cooled slightly pour over the egg, beating the mixture continuously until it will hold its shape. This frosting is suitable for use between layers of cake, but is rather too soft for the top. It remains in good condition and soft enough to be spread for many weeks and, therefore, can be made in large quantities for use as needed. After eight months, such icing made in this laboratory was found to be in good condition and soft enough to cut.

SAUCE FOR ICE CREAM.

2 tablespoons butter.
2 teaspoons cornstarch.

$\frac{1}{2}$ cup honey.

Cook together the cornstarch and butter thoroughly, being careful not to brown them. Add the honey and cook the mixture until it becomes hard when dropped into cold water and until all taste of raw cornstarch has been removed.

PUDDING SAUCE.

If a small quantity of water be added to the above sauce, its consistency is entirely changed; it becomes thinner and can not be made brittle even by dropping it into cold water. It is suitable for serving on various kinds of puddings.

STRAWBERRY SAUCE.

Strawberry sauce, for puddings or boiled rice, which is usually made by mixing butter, sugar, and mashed berries, is a good means of securing the strawberry flavor at times when berries are too high-priced to be used in large quantities. The substitution of honey for sugar has proved to be practicable. In fact, it obviates one of the chief difficulties in making this sauce—the tendency to curdle.

2 tablespoons butter.
 $\frac{3}{4}$ cup mashed strawberries.

$\frac{1}{2}$ cup honey.

Beat together the honey and butter. Add the strawberries slowly, keeping the mixture cool by setting the dish in water. Serve on boiled rice or cottage pudding.

SALAD DRESSING.

4 egg yolks.
2 tablespoons vinegar or lemon juice.
2 tablespoons butter.
2 tablespoons honey.

1 teaspoon mustard.
1 teaspoon salt.
Paprika to taste.
1 cup cream.

Heat the cream in a double boiler. Beat the eggs, and add to them all the other ingredients but the cream. Pour the cream slowly over the mixture, beating constantly. Pour it into the double boiler and cook until it thickens, or mix all the ingredients but the cream and cook in a double boiler until the mixture thickens. As the dressing is needed combine this mixture with whipped cream. This dressing is particularly suitable for fruit salads.

NOUGAT.

- | | |
|--------------------------------|------------------|
| $\frac{3}{4}$ cup honey. | 1 pound almonds. |
| $\frac{1}{2}$ cup brown sugar. | 2 egg whites. |

Boil the honey and sugar together until drops of the mixture hold their shape when poured into cold water. Add the whites of the eggs, well beaten, and cook very slowly, stirring constantly, until the mixture becomes brittle when dropped into water. Add the almonds and cool under a weight. The candy can be broken into pieces, or may be cut and wrapped in waxed paper.

HONEY FUDGE.

- | | |
|--------------------------------|--------------------------|
| 2 cups sugar. | $\frac{1}{2}$ cup water. |
| $\frac{1}{2}$ cup honey. | 2 egg whites. |
| 1 teaspoon of vanilla extract. | |

Boil together the sugar, honey, and water until the sirup spins a thread when dropped from a spoon (about 250° F.). Pour the sirup over the well-beaten whites of the eggs, beating continuously and until the mixture crystallizes, adding the flavoring after the mixture has cooled a little. Drop in small pieces on buttered or paraffin paper. The vanilla may be omitted.

HONEY CARAMELS.

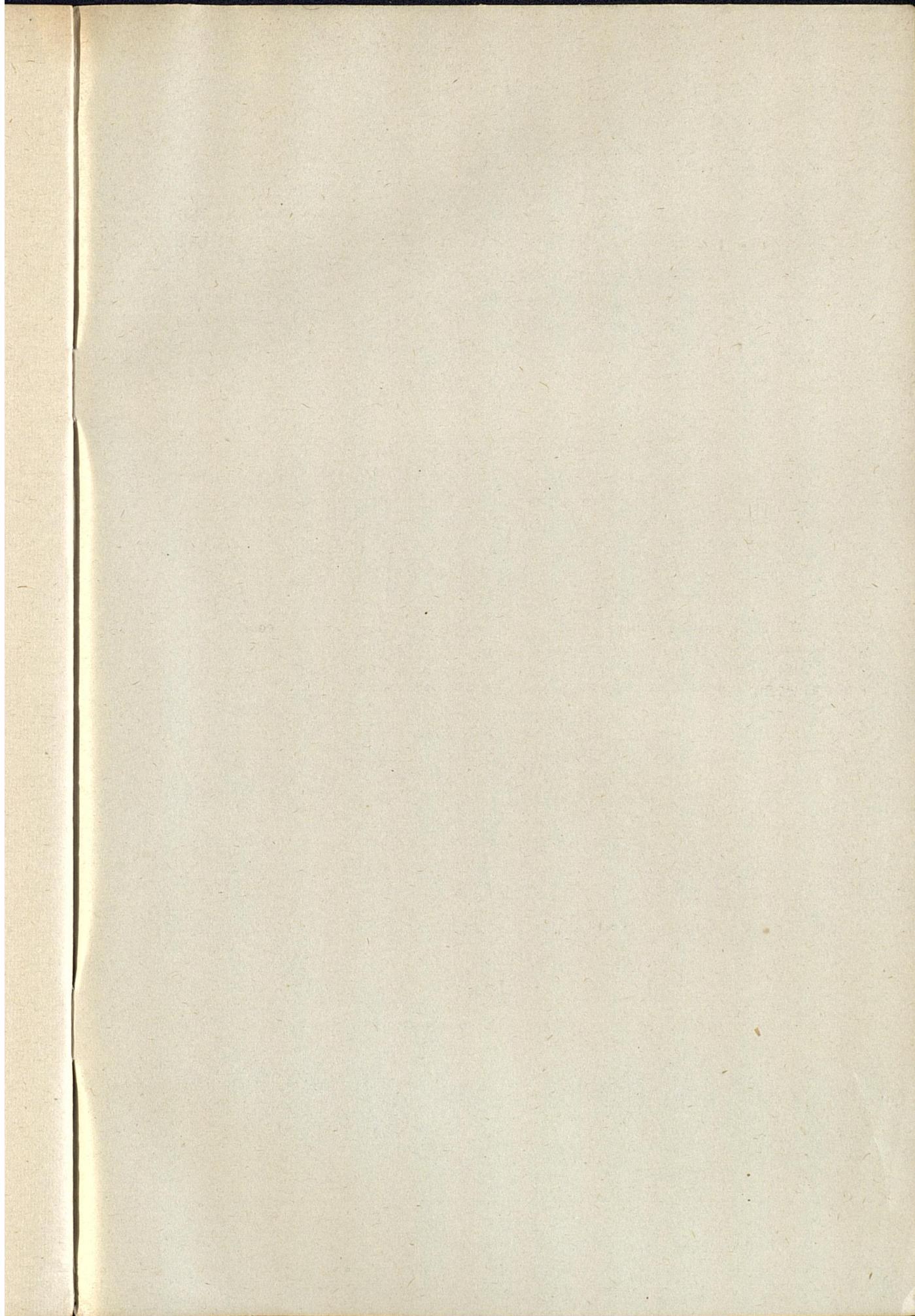
- | | |
|----------------------------------|---------------------------|
| 2 cups granulated sugar. | $\frac{1}{4}$ cup honey. |
| $\frac{1}{2}$ cup cream or milk. | $\frac{1}{4}$ cup butter. |

Mix the ingredients; heat and stir until the sugar is dissolved; then cook without stirring until a firm ball can be formed from a little of the mixture dropped into cold water. Beat the mixture until it crystallizes, pour into buttered pans, and cut into squares. The addition of pecan nuts improves these caramels.

HONEY POPCORN BALLS.

Honey can be heated up to about 245° F. without being greatly changed in color or flavor. If it is heated carefully most of the water is expelled. The honey then becomes hard on cooling and can be used for making popcorn balls. To make them, dip the popped corn into the hot honey, shape into balls and cool. Honey popcorn balls absorb moisture on standing in the air. They must therefore be either kept very closely covered or reheated and dried before being used.





ORIGINAL ARTICLES

THE EFFECT OF THE VARIOUS TYPES OF EXERCISE ON THE
HEART AND CIRCULATION

By J. H. HARRIS, M.D., and J. H. HARRIS, M.D.,
University of Chicago, Chicago, Ill.

Abstract

The effect of the various types of exercise on the heart and circulation was studied in a series of experiments on man.

The results of the experiments show that the heart rate and the volume of blood pumped by the heart increase with the intensity of the exercise.

Introduction

The purpose of this study was to determine the effect of the various types of exercise on the heart and circulation.

The experiments were conducted in a series of three parts. In the first part, the effect of light exercise on the heart rate and the volume of blood pumped by the heart was studied.

Methods

The heart rate was determined by counting the pulse rate. The volume of blood pumped by the heart was determined by the Fick method.

Report of the President of the Ohio State University.

REPORT

To the Secretary of the Interior
Washington, D. C.

SIR:— I have the honor to submit my annual report of the condition and progress of the Ohio State University for the year ending June 30, 1895.

The whole number of students in attendance during the academic year was 805. Their distribution is shown in part

President of the Ohio State University

Graduate Students..... 30

Undergraduate Students—

TO THE

FOUR-YEAR COURSES:

Seniors..... 23

Juniors..... 22

Sophomores..... 125

SECRETARY OF THE INTERIOR

THREE-YEAR COURSES:

Mineralogy..... 20

Veterinary Medicine..... 12

Preparatory to Medicine..... 7

AND THE

TWO-YEAR COURSES:

Agriculture..... 41

Mining..... 11

Ceramics..... 11

SECRETARY OF AGRICULTURE.

Dairying—Three Years..... 9

THE SCHOOL OF LAW.

Seniors..... 33

Juniors..... 20

PREPARATORY DEPARTMENT.

Students..... 60

For the Year Ending June 30, 1895.

Deduct names counted twice..... 42

Total..... 805

REPORT

President of the Ohio State University

HANN & ADAIR, PRINTERS, COLUMBUS.

SECRETARY OF AGRICULTURE

for the Year Ending June 30, 1897

Report of the President of the Ohio State University.

To the Secretary of the Interior and the Secretary of Agriculture,
Washington, D. C.:

SIRS — I have the honor to submit my annual report of the condition and progress of the Ohio State University for the year ending June 30, 1895.

The whole number of students in attendance during the academic year was 805. Their distribution is shown in part by the following summary:

COLLEGIATE DEPARTMENT.

Graduate Students	20
Undergraduate Students —	
FOUR-YEAR COURSES:	
Seniors	84
Juniors	93
Sophomores	129
Freshmen	186
Special Students	46
	— 538
THREE-YEAR COURSES:	
Pharmacy	45
Veterinary Medicine	16
Preparatory to Medicine	7
	— 68
TWO-YEAR COURSES:	
Agriculture	41
Mining	11
Ceramics	11
	— 63
Dairying — Three Months	43

THE SCHOOL OF LAW.

Seniors	43
Juniors	22
	— 65

PREPARATORY DEPARTMENT.

Students	50
	— 847
Deduct names counted twice	42
Total	805

The number in the school of agriculture was as follows : In agriculture, 29; in horticulture and forestry, 8; in the two-year course in agriculture, 45. Total, 82.

The number in the school of engineering was as follows: In civil engineering, 70; in mine engineering, 18; in mechanical engineering, 37; in electrical engineering 116; in industrial arts, 4; in the short course in mining, 11; in ceramics, 11. Total, 267.

In the school of veterinary medicine there were 16; in the school of pharmacy, 45; and in the course preparatory to medicine, 7. Total, 68.

The total number in the technical schools was 417.

Three new courses were offered for the first time. One of these was a course in ceramics and clay-working, which had been provided for by the State legislature. The sum of five thousand dollars was appropriated to establish and maintain it the first year, and two thousand five hundred dollars to maintain it the second year. Edward Orton, Jr., E. M., was chosen director.

A two-year course of study was adopted and the department has been temporarily located in Orton Hall. Kilns, pyrometers and all the apparatus necessary for clay analysis and manufacture were provided, and the department opened for the reception of students in September.

Liberal contributions to the equipment were made by manufacturers. The director says of the plant: "It is unquestionably the first laboratory on this continent equipped for these purposes by an educational institution; and, as far as I can learn, its equipment compares favorably with any abroad." There were eleven students in the course, and the work has been begun very satisfactorily.

A course in dairying was another new feature of the year. Rooms in the chemical building were fitted up and supplied with vats, separators, churns, butter-workers, cheese-press, curd-mill, milk-testers, scales, refrigerator, and all the necessary apparatus, both hand and power, for per-

forming the processes of the dairy after the most approved methods. Mr. DeWitt Goodrich was placed in charge, and forty-three students received instruction. The work was highly successful.

The third new course was one preparatory to the study of medicine. It provides work for three years, consisting chiefly of studies in science, most of them such as require laboratory practice. To these are added English, and German or French, Latin, political economy and psychology. This course was chosen by seven students.

Two hours a week were given by the class in agriculture (1) to the study of soil physics. Each student performed and reported on eight experiments. It is the purpose to give still more attention to this kind of instruction, as the results have been very satisfactory.

The experiments with fertilizers and in the rotation of crops conducted for several years for the Ohio Experiment Station, have been continued; and some additional experiments in corn culture, milk and egg production, and pig feeding have been carried on.

On the first of April Wm. D. Gibbs, B. Sc., assumed the duties of foreman of the farm in place of Franklin P. Stump, B. Agr., resigned; and at the close of the year Mr. Gibbs was elected assistant professor of agriculture, his former position being filled by the election of Mr. Charles W. Burkett.

James S. Hine, B. Sc. in Agriculture, who was foreman in the department of horticulture and forestry, was elected assistant in entomology, and assigned to the department of zoölogy and entomology. His place in the department of horticulture and forestry was filled by the election of Mr. C. B. Hine.

In horticulture the plan of teaching was somewhat varied from that of former years, with a view to making it more practical. Not only was the class-room instruction supplimented as heretofore with practice in the laboratory, the green-house, the garden and the orchard, but each stu-

dent in horticulture (1) kept a journal in which he recorded briefly the more important operations and occurrences of each day in the department, such as the weather, the dates of planting, cultivating and harvesting the principal crops, the time of blooming in the garden and orchard, the appearance of weeds, insects and birds, the products sold and the prices received. These records were examined from time to time and suggestions were made for improving them.

The work of the other departments immediately concerned with instruction in the subjects pertaining to agriculture, was carried on after the methods and on about the same scale as in the preceding year.

Some important additions were made to the machinery in the department of industrial arts. The purchases amounted to one thousand dollars. A few donations were received. Twenty-eight cases for various purposes, a nine-inch speed lathe, a ten-inch, four-jaw independent chuck, a set of fourteen milling-cutters, a number of taps, counter-boxes and other special tools were made by student labor.

Professor S. W. Robinson, the head of the department of mechanical engineering, was absent on leave for the year, on account of broken health. At this writing it is not certain whether he will resume his duties for the coming year or not. In his absence his work was distributed, the laboratory being under the direction of his assistant, Embury A. Hitchcock, M. E., the senior class being assigned to Director Williston of the industrial department, and the junior class to Henry C. Lord, B. Sc., assistant in mathematics and astronomy. An additional assistant was employed to teach the classes in mathematics formerly heard by Mr. Lord.

Owing to the crowded condition of the laboratory of agricultural chemistry, the students in engineering have been transferred to the department of general chemistry, and a new laboratory for their accommodation was fitted up in Hayes Hall. It was provided with about sixty desks.

The report of the treasurer of the University to the Secretary of the Interior and the Secretary of Agriculture, shows the manner in which the last installment of money received under the act of congress of August 30, 1890, has been disbursed. The other statistical information called for is contained in the following tables :

II. Receipts for and During the Year Ended June 30, 1895.

1. State aid (a) Income from endowment granted by State (State tax).....	\$85,510 38
(b) Appropriation for current expenses.....	
(c) Appropriation for building or other special purposes.....	4,952 89
2. Federal aid: (a) Income from land grant, act July 2, 1862.....	32,915 14
(b) For experiment stations, act of March 2, 1887	
(c) Additional endowment, act of August 30, 1890.....	20,000 00
3. Fees and all other sources	23,740 38
Total	\$167,078 79

III. Expenditures for and During the Year Ended June 30, 1895.

1. College of Agriculture and Mechanic Arts.....	\$92,340 49
2. Experiment station.....	
3. All other departments	70,548 00
Total expenditures.....	\$162,888 49

IV. Property and Equipment, Year Ended June 30, 1895.

Value of all buildings	\$390,000
Other equipment.....	130,000
Buildings used (but not exclusively) by the agricultural and mechanical departments.....	\$350,000
Other equipment, say.....	100,000

Total number of acres, 337; acres under cultivation, 170; acres used for experiments, 65; value of farm lands, \$68,000 (as farm land); amount of all endowment funds, \$546,202.17.

V. Library, Year Ended June 30, 1895.

1. Number of bound volumes, June 30, 1894....	13,473; pamphlets, 7,000
2. Bound volumes added during year ended June 30, 1895.....	3,257; pamphlets, 1,000
Total bound volumes.....	16,730; pamphlets, 8,000

47-M-64

VI. Faculty During Year Ended June 30, 1895.

1. College of agriculture and Mechanic Arts:	Male.	Female.
(a) Preparatory classes	3	1
(b) Collegiate and special classes.....	56	1
(c) Total, counting none twice.....	56	1
2. Number in all other departments (excluding duplicates)	21	

VII. Students During Year Ended June 30, 1895.

1. College of Agriculture and Mechanic Arts:	Male.	Female.
(a) Collegiate and special classes.....	452 ⁽¹⁾	6 ⁽¹⁾
Total, counting none twice	451	6
2. Number in all other departments	236	122
3. Number of students that pursued courses in agriculture, 70 ⁽²⁾ ; mechanical engineering, 37; civil engineering, 70; electrical engineering, 116; mining engineering, 29; veterinary science, 16 ⁽³⁾ ; military tactics, 310.		
4. Number of degrees and kind conferred in 1894-95: On men, B. A. 6.; B. Ph., 11; B. Sc., 9; C. E., 9; E. M. (Eng. of Mines), 1; M. E., 2; E. E., 15; G. Ph., 11; D. V. M., 4; B. LL., 16; M. A., 1; M. Agr., 1; D. Sc., 1. On women, B. A., 13; B. Ph., 8; B. Sc., 3; G. Ph., 1; M. A., 1.		

W. H. SCOTT,

President.

AUGUST 13, 1895.

(1) Including the students in the general science course, 34.

(2) Also in horticulture and forestry, 8, and in dairying, 43; total, counting none twice, 89.

(3) Pharmacy, 45; ceramics, 11; industrial arts, 4.

NINTH REPORT OF THE COMMITTEE ON THE METRIC SYSTEM OF WEIGHTS AND MEASURES.

(The Boston Society of Civil Engineers is not responsible, as a body, for the statements and opinions advanced in any of its publication.)

TO THE BOSTON SOCIETY OF CIVIL ENGINEERS:

Bill in Congress.

Your committee, instructed March 16, 1881 to "gather from time to time and present to the Society all attainable information relative to the introduction of the metric system," has to say that in the national House of Representatives, June 30, 1884, there was introduced from the Committee on Coinage, Weights and Measures, and is now pending, a bill (of which a copy is annexed) requiring the Government Departments to use the metric system from March 4, 1889. Two things remain to be done: to pass the bill, and to carry its provisions into effect.

First, such a bill will be passed when every Congressman knows that his constituents demand it. Hence every citizen is advised to mail to his Representative, or to any other Representative with whom he may be better acquainted, addressing House of Representatives, Washington, D. C., his petition, either in the simple form appended to this report or in any other form. Under the rules such petitions are referred to the Committee on Coinage, Weights and Measures, which has charge of the bill. If the press of business should prevent the present Congress from acting on it, the next Congress can be memorialized, and as new Congresses come in every two years, they can be successively appealed to until some enactment is made.

Secondly, to get the proposed law so carried into effect as to do the most good requires an acquaintance with the metric system by the people with whom the government deals as well as by the government officers; it requires that the metric system should be generally adopted in private transactions at the same time as in governmental transactions or as rapidly as possible thereafter; it requires that between now and the date to be fixed by the enactment, the preparatory steps of the change should be deliberately and carefully made in all other classes of measuring as they have already been, or are now being made in various branches of work specified in the several reports of your committee during the past nine years.

Recent Progress.

Since its last report a few additional particulars of this gradual progress have been collected, some of little significance, some of much.

Electrical science, whose applications are now being marvelously developed, has its units, the *ohm*, *volt*, etc., founded on the metric measures. The basis for the system was furnished by a committee of the British Association for the Advancement of Science. At an international convention, which met at Paris in April, 1884, where there were nine delegates deputed by the British Government, and where the United States, Russia, Persia, China and Japan were also among the nations represented, it was agreed, after ample discussion, that the legal *ohm* is the resistance of a column of mercury one square millimeter in cross-section, and 106 centimeters in length at the temperature of melting ice. This and other units connected with the centimeter, gram and second were indorsed. The American Electrical Conference called together in Philadelphia, 8th September, 1884, for the purpose, among other things, of taking authoritative action respecting these electrical standards, favored their adoption, and deemed it of national importance that Congress should fix standards of electrical measures.

At Minneapolis flour is put up in bags of 50 kilos and 100 kilos for exportation to the continent of Europe.

The Barnes micrometer caliper, patented in 1883, for measuring wire, etc., is advertised by A. J. Wilkinson & Co., of this city, graduated either in metric measure or in decimals of an inch.

An important step preparatory to the free use of the metric system is the publication in metric measure of such reference books and tables of data as are commonly used in various professions and trades. Its gradual introduction in such places comes within almost every one's observation. In the table issued by the Iron and Steel Wire Manufacturers' Association, England, giving sizes, weights and breaking strains of iron wire according to the imperial standard wire gauge established March 1, 1884, diameters are given in millimeters as well as in inches. Metric expressions of quantity appear very frequently upon the pages of the ninth edition of the *Encyclopædia Britannica*, now in course of publication, but were found scarcely anywhere in the eighth. In the forthcoming edition of Henck's *Field Book for Railroad Engineers*, a table of metric railway curves is for the first time inserted.

W. S. Fortescue & Co., of Philadelphia, have recently published *Metrical Tables*, simply arranged on a large sheet, by Olin H. Landreth, professor of engineering in Vanderbilt University, Nashville, Tenn.

In the *Transactions*, published by the Association of Engineering Societies, there have been up to the present time 118 papers containing expressions of weight or measure; 8 of these have used the metric system chiefly or wholly; 13 others have contained metric in addition to old denominations; the remaining 97 contained only the old weights and measures, among others the 4-rod chain with its link, the front foot, the square (of 100 square feet), the miner's inch of running water, the perch of masonry, the bushel of coal and of grain, the fluid ounce, the minim, two different tons, the troy ounce and the drachm.

The Civil Engineer's Way.

A step that the engineer has frequently taken, and can perfectly well take without waiting for his neighbors, or for legislation, is to add a metric linear scale to all the plans drawn in his office.

In land surveying not connected with previous work and not to be directly followed by construction, such surveying, for example, as is often done for determining areas of making plans and descriptions for record, metric measures may easily be used in the field. Some cases in which they have been used have been mentioned in previous reports. A new case is the surveying of some plantations near West Point, Virginia, during the present year by Mr. F. E. Montague, who had to reduce all his results to old denominations for the accommodation of the conservative landholders.

Another introductory step that engineers would do well to take is to abandon the U. S. gallon in water computations as a worthless unit. American water-meters read in cubic feet; the city of Boston measures water with them and makes out consumers' bills in cubic feet. To supply incongruity, the paper on which the city of Boston takes the diagrams of its Deacon waste water meters is ruled to read U. S. gallons and the reports of the Boston Water Board give in U. S. gallons statistics of consumption, quantities pumped, contents of reservoirs and flow of streams, which means that somebody's labor was expended in computing the figures from dimensions measured in feet and inches. The liter would be no more awkward than the U. S. gallon is in its relations to most of the other kinds of measure used for similar purposes, as is shown by the little table below giving their equivalents.

	Cu. inches.	Number in a cu. ft.	Number in a U. S. bushel.	Pounds of water.	Fraction of British gallon.	Number in a cu. meter.	Kilos of water.
U. S. gallon.....	231.	7.4805	9.3092	8.3452	.83311	264.18	3.7853
Liter....	61.025	28.316	35.238	2.2046	.22009	1000.00	1.

The "Winchester" or U. S. gallon was abandoned by Great Britain about 60 years ago. It is frequently a fictitious unit, 1 cu. ft. making $7\frac{1}{2}$ nominal gallons, instead of 7.4805+ U. S. gallons, or $1\frac{1}{4}$ cu. ft. per second making 1,000,000 nominal gallons per day instead of 969,475 U. S. gallons; in either of which cases the spurious unit appears to be quite superfluous; if a certain number of cu. ft. is meant, why should it not be said?

In water analysis the old custom of stating the amount of impurities in grains per gallon is giving place to the expression in parts per 1,000 for mineral waters, and in parts per 1,000,000 or per 100,000 for potable waters; the latter has been used more commonly, but parts per 1,000,000 have the advantage of corresponding to milligrams per liter or grams per cubic meter.

Mr. Rudolph Hering, hydraulic and sanitary engineer, of Philadelphia, frequently

uses the metric system in his private work to simplify calculation, translating his results when necessary into old denominations.

What is the Use?

Discussion of the metric reform has digressed so that the chief benefits it promises are in danger of being lost sight of. Besides being a system (which our unrelated old weights and measures notoriously are not), the metric system is *decimal*, and has the same advantage as our decimal money, which was adopted by act of Congress a century ago, but which was brought into complete use by our people only after years of annoyance from conflicting coinages and reckonings, such an annoyance as inevitably accompanies the introduction of any improvement. Let us now adopt the meter, gram and liter, to complete the process of decimalization. If, excepting the temporary inconvenience and expense of a change, there is any reason why we should adhere to the yard, pound and gallon, then let us, for the same reason, return to our hereditary pounds sterling, shillings and pence, and not stultify ourselves by acting inconsistently in the two similar cases. There ought to be a correspondence between our coinage system and our weights and measures for the sake of convenience, as may be simply illustrated. If iron is worth \$40 per metric ton, it is obviously worth 4 cents per kilo; but if iron is worth

\$40 per old ton, the price per pound must be ciphered out as $\frac{4000}{2240}$ cents. If land is worth

\$1,000 per hektar, it is obviously worth 10 cents per square meter; but if land is worth

\$1,000 per acre, the price per square foot must be ciphered out as $\frac{100000}{43560}$ cents. A com-

munity engaged in commercial business will find such correspondence vastly useful. Would we see ourselves as others see us? In Sweden in 1848 Mr. Wallenberg opposed the decimalization of money without weights and measures, because a visit of three years to America had shown him how inconvenient in business is a duodecimal system of weights and measures combined with a decimal currency.

That decimal subdivision of weights and measures is destined to prevail here is a plain inference from the fact that decimals of the old units are perpetually being used, in spite of their incongruity with the old established subdivisions. Surveyors have used decimals of the acre and decimals of the furlong (the chain still used on United States public land surveys as well as in England and her colonies), and they now use decimals of the foot in measuring land and in measuring vessels for tonnage. Decimals of the inch are used by machinists, on gauging-rods for casks, to express size of wire and sheet-metal, etc., etc. Some mills use decimals of the hour and astronomers use decimals of the day, hour and minute. The British authorities provide standard small weights, which are decimals of the ounce and the grain. Yet the awkward relation of these decimals to the other recognized subdivisions is always making trouble. Much more acceptable, then, must be decimals which are themselves the standard subdivisions and which harmonize with all parts of a complete system; they are to be had by adopting the metric units. For instance, in such handy volumes as Trautwine's Civil Engineer's Pocket-Book and Shunk's Field Engineer are comprehensive tables for reducing inches and their binary subdivisions to decimals of a foot, also tables for the interconversion of gradient expressions in decimals per 100 and feet per mile. The existence of these tables testifies that such conversions are common, and that assistance is wanted to make them. These things and many others like them can be dispensed with by the adoption of the metric system; for everybody will know that centimeters are hundredths of a meter, and will no more need a table for the conversion than he now does for converting cents into decimals of a dollar; and every engineer will know that a gradient of 15 meters per kilometer is $1\frac{1}{2}$ per 100, and will no more need a table to show it than he now does to show that a tax of \$15 on every \$1,000 is at the rate of $1\frac{1}{2}$ per cent. So in those odd classes of measure where decimals of old units have already been thrust, greater convenience will be obtained by introducing the completely decimal system.

Moreover that will extend the benefits of decimalization to all other classes of measure and simplify their relations with one another. Instead of laboriously reckoning that if rails weigh 60 pounds per yard, a mile of track requires

$$\frac{2 \times 60 \times 1760}{2240}$$

old tons, we can see at once that if rails weigh 30 kilos per meter, twice 30 metric tons per kilometer are required for single track consisting of two lines of rails. Contrast the reports of sewage farms in England and on the continent of Europe; at one of the latter

15, liters of sewage per square meter can be applied to the land per day, and it is a convenience in calculation that this is equivalent to a depth of 15 millimeters over the surface. If at an English farm 15,000 imperial gallons per acre can be applied per day, it is not convenient to calculate the equivalent depth in inches, equal to

$$\frac{15000 \times 277.274}{43560 \times 144}$$

In pharmacy an excellent example is now set for other business to follow. Prescriptions have heretofore been written in the mysterious denominations of the old apothecaries' tables, and with the Roman numeral letters; but a change is now in progress to decimal arithmetic with the common, or Arabic, figures and the metric system of weights and measures. Here is the prescription for a mixture with quantities expressed in the customary style in column 1; column 2 gives the metric expressions of quantity to be substituted in order to convert it into a metric prescription.

	Column 1.	Column 2. Gramma.
R Quin. Sulphat.....	gr. xvi.	1.
Strych. Sulphat.....	gr. ss.	.03
Acid Hydrochlor. Dil.....	℥. lxxx.	5.
Tr. Zingiberis.....	ii.	7.50
Tr. Card. Co.	iiss.	9.50
Syrupi.....	ii.	80.
Aquam.....	ad ℥. iv.	40.
M. Sig. Dose, a tablespoonful.		

In a case of sickness, last summer, a lady tried to telegraph a prescription written in the customary style, but as neither she nor the telegraph operator understood the expressions of quantity, they naturally failed to communicate them correctly, though the names of the ingredients were successfully transmitted. If the metric system were in use by everybody prescriptions could easily be telegraphed. This incident is one little illustration of the really great disadvantage of weights and measures peculiar to a special class of business and unintelligible to persons outside of that business. Into the same category with the scruple and minim of the apothecary must be put the surveyor's link, the perch of masonry, the miner's inch, the jeweler's carat and the horse-jockey's hand. Other units are equally to be condemned, if not for the same reason; for instance the U. S. gallon already spoken of, the U. S. bushel of 2,150.42 cubic inches and the U. S. troy pound of 5,760 grains, all of which Great Britain has abandoned. If physicians and apothecaries are making a judicious reform, let all our people do likewise and adopt the metric system throughout. If, on the contrary, there is any sufficient reason why we should adhere to our other hereditary units, let us for the same reason urge our physicians and apothecaries to adhere to their U. S. units (abandoned by the mother country) and to their antiquated jargon.

Respectfully submitted,

CHARLES H. SWAN,
FRED. BROOKS,
CLEMENS HERSCHEL, } Committee.

Oct. 15, 1884.

To the Hon. the Senate and House of Representatives of the United States in Congress assembled:

The undersigned prays your honorable body to enact the bill (H. R. 7492, 48th Congress, 1st Session) which was introduced June 30, 1884, by Mr. Everhart, as follows:

A BILL

To establish the metric system of weights and measures in the Departments of the Government.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled :

That from and after the fourth day of March, anno Domini eighteen hundred and eighty-nine, the metric system of weights and measures, as recognized and expressed in section thirty-five hundred and seventy of the Revised Statutes, shall be exclusively employed by the several Departments and branches of the Federal Government in the affairs of the United States: Provided, that in all other transactions than those in which the United States is a party it shall be lawful to employ the weights and measures now in use.

SEC. 2. That a knowledge of the said metric weights and measures shall be taught in all the schools and colleges now under the control of the Federal Government or hereafter aided by it, or such knowledge shall be required for admission to the said schools and colleges.

SEC. 3. That all laws inconsistent herewith are hereby repealed.

NARRATIVE AND STATISTICAL REPORTS

—OF THE—

President, and Statistical Report of the Secretary of the
Board of Trustees, as Acting Treasurer, of

Alcorn Agricultural and Mechanical College,
OF MISSISSIPPI,

—TO THE—

Secretary of the Interior and
the Secretary of Agriculture,

AS REQUIRED BY SECTION 3 OF THE ACT OF CONGRESS OF
AUGUST 30, 1890.

ALCORN A. & M. COLLEGE, }
WESTSIDE, MISS. }

*The Hon. Secretary of the Interior and the Hon. Secretary of
Agriculture:*

GENTLEMEN—In accordance with the requirements of Section 3 of an Act of Congress which became law August 30, 1890, and known as the new Morrill Bill, my second annual report is presented as follows:

A ONE-STORY frame, forty-nine by seventy feet, was erected during the year and fitted up with benches, tools, etc., necessary to give first-class instruction in carpentry; a suitable instructor was employed and thirty boys took lessons in that trade this year. A similar building has been put up and will soon be fitted out with forges, tools, etc., and an instructor placed in charge to teach blacksmithing the coming year. Eight young men have received house-painting instruction and practice during the past session. The financial reports herewith attached as parts of this report, will show that a quantity of apparatus, Text and Reference books, etc., have been added to our facilities for instruction in the various departments.

This institution receives nothing under the Experiment Station Act of Congress of 1887, and hence there is no experiment farm connected herewith, but we have eighty acres under cultivation, and we endeavor as far as we have the implements, appliances, and teaching force, to make it a practical and model farm, up to the improved ideas of Scientific Agriculture.

Only a slight amount of additions has been made to our facilities in the Agricultural department.

The farm yielded last year, however, as it has done annually for eight or nine years, fine crops of corn, peas, potatoes, pumpkins, oats, hay, garden vegetables, etc., besides slaughtered from its own raising a few sheep and cattle, and over five thousand pounds of pork.

The increased funds at their disposal through the Act of August 18, 1890, enabled the Trustees in making plans for the coming year at their meeting of June, 1891, to employ four professors, including the President, instead of only two as heretofore. So that the work of the year opened last September with a President, three Professors, one Assistant Professor, and four Tutors, besides an Instructor in Carpentering.

The number of students had so increased, however, that by March last, it became desirable to engage an additional Tutor.

The institution has steadily increased in attendance, from 113 in the year 1882-'3, to 276 during the year 1891-'2, as the year just ended. The enrollment could have been greater for any one of the last five years but for the fact that our dormitory capacity was limited.

Upon the recommendation of our Governor the 1892 Legislature appropriated \$8,000 to erect a new building to supply a long-felt need in recitation rooms as well as dormitory rooms. This building is to be a two-story frame, is to be put up by students under the direction of their teacher, and is to be ready for occupancy some time during the coming school year.

During the year a two-room cottage for dormitory purposes, and a cottage with two large and three small rooms, was built for a hospital.

While the health of the locality and the school is good, yet the need of a hospital-building has been one of the keenly-felt needs of the College for some years.

A graduate from this institution is Professor of Agriculture at Prairie View Normal School of Texas; another is President of Gibsland College of Louisiana; another is a minister and editor of a magazine in Tennessee; another is a prospering furniture merchant of Nashville; another is an M. D. and a clerk in the Departments at Washington, while in our own State a number are heads of schools or prospering farmers. We do not know of a single instance of any one of our sixty-two graduates who is not making a good living. Most of them are filling with credit to themselves and to this institution, positions of influence and usefulness in their respective communities. In fact, the general good conduct of our students, our graduates especially, is one of the chief influences that gives the College constantly increasing favor with the most intelligent, fair-minded, and far-seeing people of the State who recognize it as exerting moulding power for good upon the State's future citizens.

There are yet a number of improvements that may be made that would contribute much to the efficiency of the work, but it will take some time to try to put into successful operation those things that have been determined upon before others are undertaken.

Much is being done to familiarize the students with hogs, sheep, mules, and cattle, and their diseases, as well as the kind of treatment and attention best suited to their nature. Except a registered Devon bull our stock lacks in the quality of blood.

Respectfully submitted,

J. H. BURRUS, PRESIDENT.

July 28, 1892.

THE PRESIDENT'S STATISTICAL REPORT.

Name of Institution—Alcorn Agricultural and Mechanical College; Postoffice—Westside; State—Mississippi.

Statistics to accompany Report of the President of said Institution to the Secretary of Agriculture and the Secretary of the Interior, as required by act of Congress of August 30, 1890, in aid of Colleges of Agriculture and the Mechanic Arts.

I.—Receipts for and During the Year Ended June 30, 1892.

1. State aid (a) Income from endowment.....	\$.....
(b) Appropriation for current expenses.....	3,571 25
(c) Appropriations for building or other special purposes.....	10,000 00
2. Federal aid:	
(a) Income from land grant, act July 2, 1862..	5,678 75
(b) For experiment stations, act March 2, '87.	.....
(c) Additional endowment, act Aug. 30, '90....	9,378 63
3. Fees from all other sources.....	599 60
Total receipts.....	\$ 29,228 23

II.—Expenditures for and During the Year Ended June 30, 1892.

1. College of Agricultural and Mechanic Arts..	\$ 23,294 68
2. Experiment Station.....	.....
3. All other departments, if any.....	.....
Total expenditures.....	\$ 23,294 68

III.—Library.

1. Number of bound volumes, June 30, 1891....	2,411; pamphlets, 2,041.
2. Bound volumes added during year ended June 30, 1892,	446; pamphlets, 705.
Total bound volumes.....	2,875; pamphlets, 2,746

IV.—Faculty During the Year Ended June 30, 1892.

Number of Professors and Instructors in College of Agriculture and Mechanic Arts...Males, 11; Females,
 Number of Staff of Experiment Station....Males,..
 Females,
 Total, counting none twice, Males, 11; Females,.....
 Number in all other departments,..Males, ...; Females,.....

V.—Students During the Year Ended June 30, 1892.

1. College of Agriculture and Mechanic Arts:
 (a) Preparatory Classes..Males, 217; Females.... 12
 Collegiate and Special Classes.Males, 46; Females, 1
 Total in College of Agriculture and Mechanic Arts,
 Males,.....263; Females, 13
 2. In all other departments.....
 Value of farm lands, \$2,500; total number of acres.. 300
 Acres under cultivation, 80. Acres used for experiments.....
 Our experiments are few but we aim to make our farm a model.
 Agricultural Department: Value of buildings..\$ 1,000 00
 Of other equipments..... 800 00
 Mechanical Department: Value of buildings... 1,500 00
 Of other equipments..... 600 00
 Of other departments: Value of buildings..... 45,000 00
 All other equipments..... 2,500 00

(Signed):

J. H. BURRUS,
 President.

(Title of officer reporting):

(Date): July 28, 1892.

Respectfully,

J. H. BURRUS.

REPORT OF TREASURER.

Name of Institution: Alcorn Agricultural and Mechanical College. Post-office: State: Mississippi.

REPORT OF TREASURER of said Institution, to the Secretary of Agriculture and the Secretary of the Interior, of amount received under act of Congress of August 30, 1890, in aid of Colleges of Agriculture and the Mechanic Arts and of the disbursements thereof, to and including June 30, 1892. (Report due September 1. See explanations on back):

Date of receipt of 1st installment, Febru'y, '91,
 amount.....\$ 7,494.375
 Was 2d Installment received prior to June 30,
 1891? If so, give date, June 1..... 8,000.00
 Total received by Institution to June 30, '91. 15,494.375

Amount thereof expended to June 30, 1891....	3,446.54
Balance on hand July 1, 1891	\$ 12,047.835
Was 2d Installment received after June 30, '91?	
If so, give date.....	
Date of receipt of 3d installment, Nov. —, '91	9,378.63
Total available for year ended June 30, '92.	21,426.465
Disbursements thereof for and during the year ended June 30, 1892 :	
In Agriculture, as per Schedule A.....	\$ 2,473.84
In Mechanic Arts, as per Schedule B.....	1,954.72
In English Language, as per Schedule C.....	2,830.495
In Mathematical Science, as per Schedule D...	2,970.60
In Physical Science, as per Schedule E.....	1,650.03
In Natural Science, as per Schedule F.....	893.47
In Economic Science, as per Schedule G.....	

Total expended during the year.....	\$ 12,773.155
Balance remaining unexpended July 1, '92..	8,653.31

I HEREBY CERTIFY, That the above account is correct and true, and together with the schedules hereunto attached, truly represent the details of expenditures for the period and by the institution named, and that said expenditures were applied only to instruction in Agriculture, the Mechanic Arts, the English Language, and the various branches of Mathematical, Physical, Natural and Economic Science, with special reference to their applications in the industries of life, and to the facilities for such instruction.

T. F. DANIELS,
Secretary of Board of Trustees.

SCHEDULE A.

Disbursements for instruction in Agriculture and for facilities for such instruction, during the year ended June 30, '92.

I. For instruction, viz.:

For the salaries of President and one Tutor. \$ 2,400 00

II. For facilities, as follows:

1. Apparatus.....	
2. Machinery.....	
3. Text-books and reference-books.....	61 08
4. Stock and material.....	12 76

Total.....	\$ 2,473 84
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SCHEDULE B.

Disbursements for instruction in Mechanic Arts and for facilities for such instruction, during the year ended June 30, 1892.

I. For instruction, viz.:

For the salary of one Professor.....\$ 825 00

II. For facilities, as follows:

1. Apparatus.....	\$	
2. Machinery—Tools.....		1,035 01
3. Text-books and reference-books.....		94 71
4. Stock and material.....		

Total.....	\$	1,954 72
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SCHEDULE C.

Disbursements for instruction in English Language and for facilities for such instruction, during the year ended June 30, 1892.

I. For instruction, viz.:

For the salaries of 1 Professor and 2 Tutors..\$2,155.01.5

1. Apparatus.....		177 47
2. Machinery.....		100 00
3. Text-books and reference-books.....		398 00
4. Stock and material.....		

Total.....	\$	2,830.495
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SCHEDULE D.

Disbursements for instruction in Mathematical Science and for facilities for such instruction, during the year ended June 30, 1892.

I. For instruction, viz.:

For the salaries of 1 Professor and 2 Tutors.\$ 2,825 00

II. For facilities, as follows:

1. Apparatus.....		84 00
2. Machinery.....		
3. Text-book and reference-books...		41 60
4. Stock and material.....		20 00

Total.....	\$	2,970 60
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SCHEDULE E.

Disbursements for instruction in Physical Science and for facilities for such instruction, during the year ended June 30, 1892:

I. For instruction, viz.:	
For the salaries of 1 Professor.....	\$ 1,125 00
II. For facilities, as follows:	
1. Apparatus.....	449 84
2. Machinery.....	
3. Text-books and reference-books.....	75 19
4. Stock and material.....	
Total.....	\$ 1,650 03

SCHEDULE F.

Disbursements for instruction in Natural Sciences and for facilities for such instruction, during the year ended June 30, 1892:

I. For instruction, viz:	
For the salary of 1 Tutor.....	\$ 600 00
II. For facilities, as follows:	
1. Apparatus.....	\$ 78 89
2. Machinery.....	
3. Text-books and reference-books.....	149 58
4. Stock and material.....	65 00
Total.....	\$ 893 47

SCHEDULE G.

Disbursements for instruction in Economic Science and for facilities for such instruction, during the year ended June 30, 1892:

I. For instruction, viz.:	
For the salaries of.....	
II. For facilities, as follows:	
1. Apparatus.....	
2. Machinery.....	
3. Text-books and reference-books.....	
4. Stock and material.....	
Total.....	

IX.

CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF
HARVARD COLLEGE.A NEW METHOD OF PREPARING BORNEOL FROM
CAMPHOR.

BY C. LORING JACKSON AND A. E. MENKE.

Presented June 13th, 1883.

THE natural borneol (Borneo camphor), obtained from the *Dryobalanops Camphora*, is brought from the East so rarely that specimens of it can be obtained in this country or in Europe only with the greatest difficulty; most chemists, who have studied this substance, have confined their attention therefore to the borneol obtained from ordinary camphor, which has been proved to be identical* with the natural product.

So far as we can find, there are but two methods of making borneol from camphor, — one by the action of potassic hydrate, which is due to Berthelot,† the other that of Baubigny,‡ consisting in treating camphor with sodium, and separating the sodium camphor from the sodium borneol by carbonic dioxide. Both leave much to be desired, since the product of the first is a mixture of camphor and borneol, which must be purified by treatment with stearic acid, and according to Kachler§ the yield is very small, while the second yields pure borneol, it is true, but theoretically only one half of the camphor can be converted into borneol, although an amount of sodium is required which corresponds to the whole weight of camphor used.

In the course of some experiments on camphor, which led to no result so far as their main object was concerned, it was necessary for

* Kachler. Wien Acad. Ber. (2 Abth.), 78, July.

† Ann. Chim. Phys., ser. 3, lvi. p. 78.

‡ Ibid., ser. 4, xix. p. 221.

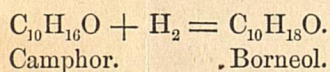
§ Ann. Chem. Pharm., clxiv. p. 75.

us to become acquainted with the reduction of camphor; but, to our great surprise, we were unable to find any description of experiments on this subject, unless the statement in Beilstein's *Handbuch der Organischen Chemie*, page 1763, that sodium amalgam does not act on camphor, comes under this head. We were compelled, therefore, to experiment ourselves, with the following result. 25 g. of camphor, melting at 175° , were dissolved in moist toluol, and sodium and water added at intervals, until a sample showed the melting-point of borneol, 197° – 198° ; the toluol was then driven off by heat, and a yellowish white mass obtained, with the smell at once like camphor and pepper, described as that of borneol. It was purified by sublimation, and analyzed with the following results:—

0.1642 g. of substance gave 0.4700 g. of carbonic dioxide, and 0.1772 g. of water.

	Calculated for $C_{10}H_{18}O$.	Found.
Carbon	77.93	78.07
Hydrogen	11.69	11.98

The substance is borneol, therefore, and the reduction of the camphor takes place, as was to be expected, according to the reaction.



The ease with which borneol was formed in this experiment led us to the following method for making borneol from camphor, which gives essentially the theoretical yield of nearly pure borneol with remarkably little trouble.

It consists in dissolving the camphor in about ten times its weight of common alcohol, and adding one third* more than the amount of sodium calculated from the reaction. The sodium is added in pieces of somewhat less than a gramme at a time, and in working with quantities not over ten grammes the action can be carried on in an open flask without cooling. As soon as all the sodium has disappeared, which takes less than three quarters of an hour with ten grammes of camphor, part of the alcohol is distilled off, and water added, which precipitates crude borneol. This is freed from sodic hydrate by washing with water; after which one crystallization from the smallest possible amount of hot alcohol is sufficient to raise its melting-point to 197° , that of borneol. In this way 10 g. of camphor yielded 9.5 g.

* Probably a smaller excess of sodium would be sufficient.

of the crude borneol, instead of 10.1 g., — that is, 94 per cent of the theory; whereas, according to Baubigny's method, 4 g. of sodium, the amount which yielded 9.5 g. of borneol in our process, would have given only 6.6 g.

Our method, therefore, is superior to the other two in economy, as well as in the ease and speed with which it can be conducted.

47-M-64

[From the PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT
OF SCIENCE, Vol. XXXIV, Ann Arbor Meeting, August, 1885.]

RELATIVE VALUES OF HUMAN FOODS. By Maj. HENRY E. ALVORD,
Houghton Farm, Mountainville, New York, N. Y.

[ABSTRACT.]

THERE are different ways of comparing human foods upon the score of economy. If one attempts to consider at once their digestibility, chemical composition and usual cost, besides other conditions which should not be ignored, the problem becomes very complex. It is hard to define the average human stomach, and we are so much in the dark on the questions of actual proportions of digestibility in different forms of food, that it is safer to drop this factor than to include it. Chemical knowledge of foods and their market prices, are sufficient, when combined, to form an interesting study.

The basis selected for comparison is all-important. A casual observation shows the necessity of separating foods into two grand divisions, animal and vegetable, and of selecting a basis for each.

If any food could be found in common use, at a fairly steady price and useful only for its protein, the direct value or cost of protein could be determined. This being impracticable, a standard food, like average ox-beef, flesh free from bone, may be taken and the cost of protein obtained by difference. We will assume that the fats of average beef and pure lard are equivalent in nutrition and wholly digestible, and take lard at 12 cents per pound as the safest base for animal foods. In average ox-beef there are 5.2 per cent of fats and 23.4 per cent of protein. Placing such beef at 16 cts. per pound, the account will stand thus per hundred-weight:

100 lbs. beef	\$ 16.00
5.2 " fat	.624
21.4 " protein	15.376

From these figures is obtained the cost of nutrients in animal foods, viz. :—protein, 72 cts. pr. lb. ; fats, 12 cts. ; carbohydrates, 7 cts.

The old German ratio of carbohydrates and fats of 1:2.5 so largely adopted in this country was never fully accepted and later investigations show its inaccuracy. We are well supported in substituting 1:1.75. Therefore to get carbohydrates from fats, deduct 43 per cent from the latter.

For vegetable foods, the potato is unquestionably the best basis, and the price per bushel is taken at 60 cts. or \$1.00 per cwt. Four cents is assigned as the value of the unextracted starch and the other carbohydrates, and by a calculation analogous to that for beef, potatoes being rated as about 20 per cent carbohydrates, the value of nutritious matter in vegetable foods is fixed thus:

Protein, 10 cts. per lb. ; carbohydrates, 4 cts. per lb.

Based upon these values, the following table has been compiled.

It gives the chief nutrients, the value and average price, approximately, of 100 pounds of thirty common articles of food, half animal and half vegetable. The fats are included in the column headed carbohydrates. A column is added at the right indicating by the signs, plus and minus, whether the usual selling price, as stated, is more or less than the food value, computed as above.

[See Table on next page.]

The figures for the chemical composition of the foods named are taken from such authority (see appended Note) that they can hardly be questioned. If exceptions are taken to the assumed prices of the basic articles, it is manifest that by a simple calculation based upon actually existing market rates, the columns of food values may be easily reconstructed to suit any given locality.

The column of average market price is simply for illustration and will vary with time and place.

This inquiry into the relative value of human foods was instituted for the purpose of making an accurate economic comparison between the different products of the dairy and between those and standard articles of diet. Attention is invited to these facts, as exhibited by the table.

COMPOSITION AND VALUE OF FOODS.

PER ONE HUNDRED POUNDS.					Price g'tr + or less - than value =	
NAME.	Protein.	Carbo- Hydrates	Value.	Average Market Price.		
Standard Cows' Milk.....	4 00	10 52	\$3 54	\$3 25	a	—
Cows' Milk (average all kinds)....	3 41	11 23	3 24	2 79	b	—
Skimmed Milk	3 06	6 15	2 63	1 77	c	—
Butter-milk	3 78	5 89	3 13	1 77	d	—
Cream.....	3 70	48 51	6 06	12 50		+
Butter	0 86	146 05	10 67	25 00		+
Fat Cheese.....	27 16	55 78	23 46	14 00		—
Average Ox Beef.....	21 39	9 08	16 32	16 32		=
Fat Veal.....	18 88	13 89	14 57	15 00		+
Fat Mutton.....	14 80	63 73	15 12	15 00		—
Fat Pork	14 54	65 35	15 04	13 00		—
Domestic Fowl (fat)	18 49	17 54	14 54	16 00		+
Hens' Eggs.....	12 55	21 74	10 56	10 65	e	+
Salmon.....	13 10	12 67	10 32	30 00		+
Mackerel	23 42	11 83	17 69	10 00		—
Cod Fish (dried)	17 90	2 25	13 05	8 00		—
Oysters.....	4 95	3 27	3 97	10 00		+
Fine Wheat Flour.....	8 91	76 12	3 94	3 00		—
Fine Wheat Bread	6 82	53 69	2 83	4 00		+
Oat Meal	15 50	74 37	4 52	3 00		—
Potatoes	1 79	20 84	1 01	1 00		=
Rice	1 81	76 61	3 24	6 00		+
Beans	23 56	52 10	4 44	4 00		—
Pease.....	22 63	56 25	4 51	5 00		+
Cabbage.....	2 95	9 24	0 66	1 00		+
Onions (red)	1 68	10 99	0 61	2 00		+
Tomatoes	1 25	4 66	0 31	2 00		+
Cane Sugar.....	0 35	96 73	3 90	6 00		+
Honey.....	1 29	81 43	3 39	25 00		+
Apples	0 39	13 74	0 59			+
Peaches	0 65	12 57	0 57			+
Grapes	0 59	17 11	0 74			+
Strawberries	1 07	8 48	0 45			+
Dried Apples.....	1 06	55 97	2 35			+

Notes:—a, 7c. per qt.; b, 6c. per qt.; c, 4c. per qt.; d, 4c. per qt.; e, 16c. per dozen

Skim-milk, butter-milk and cheese at their usual retail prices, are cheaper as nutritious food than any other articles on the list, and are approached in this respect only by fresh mackerel and dried cod-fish. On the contrary, butter costs two or three times its real food value, and often more. What shall be said of domestic economy in America, where more butter and less cheese are consumed per capita than in any other nation in our zone? And of the government of some of our great cities where Boards of Health absolutely prohibit the sale of skimmed milk and actually destroy all that can be found? Of butchers' meats, pork and mutton are the cheapest and veal the dearest. Of fish, mackerel is the cheapest while salmon and oysters are about as dear relatively as butter.

Eggs generally sell at their full food value. Wheat-flour, oat-meal and beans are the cheapest forms of vegetable food, nearly all other vegetables (except potatoes) as well as the fruits, costing more than they are worth for their nutritive properties alone.

GENERAL NOTE: Additional Tables have been prepared to accompany the foregoing on the same plan, but with several additional columns for chemical composition, embracing also every known article of human food. As illustrating their completeness, this classified summary is given: flesh, 19 articles; fish, 14 articles; fowl, eggs and game, 12 articles; dairy products, 18 articles; cereals and legumes, 10 articles; flour, meal, bread, etc., 17 articles; vegetables, 20 articles; fruits, 20 articles, and sweets 5 articles: in all 135 articles. To these have been added a Table, giving the amounts, composition and nutritive ratio of food actually consumed by persons of different ages and in varied occupations, as observed in 32 individuals. All these Tables are compilations only and are mainly translated from the work of Dr. J. Koenig entitled *Zusammensetzung der menschlichen Nahrungs und Genussmittel*.

Dr. Koenig collected his analyses from the best chemists, naming his authorities, and in most cases gives the mean of a number of analyses, — as for example, 37 for beef, 184 for wheat, 70 for potatoes, 57 for sugar, 17 for apples, 89 for butter, 100 for cheese and 339 for milk. The labor of translation, with the recalculation of weights, values, etc., and careful verification, has been performed by Mr. F. E. Emery, B.S., of Maine, my principal assistant in the Experiment Department of Houghton Farm.

TELEMETRIC AID TO METEOROLOGICAL RECORDS. By HENRY E.
ALVORD, C. E., Houghton Farm, Mountainville, N. Y.

[ABSTRACT.]

A REPORT of progress in endeavoring to secure at Houghton Farm, mechanical devices for automatic and continuous records of meteorological phenomena. The experience with special mercurial thermometers, and thermo-couples, in taking soil and atmospheric temperatures, is described in Houghton Farm pamphlets, *Agricultural Physics*, Series I, Nos. 3 & 4, 1883: Penhallow. This paper describes a recent trial of the system of Telemetry in connection with temperatures.

This term, Telemetry, has been applied to electrical apparatus, by which variable physical forces, such as temperature and pressure, are indicated and recorded at any distant point. The system consists of two instruments, the transmitter, which indicates the variable force at the place where it exists, and the receiver or counterpart instrument at the place where the variations are desired to be known, to which the recorder is attached. These two instruments are maintained in perfect unison, automatically, by the skilful application of electricity, upon the open circuit principle, thereby involving but slight expenditure of battery power. To fully describe the mechanism here is unnecessary.¹ For application to temperature, the transmitter is connected with a delicately adjusted metallic thermometer, of the Brequet form; its index hand is on the same central shaft which carries the contact arm of the transmitter. This combined instrument is called the Telethermometer. At the point of observation is the metallic thermometer, and at the office, which may be at any reasonable distance, the mechanism which furnishes on a dial, made in ink, a continuous record of the variation. The recorder is arranged for dial records of a single day or a week and with a fair range in the scale, so it may be adjusted to suit the particular work in hand.

Tables and charts are presented, comparing the records for six months, of a telethermometer and of standard mercurial thermometer used as a check on the former. The labor involved in the two methods is also compared.

The complete record of the telethermometer is far preferable in itself, besides the greater economy of the system, which is beyond comparison. Always provided that the telemetric record is accurate.

¹ See "The Electrician and Electrical Engineer" for December, 1884.

The comparative trial of these six months has its greatest interest and value in the evidence furnished on this point of accuracy. The observations on standard and verified mercurial thermometers were a sufficient check upon the new instruments. It appears from the table and the chart made therefrom, that the telethermometer was tardy in following the changes of temperature and failed to reach the extreme point for some time. It is important to know just how long a period of constant temperature above or below the last moment recorded, is required to operate the instrument, but as yet our observations are not close enough to settle this point. This failure of the telethermometer to mark the extreme, is far more noticeable as relates to the minimum. A slight change in the transmitter was made early in July, and with good results, for the record of that month is the best. This remains true of the first half of August, which is also recorded on the chart. A summary of thirty days in July and August gives this comparison.

Mean Temperatures (F.) :—	Max.	Min.	Range.	Daily Mean.
Mercurial Thermometer . .	86.4	63.3	23.1	79.20
Telethermometer	85.1	67.5	17.6	79.15

The daily mean given is from the thirteen hourly readings. The differences during the month were from 0 to 2.2 degrees, with an average of but .76 of one degree for the whole time. This falls within a reasonable limit of error in observation. On this record alone the new system is a complete substitute for the old. But this daily mean omits the minimum records, where the greatest errors occurred. The variation in the mean daily range is seen to be 5.5 degrees, which is far too much. There must be either greater delicacy in the metallic thermometer, or quicker action in operating the contact mechanism of the transmitter, or both, to meet all our requirements. This can probably be done. Mr. Clarke is constantly improving the mechanism of the Telemeter and the various instruments to which it is applied. A late form of the telethermometer exposes the thermometer itself more, and much increases its sensitiveness and promptness of action.

The Telethermometer is, therefore, including the faults noted, the best aid yet found in recording atmospheric temperatures for agricultural purposes ; but for soil temperatures special instruments must be constructed and some additional device seems necessary for correcting or setting the instrument in the ground, without exhuming, in case accident throws it out of gear as indicated by the recorder.

PENNSYLVANIA
STATE COLLEGE
AGRICULTURAL BULLETINS.
IX.

PENNSYLVANIA STATE COLLEGE
BULLETINS.

Nos. 1, 2, and 3 of the BULLETINS are exhausted. A limited supply of the others can be obtained by addressing THE PRESIDENT OR THE PROFESSOR OF AGRICULTURAL State College, Centre county, Pennsylvania. Correspondence is invited.

**The Results of Experiments Showing the Effect of various Fertilizers
on the Growth of Corn, Oats, and Wheat.**

BULLETIN No. 8 is devoted to a statement of some of the results of experiments with fertilizers on the Central Experimental Farm of the College. The results of similar experiments on the Eastern Experimental Farm are presented here as corroborating in a marked manner some of the conclusions that seemed to be warranted by the figures given in that BULLETIN. The experiments conducted on the two farms are similar in all their main features, and for information as to the plan, kind of fertilizing material used, &c., reference is made to the last BULLETIN.

There is one important difference in the conditions existing in the two cases, which is that the soil of the experimental plots is much more exhausted at the Eastern than at the Central farm. This is plainly shown by the great difference in the natural yield of the unmanured plots in the two places.

The table on page 69 gives the yield of all the plots in the several series for three years:

The following facts become evident upon a careful study of that table:

1. *Phosphoric acid* was the ingredient of the fertilizers having the predominating influence.

Alone it produced a marked increase of crop, while nitrogen and potash either alone or combined had no appreciable effects.

2. *A complete fertilizer* proved more efficient than a partial fertilizer. The efficiency of the phosphoric acid was increased by adding to it both nitrogen and potash more than by adding either alone.

3. *The increased yield* due to the use of the fertilizers was many times greater with the wheat than with the corn. This was due undoubtedly, as was stated in BULLETIN, No. 8, in explanation of the same result on the Central farm, to the fact that the corn was planted in sod. It has uniformly been observed in all the experiments conducted on the College farms that where corn is planted in sod the fertilizers applied, even yard manure, have comparatively little effect in increasing the growth of the crop.

**The Uniformity of the Natural Production of a Series of Plots or the
Necessary Error Involved in Field Experimentation.**

There is scarcely any one interested in agricultural experiments who will not admit that the ultimate test of many theories must be found in field experimentation. While this is acknowledged, all who have conducted or watched field experiments by the plot method are aware that there is great difficulty in avoiding error, and that this is largely due to unavoidable differences in the yield of small plots, because of natural variations in the fertility of different parts of the same field. Some have gone so far as to assert that this difficulty cannot be overcome to a suffi-

	Quantity of fertilizer per acre.	1881.			1882.				1883.			
		TIER 1.			TIER 1.		TIER 2.		TIER 1.		TIER 2.	
		Nitrogen—pounds.	Phosphoric acid—lbs.	Potash—lbs.	CORN.		OATS.		WHEAT.		OATS.	
					Shelled corn, bu.	Shelled corn—bu.	Grain—bushels.	Straw—pounds.	Grain—bushels.	Straw—pounds.	Grain—bushels.	Straw—pounds.
1. Nothing,	240	24	48	100	18	980	22	980	47.5	2 250	3.3	300
2. Dried blood,	300	48	100	100	18.3	980	22	980	48.8	2 680	3	180
3. Dissolved bone black,	200	48	100	100	22.5	1,220	26.6	1,220	53.3	2 880	11.7	1,100
4. Muriate of potash,	540	24	48	100	15.7	1,150	25.5	1,150	42.5	2 800	3.8	210
5. Dried blood and dissolved bone black,	440	24	48	100	22.8	1,140	27.3	1,140	58.2	3,040	15.7	1,460
6. Dried blood and muriate of potash, 200 pounds,	500	24	48	100	22	1,160	26.6	1,160	47	3,450	4.3	500
7. Dissolved bone black, muriate of potash,	740	24	48	100	19.6	1,240	30.6	1,240	57	3,880	16.7	1,000
8. Nothing,	980	24	48	100	16.6	720	20	720	43.5	3,280	2.8	130
9. No. 7 and dried blood, 240 pounds,	980	48	100	100	16	1,160	29.3	1,160	51.5	3,680	20.7	1,360
10. No. 7 and dried blood, 480 pounds,	1,220	72	100	100	20.6	1,180	31.3	1,180	52	3,480	22.3	1,900
11. No. 7 and dried blood, 720 pounds,	500	24	48	100	18	1,140	29.3	1,140	57.2	3,680	23.3	1,480
12. No. 7 alone,	680	24	48	100	17.4	1,040	30	1,260	50	3,680	17.3	800
13. No. 7 and nitrate of soda, 160 pounds,	820	48	100	100	20.4	1,180	29.3	1,180	55	3,680	18.7	900
14. No. 7 and nitrate of soda, 320 pounds,	980	72	100	100	21.1	1,220	29.3	1,182	72	3,680	21	2,040
15. No. 7 and nitrate of soda, 480 pounds,	500	24	48	100	18.5	1,040	24	1,000	60	3,700	22	2,680
16. Nothing,	500	24	48	100	18.6	1,040	27.3	1,000	60	3,080	4	1,000
17. No. 7 alone,	620	24	48	100	18.6	1,040	27.3	1,040	58.2	3,280	16.3	1,820
18. No. 7 and sulphate of ammonia, 120 pounds,	740	48	100	100	13	1,660	27.3	1,660	58.2	3,280	24	1,760
19. No. 7 and sulphate of ammonia, 240 pounds,	820	72	100	100	18.8	1,600	28	1,600	53.2	3,480	25.3	2,280
20. No. 7 and sulphate of ammonia, 320 pounds,	12,000	23.3	100	100	18.8	1,390	26	1,390	58	3,320	25.7	2,460
21. Yard manure,	320	24	48	100	17.4	1,280	23.3	1,280	45.2	2,680	10	1,200
22. Plaster,	320	24	48	100	17.4	1,080	21.3	1,080	47.2	2,520	10.2	420

* No. 7 means the fertilizers of plot 7.

cient extent to admit of the use of the results of field experiments as a basis for reliable conclusions. Others believe that with proper precautions such experiments can be made to determine to quite a close approximation the comparative effect of different fertilizers, different methods of tillage, &c. It is certainly true that if a single plot is compared with some other plot in the same series, the natural difference in production is sometimes as great as would be expected if one plot had been manured and the other had not. Even contiguous plots occasionally yield quite different results under the same treatment.

Notwithstanding these facts, it is the opinion of the writer, after conducting considerable many field experiments, and noting the results from a great many others, that it is possible to reduce the error of field experiments to such a small amount that it will not materially vitiate the reliability of the conclusions that may be drawn.

One of the experiments on the Central Experimental Farm during the summer of 1883 was the testing of the uniformity of production of thirty-six plots of land which are now being used for various experiments. These plots are contained in two series or tiers running parallel to each other. Each plot is one rod wide and eight rods along, containing one twentieth of an acre, and is separated from the contiguous plots by a strip of land two feet wide.* No fertilizer was applied to any of these plots, and they were treated exactly alike as to manner and time of cultivation and quantity of seed. The table on page 71 gives the yield of the individual plots in each series, the average yield for all the plots of each series, the variation of each plot from the average yield, and the average variation.

The next table shows the maximum and the mean variations from the average yield, for both series of plots:

	FIRST SERIES.						SECOND SERIES.					
	Grain.		Straw.		Total yield.		Grain.		Straw.		Total yield.	
	In bushels.	In per cent. of average yield.	In pounds.	In per cent. of average yield.	In pounds.	In per cent. of average yield.	In bushels.	In per cent. of average yield.	In pounds.	In per cent. of average yield.	In pounds.	In per cent. of average yield.
Maximum above average yield, .	5.6	10.8	484	18.0	669	15.4	9.4	20.0	316	12.7	417	10.5
Maximum below average yield, .	8.8	16.9	726	27.1	571	13.2	8.7	18.6	304	12.2	383	9.6
Greatest variation between any two plots,	14.4	27.7	1,210	45.2	1,240	28.7	18.1	38.7	620	24.9	800	20.1
Mean variation from the average	3.6	6.9	209	7.8	209	4.8	3.2	6.8	122	4.9	182	4.6

This table shows that the mean variation from the average yield is in every case quite small, but it is very plain that the differences between

* For description of the soil of these plots see BULLETIN, No. 8.

Table showing the Comparative Yield of small Plots of Land when treated alike.

	FIRST SERIES.				SECOND SERIES.			
	YIELD OF OATS PER ACRE.				YIELD OF OATS PER ACRE.			
	Grain. Bushels	Straw. Pounds	Total Yield. Pounds	VARIA- TION FROM THE AV- ERAGE YIELD OF ALL THE PLOTS IN THE SERIES.	Grain. Bushels	Straw. Pounds	Total Yield. Pounds	VARIA- TION FROM THE AV- ERAGE YIELD OF ALL THE PLOTS IN THE SERIES.
A,	43.8	2,900	4,300	-31	56.2	2,600	4,400	+9.4
B,	43.1	2,920	4,300	-31	45.6	2,740	4,200	-1.2
C,	52.5	2,720	4,200	-131	47.5	2,380	3,900	+0.7
D,	48.4	2,760	4,300	-31	44.4	2,480	3,900	-2.4
E,	50.6	2,880	4,500	+169	47.5	2,380	3,900	+0.7
F,	49.4	2,620	4,200	-131	50.6	2,180	3,800	+3.8
G,	48.4	2,460	4,000	-331	39.0	2,360	3,600	-7.8
H,	50.0	2,700	4,300	-31	47.5	2,580	4,100	-0.7
I,	52.5	2,420	4,100	-231	43.7	2,400	3,800	-3.1
J,	50.0	2,900	4,500	+169	38.1	2,480	3,700	-8.7
K,	57.5	3,160	5,000	+669	47.5	2,780	4,300	+0.7
L,	56.2	2,900	4,700	+369	47.5	2,380	3,900	+0.7
M,	55.0	2,740	4,500	+169	50.6	2,480	4,100	+3.8
N,	55.0	2,740	4,500	+169	43.7	2,500	3,900	-3.1
O,	56.2	2,300	4,100	-231	44.4	2,380	3,800	-2.4
P,	55.6	2,420	4,200	-131	50.6	2,380	4,000	+3.8
Q,	56.9	2,680	4,500	+169	49.0	2,440	4,000	+2.2
R,	53.7	1,950	3,760	-571	50.0	2,800	4,400	+3.2
Average,	51.9	2,676	4,331	209	46.8	2,484	3,983	182

plots, or even the variations of a few single plots from the average yield, are quite large. A closer examination of the first table shows, however, that the cases of large variation from the average yield are quite few. No one of twenty-nine plots out of the thirty-six varies in production of grain more than 8.2 per cent. from the average. With twenty-three plots the variation from the average yield of grain was less than the mean variation.

Nevertheless, it is quite evident that, although these plots were laid out on land of more than average uniformity in quality, the comparison of the yields of single plots for a single year, in order to determine the effect of different fertilizers or different methods of treatment, might be very misleading.

How, then, is it possible to avoid the errors thus arising? The method taken to accomplish this in the experiments with various crops, the results of which have previously been given,* is to treat several plots in each series in the same manner, these plots to be distributed through the series. For instance, in the experiments to which reference has been made, there are in each series five plots receiving no fertilizer, and each of the principal methods of manuring are carried out on four plots. In all cases those plots which are treated alike are distributed as regularly as possible throughout the series to which they belong. Not only this, but there are four similar series, on each of which the experiments will be kept up for a number of years. It is believed that in this way the necessary error of the final results will be reduced to a small percentage. The following averages of the yields given in the last table but one, show how very probable it is that the average of four plots, regularly distributed through the series of eighteen, will vary but little from the average of all:

	FIRST SERIES. GRAIN.	SECOND SERIES. GRAIN.
Average yield of all plots,	51.9 bushels.	46.8 bushels.
Average yield of plots A, E, I, and M,	50.5 "	49.5 "
Average yield of plots B, F, J, and N,	49.4 "	44.5 "
Average yield of plots C, G, K, and O,	53.5 "	44.6 "
Average yield of plots D, H, L, and P,	52.6 "	47.5 "

The next table shows that even the average yield of three plots, quite widely separated in a series of eighteen, approximates very closely to the mean yield of all:

	FIRST SERIES. GRAIN.	SECOND SERIES. GRAIN.
Average yield of all plots,	51.9 bushels.	46.8 bushels.
Average yield of plots A, G, and M,	49.1 "	48.6 "
Average yield of plots B, H, and N,	49.4 "	45.6 "
Average yield of plots C, I, and O,	53.7 "	45.2 "
Average yield of plots D, J, and P,	51.3 "	44.4 "
Average yield of plots E, K, and Q,	55.0 "	48.0 "
Average yield of plots F, L, and R,	53.0 "	49.4 "

*See BULLETIN, No. 8.

From all that precedes, it seems very probable that when several plots, distributed quite regularly throughout a series, are treated in the same manner, any considerable variation of their average production from the average production of several other plots similarly distributed but differently treated, can be credited largely to the difference of treatment. Of course, slight effects of fertilizers or methods of cultivation might fail to appear even by this method. If, however, more than one series of plots are used and the experiments are kept for several years, the chances are almost entirely in favor of small errors.

The results given in this BULLETIN are published in order to show that accurate final conclusions about any method involved in farm practice can be reached only after the expenditure of much care, time, and labor; and the desire is also to discourage the practice of drawing conclusions from the comparative yield of single plots for a single year. Farmers often do this. It is not intended, however, to discourage field experiments when properly conducted, or to diminish confidence in the results that are obtained with the use of proper precautions.

How to Conduct Experiments.

The following are some of the rules that should be observed in experimenting with plots:

1. The land selected for the plots should be as level and as uniform in quality as possible.
2. The plots should be long as compared with their width.
3. When the surface of the land is all inclined one way, the length of the plots should extend up and down the inclination.
4. The treatment of the plots should vary in time and manner only in those plots which it is desired to test.
5. All the plots should be treated alike for at least one season in order to test the extent of their natural variations of fertility.
6. Each of the methods of manuring or of tillage which are to be tested should be carried out on several plots well distributed in the series.
7. The experiments should be kept up for several years.
8. All possible precautions should be taken against errors of observation, as in measurements, weighings, &c.
9. The work should be honestly done, viz: No results should be excluded unless some error is known to have been introduced which renders them worthless.

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Fall Term begins Sept. 10, 1884. Winter Term begins Jan. 7, 1885.
Spring Term begins April 10, 1885.

For Catalogue and Full Particulars, address the President,
STATE COLLEGE, CENTRE COUNTY, PA.

Analyses of Commercial Fertilizers.

The samples of commercial fertilizers, which served for the analyses reported within a few subsequent pages, were taken from new stock of the present season by responsible parties. The results of our examination are published at this time with the special consent of the Secretary of the State Board of Agriculture.

A statement, giving *the mean* of the *trade values* of the essential fertilizing ingredients in raw materials and agricultural chemicals in our section of the country during the six months preceding the 1st of March, 1888, accompanies these analyses, to assist farmers in ascertaining the approximate *commercial value* of manurial substances offered for sale in our markets.

The customary *commercial valuation* of manurial substances is based on the average trade value of the essential fertilizing elements specified by analyses. The money value of the higher grades of agricultural chemicals and of the higher priced compound fertilizers, depends in the majority of cases *on the amount and the particular form of two or three essential articles of plant food*, i. e., phosphoric acid, nitrogen and potash, which they contain.

The special commercial value per ton affixed to the analysis of each of the subsequent stated brands of fertilizer, shall inform the consumer, as far as practicable, regarding the *cash retail price at which the several specified essential elements of plant food, in an efficient form, have been offered of late for sale in our large markets.*

The approximate market value of different brands of fertilizers, obtained by the current mode of valuation, *does not intend* to express *their respective agricultural value*, i. e., *their crop producing value*. The higher or lower market price of different brands of fertilizer *does not necessarily* stand in a direct relation to their particular fitness, without any reference to the particular condition of the soil to be treated, and the special wants of the crops to be raised by their assistance. To select judiciously from among the various brands of fertilizers offered for patronage requires in the main two kinds of information, namely, we ought to feel confident that the particular brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost; and that it contains them in such form and in such proportions as will best meet existing circumstances and special wants. In some instances it may be mainly phosphoric acid or nitrogen or potash, in others, two of them, and in others again, all three. The manufacturer fulfils his part of the business transaction by selling actually, what he states, at a reasonable cost. The farmer is responsible for a careful consideration of his special wants before deciding what particular, simple or compound, manurial substance to secure. Having attended to this matter well, he can claim for himself, substantially, as far as human effort is concerned, the credit of a good success.

LABORATORY NO.	NAME OF BRAND.	NAME OF MANUFACTURER.	SAMPLED AT
1	"Americus" Ammoniated Bone Superphosphate,	Williams & Clark Co., New York City, N. Y.	Springfield.
2	"Americus" Potato Fertilizer,	"	"
3	H. L. Phelps' Complete Manure; Guano and Potash,	Prentiss, Brooks & Co., Holyoke, Mass.	Holyoke.
4	H. L. Phelps' Phosphate,	"	"
5	H. L. Phelps' Complete Manure for Corn and Grain,	"	"
6	Bradley's XL Superphosphate of Lime,	Bradley Fertilizer Co, Boston, Mass.	Northampton.
9	Crocker's Potato, Tobacco and Hop Phosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	"
10	Mapes' Corn Manure,	Mapes Formula and Peruvian Guano Co., New York City.	"
12	Mapes' Potato Manure,	"	"
14	Bowker's Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.	Worcester.
15	Stockbridge's Manure for Vegetables,	"	"
20	Randall's Combined Bone and Potash,	Benj. Randall, Boston, Mass.	Boston.
23	Crocker's Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Concord.
24	Standard Superphosphate,	Standard Fertilizer Co., Boston, Mass.	Boston.
25	Allen Fertilizer,	American Manufacturing Co., Boston, Mass.	"
26	Darling's Animal Fertilizer,	L. B. Darling Fertilizer Co., Pawtucket, R. I.	"
60	Swan Island Guano,	Hargrave Manufacturing Co., Fall River, Mass.	Springfield.
61	Hargrave's Ground Bone,		Amherst.
62	Cotton Hull Ashes,		Whately.
63	Cotton Hull Ashes,		So. Deerfield.

Laboratory No.	BRAND.	Nitrogen in 100 pounds.		Phosphoric Acid in 100 pounds.						Potassium oxide in 100 lbs.		Valuation per 2000 pounds.		
		Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.					
							Found.	Guaranteed.	Found.	Guaranteed.				
1	"Americus" Ammoniated Bone Superphosphate,	14.87	2-3	9.63	.61	.41	10.65	11-13	10.24	10-12	2.54	2-3*	\$28.97	
2	"Americus" Potato Fertilizer,	10.85	3-4	6.35	1.01	1.63	8.99	7-8	7.36	6-8	7.94	8-10*	34.49	
3	H. L. Phelps' Complete Manure; Guano and Potash, ..	8.94	3.3-4.1	3.34	2.39	3.26	8.99		5.73	4-5	6.12	5-7	37.54	
4	H. L. Phelps' Phosphate,	9.75	2.5-3.3	5.46	2.98	2.70	11.14	10-12	8.44		3.75	3-4	30.26	
5	H. L. Phelps' Complete Manure for Corn and Grain, ...	9.74	4.07	5.83	1.64	4.47	11.94	8-10	7.47	6-8	7.19	7-8	34.01	
6	Bradley's XL Superphosphate of Lime,	14.57	3.03	2.5-3.25	9.44	.64	3.71	13.79	11-14	10.08	9-11	2-3*	30.32	
9	Crocker's Potato, Tobacco and Hop Phosphate,	13.32	2.71	8.01	3.01	2.29	13.31	8-12	11.02	8-12	4.09	3.5-4.5*	32.15	
10	Mapes' Corn Manure,	12.73	4.40	3.7-4.1	6.66	2.37	4.42	13.45	10-12	9.03	6.36	6-7	36.80	
12	Mapes' Potato Manure,	9.98	3.80	3.7-4.1	4.22	3.53	6.18	13.93	8-10	7.75	5.73	6-8*	34.60	
14	Bowker's Hill and Drill Phosphate,	13.06	3.27	2.5-3.25	7.84	2.98	2.31	13.13	11-14	10.82	10-12	2-3*	31.67	
15	Stockbridge's Manure for Vegetables,	11.03	3.77	3.25-4.25	6.21	3.11	1.68	11.00		9.32	8-10	4.04	5-6	31.49
20	Randall's Combined Bone and Potash,	12.33	2.33	1.6-2.5	2.29	5.10	7.04	14.43	13-16	7.39	5-7	2.44	2-3	25.29
23	Crocker's Ammoniated Bone Superphosphate,	11.32	3.20	2.9-3.7	7.87	1.01	2.92	11.80		8.88	8-12	1-3*	27.66	
24	Standard Superphosphate,	10.85	3.56	2.25-3.25	9.05	1.92	3.04	14.01	11-16	10.97	9-13	1.83	2-4	32.49
25	Allen Fertilizer,	21.14	2.50	2.0-3.1	5.45	2.47	1.79	9.71	6-10	7.92	5-8	5.19	4-6	26.16
26	Darling's Animal Fertilizer,	17.08	4.08	3.3-5	2.67	2.04	5.84	10.55	10-12	4.71	4.16	4-6		27.83
60	Swan Island Guano,	14.97	0.52		4.15	16.77	20.92		4.15		0.89			15.42
61	Hargrave's Ground Bone,	12.43	2.68		6.20	19.34	25.67	18.8	6.33	4-12	26.66			35.82
62	Cotton Hull Ashes,	8.90					9.76			19.07	41.04			41.04
63	Cotton Hull Ashes,	10.15					15.37				39.42			39.42

* Sulphate of Potash, the source of potash.

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TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1888. Cents per pound.
Nitrogen in ammoniates,	17½
“ “ nitrates,	16
Organic nitrogen in dry and fine ground fish, meat, blood,	
cotton-seed meal and castor pomace,	16½
“ “ “ fine ground bone and tankage,	16½
“ “ “ fine ground medium bone and tankage,	13
“ “ “ medium bone tankage,	10½
“ “ “ coarser bone and tankage,	8½
“ “ “ hair, horn-shavings and coarse fish scrap,	8
Phosphoric acid soluble in water,	8
“ “ soluble in ammonium citrate,	7½
“ “ in dry ground fish, fine bone and tankage,	7
“ “ in fine medium bone and tankage,	6
“ “ in medium bone and tankage,	5
“ “ in coarser bone and tankage,	4
“ “ in fine ground rock phosphate,	2
Potash as High Grade Sulphate, and in forms free from Muriate or Chlorides,	5½
“ “ Kainite,	4¼
“ “ Muriate,	4¼

Trade Values in Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The organic nitrogen in these classes of goods is valued at the highest figures laid down in the Trade values of Fertilizing Ingredients in Raw Materials, namely, 16.5 cents per pound; it being assumed that the organic nitrogen is derived from the best sources, viz., animal matter, as meat, blood, bones or other equally good forms, and not from leather, shoddy, hair, or any low-priced inferior form of vegetable matter, unless the contrary is ascertained.

Insoluble phosphoric acid is valued at three cents, it being assumed, unless found otherwise, that it is from bone or similar source and not from rock phosphate. In this latter form the insoluble phosphoric acid is worth but two cents per pound.

For farther details see Bulletin 28, March, 1888.

C. A. GOESSMANN, *State Inspector.*

AMHERST, MASS., May 14, 1888.

DEAR SIR:
With a view to obtaining accurate information regarding all the counties for the use
of persons seeking homes and investments in Kentucky, the following list of questions has been
prepared for the purpose of suggesting to delegates the facts that will be desired. It is urgently
requested that the Auxiliary Committee for your county will have these questions accurately and
carefully answered and mailed to this office not later than September 1st.
By order of the Committee

THE

YOUNG E. ALLISON, Secretary.

KENTUCKY STATE INDUSTRIAL



AND COMMERCIAL CONFERENCE.

POINTS OF INFORMATION DESIRED.

Handwritten notes and lines for recording information.

LOUISVILLE, July, 1887.

DEAR SIR:

With a view to obtaining accurate information regarding all the counties for the use of persons seeking homes and investments in Kentucky, the following list of questions has been prepared for the purpose of suggesting to delegates the facts that will be desired. It is urgently requested that the Auxiliary Committee for your county will have these questions accurately and carefully answered and mailed to this office not later than September 1st.

By order of the Committee.

YOUNG E. ALLISON, Secretary.

COUNTY.

1. What is the proportion of timbered and cleared land in your county?

W. W. Estill
R. J. Shum

2. What is the average price per acre of improved farming lands?

W. W. Estill
R. J. Shum

3. What is the average price per acre of timber lands?

W. W. Estill
R. J. Shum

4. What are the staple crops grown, and what is the average yield per acre of each?

W. W. Estill
R. J. Shum

5. What towns are in your county, and the population of each?

G. W. Rank

6. What is the character of the county roads?

Estil
Shum

7. How many miles of railroad in the county? How many are projected?

G. H. Rank

8. What are the special or peculiar products of your county, and how are they being developed?

9. What grasses succeed best in your county?

Dr. R. J. Shum
in Estil

10. Name the streams in your county available for water-power, and give number of months the streams are flowing?

11. What is the increase of population in your county since 1880, where are the new comers from, and what nationality, and are they farmers or towns-people?

G. H. Rank

12. What has been the increase in manufactures in your county since 1880?

Mr. Rank

13. Number of manufactories, and names and character of the same?

Mr Rank

14. Total amount of capital invested as compared with 1880?

Mr Rank

15. Number of hands employed in same, as compared with 1880?

Mr Rank

16. What enterprises could be most advantageously started in your county?

Mr Rank

17. What character of mineral wealth has your county, and how many mines, etc., are in operation?

Prof Anderson

~~18.~~ Add what other information you may deem of importance.

SCIENTIFIC ASSISTANT IN ANIMAL BACTERIOLOGY. SCIENTIFIC ASSISTANT IN PLANT PATHOLOGY.

DEPARTMENT OF AGRICULTURE.

FEBRUARY 6-7, 1907.

The United States Civil Service Commission announces an examination on February 6-7, 1907, at the places mentioned in the list printed hereon, to secure eligibles from which to make certification to fill a vacancy in the position of scientific assistant in plant pathology, \$1,000 per annum, Bureau of Plant Industry, a vacancy in the position of scientific assistant in animal bacteriology, \$840 per annum, Bureau of Chemistry, and vacancies as they may occur in the Department of Agriculture requiring similar qualifications.

As the Commission has experienced considerable difficulty in securing eligibles for these positions, qualified persons are urged to enter this examination.

Age limit, 20 to 40 years on the date of the examination.

This examination will comprise a basis, consisting of obligatory subjects, and the major optional subjects of animal bacteriology and plant pathology, applicants being required to take but one major optional subject. A maximum credit of 500 is assigned to the major optional subjects. No minor optional subjects will be given with this examination. Each applicant will be required to pass in the basis, or obligatory subjects, before any rating will be given in the major optional subjects.

To become eligible for the specific vacancies, it will be necessary for competitors to attain the rating required for eligibility in the basis and in one of the major optional subjects.

<i>Obligatory subjects (or basis examination).</i>	<i>Credit assigned.</i>
1. English composition and report writing.....	300
2. Arithmetic (fundamental rules, fractions, percentage, interest, discount, analysis, and statement of simple accounts).....	200
3. General educational training.....	500
Total.....	1,000

The figures opposite each subject indicate (1) the relative value and (2) the credit that will be given as a maximum rating on such subject in the examination. No competitor who attains less than a total of 700 credits in the obligatory subjects and a credit of less than 350 in the major optional subject will be eligible for appointment. No optional subjects will be considered if less than 70 per cent of the credit assigned is attained.

The time allowed for each optional subject will be indicated on the question sheet.

The subjects of animal bacteriology and plant pathology will comprise the following elements:

	<i>Credit assigned.</i>
1. A thesis, preferably on some phase of the subject, to be submitted with the application ..	100
2. Practical questions.....	300
3. Training and experience in the specific work covered by the subject	100
Total.....	500

If the thesis has no bearing whatever upon the optional subject selected, no credit will be given for the thesis unless a rating of at least 70 per cent is received in the practical questions and in training and experience. The length of the thesis may be determined by the applicant and may be in hand-writing or typewriting.

Two days will be required for this examination.

This examination is open to all citizens of the United States who comply with the requirements.

This announcement contains all information which is communicated to applicants regarding the scope of the examination, the vacancy or vacancies to be filled, and the qualifications required.

Applicants should at once apply either to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners at any place mentioned in the list printed hereon, for application Form 1312. No application will be accepted unless properly executed and filed, with the thesis required, with the Commission at Washington. In applying for this examination the exact title of the position sought, as given at the head of this announcement, should be used in the application.

As examination papers are shipped direct from the Commission to the places of examination, it is necessary that applications be received in ample time to arrange for the examination desired at the place indicated by the applicant. The Commission will therefore arrange to examine any applicant whose application is received in time to permit the shipment of the necessary papers.

Issued January 3, 1907.

United States Civil Service Commission, Washington, D. C.

The examination referred to in the accompanying newspaper announcement may be taken on the date mentioned therein at any of the places named below. **No request will be granted for examination on any other date or at any other place.** Application blanks may be secured from the secretary of the local board at any of the following-named places. At places marked "C. H." applicants should apply at the custom-house; at other places application should be made at the post-office.

ALABAMA -----	{ Birmingham. Mobile. Montgomery.	MAINE -----	{ Bangor. Bath. Calais. C. H. Houlton. Lewiston. Portland.	OHIO -----	{ Cincinnati. Cleveland. C. H. Columbus. *Ironton. Toledo. Zanesville.
ARIZONA -----	{ Phoenix. Prescott. Tucson.	MARYLAND -----	{ Baltimore. Cumberland. Salisbury.	OKLAHOMA -----	{ Enid. Guthrie. Oklahoma.
ARKANSAS -----	{ Fort Smith. Little Rock. Texarkana.	MASSACHUSETTS -----	{ Boston. Fall River. Fitchburg. Lawrence. Pittsfield. Springfield. Worcester.	OREGON -----	{ Astoria. C. H. Baker City. Eugene. Portland.
CALIFORNIA -----	{ Fresno. Los Angeles. *Marysville. Sacramento. San Francisco. San Jose. San Luis Obispo.	MICHIGAN -----	{ Detroit. Grand Rapids. Manistee. *Marquette. Saginaw. Sault Ste. Marie.	PENNSYLVANIA -----	{ *Altoona. Harrisburg. Philadelphia. Pittsburg. *Warren. Williamsport. Wilkesbarre.
COLORADO -----	{ Denver. Durango. Fort Collins. Grand Junction. Pueblo. Trinidad.	MINNESOTA -----	{ Duluth. Mankato. St. Paul.	PORTO RICO -----	{ *San Juan.
CONNECTICUT -----	{ Hartford. C. H. Middletown.	MISSISSIPPI -----	{ Greenville. *Meridian. Vicksburg.	SOUTH CAROLINA -----	{ Charleston. Columbia. *Greenville.
DIST. OF COLUMBIA -----	{ Washington.	MISSOURI -----	{ Jefferson City. Kansas City. Kirkville. Springfield. St. Joseph. St. Louis.	SOUTH DAKOTA -----	{ Aberdeen. Deadwood. Sioux Falls. Watertown.
FLORIDA -----	{ Jacksonville. *Key West. Miami. Pensacola. *Tampa.	MONTANA -----	{ *Billings. *Bozeman. Butte. *Great Falls. Helena. Missoula.	TENNESSEE -----	{ Bristol. Chattanooga. Knoxville. Memphis. Nashville.
GEORGIA -----	{ *Athens. Atlanta. Augusta. Macon. Savannah. *Thomasville.	NEBRASKA -----	{ Grand Island. Lincoln. Omaha.	TEXAS -----	{ Austin. Dallas. El Paso. C. H. Houston. San Antonio. Waco.
HAWAII -----	{ *Honolulu. C. H.	NEVADA -----	{ *Reno.	UTAH -----	{ *Logan. Salt Lake City.
IDAHO -----	{ Boise. Moscow.	NEW HAMPSHIRE -----	{ *Claremont. Concord. Keene. Portsmouth.	VERMONT -----	{ Montpelier. Rutland. St. Johnsbury.
ILLINOIS -----	{ Cairo. Champaign. Chicago. Peoria. Quincy. Springfield.	NEW MEXICO -----	{ Albuquerque. Las Vegas.	VIRGINIA -----	{ *Lynchburg. Norfolk. Richmond. Roanoke. Staunton.
INDIANA -----	{ Bloomington. Evansville. Fort Wayne. Indianapolis. Lafayette.	NEW YORK -----	{ Albany. *Brooklyn. Buffalo. Ithaca. Ogdensburg. Plattsburg. C. H. Rochester. Syracuse. Utica.	WASHINGTON -----	{ Bellingham. Port Townsend. C. H. Seattle. Spokane. Tacoma. Walla Walla.
INDIAN TERRITORY -----	{ Ardmore. Muskogee. South McAlester.	NORTH CAROLINA -----	{ Asheville. Charlotte. Raleigh. Wilmington.	WEST VIRGINIA -----	{ Charleston. Fairmont. Parkersburg.
IOWA -----	{ *Ames. Des Moines. Dubuque. *Fort Madison. Iowa City. *Mason City. Sioux City.	NORTH DAKOTA -----	{ Bismarck. Fargo. *Grand Forks. *Minot. *Pembina. C. H.	WISCONSIN -----	{ Appleton. Ashland. Chippewa Falls. La Crosse. Madison. Marinette. Milwaukee. Wausau.
KANSAS -----	{ Fort Scott. Salina. Topeka. Wichita.			WYOMING -----	{ Cheyenne. *Laramie. Sheridan.
KENTUCKY -----	{ Lexington. Louisville. Paducah.				
LOUISIANA -----	{ Baton Rouge. New Orleans. C. H. Shreveport.				

* Boards of Pension Examining Surgeons are located at all places mentioned in this list, except those marked thus: *.
† For information, application blanks, etc., apply at rooms of Civil Service Board, Custom-House, New York City.

SCIENTIFIC AID.
DEPARTMENT OF AGRICULTURE.

The United States Civil Service Commission invites special attention to the examination for scientific aid, applications for which may be filed at any time.

Eligibles are particularly desired at this time to fill a vacancy in the position of scientific aid (male) qualified in animal husbandry, in the Bureau of Animal Industry, Department of Agriculture, at \$480 per annum, and other similar vacancies as they may occur in that Department. For the specific vacancy mentioned, only such applications will be considered as are filed with the Commission at Washington prior to the hour of closing business on March 8, 1905.

Age limit, 20 years or over on the date of the examination.

Applicants must be graduates of colleges in courses of study tending to qualify them for the scientific work of the Department of Agriculture. They are not assembled for this examination, but must submit all the required material with their applications.

The examination will consist of the subjects mentioned below, weighted as indicated:

<i>Subjects.</i>	<i>Weights.</i>
1. College course with bachelor's degree, including a certified statement in detail of courses of study pursued and standing in each.....	40
2. Postgraduate course or special qualifications, including a certified statement of courses of study pursued and standing in each	30
3. Thesis or other literature on a scientific subject bearing upon the work the applicant desires to pursue	30
Total.....	100

This examination is open to all male citizens of the United States who comply with the requirements.

Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for application Form 304 and special forms. Applications should be properly executed and, with the material required, filed with the Commission at Washington, as indicated above. In applying for this examination the exact title as given at the head of this announcement should be used in the application.

Issued February 6, 1905.

BOTANIST.

MARCH 8, 1905.

The United States Civil Service Commission announces an examination on March 8, 1905, to secure eligibles from which to make certification to fill a vacancy in the position of botanist (male) at \$75 per month, in the National Museum, and vacancies as they may occur in any branch of the service requiring similar qualifications.

Applicants will not be required to appear at any place for examination.

The examination will consist of the subjects mentioned below, weighted as indicated:

<i>Subjects.</i>	<i>Weights.</i>
1. Undergraduate work, particularly in botany, Latin, French, and German (the competitor will be required to submit a statement indicating definitely the amount of work done in each of these subjects in his college course)	10
2. Postgraduate work done in botany, which must be shown by a statement indicating the college or botanical institution in connection with which and under whose supervision the work was done, the amount of field work done, and when and where. The statement should also show any degrees received and indicate the experience the applicant has had in caring for a large herbarium)	30
3. Botanical papers published (the applicant will be required to file a list of all papers published by him and copies of one or more papers on the subject of systematic botany)	30
4. Original thesis on care, arrangement, and development of a large herbarium	30
Total.....	100

Age limit, 20 years or over on the date of the examination.

This examination is open to all citizens of the United States who comply with the requirements.

Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for application Form 304. No application will be accepted unless properly executed and, with the material required, filed with the Commission at Washington prior to the hour of closing business on March 8, 1905. In applying for this examination the exact title as given at the head of this announcement should be used in the application.

Issued February 4, 1905.

SCIENTIFIC ASSISTANT.

DEPARTMENT OF AGRICULTURE.

MARCH 29, 1905.

The United States Civil Service Commission announces an examination on March 29, 1905, at the places mentioned in the accompanying list, to secure eligibles from which to make certification to fill a vacancy in the position of scientific assistant (male) qualified in agronomy, at \$1,200 per annum, in the Bureau of Plant Industry, Department of Agriculture, and vacancies as they may occur in that Department requiring similar qualifications.

The examination will consist of the subjects mentioned below, weighted as indicated:

<i>Preliminary subjects.</i>	<i>Weights.</i>
1. College course with bachelor's degree (including a certified statement in detail of courses of study pursued and standing in each)	40
2. Postgraduate course or special qualifications (including a certified statement in detail of courses of study pursued and standing in each)	30
3. Thesis, or other literature (on a scientific subject bearing upon the work the applicant desires to pursue)	30
Total	100

Applicants who have already qualified as scientific aids should so state in their applications for scientific assistant, giving the dates when their applications were filed and the average percentages attained.

Applicants who comply with the preliminary requirements will be examined in agronomy.

Age limit, 20 years or over on the date of the examination.

This examination is open to all citizens of the United States who comply with the requirements.

Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for application Form 304 and special form (special forms are not required of those who have qualified as scientific aid). No application will be accepted unless properly executed and filed with the Commission at Washington. In applying for this examination the exact title as given at the head of this announcement should be used in the application.

As examination papers are shipped direct from the Commission to the places of examination, it is necessary that applications be received in ample time to arrange for the examination desired at the place indicated by the applicant. The Commission will, therefore, arrange to examine any applicant whose application is received in time to permit the shipment of the necessary papers.

Issued February 28, 1905.

United States Civil Service Commission, WASHINGTON, D. C.

The examination referred to in the accompanying newspaper announcement may be taken on the date mentioned therein at any of the places named below. **No request will be granted for examination on any other date or at any other place.** Application blanks may be secured from the secretary of the local board at any of the following-named places. At places marked "C. H." applicants should apply at the custom-house; at other places application should be made at the post-office.

ALABAMA -----	{ Birmingham. Mobile. Montgomery.	MAINE -----	{ Bangor. Houlton. Machias. C. H. Portland.	OKLAHOMA -----	{ Enid. Guthrie. Oklahoma.
ARIZONA -----	{ Phoenix. Prescott. Tucson.	MARYLAND -----	{ Baltimore. Cumberland. Salisbury.	OREGON -----	{ Astoria. Baker City. Eugene. Portland.
ARKANSAS -----	{ Fort Smith. Little Rock. Texarkana.	MASSACHUSETTS -----	{ Boston. *Fall River. *Fitchburg. Springfield.	PENNSYLVANIA -----	{ Altoona. Harrisburg. Philadelphia. Pittsburg. *Warren. Williamsport. Wilkesbarre.
CALIFORNIA -----	{ Fresno. Los Angeles. *Marysville. San Francisco.	MICHIGAN -----	{ Detroit. Grand Rapids. Manistee. *Marquette. Saginaw. Sault Ste. Marie.	PORTO RICO -----	*San Juan.
COLORADO -----	{ Denver. Durango. Grand Junction. Pueblo. Trinidad.	MINNESOTA -----	{ Duluth. Mankato. St. Paul.	SOUTH CAROLINA -----	{ Charleston. Columbia. *Greenville.
CONNECTICUT -----	{ Hartford. Middletown.	MISSISSIPPI -----	{ Greenville. *Meridian. Vicksburg.	SOUTH DAKOTA -----	{ Aberdeen. Deadwood. Sioux Falls. Watertown.
DIST. OF COLUMBIA -----	Washington.	MISSOURI -----	{ Jefferson City. Kansas City. Kirksville. Springfield. St. Louis.	TENNESSEE -----	{ Bristol. Chattanooga. Knoxville. Memphis. Nashville.
FLORIDA -----	{ Jacksonville. *Key West. Pensacola. *Tampa.	MONTANA -----	{ *Billings. *Bozeman. Butte. *Great Falls. Helena. Missoula. Grand Island.	TEXAS -----	{ El Paso. Fort Worth. Houston. San Antonio. Waco.
GEORGIA -----	{ *Athens. Atlanta. Augusta. Macon. Savannah. *Thomasville.	NEBRASKA -----	{ *Reno. Lincoln. Omaha.	UTAH -----	{ *Logan. Salt Lake City.
HAWAII -----	*Honolulu. C. H.	NEVADA -----	{ *Claremont. Concord. Keene. Portsmouth.	VERMONT -----	{ Montpelier. Rutland. St. Johnsbury.
IDAHO -----	{ Boise. Moscow.	NEW HAMPSHIRE -----	{ Albuquerque. Las Vegas.	VIRGINIA -----	{ *Lynchburg. Norfolk. Richmond. Roanoke. Staunton.
ILLINOIS -----	{ Chicago. Peoria. Springfield.	NEW MEXICO -----	{ Albany. Brooklyn. Buffalo. Ithaca. Plattsburg. C. H. Rochester. Syracuse. Utica.	WASHINGTON -----	{ Bellingham. Port Townsend. C. H. Seattle. Spokane. Tacoma. Walla Walla.
INDIANA -----	{ Evansville. Fort Wayne. Indianapolis. Lafayette.	NEW YORK -----	{ Asheville. Charlotte. Raleigh. Wilmington.	WEST VIRGINIA -----	{ Charleston. Fairmont. Parkersburg.
INDIAN TERRITORY -----	{ Ardmore. Muskogee. South McAlester.	NORTH CAROLINA -----	{ Fargo. *Grand Forks. *Pembina. C. H.	WISCONSIN -----	{ Appleton. Ashland. Chippewa Falls. La Crosse. Madison. Marinette. Milwaukee.
IOWA -----	{ Des Moines. Dubuque. *Fort Madison. Iowa City. *Mason City. Sioux City.	NORTH DAKOTA -----	{ Cincinnati. Cleveland. Columbus. *Ironton. Toledo. Zanesville.	WYOMING -----	{ Cheyenne. *Laramie.
KANSAS -----	{ Fort Scott. Salina. Topeka. Wichita.	OHIO -----			
KENTUCKY -----	{ Lexington. Louisville. Paducah.				
LOUISIANA -----	{ Baton Rouge. New Orleans. C. H. Shreveport.				

BACTERIOLOGICAL CHEMIST.

BUREAU OF CHEMISTRY, DEPARTMENT OF AGRICULTURE.

MAY 17, 1905.

The United States Civil Service Commission announces an examination on May 17, 1905, to secure eligibles from which to make certification to fill a vacancy in the position of bacteriological chemist in the Bureau of Chemistry, Department of Agriculture, at \$2,000 per annum, and vacancies as they may occur in any branch of the service requiring similar qualifications.

Applicants will not be required to appear at any place for examination.

The examination will consist of the subjects mentioned below, weighted as indicated:

<i>Subjects.</i>	<i>Weights.</i>
1. Education and training in bacteriology and chemistry (the competitor will be required to submit a complete statement of his education and training in bacteriology and chemistry, indicating the college or institution in which the instruction was acquired, and the degrees received. He will also be required to file a list of all papers published)	25
2. Experience in the inspection of foods from a bacteriological and chemical standpoint (a statement should be submitted showing fully and in detail all the experience the competitor has had in the inspection of foods from a bacteriological and chemical standpoint, stating the institutions in which and the names of the persons under whose supervision the work was performed)	25
3. Thesis not to exceed 3,000 words on the chemical changes produced in foods by bacterial action. The thesis should include original work by the competitor and will be rated as follows:	
General character	25
Original work described	25
Total	100

Age limit, 22 years or over, on the date of the examination.

This examination is open to all citizens of the United States who comply with the requirements and who are graduates of institutions of learning, and who have the degree of Ph. D. or show a training equivalent thereto.

Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for application Form 304 and special form. No application will be accepted unless properly executed and filed, with the material required, with the Commission at Washington prior to the hour of closing business on May 17, 1905. In applying for this examination the exact title as given at the head of this announcement should be used in the application.

Issued April 21, 1905.



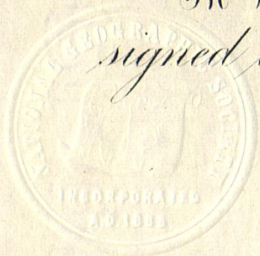
The National Geographic Society

Through the Board of Managers at a
meeting held in Washington, District of
Columbia in the United States of America,
on the seventh day of April 1905
has elected

James K. Patterson, Ph.D., D.D.,
of Lexington, Ky.,

a member of that Society

In Witness Whereof, this certificate has been
signed and presented.



O. P. Austin,
Secretary.