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WEATHER CONTROLS OVER THE FIGHTING DURING THE AUTUMN OF 1918[1]

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THE Allied advance on the western front, which began on July 18, continued into the autumn with remarkable success until the ending of the war. Almost every day brought the news of a gain of territory; of the recapture of towns and villages; of the taking of prisoners and of guns. It seemed as if weather conditions, however unfavorable, could hardly make any difference in the carrying on of so aggressive a campaign, yet the autumn of 1918 was, in many respects, the most critical season, meteorologically, of any period of equal length during the whole war. It is easy to understand why this was the case. In the preceding years of the war, the winter storms, and cold, and mud on the western front necessitated a decided slackening of military operations between about the middle of November and early December. This happened in spite of emphatic

[1] Continued from THE SCIENTIFIC MONTHLY for October, 1918, p. 298.

Author's Note.—This series of papers on the weather factor in the Great War comes to a conclusion with the signing of the armistice by Germany. In the preparation of these articles, published in THE SCIENTIFIC MONTHLY and elsewhere, the writer had two things in mind. It was his belief that, as a part of the scientific history of the Great War, as full an account as possible should be kept of the meteorological conditions which affected the operations on all the battle-fronts. The other object was a practical one. It was felt that a discussion of the climatic conditions of the various war zones, and of the meteorological difficulties which were likely to affect, and which did affect, military operations, might be of some help in our own preparation for and conduct of the war. The facts set forth in these papers were collected from all available, reliable sources of information, chiefly the official headquarters' despatches, and the letters of well-known war correspondents. Later, and more complete, information may indicate that some of the statements which the writer has made should be modified, but it is his belief that what has been included is essentially complete and essentially correct.

predictions, previously made by the military commanders, that the fighting would "continue as usual throughout the winter." The 1918 summer and autumn campaign on the part of the Allies was perfectly clearly a neck-and-neck race with the weather. It was the business of the Allies to force an overwhelming defeat of the German armies during the few remaining weeks of "fighting weather," and to make it impossible for the enemy to postpone the final decision until after another winter of relative inactivity. Again, in case a definite military decision should prove unattainable before winter, it was clearly to the advantage of the Allies to push on, beyond the area of destruction and desolation left by the Germans during the earlier part of their retreat, where there were no houses or shelters of any kind and no fuel, to the towns and large cities of eastern France and Belgium. Here adequate provision for billeting the soldiers could be made. The Hindenburg Line itself, with its elaborate concrete shelters and dugouts, was an important objective before winter, for this same reason. Mr. Charles H. Grasty, the well-known *New York Times* correspondent, in a cabled despatch from Paris, dated September 11, reported having asked a French military authority why the Allied troops did not rush ahead and crush the Germans at once. The reply was:

> There's one Generalissimo whom all belligerents take orders from, General Mud. If we could continue summer weather conditions another three months, we might get a decision. But it's unsafe to reckon on more than five weeks of good offensive weather. From the Somme to the Channel the character of the soil renders the mud the worst in all creation after the autumn rains begin in good earnest.

The Germans, on their part, had every reason for prolonging the fighting until the advance of winter should delay the enemy pursuit, and bring a cessation of active operations. Germany would then be in a position to rest and to reorganize her forces, and to suggest peace negotiations on the basis of a stalemate on the western front. Both sides were thus fighting with the strongest possible meteorological pressure behind them. For both sides, everything depended on the time of the setting in, and upon the severity, of the winter.

During the first days of September, the despatches mentioned the "unprecedented dryness" of the season as having been remarkably favorable for the movement of the Allies' troops, guns, tanks and supplies. In the absence of direct meteorological records from overseas, it is impossible to determine whether the term "unprecedented dryness" was warranted, but it is clear that the roads were in good condition and that the Germans tried to hamper the Allied advance by flooding, wherever possible. The autumn rains were, however, not long delayed. For about a week, following September 8, heavy storms and chilly winds swept the entire battle area, slackening the progress of the Allies but not stopping their steady, although slower, advance. The men were drenched to the skin, and "felt the wind like a knife-blade." Yet there was a blessing in the rain, well recognized by some of the troops, for it laid the dust which was blowing from the battlefields covered with dead bodies of men and of horses, and it prevented the explosion of many shells which struck in pools of water.

As the milder and more peaceful weather of summer on the western front gradually gives way to the stormier and more turbulent autumnal types, it is inevitable that active military operations should be oftener slackened, or even entirely interrupted. The fighting conditions are less favorable. The weather changes are more frequent and violent. The rain is more chilling, and snow and sleet begin to fall. Observation, on the surface or in the air, becomes more difficult, often even impossible, owing to clouds, or mist, or fog. Gunfire becomes inaccurate. Lower temperatures, especially during the autumnal nights, cause discomfort or suffering, and bring calls for warmer clothing and for fires. The traditional mud of Flanders makes the most serious trouble during the autumn rains, which are characteristic of that region. Flanders mud has played its part in every war fought over this same territory throughout history, and has over and over again proved a serious handicap in the present war. This mud is most troublesome in the colder months, for storms are then most, and spells of fine weather then least, frequent. The rains on the western front are not unusually heavy in the sense that they give a large annual rainfall, but they come fairly steadily throughout the year; the country is mostly very flat and poorly drained; the soil is quickly water-logged, and the trenches and shell-craters serve as so many reservoirs for collecting water. "Seas of mud," "quagmires," "morasses," "bogs" are expressions used to describe conditions which have prevailed since the war on the western front began. Incessant labor must be expended to keep the roads in condition for traffic. The rivers are frequently in flood, carrying away bridges and turning the lower lands into temporary shallow lakes. The relation between the weather and military operations, especially in autumn and winter, is like a see-saw. Spells of stormy weather and of deep mud mean tremendous difficulties of transportation and of troop movements, and hence involve a slackening of operations. Spells of fine weather mean greater aerial activity; more intense artillery action, and more favorable conditions for all movements.

With the progression of the seasons, from summer to fall, it was inevitable that what has happened in the past four years on the western front would happen again in the autumn of 1918. There is no reason to suppose that the months of September, October and November of the present year were any more unfavorable, or brought any more rainfall, than they normally do, although the official despatches, and the war correspondents' cabled letters, lay unusual emphasis upon meteorological handicaps. This fact is, however, doubtless due to the intensity of the fighting, and to the tremendous effort which the Allied forces were making to bring the war to a successful ending before winter set in. It would be a tedious repetition to enumerate here all the many cases in which weather conditions controlled the military operations on the western front during the past autumn. The rains; the chilling winds; the low clouds; the fogs; the cold nights; the mud; the water-filled shell-craters; the flooded rivers; the swamps—all played their part. Sometimes weather conditions favored the enemy; sometimes they favored the Allies. On the whole, every bit of delay resulting from stormy weather and difficulties of transportation worked in favor of the enemy, for it gave him just so much more time to organize his retreat and remove his supplies, and it hampered just so much the Allies' progress in their pursuit of the retiring Germans. The successful elimination of the St. Mihiel salient by French and American troops just before the middle of September, although it occurred early in the autumn, furnished striking illustrations of the meteorological difficulties with which the armies had to contend. The advance was begun early in the morning after a rainy night, in a driving rain and mist which made aerial observation difficult, and was followed by a strong westerly wind which hampered balloon and airplane work. The roads were deep in mud, and the fields soggy. The movement of heavy guns and transports was very difficult, the mud proving too much for many of the tanks, although these were small and relatively light, and had a wide tread. "The infantrymen slipped and waded in pursuit of the retreating enemy." In spite of the bad weather, American bombers did effective work, driving down enemy airplanes and balloons and attacking German supply trains. The main road of the enemy's retreat became congested because of the mud, and here the American aviators, flying very low, were able to use bombs and machine guns to good effect.

Over and over again, with almost wearisome monotony, the despatches throughout the autumn mention the extraordinary difficulties resulting from the bad weather and the mud. But throughout all the reports there runs the splendid story of the advance of the Allied troops in spite of all obstacles; and of the cheerful endurance, on the part of the men, of discomfort and suffering in the cold and wet. One despatch (September 12) mentioned the pouring rains which forced "the Allied airmen to cease their punishment of the Germans." On September 30 "wintry winds and rains, sweeping in from the North Sea," drenched the men, and chilled them to the bone. Under that date Mr. Philip Gibbs cabled to the *New York Times*:

> There was wild weather last night, with a gale of wind blowing and heavy rainstorms over the battlefields. . . . It was bitter cold for the brave troops, and this morning some of them I met had chattering teeth, after a night without sleep, but they endure these discomforts bravely, and the vision of victory keeps them warm in soul, if not in body.

Advancing autumn brought the more stormy weather which is characteristic of October and November on the western front. Special mention was several times made of the extraordinary difficulties encountered by the American troops in the Argonne forest, where, in addition to the natural handicaps resulting from the terrain, there were the barbed wire, and traps, and machine gun nests, and "mud and rain—everlasting rain" (October 1). Many supplies had to be carried on the backs of the soldiers. "I guess he (the enemy) is as wet as I am, and that helps some" was the statement of an American soldier to a war correspondent. A cable despatch to the *New York Times* (October 1) contained this significant statement: "The elements continue unfavorable. To say that the continued rain is German weather is no figure of speech, for our supplies and guns and ammunition must be brought up through seas of mud. . . ." That such conditions hampered the Allies was generally recognized, and on one occasion (October 16) the Germans, "favored by the bad weather and bad roads" which slowed up the Allied supply trains, made a temporary stand on a line from the region north of Sissonne to Rethel.

In the Flanders region, as a correspondent cabled on October 15, "the battle may be said to be almost as much against the weather and the mud as against the Germans. But, while this sort of sticky ground hampers the Allied troops, it hinders even more the enemy, who is trying to move his materials away under a heavy fire and through the mired ground of the Flanders lowlands." That the Allied advance continued in spite of the extraordinary handicaps of weather, and mud, and difficult transport, is remarkable. Mr. Philip Gibbs cabled to the *New York Times* on October 23:

> The British troops slogged through water pools and trudged down rutty roads with the mud splashing them to their neck, while lorries surged along broken tracks, swung around shell craters and skirted deep ditches. Gun teams with all their horses plastered to the ears with mud traveled through the fog to take up new positions beyond the newly captured towns. All this makes war difficult and slow, and what is most amazing is the speed with which the armies are following up the German retreat like a world on the move, with aerodromes and hospitals, telegraph and transport, headquarters staffs and labor companies, all the vast population and mechanism which make up modern armies, across battlefields like the craters of the moon to country forty miles from their old bases.

In the latter part of October the Germans were using a great deal of mustard gas against the American troops. This gas is reported to be especially dangerous in wet weather, because in damp air it remains long in the hollows, where the shells land, and it also burns through wet clothes more easily than through dry.

Two branches of military activity are peculiarly hard hit by stormy weather. Tanks can only be used with difficulty, if at all, in deep mud, and heavy rain and low clouds prevent almost all aerial work. Balloons are not sent up and airplane observers, when they fly at all, can see only when very close to the ground. "German weather" was reported November 4. Heavy rains forced the Allies to advance slowly. The increasing distances from headquarters to the front added daily to the tremendous task of repairing roads, and of maintaining transport. On November 5, because of bad weather, the Allied front line troops lost touch with the main body of the enemy. On the same day Field Marshal Haig reported: "In spite of a heavy and continuous rain our troops have pressed the retiring enemy forces closely throughout the day, driving the rearguards wherever they have sought to oppose our advance and taking a number of prisoners." Persistent and heavy rains, or thick mists, continued along the whole battle-front until hostilities ceased. In spite of "very difficult weather," and of the deep and sticky mud, the Allied troops continued to make remarkable progress. These unfavorable conditions were bad for the Allies, because the pursuit was slackened, as was clearly indicated in the despatches, but, as one correspondent emphatically expressed it, "the imagination fails to conceive what it must be on the German side of the lines, where the retreating army looks back over its shoulders at the menace in pursuit, and where every block of traffic means terror, or death, or capture, because the British flying men are out, and the British guns are pounding the roads, and British troops are marching on."

Early morning fogs, or "mists," often served as a screen for the attacking troops. Such cases occurred on the British front, in the Douai-Cambrai region, on September 27, where the fog "assisted in bewildering the enemy"; on September 29, on the St. Quentin front, where the fog was so thick that it was impossible to see "the length of a gun-team ahead"; on the American front in the Argonne forest on October 1, when the small tanks came out of the fog, unexpectedly, "like phantoms," and fell on the Germans in the rear; in the sector south of Cambrai on October 8, where British, French and Americans launched an attack in a thick "mist" and fog. Again, on October 9, a fog "proved a big help" to the American attacking troops in the Argonne forest. On October 18, in the Le Cateau sector, "American tanks . . . crossed the Selle River in a dense fog, steering by compass, leading the attack against the Germans. Prisoners said they were overcome by the suddenness of the arrival of the tanks in the fog." Other cases occurred on October 24, on the American front, and also on the British front in Flanders. The "thick wet fog" in the latter case was reported as very much in favor of the attacking troops, for it "blinded" the German machine gunners. November 1 and November 3 furnished further illustrations of similar conditions on the American front. In the advance on Landrecies the tanks had to steer by compass through the dense white fog of early morning. One report (November 8) mentions the fact that, owing to an all-day fog, American aviators were unable to keep watch on the retreating enemy, and this aided the German withdrawal.

The effect of spells of fine weather must not be lost sight of. In the midst of the storms, which are the dominant condition on the western front in the autumn months, the rarer spells of dry, clear weather are peculiarly welcome, and exert marked controls over military activities. Thus, on September 15–16, fine weather, "with just the first touch of autumn in the wind at night" but with warm "perfect" days, was a welcome relief to the men, and a real help in the work of road-mending and of railway and camp construction. Every spell of fine weather brought increased activity, especially in the air. Under date of September 27, Mr. G. H. Perris cabled to the *New York Times* from the French front:

> It was a matter of universal congratulation that the morning fog had early given way before the bright sunshine. A mist at the hour of assault is not an unmixed disadvantage, for it covers the infantry advance and blinds the enemy machine gunners; but the importance of aerial observation, especially for the correction of artillery fire, has become so great that the momentary screen gained by the ground forces is no compensation for the crippling of the aviators. A burst of fine weather at such a juncture has also a considerable moral influence. No man is quite strong enough to be indifferent to accident; and, as when a vast and perilous venture falls upon bad conditions, those who must sustain it are discouraged as well as obstructed, so the happier turn of fortune is a double aid.

Good weather on October 1 "did wonders for us in the way of repairing the roads, and to-day's reports are that traffic conditions have improved 100 per cent. over two days ago, when, it may be stated, our service of supply was in a sorry plight through no fault of its own." The comfort of the men is obviously greatly affected by the weather conditions. Dry spells, with improved transportation, mean more regular and better meals, and dry blankets, to say nothing of the cheering effect of sunshine on the spirits of the men.

Preparations had been made for carrying on the war through the winter. Under date of October 4 it was reported that most of the American troops had been supplied with sleeveless, felt-lined leather coats, "while trucks moving from the rear bore ton upon ton of overcoats." At the end of October, the Forestry Section of the A. E. F. promised to have ready by January 1, 1919, 100,000 cubic meters of fuel wood. This was to come from dead wood and from refuse in the forests. No fine trees were to be cut.

Early in October (third) the statement was made, in a despatch from overseas, that American naval officers looked for increasingly difficult times for the German submarines. In summer, by operating far out, the losses may have been reduced, as well as the successes, but the coming on of winter storms was expected to drive the submarines into more sheltered waters, where air patrols, and submarine chasers and destroyers would have a better chance to attack them. A good deal was said about the relatively small amount of aerial activity on the part of the Germans during the summer and early autumn. In explanation of this fact, some of the Allied aviators maintained that the enemy machines were being conserved by using them on cloudy days only. They could then navigate by compass above the clouds; swooping down when necessary, and then disappearing again within the clouds. An interesting case of camouflage was reported in connection with the use by the Allies of figures of soldiers painted on thin boards, and cut out very much as paper dolls are cut out by children. During the night these silhouettes were placed out in open order in front of the lines, and on a foggy morning, being mistaken by the Germans for real men, usually drew the enemy's fire and thus revealed the position of the enemy's guns in advance of the attack.

On the Italian front there was little activity until late in October. Early in September (fifth), in the northern part of the Tonale Pass, there was hard fighting "among the eternal snow and ice." On September 25, Italians and Czecho-Slovaks made a surprise attack on the Asiago Plateau in a violent storm. On October 24 a new—and the final—Italian and Allied offensive began on the mountain front between the Brenta and Piave rivers, in unfavorable weather. The time of the year was certainly not propitious for a mountain campaign, for by late October the snowfall in the mountains is already considerable, and almost certain to cause serious difficulties of troop movements and of transport. The reason for beginning the offensive at that time was doubtless to be sought in the political condition of Austria-Hungary. On the other hand, on the southern Piave, winter fighting is quite possible, for the precipitation there is rain rather than snow. It may be that General Foch had planned the Italian offensive for a time when Austria's main lines of communication with the front should be blocked with snow. The weather in the mountains was reported as unfavorable (October 24–29), but the Italian troops were successful. The Italian statements regarding the operations on the Piave were rather guarded. Conditions had threatened a rise in the river, but with three successive days of fair weather (October 30) a large body of troops was able to cross the Piave, and continue their pursuit of the retreating enemy. The danger that a sudden fall of rain in the mountains would bring the Piave down in flood, as happened during the last Austrian offensive, did not occur, although there were reports on October 28 that operations had been checked by a rise in the river. Military operations on the Italian front ended when the armistice went into effect, November 4.

In Mesopotamia and Palestine the British forces achieved complete success. Because of the "closed season," resulting from the heat and drought of the summer, little was heard of

Gen. Allenby after the first of May, when he had taken Es-Sault, and had reached a point on the railroad about 110 miles from Damascus. Some details, not earlier available, have come through regarding the difficulties which were met with in the progress of the campaign which followed the capture of Jerusalem (early December, 1917). These facts are taken from a diary of a member of the Imperial Camel Corps, and were sent to this country by Mr. Allan Hunter, a member of the American Red Cross in Palestine. That being the rainy season in Palestine, the trouble, as was to be expected, was mostly with the rain and mud. Immediately after crossing the Jordan, "there was a huge dust storm, accompanied by rain, which made it very unpleasant." The men suffered greatly because of the frequent rains and cold. The mud became "simply atrocious." On one occasion the camels had to be pulled along by their bridles. "The trek was literally through feet of mud and water." Just before reaching Es-Sault "hailstones and bitter cold and the usual mud" were experienced. There is also reference to "very heavy dew, which went through bivvy sheet and valise and waterproof sheets." These heavy dews are a well-known climatic characteristic of Palestine, especially on the interior highlands.

Gen. Allenby started his autumn (1918) campaign very early (September 19), before the best season for military operations in Palestine usually begins, doubtless in order that he might have the whole of the campaign season before him. One point in the British advance is especially interesting. This being still the dry season, marching troops naturally raise clouds of dust, and their movements are thus revealed to the enemy. It was doubtless partly for this reason that Gen. Allenby's troops "were always moved by night, and remained hidden in the orange and olive groves in the daytime." In Mesopotamia, also, the hot summer was a time of relative inactivity, but with the coming of autumn the British forces advanced up the Tigris in coordination with the movements of Gen. Allenby's forces in Palestine. The result of the combined operations is well known. The Turkish armies were defeated, and Turkey was driven to surrender.

From Russia, in its state of chaos, but little trustworthy news has come through. As early as August 28 a despatch from Archangel referred to the work of an Allied commission which was then considering the question of supplying the people with winter clothing and with provisions. An interesting despatch (September 4) mentioned the arrival of American troops at Archangel, most of them being "from States where the winters are like those of Russia." Under date of October 20, a press despatch from Archangel reported:

> An unusually late winter in northern Russia was ushered in to-day by a heavy fall of snow. The Dvina and Vaga Rivers, which usually are closed at this date, are still ice free. The American and other soldiers are being equipped with semi-arctic uniforms, including sheepskin greatcoats and Arctic felt boots.

In Siberia, preparations for a hard winter's fighting were being made early in September. American troops were then being fitted out with fur caps, mittens, overcoats and heavy fur-lined shoes. "They will wear the same clothing as troops stationed in Alaska." "Typical American fall weather" was reported as prevailing at Khabarovsk on the arrival of American troops there (October 14). From the American Government, through the Red Cross, 75,000 sweaters and overcoats for the Czecho-Slovak troops arrived in Vladivostock on October 16. As an "emergency relief," other supplies of warm clothing had been previously distributed to these troops. One of the most difficult questions confronting the Allies in Siberia was that of transportation by the Trans-Siberian road during the severe cold and icy gales of winter.

From the Balkans there were very few reports of meteorological interest. Quick work by the Allied troops was imperative, for the winters of the Balkan mountains begin early, and are severe. Increasingly unfavorable weather was noted early in October. The ending of the war before mid-autumn came at the time when military operations in the Balkan highlands are usually beginning to be seriously interfered with by bad weather.

Thus ends the meteorological chronology of the war which has been the subject of the present series of articles. When the complete scientific history of the Great War comes to be written, by no means the least important, or least interesting chapter will be that which relates to the weather controls over the operations on all the fronts. It is the hope of the writer that the facts which he has collected and summarized in the series of articles now ending may be a helpful contribution to the more complete discussion which may follow.

SOCIAL AMELIORATION AND EUGENIC PROGRESS

By Professor S. J. HOLMES

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THE relation between social progress and the improvement of the inborn qualities of the human race is a question upon which we meet with much difference of opinion. The progress in ideas and institutions which forms so conspicuous a feature of our recent history by no means implies a corresponding improvement in the characteristics that we owe to heredity, and in fact may go along with biological decadence. Civilization, biologically considered, is a comparatively recent and somewhat anomalous racial experience, and it brings in its train a number of agencies which tend to oppose the operation of those selective forces which most biologists regard as mainly responsible for the evolution of organic life. Our modern warfare in leading to the elimination of our best stocks; our fostering of the weak and defective; the decline of the birth rate among those classes of society which have risen into the successful ranks—all tend to recruit the next generation from stocks of relatively inferior racial qualities. There is little doubt that the most potent of these forces is the relative sterility of those classes whose inheritance of desirable traits of mind and character we have every reason to believe is above the average. In the animal world individuals that attain supremacy over their fellows generally succeed in leaving the most numerous progeny. But under modern social conditions this natural relationship between net fecundity and the qualities that lead to supremacy has undergone a curious reversal. Those who succeed leave few offspring, while the failures, the mentally subnormal and the improvident who are restrained by no considerations of prudence from perpetuating their kind and leaving them to the tender mercies of Providence or the poorhouse, continue to multiply with relatively unabated rapidity. Whatever may be the forces working towards the improvement of our hereditary endowments, it is evident that so long as preponderating fecundity belongs to those who drift instead of to those who attain mastery the race stands in very serious danger of deterioration.

It is unnecessary to dwell further upon this situation which has been discussed so frequently in recent years. Our present aim is to enquire whether or not the future improvement of our social institutions, granting that they continue to improve, promises to counteract, in any effective way, the forces that are now working toward racial decadence.[1] Most people look forward optimistically to an era of accomplished reform when education and culture will become much more widely spread, when wealth will be more equitably distributed, and when people in general will be good and happy. Assuming that these sanguine expectations will be in the main fulfilled, what will be the probable effect upon our racial inheritance?

Unless one were a Lamarckian and believed that the results of individual improvement were bequeathed to following generations, the answer to this question would not be immediately evident at least. Most biologists at the present time are not Lamarckians, and their answer to the question would probably depend upon their estimate of the way in which the various selective agencies to which mankind is exposed are affected by social progress. There are many factors, both social and biological, which must be considered in dealing with this problem; and judging from the expressed opinions of a number of biologists one may be pretty sure that the question would be answered in several different ways.

Writers on social evolution often assume a certain antagonism between racial welfare and the general improvement of the conditions of life. Conditions must be bad enough, at least for a goodly number of people, so that the "beneficent working of the survival of the fittest" is not interfered with. Herbert Spencer warns legislators against any artificial interference with the competition whereby the ill-endowed are condemned to "abject misery" and early death. "Manifestly," he says, "an opposite régime, could it be maintained, would, in course of time, be fatal to the species." According to Professor Haeckel,

> The theory of selection teaches us in human life, exactly as in animal and plant life, at each place and time only a small privileged minority can continue to exist and flourish; the great mass must starve and more or less prematurely perish in misery. . . . We may deeply mourn this tragic fact, but we can not deny or alter it. "Many are called but few are chosen." This selection, this picking out of the chosen, is necessarily combined with the languishing and perishing of the remaining majority.

[1] A discussion of some of these forces is contained in an article by the writer on The Decadence of Human Heredity which appeared in the Atlantic Monthly for Sept., 1914.

If the weak must be crushed in order that the best types may inherit the earth it is obvious that a condition of society which greatly improves the living conditions of the less highly favored of the human breed would be fatal to the evolution of the race.

It is scarcely necessary to point out that Haeckel's picture of selection in human society is grossly overdrawn. But the central idea expressed, *i. e.*, the necessity for maintaining the struggle for existence in order to insure progress, is voiced by a number of post-Darwinian writers on social evolution. To quote the words of a prominent social Darwinist, Mr. Benjamin Kidd:

> We shall perceive, when we understand the nature of the forces at work beneath the social phenomena of our time, that in whatever direction we may cast our eyes, there is no evidence that the rivalry and competition of life, which has projected itself into human society, has tended to disappear in the past, or that it is less severe amongst the most advanced peoples of the present, or that the tendency of the progress we are making is to extinguish it in the future. On the contrary, all the evidence points in the opposite direction. . . . The races who maintain their places in the van do so on the sternest conditions. We may regulate and humanize those conditions, but we have no power to alter them; the conflict is severest of all when it is carried on under the forms of the highest civilization. The Anglo-Saxon looks forward, not without reason, to the days when wars will cease; but without war, he is involuntarily exterminating the Maori, the Australian, and the Red Indian, and he has within his borders the emancipated but ostracized Negro, the English Poor Law, and the Social Question; he may beat his swords into ploughshares but in his hands the implements of industry prove even more effective and deadly weapons than the swords.
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> These are the first stern facts of human life and progress which we have to take into account. They have their origin not in any accidental feature of our history, nor in any innate depravity existing in man. They result, as we have seen, from deep-seated physiological causes, the operation of which we must always remain powerless to escape.

Individual man, as Mr. Kidd conceives him, is but a pawn in Nature's game—a game in which he as an individual has no particular interest. Nature, "so careful of the type" and "so careless of the single life," is ever ready to sacrifice the individual in the interest of the social organism to which he belongs. "The teaching of reason to the individual," says Mr. Kidd, "must always be that the present time and his own interest therein are all-important to him. Yet the forces which are working out our development are primarily concerned not with these interests of the individual, but with those widely different interests of a social organism subject to quite other conditions and possessed of an indefinitely longer life."

To induce man to sacrifice his interests and to work for the welfare of his social group is a problem which Nature has solved by endowing him with various social instincts and emotions, and particularly with those traits which make him a religious animal. As only egoism is rational, according to Mr. Kidd, man must be bamboozled into altruism in some way if Nature is to gain her end of promoting human progress for which, it is claimed, there is "no rational sanction." To effect this consummation is the lofty function of religion. By furnishing him with non-rational sanctions for conduct which makes for social as opposed to individual welfare, Nature has made man a willing dupe, content to tolerate a social system in which natural selection has free play and in which much misery must be endured in order that social evolution may continue its course.

This is, I think, a fair statement of Mr. Kidd's view, though expressed in phraseology less dignified and persuasive than that which captivates the readers of "Social Evolution." It is but natural for Mr. Kidd to conclude that the evolution which is now going on in the human race, and which has been going on for many centuries, is not primarily in the field of intellect, but of instinct. Nature does not favor the development of intellect beyond the point at which the latter becomes unmanageable and refuses to subordinate itself to Nature's ends. The great danger that comes from the gradual extension of the sphere of individual rights, and the emancipation of the intellect from the reign of dogma is that the subordination of individual to social welfare may become so weakened that the life of the group is seriously imperiled. A discordant individualism is a decided military disadvantage, whatever may be said for it in other relations. Selection would therefore favor those groups in which the instincts that secure subordination and effective coordination were best developed, and in which the intellect was kept in a proper subjection to the instincts which afford the basis of social organization.

From Mr. Kidd's standpoint the prospect of much further advancement of the intellectual endowments of the race is not encouraging. Reason, being essentially anti-social, must be directed to social ends by instinct, or through institutions founded on instinct, which afford the necessary non-rational sanctions for social behavior. It is assumed that whatever advances we may make in the future must be accomplished through intense rivalry and the elimination of the unfit. Rivalry within the group leading to the suppression of inferior individuals, and rivalry between groups leading to the elimination of tribes and nations which have less corporate efficiency must continue to exist unless degeneration overtake the race. Racial progress, like the bloodthirsty gods of the ancient Aztecs, must have its human victims. If our social order does not furnish them we shall pay the heavier price of insidious racial decay.

For a social philosophy of this sort the hope of a future state of society in which there shall be no more war and no squalid poverty, and in which individuals may live with comparative ease and comfort, freed from the hardships of an oppressive struggle for existence, is an idle dream. Fate has decreed that such things can not be, or at least, that they can not last. Has Mr. Kidd presented a faithful account of the actual operation of selective forces in human society? Though less obviously overdrawn than the picture given by Professor Haeckel, the presentation of the situation in "Social Evolution" is permeated by the same misconceptions and limitation of viewpoint. There was a tendency among earlier post-Darwinian writers, notwithstanding Darwin's warning to the contrary, to conceive of the struggle for existence in a too literal sense as necessarily implying rivalry, a sort of "Hobbesian war of each against all" resulting in the elimination of the weaker individuals. It was customary to look upon Nature as "red with tooth and claw" and to picture the struggle for existence as an active encounter of rival organisms in which victory came as the reward of strength or cunning. As a matter of fact a very large part of the selective elimination that takes place in the organic world is accomplished in a very peaceful and unobtrusive way. What may properly be termed rivalry, or the struggle of one organism with another, constitutes but a part, and in many species a very minor part, of the selective process. Organisms may survive by virtue of increased resistance, freedom from organic defect, or the possession of better adaptations to countless environmental agencies, without involving anything of struggle, except in a very figurative sense, of one organism with another. Doubtless the kind of struggle in which the success of one individual is based upon the failure of another, as in actual conflict or rivalry for food or mates, has played a very important rôle in the evolution of animal life, but, like other forms of selection, its incidence changes with circumstances. If it has tended to produce higher types of life among the animals below man, it does not necessarily follow that it will work in a similar way among civilized mankind. Natural selection may favor progressive evolution at one time and degradation of structure and function at another. And we should therefore proceed with caution in applying our biological formulas from one group to another when we are dealing with problems of progressive development. How any form of natural selection operates under the complex circumstances of human civilization can not be decided *a priori*, but only by a careful study of its actual operation. It is quite possible, therefore, that the biologically novel conditions of civilized life may have involved such modifications of the workings of competitive struggle that its actual effects are very different from what they are in the lower animals.

To conceive of natural selection solely in terms of one of its methods of operation, that of competitive struggle, and to assume that competitive struggle is necessary for the progressive evolution of men, are two fundamental errors that are only too commonly found in the writings of the social Darwinist school. Upon these doctrines as a foundation has been reared more than one superstructure of social philosophy which has doubtless influenced in no small degree the international relationships of modern states. It is scarcely necessary to dwell upon the extreme importance of the deductions which might logically be drawn if the biological doctrines we have mentioned are of universal validity. We are only too familiar in these days with the policy and practises which a perverted Darwinism has been used to support.

Competitive struggle may take place between groups, or between individuals within a group. In intra-group rivalry, physical encounters have been all but entirely superseded by economic competition, and the latter seems to have increased as civilization has advanced. But competitive struggle within a group seldom leads directly to elimination, although it may give rise to conditions of life which cause an increased death rate. Those who are forced by this struggle into the ranks of the dependent classes, far from being extinguished, respond by an enhanced fecundity which more than offsets their increased death rate. As a result of forces peculiar to our social régime there has come to be established a biologically anomalous correlation between failure and fecundity which deprives of much of their force the pleas for the value of competitive struggle.

We may be told that the reason for the failure of competitive struggle is because we are too humane and extend the helping hand to too many who, in the interest of the race, should be allowed to perish. It is questionable, however, if the withdrawal of all organized and private charity would produce a much higher death rate among the ill-endowed than occurs to-day. But whatever some writers might deem more favorable conditions for racial evolution, it is evident, I think, that the actual workings of competitive struggle are quite different from what have been pictured by most social Darwinists.

The deteriorating effect of unmitigated industrial competition has been clearly brought out by Prof. Karl Pearson in his criticisms of those social Darwinists who attempt to use the Darwinian theory of natural selection as an argument against socialism. While Pearson and his co-workers have attempted to demonstrate by statistical methods that natural selection is a potent factor in man as in lower organisms, the contention is made that it is not through the struggle of man with man for the necessities of life that its racial benefits are brought about. Conditions which entail a high death rate among the ill-endowed are apt to prove unwholesome to many others as well, and would therefore produce a general deterioration of the efficiency of the whole social group. A country in which a considerable proportion of the inhabitants are forced by industrial competition into conditions of squalor that sap the energies of mind and body, and in which a still larger part of the inhabitants suffer more or less injury from the severity of the struggle for existence, can scarcely compete on equal terms with a nation whose population enjoys a higher and more wholesome standard of living. A piece of mechanism which uses up a great deal of energy in internal friction is not an effective product. And a country which permits internal rivalries to waste its resources of human life is poorly equipped for any contest which may endanger its national existence.

In common with many militaristic writers Pearson attributes an important rôle to group selection whether it takes the form of actual war, or competition for markets, trade routes and spheres of influence. It is undeniable that this factor has been a potent one in the progressive evolution of man, but it is dangerous to conclude that it will continue to function in the same way under the peculiar conditions of our modern civilized life. Struggle of group with group has developed the instincts that make for mutual support and corporate efficiency; in a word, it has moulded man into a social animal. But our debt to this stern mother of altruism should not be taken as incontestable evidence that her services will always be indispensable.

Under modern systems of warfare it is not so much blood that tells as organization, training and equipment. Which of the warring nations of Europe is most favored by inherited endowments is still far from being established. Practically all of them are mixtures of ethnic stocks to a degree that a racial analysis is well nigh impossible. And whatever the issues of the present war may be, there is no assurance that the inhabitants of the victorious nations will multiply more rapidly than those of the vanquished. Among civilized peoples war generally leads to the extension not of a people, but of power, policies and financial gain. A nation may be vanquished by war, time after time, as Austria has been during the nineteenth century, and at the same time increase in population, wealth and military strength.

Should wars be carried on to the extermination of the vanquished they might be justified on biological grounds, provided of course that the victors owed their supremacy to their innate superiority instead of to organization, equipment, discipline, numbers, or any of the other circumstances that commonly decide the issue between contending armies. To a certain extent it is perhaps allowable to assume that those peoples with the best endowment of intellect and character will, on the average, develop the most efficient preparation for war. Notwithstanding all that has been written from DeGobineau to Houston Chamberlain and Madison Grant on the innate superiority of this or that chosen people, the differences in culture and military efficiency among modern civilized nations are much more clearly traceable to extrinsic causes than to any factors which can be specified by the biologist. Russians and Servians retreat before well-drilled and equipped German armies for much the same reason that the ancient Germans and Gauls were unable to stand before the legions of the Romans. Nations march forward on the road to civilization at a very unequal pace. And history has repeatedly shown that the backward and relatively defenseless people of one era may prove to be the highly cultured and conquering nation of the next.

It is not to be inferred that civilized peoples have an equivalent inheritance. They differ quite evidently in temperament and instinctive bent, but, while they probably differ also in their intellectual aptitudes, we know too little on this score to distinguish the effects of hereditary from environmental factors. Any successful attempt to evaluate the innate mental differences of peoples would involve a thorough investigation by the best modern methods and on an extensive scale. As no such investigation has ever been made we have no very adequate basis for asserting which of the civilized peoples of the earth are the most highly gifted with inherited qualities.

It may seem very plausible to speak of the advantages accruing from the conflict of nation with nation and the consequent survival of the best endowed stocks. But even if the victory came to the peoples having superior hereditary qualities, it by no means follows that the vanquished would be supplanted by the victor. Should conflict result in placing a nation in a position of economic disadvantage such as would result if it were overrun by its conquerors who monopolize the positions of power and profit, the probable result would be that the conquered would outbreed their conquerors and regain through the cradle what was lost on the battlefield.

Under other conditions, however, where conflict leads to the expansion of a victorious people who replace the primitive inhabitants of the realm, or where industrial supremacy yields the material support for an increased population group rivalry may effect a racial advance. The Anglo-Saxon people have doubtless profited by both of these means. Conflicts with inferior races in so far as they prove to be directly or indirectly wars of extermination may lead to racial improvement, but the biological effect of war between civilized states is a much more difficult problem.

In view of the many considerations involved in such problems it is evident, I think, that the influence of group selection can not be determined *a priori* simply by the extension of a biological formula to human society. Group selection, like intra-group selection, may work in very different ways according to circumstances. Social philosophers who seize upon biological formulas and apply them uncritically, as they usually do, to the evolution of human society are apt to be led into very erroneous conclusions on matters of the gravest import. Just as competitive struggle between individuals may, under our present régime, give rise to injurious effects which more than outweigh its advantages, so may the struggle between groups lead to results quite at variance with what is commonly supposed to occur. We have become so imbued with the idea that the struggle for existence simply means that the weak go to the wall while the strongest and most highly developed come out ahead, that we lose sight of the ulterior consequences of the process, and especially the fact that the changes wrought by selective forces may be progressive or retrogressive as a multitude of attendant circumstances determine. It should always be borne in mind that the course which it is biologically most advantageous to follow is not infrequently the downhill path. Whether warfare, or any other form of group struggle, leads nations along the path of progress, either biologically or culturally, is a question which can not be solved by abstract and general disquisitions on the survival of the fittest or the manifest destiny of superior peoples. It is a question which must be solved in each particular case by a thorough inductive inquiry.

Investigations of the biological effects of war have been few. It is scarcely to be gainsaid that in modern warfare the most vigorous and efficient suffer the greatest loss of life at the front, leaving the race to be continued by the less desirable parents who remain behind. But for the full determination of the biological effects of war we must pass beyond the effects of individual selection within the group to the biological outcome of the struggle of one group with another. One may contend with Steinmetz and Schallmeyer, who concede that military selection tends to destroy the best blood of the nation, but who maintain that the biological advantages of the victory of the superior forces more than compensate for this evil. Satisfactory proof of this thesis, however, demands much more critical work than that which has been devoted to the task. The studies of La Pouge, Ammon, and a few others who have attempted to investigate what the effects of group selection actually have been, have made little more than a feeble beginning of an undertaking beset with many difficulties and full of unexpected developments beyond the conception of most proponents of militarism. It is important to recognize that the imaginary solutions of this problem that have so long passed for the real ones and have been taken as postulates by such writers as Von Moltke, Steinmetz and Bernhardi in their attempts to justify war on the grounds of biological necessity have little support from inductive investigation. Whatever may be said in favor of war on other grounds, the biological argument is one of very dubious value, especially as applied to the struggles between modern civilized states.

If neither individual competition nor group selection has the unequivocal importance for racial progress that has been attributed to it, the consequences of social amelioration and exclusive devotion to the arts of peace may not, after all, be so disastrous, at least biologically. But if social evolution has so modified the operation of these factors that they can no longer be regarded as obviously making for race progress, to what must we look for further advance? Natural selection is doubtless still operating in various ways. We know as a matter of fact that some hereditarily degenerate types are on the average short-lived, and that strains with a diathesis to certain diseases tend to die out. Several of the studies on natural selection in man, especially those dealing with the racial influence of infant mortality, have yielded results about which there has been considerable controversy. To ascertain just how natural selection is operating among human beings is a problem involving many technical difficulties that often tax the abilities of the most expert biometrician. Thére can be little doubt, however, that the intensity of natural selection has been diminished through the advances of medical science, and that it will continue to decrease with the improvement of the conditions under which people live. In some respects this diminished activity will be racially bad, but if social amelioration should bring about the abolition of warfare and equalize the birth rate so as to check some of the prevalent evils of differential fecundity it is not improbable that the net result would be advantageous.

There is one factor in our problem which we have not yet considered and which, despite its very great importance, has been almost entirely neglected in considering problems of human evolution, and indeed problems of evolution in general. This is the question, How does the changing complex of environmental forces which is brought about by social evolution affect the kinds of variations that are produced as material for the action of selective forces? It is obvious that if hereditary variations did not arise from time to time, selection would be unable to accomplish anything. It is equally obvious that whatever selection can accomplish is conditioned upon the kinds of variations which are offered for its choice. The selective breeder would never be able to create a race of six-toed cats unless an occasional kitten with more than five digits should happen to present itself. No breeder of plants would try to produce a grass with divided leaves because no trace of such a variation has ever been known to occur in human experience. Natural selection must take what has arrived as a basis for what it may succeed in building up. It is like a builder who employs the stones fashioned for him by some one else, and whose choice is limited to using or rejecting what is supplied to him. A builder could never erect a marble palace if his materials were limited to a varied assortment of cobble stones. And natural selection could never produce anything not already fashioned beforehand by those forces, whatever they may be, that determine the nature of hereditary variations.

What causes hereditary variations to arise in organisms is a subject about which we know almost nothing. One can number on the fingers of one hand the investigations of any importance that deal with this problem. Beyond the fact commented on by Darwin that changed conditions of life tend to enhance variability, very little was known about the production of variations through environmental changes until the experiments of Tower showed that in the Colorado potato beetle a high temperature and an unusual degree of humidity during the period of maturation of the sex cells resulted in the production of well-marked mutations which bred true to type. The stability of these new mutations indicated that they owed their origin to changes in the germ plasm brought about by changed external conditions. In the evening primrose, *Œnothera lamarckiana,* and a few other plants stable mutations have been produced by the action of chemicals injected into the ovary, and by treating the plants with rays emanating from radium.

The experiments thus far performed afford a certain amount of evidence for the conclusion, to which one would naturally be disposed on *a priori* grounds, that the kinds of variations that arise in organisms are conditioned by the nature of environmental forces. If this be true, we are naturally led to enquire how the changing environment to which civilization exposes the human race affects the trend of variations that arise in the germ plasm. With our unnatural indoor life, the unwholesome living conditions of a large part of our wage-earning population, the increasing drift of people into large cities, our alcoholism, and our numerous diseases, it can hardly be expected that the germ plasm of the race will escape being affected in some way. But how? Here we are compelled to confess practically complete ignorance. Were we to judge by analogy with what has happened with our domestic animals, which are relatively degenerate from the standpoint of physical vigor and general intelligence, the probable outcome would not be reassuring. We might be disposed to infer that germinal variations arising in response to agencies which impair the vitality of the body would probably give rise to inferior progeny. The disastrous effects of lead poisoning upon the children of workers in lead, even when the father alone is affected, may be an indication of the kind of influence which might be anticipated from the action of an unwholesome environment. We know too little, however, of the permanence of the transmitted effects of lead poisoning to base anything more than a very tentative supposition on these results.

With regard to the important question of the hereditary influence of alcohol our knowledge, although still very unsatisfactory, affords some ground for more or less probable inference. While statistics show that epilepsy, insanity, and feeblemindedness occur with much more than average frequency among the offspring of parents addicted to alcohol, this correlation may be due to the fact that parental alcoholism is so often the result of a neuropathic constitution, and that it is the inheritance of this constitution, and not the effect of parental intemperance, that disposes the children of alcoholics to various forms of nervous malady and mental defect. Statistics may discover correlations but they are seldom adequate for establishing causal connections. As the method of experiment to which recourse must usually be had in the endeavor to ascertain causes can not well be applied to human beings, the most promising field of enquiry is afforded by experiments on animals. If alcohol were found quite generally to produce hereditary defects in animals, we should have a strong argument in favor of its producing similar results also in man.

Of the investigations that have yielded indications of the injurious hereditary effects of alcohol, the recent work on guinea pigs by Stockard and his colleagues is the most noteworthy. The animals employed were bred and shown to be capable of producing normal offspring before they were subjected to the influence of alcohol. Control experiments with untreated animals were also carried on side by side with animals to which alcohol was given, and the offspring of the two sets carefully compared. Without describing the methods of experimentation or giving the details of the results, it may suffice to state that the alcoholized guinea pigs gave rise to a much larger proportion of still-born offspring and offspring which lived but a short time than did the controls. It is particularly noteworthy that when the male parent alone was given alcohol the percentage of defective offspring was strikingly large, although the largest proportion was obtained from the matings in which both parents were alcoholized. It was further shown —and this is particularly significant in relation to our problem—that when the offspring of alcoholized parents were bred without being subjected to alcohol they gave rise to a large percentage of defective animals. Deformities such as an eyeless guinea pig, animals with a reduced number of digits, dwarfs, and many other kinds constituted 5.23 per cent. of ordinary alcoholic strains, and 14.81 per cent. of inbred alcoholic strains, while no deformities appeared among the animals bred from normal parents.

These experiments, unlike most previous studies, were carried out on an extensive scale and with due checks and controls, and they seem to afford strong evidence for the conclusion that alcohol administered to guinea pigs gives rise to defects in the progeny which are capable of being transmitted to subsequent generations. Recently Pearl has applied Stockard's methods to the domestic fowl, but instead of obtaining evidence of inherited injury he found that the progeny of the treated birds were slightly above the controls in fecundity and apparent vigor. These results are not necessarily inconsistent with those obtained by Stockard, since the germ plasm of the fowl may be much less easily affected by alcohol than that of the guinea pig. Further experimental work on this important topic is much to be desired before we can be entirely justified in drawing conclusions concerning the hereditary influence of alcohol in man. At present, all that we are warranted in inferring is that alcoholism in man is a more or less probable source of hereditary defect.

The same guarded conclusion should be drawn, I believe, in regard to other so-called "racial poisons." The terrible consequences which luetic infection entails upon following generations are primarily due to the transfer of pathogenic germs from parent to offspring, instead of to heredity in the proper sense of this term. Nevertheless, it is a distinct possibility that the toxins carried in the bodies of the unfortunate victims of this common malady may injure the germ plasm in such a way as to give rise to strains with a true hereditary defect. We may have similar suspicions that the same result may be produced by tuberculosis and other diseases; but unfortunately in regard to most of these questions we can only indulge in speculation. Did we know what agencies give origin to our strains of imbeciles, lunatics and morons we might be able to nip in the bud one of the most serious of our social evils. We may have a shrewd suspicion that our modern régime with all its institutions which conspire to sap the vitality of the race is continually adding new strains of such undesirables. When experiments on the causes of variability in the lower animals have yielded us a large body of well-organized knowledge, instead of the meager and scrappy information which we now possess, we shall doubtless be in a position to draw conclusions of a high degree of probability regarding the trend of variability in man, and possibly to bring this variability in a measure under control.

Any consideration of the influence of social amelioration upon the evolution of racial qualities has to take into consideration the question of how the trend of variation in human beings will probably be affected. If, as seems not improbable, intemperance, disease, and possibly bad living conditions are productive of hereditary defect, our racial welfare may not be seriously menaced by the reduced action of selection which would probably follow upon the institution of social and economic reforms. On the contrary, the race may be freed from sources of continued contamination which act as a check upon its progress. A social system which presumably favors the "beneficent working of the survival of the fittest" by creating conditions of life that lead to a high death rate among the less successful types, may not only fail to eliminate these types, as we have attempted to show, but may be a means of actually creating the inferior variations which it is supposed to destroy.

Our aim thus far has been to show that the realization of Utopian dreams of a state of society in which the evils of poverty, intemperance, severe individual struggle and warfare have been relegated to the past does not necessarily entail biological decadence. In fact, there are reasons for believing that such a consummation would do away with many of our present sources of racial deterioration. Would it also set into operation any agencies which would promote racial advancement?

If the cure for democracy is more democracy, it may also be true that the cure for the cure for the racial evils of civilization is more civilization. An enlightened society, possessing a knowledge of the principles of its own evolution, and mindful of the welfare of future generations, may accomplish much in the direction of eugenic progress. The control of the birth rate which mankind is now exercising from prudential considerations, or the more laudable motive of giving better advantages to a few children rather than mere maintenance to many, might, in such a society, be utilized more for social and less for individual ends. With parenthood placed upon a voluntary basis we might reasonably expect that the less desirable stocks would show an increased tendency toward elimination and that the rearing of children would be undertaken in greater measure by the classes more amenable to the influence of the sense of racial obligation.

Alfred Russel Wallace entertained great hopes of race improvement through the financial emancipation of women. When women are no longer tempted to marry for support they will, according to Wallace, be more apt to select only superior types of men to be the fathers of their children. As a means of race improvement doubtless marriage selection has magnificent possibilities. But when we reflect upon the frequency of marriage among the Jukes and Kallikaks on the one hand, and the low marriage rate of women graduates of colleges on the other, it must be admitted that, as a factor in race progress, marriage selection at present is a miserable failure. Mere economic reform can not be relied upon to improve matters greatly unless it is accompanied by a general diffusion of education; and education will avail little unless it includes the inculcation of a sense of responsibility for the hereditary qualities of future generations. Education is eugenically of value chiefly as affording a basis for the development of a "eugenic conscience" which is now sadly lacking in most people of culture. It is a hopeful sign, however, that here and there among people who have inherited a generous measure of desirable traits eugenic considerations have led to the rearing of larger families. One is therefore encouraged to have sufficient confidence in human nature to believe that the spread of eugenic education, so that people of superior endowments will have the matter of their obligations to the race brought squarely home to them, will not fail to have an effect in checking the evils of our present differential fecundity.

Racial improvement has doubtless very intimate relations to the improvement of the economic conditions which now oppress a very large proportion of mankind. A society with well-marked castes will probably make little progress if it includes an ignorant and poverty-ridden proletariat. Under a régime which affords better educational advantages and a higher standard of living for the less successful classes, the relatively high birth rate of those who multiply through sheer lack of restraint would probably be reduced. Economic reform is by no means the panacea for racial and social ills that it is apparently taken to be by many socialistic theorists, but it would afford conditions under which the operation of eugenic ideals would doubtless be more effective than under our present social order. Greater equality in the distribution of wealth would tend to bring about greater equality in the birth rate of different classes. With a higher general standard of education and a diffusion of the sense of obligation to transmit socially valuable qualities to future generations, conditions might possibly be changed so that a greater relative fecundity would come to characterize the more vigorous, intelligent, and public-spirited members of the community. Should society succeed in restoring the correlation between fecundity and the possession of superior qualities—a correlation which our present civilization has pretty effectually subverted—humanity would once more be on the highway of racial advance.

THE LOCALIZATION OF INDUSTRY

How it starts; Why it grows and persists

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"PILL-ALLEY" is the college slang for a certain stately elm-arched street lined with colonial mansions. The name "Pill-Alley" is a recognition of the large number of doctors who live along that one avenue. The old college town is by no means the only place that shows evidence of the singular tendency for professional men to hang their shingles one beside the other. Nor is this peculiarity confined to the professions, for a similar liking for the neighborhood of their rivals is shown by retailers, wholesalers and even by manufacturers. Dentists as a rule hive in one office building, opticians open their shops along the same thoroughfare, department stores crowd about some one vantage point, wholesale leather dealers jostle each other in their neighboring warehouses, and wholesale wool merchants congregate near a common marketplace. Manufacturers, too, show the same tendency. More than three fourths of the collars and cuffs made in the United States come from Troy, New York; silver plate to a like degree is manufactured at Meriden, Connecticut; tanning is centered at Milwaukee, Wisconsin; and Paterson, New Jersey, is the home of silk manufacturing. So the story goes; a large number of the great and small industries of the United States are not scattered broadcast over the entire country, but are confined to one narrow locality. This fact is contrary to what common sense would seem to dictate, for apparently a business would be most assured of success where it had no competition in the immediate neighborhood, but in reality industry seems to thrive best where it throngs most. It is worth while, then, to find out how localization starts and grows, and what advantages it offers.

Some localized industries have started as a response to resources either in raw materials and power, or in unskilled labor. Others originated in particular places because they were near to their market, while a few by virtue of a monopoly control were permitted the choice of a desirable strategic location.

The presence of raw materials has been a potent factor in giving rise to localization. For example, Chesapeake Bay is the greatest bed for oysters to be found in America, and, as a result, the metropolis of the Bay, Baltimore, does more than two thirds of the oyster-canning business of the United States. One might generalize and say that, as a rule, the preserving industries localize near the source of their materials. This explains the salmon canneries of the Columbia River, the wine plants of California, the grape-juice factories of northeast Pennsylvania or northwest New York, the sweet-corn canneries of Maine, the tomato canneries of New Jersey and the slaughterhouses of Chicago.[1]

Not only perishable raw materials, but also those that are bulky, heavy or fragile, tend to collect factories near the point of origin of the crude stock. Thus Pittsburgh, near the fragile coke of Connellsville, manufactures with this fuel eight per cent. of America's rolled steel; likewise in the Lehigh Valley heavy rock is transformed into the Portland cement used to build skyscrapers in New York and Philadelphia and other cities along the Atlantic coast. Similarly Muncie, Indiana, near to abundant supplies of natural gas for fuel, is one of the largest national centers of glass-making. The fruit jars known by housewives all over the United States are manufactured there. Accordingly, in many different places raw materials of various kinds have been responsible for the fame of a locality in the industry that reshapes those raw materials into a more serviceable form.

It has frequently happened that industries called to particular places by resources in materials have remained where they started long after the local supply of crude stock has disappeared. The rubber-using factories of Massachusetts, Rhode Island and Connecticut may be taken to illustrate the point. In young America, when commerce was a source of large profit, many curious products from out-of-the-way regions of the world were carried to New England ports. Among other commodities, rubber from the Amazon entered Boston, Massachusetts; Providence, Rhode Island; and New Haven, Connecticut. The presence of this raw material gave rise to rubber-using industries in or around all three of these cities, the goods made ranging from overshoes to fountain pens. Yet crude rubber is seldom seen to-day on the docks of these maritime cities, for most of it now comes into the United States by way of New York. Despite the fact, nearly all the rubber overshoes, boots or arctics made in the United States are produced in the locality between Providence and Boston, because this was the *original*

[1] Thirty-three and one third per cent. of the nation's slaughtering is done at Chicago.

region of import. A half-dozen plants now belonging to the United States Rubber Co., as well as the factory that turns out Waterman's fountain pens, are all in one narrow valley adjacent to New Haven. The Woonsocket Rubber Company is within hailing distance of Providence, while the Hood Rubber Company is representative of scores of others that girdle Boston. Likewise the plated-jewelry industry centered in the Attleboroughs of Massachusetts, just outside of Providence, Rhode Island, is there in response to the fact that gold and silver from Spain, Portugal and the West Indies once were borne into Providence by home-bound commerce carriers. Since the European war opened, attention has been called to the predominance in firearms manufacture of three Connecticut cities; namely, Bridgeport, New Haven and Hartford. These cities are now famous for rifles and revolvers because at one time western Connecticut produced a grade of iron from local ores that was better fitted than that found anywhere else for making weapons or edge tools. In all of these cases, the rubber mills, the jewelry factories or the firearms plants, the present-day greatness of the industries entirely overshadows the fact that they came to the regions originally because raw materials were easily secured at those points.

Water power is a resource that is responsible for drawing many industries into compact units around desirable power sites. Accordingly, we find that one third of the knit underwear made in the United States is furnished by a string of towns in the Mohawk Valley from Cohoes to Utica. This is due to the circumstance that the first knitting machine run by power was set up at Cohoes to take advantage of the large amount of power available at that place. American writing-paper manufacture centers at Holyoke, Massachusetts, because the reduction of rags to pulp requires a large amount of power, and the Connecticut River at Holyoke furnishes the greatest water power in New England. The falls and canal systems at Holyoke fixed the attention of engineers upon water-propelled mechanisms, and out of their studies improved turbines arose. As a consequence, Holyoke entered the field of machinery manufacture, so that later when Niagara was bridled, the great turbines that turn Niagara's energy into usable power were made at Holyoke.

The large number of rapids and falls in the Merrimac River attracted to its banks the largest cotton mill in the world at Manchester, New Hampshire, the largest wool mill in the world at Lawrence and one of the principal cotton manufacturing cities of the United States at Lowell; no other stream in the world turns so many textile spindles as the Merrimac. Power then, as well as raw materials, is responsible for the origin of many localized industries.

An unused labor supply also frequently calls together a group of mills to take advantage of the opportunity to exploit this labor. Wherever an industry has collected a large working force of men, a situation favorable to industries using female labor is created because the wives, sisters, daughters or cousins of the male workers are glad of the chance to get a job whereby they may increase the family budget or attain individual economic independence. Hence silk mills have invaded the coal-mining districts to such an extent that Scranton, Pennsylvania, is second only to Paterson, New Jersey, in the manufacture of silk. Allentown, Pennsylvania, in the Lehigh Valley cement district, ranks abreast of Scranton in the silk industry because cement-making employs the men of the family while the silk mills give occupation to the women or girls. Industries of this sort are called parasitic because they utilize a labor force collected by some other activity.

It is apparent that some localized industries originated in a resource, or in an unused labor supply. Others have started because a large market near at hand gave the necessary incentive. The potency of a market in establishing a localized industry is seen in the case of the manufacture of agricultural implements. This industry has followed the grain belt westward; once along the Atlantic, then in interior New York and now in the middle west, manufacture and market have always coincided. Starting in Chicago, because that city has easier access to all the great agricultural states of the upper Mississippi valley, the industry has so expanded that to-day Chicago can claim a fourth of the entire nation's product.

But more than resources, more than labor, more than markets, more than any other cause for the start of a localized industry, we must recognize the power of chance. Fortuitous accident has been responsible for the feeble beginning of now strongly intrenched industries more than any other reason we may assign. Westfield, Massachusetts, now manufactures over two thirds of our whips because one irate farmer, incensed by his neighbors' pillage of his willow hedge to belabor their horses, cut the willows himself, bound them with twine and sold them to the erstwhile plunderers. That started an industry that has since made the town conspicuous. The position of Lynn in the shoe industry, the center of a circle of towns manufacturing a fourth of the shoes worn in the United States, is partly due to the chance settlement there of a Welshman named Dagys, the most skillful shoemaker in the colonies. If Dagys had happened to go to Providence or New Haven, doubtless one of these cities rather than Lynn would now have Lynn's honorable station. German Palatinates, fleeing to America, but skilled in the art of knitting, by chance found congenial religious refuge in Penn's settlement of Philadelphia. Once established on our soil, they set about their accustomed trade and soon made Germantown (part of Philadelphia) famous throughout the colonies for its stockings. To-day, as a result, Philadelphia manufactures more hosiery than any other place in the country. So the list of illustrations might be lengthened, but it would prove only more conclusively that accident is the most influential factor in determining where a localized industry will come into being.

One other factor, however, must be mentioned; namely, monopoly. In modern industry we are familiar with the spectacle of one corporation or group of allied companies gaining such ascendancy over the whole trade that arbitrary decisions replace the usual give-and-take of competition. The will of one compact unit becomes the law for the whole industry. It is obvious that such a monopolistic control may choose the most desirable locations for its plants, and concentrate its efforts in a few most advantageous places. The limitation upon the number of factories and the large output in a few selected towns or cities bears a close resemblance to localization of industry. For instance, all of the oil-refining done in America is carried on in a half-dozen great plants, some on the Atlantic coast, some in the Central West, and some along the Pacific. Similarly, sugar-refining is confined to a few strategic points. The manufacture of shoe machinery is likewise confined to one town (Beverly, Mass.) in the heart of the greatest shoemaking district. In every case, the localization is entirely artificial and could be annihilated by an adverse court decision or the expiration of patents. Before the Standard Oil Company gained its supremacy, there was no localization of refineries; the American Sugar Refining Company is responsible for the localization of its industry, and if there were no United States Shoe Machinery Company, every machine-tool center in United States would have the possibility of entering that trade. So localization induced by monopoly is only as permanent as the parent corporation that gives it birth. It is undoubtedly economic and profitable, but if competition were given full sway, monopoly-localization could not endure.

Whatever was the cause of their inception—raw material, power, unused labor, a nearby market, accident or monopoly—all localized industries have shown similar methods of growth, have profited by like advantages and suffered by reason of analogous handicaps. How a localized industry grows is a more important consideration than how it starts.

Many industries have become localized because they are family affairs, and the family has remained in one section of the country. A father in business with several sons often establishes those sons in branch plants or associated lines, which, growing to prominence around the original plant, give a reputation to the locality for that particular business. The cotton industry of southeastern New England has always been associated with the names of Slater, Borden, Sprague or Knight; the cotton manufacturing of the Merrimac River is intimately connected with the Lawrence family, while at the present time Chattanooga, Tenn., is developing into a cotton-mill center under the leadership of the Thatcher brothers and sons. In colonial America, no iron-making project was said to be complete unless a Leonard was in control, and the great brass industry of western Connecticut is the outgrowth of the Scoville, Benedict and Burnham families.

By means of shop association as well as through blood bonds, an industry increases in importance in the town where it first starts. Superintendents or foremen may be considered as members of an "industrial family" just as sons are the heirs of their fathers. When an experienced superintendent decides to become his own boss, oftentimes he finds it impossible to go to a strange place in which he is unknown; but in the town where he has worked for years, the bankers know and trust him, and the business he purposes to enter is a tested proposition. Consequently the superintendent can best succeed by establishing himself in the shadow of the plant where he was once an employee. It has been stated that every cotton mill started between 1790 and 1814 was by men who themselves had been trained by Samuel Slater, at Pawtucket, Rhode Island. Growth of this kind, through former workmen, has made Attleborough the seat of plated jewelry, and the Mohawk Valley the chief center for the manufacture of knit underwear.

Timidity of local capitalists is another cause for an industry's enlargement in a particular place. Many men with small amounts of money to invest are afraid to risk their funds in any project unless they can keep it under daily observation. Hence, they encourage new ventures in their own town as long as there is promise of profit. When New Bedford whaling captains saw their own business declining, they looked for a new opening for their financial resources. Their close neighbor, Fall River, was making great strides in cotton manufacture but the old whalers absolutely balked at furthering enterprises in another town. Instead they put their money into cotton factories in New Bedford with the result that to-day New Bedford stands second in this industry and holds first place for quality.

Sons, superintendents or local capitalists promote the early growth of an industrial center, but the mature advance is occasioned by the multiplication of allied industries, the increase in the number of supply houses or by the presence of plants utilizing wastes.

Instead of attempting to manufacture an entire shoe, many plants in Lynn or Brockton confine themselves to making heels, counters, box-toes or soles; similarly in Lowell, New Bedford, Philadelphia and other textile centers, there are enterprises that specialize in originating patterns or designs, others which prepare warps for looms and yet others that produce spools or cops to hold threads. Ventures of these kinds would meet with little success if they were attempted anywhere but in a community where the main industry was localized, because the expense of reaching a market would exhaust all profits. On the other hand, the presence of shops specializing in parts of the main product aids the larger factories, for it enables them to purchase supplies right at hand. The way in which a subsidiary industry is correlated to the principal one is familiar to every one in the case of automobile manufacture.

The greatest source of automobile accessories is Detroit, which is also the largest producer of automobiles. The association of major and minor plants may also be seen in the textile industry. Philadelphia, one of the chief textile centers of United States, has more dye-houses than any other city. In fact the close union of independent and dependent mills is one of the most striking features of our manufacturing industry. About two thirds of the needles and pins of American manufacture come from Connecticut, the state that supplies the brass of which needles and pins are made. The home of the sewing machine is Bridgeport, Connecticut; corsets, almost entirely a sewing-machine product, come from Bridgeport,[2] and New Haven.[3]

[2] Twenty per cent. of the United States total.

[3] Twelve per cent. of the United States total.

The large and small enterprises at the chief seat of an industry are a benefit to each other because by subdivision of product and by greater specialization, the costs of production are reduced, so that outside competition is easily met. Partly finished material is also produced at the very doors of the factory that will complete it for market; hence transportation charges are reduced and annoying delays in delivery obviated. Therefore, an industry once established in a locality is assured of a steady advance.

Localization, furthermore, attracts to itself plants whose business is the utilization of waste products. In order to insure a plentiful supply of raw material upon which to work, these shops must be where there are many factories creating the same sort of waste. For the factories, the presence of the waste-using shops turns a loss into profit, a charge into a credit or a liability into an asset.

An instance of this form of economy may be witnessed in the iron and steel industry. The largest steel mill in the United States at Gary, Indiana, has its complement in a great cement plant at Buffington, Indiana. The cement is manufactured from the slag that the steel mills throw out. Slag is the scum of impurities taken from the ore when iron is smelted. Ordinarily it has no value, but is one of the greatest nuisances to clear out of the way. It so happens, however, that slag usually contains sand, clay and lime, the three materials that compose cement, so that by grinding the slag and mixing the three constituents in the correct proportions cement may be manufactured. A cement plant corollary to a steel works, therefore, is a great boon to the steel concern, because by making cement of slag the premises of the steel mill are rid of the accumulation and at the same time what would otherwise be more than a loss is turned into a revenue producer.

Another illustration of the utilization of waste is seen in New York City, the nation's tailor shop. The short ends of cloth are carried to the cap shops that are usually next door to clothing factories. If there were no adjoining cap factories, the only market for remnants would be a shoddy-mill, but as a raw material for caps, the scrap cloth is more valuable than in the form of rags destined to shoddy. The arrangement is advantageous to cap makers, too, because it saves a large amount of cutting, and allows a wider range of cloth patterns than the manufacturer could afford if cloth were purchased in the whole piece.

Again, the city of Gloucester, Massachusetts, is one of the most famous fishing ports in the world. In preparing fish for sale, the heads and tails are removed. These are not thrown back into the sea, but are carried by the dray-load to a factory that is famous all over the country as a producer of glue and mucilage.

Waterbury, Connecticut, also, around which city a half of America's brass is made, has a "brass laundry" where small pieces of scrap and shavings are washed to recover the machine shop oil, to separate brass from other metals and to make the recovered brass available as raw material for recasting. This "laundry" handles twenty million pounds of brass shavings per year and adds a value of five to fifteen cents per pound.

Whenever such waste-using plants appear, they add an increment to the importance of a locality as the center of an industry; for by transforming liabilities into assets, and turning costs into profits, they aid in the defense of the community against the onslaughts of outside competition. Hence they augment the growth of the industry in the location where it is already rooted.

Frequently it happens that after a town has become thoroughly identified with an industry, its name has such an advertising value that new concerns seek it instinctively in order that the weight of the prestige of the place may bolster their own reputation. Detroit is the Mecca for incipient automobile manufacturers; the name Brockton lends quality to a shoe because Brockton has the reputation for men's high-grade footwear; New Bedford likewise stands for high-quality cotton; indeed the name of some of her mills is the recognized symbol of certain grades, for example Wamsutta sheeting. The multiplication of small plants attracted by the mere name of a town adds to the renown already attained by the community.

But what is the secret for the success of plants that swarm into one place, fiercely competing with each other and watching, hawklike, for each advantage? How can they profit in such close union?

One of the principal outstanding facts in regard to localized industries is that almost without exception they depend upon highly skilled labor. This circumstance helps to account for the paradoxical prosperity that attaches to the place where the large number of plants makes trade rivalry most vigorous.

An adequate supply of labor especially trained for the work to be done is the foremost advantage enjoyed by the individual units that comprise a localized industry. If one plant desires to expand it can draw upon the reservoir of labor already created. All the factories in the town are constantly filling this reservoir because each mill is a training school for the others. The young boys upon leaving school follow in the steps of their fathers. They learn by actual experience in the factory the moves peculiar to the particular industry; and at home, on the streets or at recreation, imbibe the secret "rules of thumb" current among the workmen and known only to them. The very atmosphere seems charged with a mysterious power that the men draw upon to further the efficiency of their labor, a force which is lost in a city whose industries are largely diversified. The whole accumulation of skill is at the beck of the firm which needs it, and in an industry where trained men are required, its value is beyond estimate. The greatest resource, for example, that the commonwealth of Massachusetts possesses is her abundant supply of skilled men and women, collected in various localities where special work is being performed. The contrast with a state like Pennsylvania is made plain if we suppose some awful catastrophe to sweep away all the people of both states. After such a calamity Pennsylvania would arise again in power, for her coal, her natural gas, her iron, and her agricultural sections—such as Lancaster County, famous for its farms—would bring a new population to work these natural resources; but Massachusetts would be dealt a blow from which she would never recover, because her greatest asset would be wiped out of existence, and instead of being a commanding industrial state, she would probably be known only as a summer resort. Skilled labor, then, is the basis for her wealth, and this resource is nursed and conserved by localized industries. Inasmuch as trade secrets and tricks of manipulation are handed down from father to son, and from friend to friend, there is a social heredity of skill transmitted from generation to generation. Newcomers are easily absorbed in the all-enveloping trade in its home place, but manufacturers who have attempted to draw away even the most highly trained individuals to act as teachers in another remote city have met with failure after failure because the *group* was not skilled and had not known the trade from childhood. The group skill found in a localized industry is the reason why the industry clings to one small section of the country; it is the greatest single advantage that employers find when they set up their plants where others have thriven for years.

Skilled labor differs radically from unskilled in its mobility. Skilled men and women dislike to move from the town where they have settled. They have made many social or economic ties that are hard to break; their friends and relatives live in the town; their fathers and mothers perhaps are buried there, they own their homes there, and have small investments in other land or maybe in the industries of the town. Hence, it means uprooting a whole life to wrench a skilled laborer away from his home town. Since so many localized industries employ skilled laborers, and inasmuch as the industries are vitally dependent upon that labor, they perforce must stay where the labor has become knitted to the locality. Quite a contrary case exists in regard to unskilled labor. This kind has no deep roots in the soil of a place; their interest is primarily financial —the pay envelope—and not social. Hence unskilled labor may be shifted from town to town with the utmost ease. This helps to explain why industries employing unskilled labor are not localized, while skilled industries are highly concentrated in particular communities.

The visible supply of labor at work in the factories is not the only advantage a localized industry offers to mill owners, for there is a secret benefit which grows out of localization, namely, the ready rapid expansion of the labor force during rush seasons by means of home work. We talk about our times as the "Factory Era," yet one half of the people[4] employed in producing wearing apparel, jewelry, silverware, paper articles, sporting goods and celluloid ware, are never housed within factory walls, but do the work in their own rooms. In Massachusetts, for illustration, home work is not confined to large cities, to tenements or to foreigners, nor is it an unofficial pittance to the poverty-stricken; on the contrary, the greatest number of home workers have a family income ranging between $750 and $1,500 a year. The tasks are performed largely by women about thirty years old who have formerly been wage-earners, but are now married and tied to their homes by children, yet glad to do little jobs to earn "pin money"[5] at times when their hands would otherwise be idle. Manufacturers are delighted to avail themselves of this labor force, for it makes no extra demands on the employers, nevertheless enables them to get out orders on time. It is their safety valve[6] since the factory force may be kept intact while the number of operatives outside the walls swells and contracts with the demand for the products. Wherever the home work necessitates some skill or previous training, the manufacturer is well nigh compelled to

[4] Mass. Labor Bulletin No. 101, Industrial Home Work.

[5] They earn about $100 a year.

[6] Or the "marginal element in labor force," to use economic terms.

locate his plant where the labor lives, if his product is subject to the whims of fashion or to seasonal variations. We can appreciate why fourteen of the twenty-eight comb factories in Leominster, Massachusetts, give out home work; why it is that in jewelry manufacture 74 per cent. of all employees are outside the factory roof; why almost all women's neckwear is made in homes, and why, even in so thoroughly mechanical an industry as shoe-making, the bows for shoes and the beading for slippers are made and attached in private dwellings. A large amount of home work is also carried on in connection with the collar factories of Troy, New York; and glove manufacture in all its stages, in Gloversville, New York, is frequently conducted upon the workers' own premises. Hence in all localized industries we must add the invisible trained labor force to that which is in plain sight in the factories; the two together form a combination whose advantage no employer can overlook. Yet there are other advantages to be found in a community whose energies are devoted to one product. Among them are the facilities offered for buying and selling.

In a localized industry small concerns may buy together and thus gain the advantage of bulk shipments, which in the course of a year would represent considerable saving. Freight rates are apt to be lower too, where there are many concerns purchasing the same sort of raw material, because the railroad will equip itself to handle the variety of freight in which its customers deal. By cooperation, the cotton manufacturers of New England have been able to secure such low commodity rates on cotton shipment that whereas formerly much of their raw material was shipped to them by water, it now comes entirely by railroad.

In selling, it is easier to dispose of wares in the vicinity of others who are doing the same thing, because a market is established to which prospective buyers come. This is the reason doctors, dentists and department stores locate where there are other doctors, dentists and department stores. A new concern can not afford to forsake the involuntary aid extended by its neighbors in the same business. Together they constitute a center to which purchasers come; separated, each concern would be forced to put forth a strenuous effort to attract buyers to its doors.

The creation of a market within a localized industry leads logically to the result that some portion of the community devotes itself more and more exclusively to the marketing side of the business. In England, Manchester is less a cotton-mill town than it is a warehouse city, where raw materials are collected for the cotton mills in nearby Bolton or Oldham, and where the cloth from those mill towns is sold. Leeds holds a similar position in respect to the iron trade of England. In Massachusetts we see a like tendency in that Boston is the warehouse for the shoe industry on its border, and in New Bedford, the old city at the center is taking over the commercial business of the cotton mills in the new developing cities at each end of the township. New Bedford really contains three cities under one name, two devoted to manufacture, one to trade. Worcester holds an analogous position for the textile mills of the Blackstone River valley, and Providence, Rhode Island, for the jewelry industry of the Attleboroughs. The cause for the segregation of the market is two-fold; on the one hand it is due to unusual transportation facilities at one part of the district in which an industry is localized, and upon the other to increasing rents at a center driving factories to the rim and leaving the heart to offices which take up little space. These central places, too, offer advantages for buyers to congregate. Aside from railway or hotel accommodations, it is easier for buyers to visit a series of warerooms close together than it is to travel from mill to mill, although the mills may all be in one district. Wherever an industry has become sufficiently developed in one locality to bring forth a central market for buying and selling, the advantages of the localization are greatly increased, since a well-defined place of bargain and sale secures more trade than would a number of scattered offices.

Not all the advantages of localization are on the side of the employers, for the employees too gain by dwelling in a city where there are many factories where men of one trade are employed. For instance, a man who is a cotton weaver stays where weaving is done in several factories, because if he loses his job in one he may be able to get a place in another. Likewise immigrants or weavers from other states will seek the town where weaving is a well-known occupation, because they have a chance of obtaining employment at the thing they know best. Consequently in a localized industry there is greater security of job for laborers than in a town where there is only one factory of a kind.

Where there are many people engaged in the same tasks, a labor union is much easier to form than in a community in which there is only one factory of any one particular type, unless that one plant is exceptionally large. A skilled man or woman fares better in a place where there are many others who possess the same kind of skill, since all can make their demands felt by acting in agreement. The cotton-mill workers of Fall River have formed unions, with the result that, although they constitute but a small fraction of the total number of wage-earners in the industry, nevertheless they set the wages for the whole group in New England. In concerted action there is strength.

To both employer and employee, therefore, localization offers many advantages, but it also has deterrent features that detract from the favorable picture we have drawn; there are shadows as well as high lights.

Chief among the disadvantages is the distance separating the industrial center from the consuming market. As we have mentioned before, buyers tend to seek the community in which an industry is localized, but these men represent wholesale houses, jobbers or large mercantile establishments, most of which of necessity must be far from the town where the goods they purchase are produced; consequently the public to which the wholesale men cater is a long way from the factories. For illustration, products manufactured in Massachusetts must be transported often half the length or the breadth of the country before they reach the individuals who actually use them. This long carriage adds freight charges to the cost of the articles that become so burdensome that an effort is made to produce the things needed nearer the point of consumption. It was for this reason that shoe factories were first set up in St. Louis, and the advantage of being nearer the market than Massachusetts has fostered its growth as a shoe center until it ranks as the third most important one in the United States, only Lynn and Brockton surpassing it, and Haverhill trailing in its wake. All the other recognized wholesale cities tend to establish shoe factories for the same reason that St. Louis secured them; thus they are becoming familiar sights in Philadelphia, Chicago and Cincinnati. For the most part, however, the disadvantage of distance from consumers is easily borne by the localized industries because their products are either small and of light weight, or have such a high value that they can bear long shipment. In every case the labor charge is a large item in the costs of production, so that if a manufacturer must choose between cheap transportation and cheaper labor cost, he unhesitatingly votes for the labor. To locate near the market but away from the recognized center of production adds greatly to the wage list, for men can be induced to leave home only by the lure of more money in their pay envelope, and, furthermore, transplanted factory operatives lose in group efficiency, as we have pointed out. As a result, the distance separating producer and consumer, although a disadvantage, is not the greatest of evils when goods are relatively easy to transport.

In like manner many localized industries are remote from their source of raw material, and therefore must face a freight charge upon every unit of stock they use. Here again the actual amounts to be paid are more startling than the relative, for the cost of cotton from the south, leather from all around the world, steel from Sweden, and rags from Europe, all form so small a portion of the value of the finished article that the mere freight charges on these commodities is a burden on the business that is scarcely recognizable statistically. So long as labor represents the largest single item in the total cost of production, localized industries as a whole will not be likely to seek a position nearer raw materials in order to save freight charges.

From the employers' point of view, the strength of labor unions in a localized industry is a thing that is abhorrent. Labor organizations are strongest in industries whose labor force is most highly skilled and collected in the narrowest area. In the grip of such unions, employers are helpless, and when pinched they wriggle, squirm and cry out just like any other weak thing in the grasp of power; their only relief is to run away. The unions of Lynn became so dictatorial in the matters of "closed shops," wages and hours of work, that several shoe firms, employing many hands, moved outright to Lowell, Massachusetts; or Manchester, New Hampshire. In these places, they have gained a temporary relief, but both towns are becoming shoe centers, so that in the course of time these manufacturers must submit to labor or seek a newer asylum. The power of unions in localized industries, therefore, is a strong force working toward decentralization, at least until unions cover the whole industry over the entire nation. Then there would be no escape anywhere and one place would be under the same conditions as another.

Competition is most severe where the competitors are closest together. In a localized industry, therefore, every manufacturer must accept the terms offered by any one of their number, otherwise all buyers would flock to the firm offering the lowest prices. Frequently in a localized industry the whole trade is demoralized by the presence of some beginner who, although skilled in his work, nevertheless is a poor business man, because he can not calculate costs accurately, and consequently bids for business by selling his goods below the actual cost of production. Of course he meets ruin eventually or changes his policy, but so long as he maintains his low price level, all other manufacturers must sacrifice profits in order to conform to it. Competition is also made a strenuous struggle by the constant strain for improved processes. No matter how carefully guarded the secret of a new device may be or how securely it may be thought to be protected by patents, nevertheless in a localized industry such a secret device soon becomes known, and every manufacturer installs it in some more or less modified form. One manufacturer's advance is immediately imitated by all others, with the result that no man can long enjoy exclusively the fruits of his own inventiveness. The study of processes is a daily grind and the race for improvements is swift indeed, yet the prize is barely attained when its value is snatched away by a new race for a new prize. This situation is highly desirable from a social viewpoint, for it tends to lower prices and widen consumption, but to the manufacturers who must bear the brunt of the business struggle, it is extremely discouraging.

From the employers' viewpoint, consequently, a localized industry has these distinct disadvantages: it is remote from its market, it strengthens the arm of labor and it promotes bitter competition. To the whole population of the town, a localized industry brings another source of dread. If, in addition to the localization[7] of the industry, the community has specialized in it also, then the fear of hard times is alway hovering over the people. To take an illustration—as long as the United States is prosperous there is hardly a better place in which to live than Attleborough, Massachusetts, for every one has plenty of money and does not stint the spending, but Attleborough, manufacturing a luxury (jewelry), early feels a fall in the industrial barometer, and during a period of financial storm there are few places more hard hit or in which people look more anxiously for a return of better conditions. This is true of every town whose industries are not diversified.

From the point of view of employees, localization is bad because it also tends toward narrowing the minds of the townspeople. A young man brought up in Fall River, say, has but little choice of occupation; he must become a weaver or a loom-fixer or some other artisan connected with cotton manufacture, because by upbringing, education and example he is forced into that path, and furthermore he goes to work at an early age. It may happen that many a square peg is rammed into a round

[7] Philadelphia is the center where carpet manufacture is localized, but Philadelphia has not specialized in that branch of business. Her industries are widely diversified. On the other hand, Trenton is not only the seat of the pottery industry, but the town has specialized in that trade. Little else is manufactured there except pottery. It is that kind of town we have in mind here.

hole in this way, or a life constricted which might under better conditions have expanded. There is something deadening to the human mind in uniformity; progress comes through variation, therefore in a town of one industry a young man loses the stimulus for self-advancement. In such a town there is little difference in social position, with the result that young people do not have the force of example prodding them to aspire toward heights above their present station. Discontent translated into action is a blessing in disguise, but in a community where all are equal, contentment with one's lot begets lethargy, because there is no contrast urging toward betterment. This contentment tends toward the creation of a laboring class that is self-perpetuating, a condition inimical to American ideals.

Indifference toward education is one of the results that flows from the creation of a labor class, for a desire for knowledge is one of the characteristics attached to progress, inasmuch as aspiration feeds on inspiration. Lowell, containing more than 100,000 people, and Lawrence, with nearly that number, each have but one high school. On the other hand, Springfield, whose population numbers about the same as Lawrence, but whose industries are highly diversified, has no less than three high schools. Worcester also has many unlike industries, and four high schools are in proportion to population three times as numerous as Lowell's, for she has one to 36,000 people, while Lowell has one to 106,000. It is a disadvantage, therefore, for a young man to grow up in a community whose industries are all alike. The chances of his getting a sound education are slim indeed.

The disadvantages of a localized industry, namely, the distance from markets for raw materials and finished goods, the strength of labor unions, the multiplication of plants, the suffering in hard times and the creation of a labor class, are outweighed by the advantages. The ability to secure the right labor, the ease of selling and advantages in buying recommend to an employer the place already established in an industry. On the part of the employees, security of jobs and opportunity for organization among the workers are strong lures toward a center recognized for a particular class of work. Therefore an industry started by a local resource or by accident continues to grow in one spot through the branching of new plants from old ones, through new concerns organized by sons or superintendents, through the advancement that comes by subdivision of product and through the accumulation of small factories that make use of waste products. Localization is therefore a persistent feature of industry.

THE NORTH SLESVIG OR DANO-GERMAN QUESTION

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IN northern Germany, just south of Denmark, is the little province of Schleswig (Danish Slesvig or Sleswic); it has been under Prussian control since 1866. In the northern part of the province are about 150,000 Danes; they have all along hoped to have this land, or at least the northern part of it, returned to Denmark, for in 1866 when Prussia acquired this province there was a clause in the treaty promising that the inhabitants of North Slesvig should be given the opportunity to vote freely whether they should belong to Denmark or to Prussia. But this clause of the treaty of Prague has never been carried out. In recent press dispatches (October, 1918) it was stated that the King of Denmark had sent a diplomatic note to Germany suggesting that she execute the terms of the treaty signed by Prussia and Austria in 1866. Later dispatches from Germany deny the receipt of such a communication from Denmark. These conflicting reports aside, it is not unlikely that when the fate of the Alsace-Lorrainers, Poles, Czecho-Slovaks and South Slavs will be determined on the principle of justice to small nationalities during the coming peace negotiations, the people of North Slesvig will also have their nationalistic claims satisfied. It is the purpose of this article to bring together the facts necessary to understand this North Slesvig question in all its historic and present aspects.

The Historic Bearings

The history of North Slesvig is a part of the history of two duchies, Slesvig and Holstein, which in 1864 fell under the control of Prussia and Austria and by 1866 came fully under the control of Prussia. These duchies had been owned by the King of Denmark since the fifteenth century. They had often caused international complications, but we shall need to speak only of nineteenth-century conditions. Although the duchies were owned by the King of Denmark, they were not a part of Denmark. Holstein was a part of the German confederation, but

Slesvig was not. Holstein and South Slesvig were German-speaking, but North Slesvig was Danish. According to a law of the duchies and by international treaties the two were indissoluble; whoever owned one duchy had to own the other. In the duchies the old Salic Law prevailed, which meant that the throne could be inherited only by direct male descendants of the ruling house. In Denmark this law had been given up. In 1848, Frederick VII., the last member of the male line in Denmark, became king and of course also ruled the duchies. After his death the duchies would go to the male line while Denmark would go to the female line. There was a strong party in Denmark that wished to have the duchies remain in possession of the Danish King, and if possible have them become a part of Denmark, at least that part north of the Eider River—the most of Slesvig. This aroused the fears of the German people, who wished to keep Holstein under German control, and if possible to have Slesvig become German too. The matter threatened to disrupt the peace of Europe, so in 1852 seven powers (England, France, Prussia, Austria, Russia, Norway and Sweden) signed the Treaty of London providing that the succession in the duchies remain in the Danish or female line, but that they were never to be united with Denmark. The Duke of Augustenburg, the claimant of the male line to the throne of the duchies, was paid an annual sum and induced to give up his claims.

In September, 1863, Frederick VII. granted a constitution to Denmark *and Slesvig*, thus implying that Slesvig was to be a part of Denmark. Frederick died in November, 1863, and his successor, Christian IX., promulgated the same constitution for Denmark and Slesvig. This was in violation of the Treaty of London. The German nation was aroused, fearing that German-speaking territory was to be forced to live under a Danish constitution. The German Diet declared in favor of breaking the Treaty of London and allowing the Augustenburg line to have the duchies. But Bismarck opposed this, for it would merely add another small state to northern Germany, a thing he wished to avoid. He demanded that the Treaty of London be observed by the King of Denmark, that is, that the constitution of Denmark be not applied to Slesvig. He persuaded Austria to support him in this demand.

As is well known, Bismarck wished to get these provinces for Prussia. Consequently he hoped the Danish King would refuse these demands and give Prussia a chance to enter a war of conquest. Therefore he falsely informed the Danish King that the English government had threatened to intervene if Prussia and Austria resorted to war. The ruse worked: the King, expecting English aid, refused to meet the demands of Prussia and Austria. These two countries then declared war on Denmark, which after a short and decisive campaign ceded Slesvig and Holstein to Prussia and Austria to dispose of as they wished.

Just as Bismarck had planned, Prussia and Austria disagreed on what should be done with the duchies. This was the immediate cause of the Prusso-Austrian War of 1866; at the end of that short but momentous war Austria was forced to cede to Prussia the duchies of Slesvig and Holstein, and Prussia has ruled them ever since.

The Danes have always claimed, and on good grounds, that there had been various arrangements and occurrences that had strengthened the claims of the female branch, and that the Treaty of London was a crime against Denmark.[1] Whatever the merits of this claim, it is certainly far more valid than the claim of Prussia, which is based merely on the right of conquest. Since 1866 the Danes have changed their attitude. They no longer claim the whole of the duchies: they readily grant that on nationalistic grounds they have no claim to Holstein and southern Slesvig, which are entirely German, but they claim the northern half of Slesvig, which is entirely Danish. Slesvig has a population of about 400,000; those in the northern part, about 150,000, are entirely Danish.

Article Five of the Treaty of Prague

When Prussia and Austria signed the Treaty of Prague at the close of the Prusso-Austrian War, Bismarck inserted a clause reading as follows: "His Majesty the Emperor of Austria transfers to his Majesty of Prussia all his claims to the duchies of Holstein and Schleswig, with the stipulation that the population of the northern districts of Schleswig are to be ceded to Denmark, if they by a free vote manifest a desire to be united with Denmark." This article was inserted at the instigation of Napoleon III. to give him some comfort for his failure to play an active part during the Prusso-Austrian War. Bismarck undoubtedly had no intention of living up to this provision of the Treaty of Prague. In 1867 the Danish government requested that Prussia arrange for the plebiscite, but

[1] A. D. Jörgensen, "The Danish View of the Slesvig-Holstein Question," *Nineteenth Century*, XLII., 918–927, December, 1897.

received an evasive reply. At the solicitation of Denmark Napoleon III. now asked Bismarck to execute the treaty, but he retorted that this was a matter to be settled solely by the signatories of the treaty. Napoleon III. was unprepared for war, and, moreover, he was also negotiating for an indemnity in the Rhine country to offset the growth of Prussia's power which resulted from the formation of the North German Confederation in 1867, and therefore he would risk nothing more in behalf of the people of North Slesvig.[2] After Prussia had defeated France in 1870–1871 there was no one to intercede for the Danes, and when Prussia and Austria drew up a treaty of alliance in October, 1878 (which was the basis of the subsequent Triple Alliance), Austria consented to cancel that clause concerning the plebiscite in North Slesvig. And now after fifty-two years it is reported that Denmark is demanding that Prussia live up to the terms of the Treaty of Prague and let the people of North Slesvig determine their own political destiny. If these Danes are ever given an opportunity to hold the plebiscite there can be no doubt as to the way they will vote, for the treatment they have received at the hands of Prussia has done nothing but stir up opposition to the existing conditions.

The Language Question

At the heart of the difficulty is the language question. The Prussian government has done all in its power to change the language of the people. It has required that all teaching in the schools must be in German. When the small children enter school they are allowed to speak Danish, for they know no German; but later they are required to speak German exclusively; if they use Danish on the playground they are punished. The Prussian government tried to Germanize the church services. In the state churches the services are all conducted in German. This has caused many on the border to go over to Denmark for religious worship; those unable to afford to do that have banded together privately and employed Danish ministers. This is not unlawful, but in one way and another, these meetings are seriously disturbed. A Prussian official must be present at every meeting. Sometimes the meetings are broken up on the ground that they have been held without securing the proper authorization. The pastor is arrested and through long delays in the trial is kept from serving his flock. The names of all attend-

[2] E. Bourgeois, "Manuel de politique étrangère," III., 699; A. Debidour, "Histoire diplomatique de l'Europe," II., 349.

ing such private meetings are known to the authorities and this information can be used in various ways against the offenders at suitable times. When Danes leave Slesvig to worship in Denmark or attend festivals or theaters their names are listed by officers on the border and on returning they are summoned before the district superintendent to give an account of themselves during their absence.

In the courts only the German language may be used. Danes unable to speak German must use an interpreter. If they use their own language in court they are fined. Germans and Danes do not associate with each other; each group has its own meetings and social gatherings. The Prussian government has permitted newspapers to be printed in Danish and six have been published regularly. But in one way and another these newspapers have been hampered. Freedom of the press has certainly been wanting. For saying things injudicious the editors have been fined and imprisoned; often the typesetters and other employees of the printing offices have been arrested or banished, thus delaying the printing of the paper.

There are also some German papers in Slesvig; they may print what they wish. Some are subsidized by the Prussian government and are urged to stir up feeling against the Danes. They attack the Danish delegates in the Prussian Landtag and the German Reichstag. They exalt German *Kultur* and belittle Danish achievements. The Prussian government even subsidizes one Danish paper whose purpose it is to stimulate loyalty to Prussia. Many bitter pamphlets and books against the Danes have been distributed in the province. However, it is a risky thing to say anything against the Germans. The Danish representative in the Reichstag, Jessen, was at different times imprisoned for a total of almost four years because he had made various harmless speeches that offended the Prussian authorities. For example, once he was imprisoned for four months because he said that one can easily understand why Bismarck would favor grain duties because he himself was owner of a large estate and would profit by the rise in tariff.

Three Danish societies, the Danish Language Society, the School Society and the Lecture Society, have been active in keeping up the Danish language and national feeling. They have distributed books and given encouragement to Danish cultural interests wherever possible to offset the Germanizing influence.

Further Bases for Ill-Feeling

The main cause of ill-feeling is Prussia's effort to make Slesvig German-speaking. However, the government makes all possible efforts to check anything that is Danish. The Danish flag may not be displayed on a house or in the windows, but is allowed within the house. In all Danish homes one will find the Danish flag and pictures of Scandinavian statesmen, scientists and literary men. Since 1865 Danish songs may not be sung anywhere. Even certain Swedish and Norwegian songs are prohibited. At times the police have broken up meetings at which a certain song of Björnson, the Norwegian poet, was sung. Danish actors and lecturers are forbidden to enter North Slesvig. Once a lecture on the sun and planets was announced by a Slesvig Dane; the local officer prohibited this because he feared that the stereopticon views by which it was to be illustrated might present pictures of Danish persons and landscapes. A Danish society that has tried to improve the breed of cattle in Slesvig has been declared by the Prussian government to be political, and at all of its meetings a Prussian officer must be present, and its members must report to the officer when they arrive and leave.

The Danish colors are red and white. Hence no one may paint his fence-posts, barns or house with these colors. On one occasion the entire edition of a book with a red and white emblem was confiscated. The wearing of clothing which has the combination of red and white is regarded as treasonable by the Prussian. If people decorate the graves of their loved ones with red and white flowers they are punished. Once a farmer housed his black dog in a red kennel; the dog died and was succeeded by a white dog. Since the white dog and the red kennel produced the Danish colors the authorities demanded that the farmer paint his kennel some other color.

When special services are held in the Prussian schools to commemorate the victory at Sedan, the Danish parents are fined if they do not send their children. Many Danish young men have emigrated to Denmark and America; when they return to visit their parents they are stopped and sent out of the country. For some decades the Prussian government tried to force the Danish farmers to emigrate and have their farms taken up by loyal Prussians. Many wealthy Germans have bought lands and established villas. But in recent years the Danish population have resisted this movement vigorously. They have refused to sell their lands, the young men stay, serve their time in the German army and return to Slesvig to keep it Danish.

In 1864, when Denmark ceded Slesvig-Holstein to Prussia and Austria, the two latter countries agreed that all Danish inhabitants of North Slesvig that wished to remain Danish citizens need not become naturalized and were to be unmolested so long as they did nothing to create sedition. No one born under Danish rule was to be banished. But after Prussia gained sole control and began her policy of Germanization she often banished Danes; in some years as many as five or six hundred were banished. Any Dane that does anything unfriendly to the Prussian government is banished. This often means the loss of good positions, business and property interests. Even the Danes that have accepted Prussian rule are subjected to annoyances. If they import Danish servants or harvest hands the government expels these workers; this may occur at harvest time when crops are lost if there is not adequate help. With all of these irritating acts of the government one would not be surprised to find that North Slesvig is a lawless country. The opposite is true. According to Prussian official statistics there is no part of the German Empire that has so few criminal cases as this region. There are only half as many cases of theft, robbery and murder as in the rest of Prussia on the average.[3]

North Slesvig is represented by one deputy in the Imperial Reichstag and by two deputies in the lower house of the Prussian Landtag or parliament. If gerrymandering had not taken place in 1867 there would have been more Danes in the Reichstag; there are three Germans and one Dane from Slesvig. The districts have not been changed anywhere in Germany since 1867. In these two legislative bodies the Danish representatives persistently protest against the injustice done the Danes and demand that the Treaty of Prague be observed. But their speeches are interrupted; the Danish deputies have no influence on German and Prussian legislation. However, their activities are a testimony to the fact that even a half of a century of oppression can not kill a national spirit.

[3] L. Warming, "The North Sleswig Question," *American Journal of Sociology*, VIII., 289–355; W. Hartmann, "Germany and the Danes in North Schleswig," *Nineteenth Century and After*, LIV., 55–65; E. Givskov, "Germany and her Subjected Races," *Contemporary Review*, LXXXVII., 813–824.

Attitude of the Government and People of Denmark

The Danish people have felt very keenly the spoliation of their country in 1864 and the mistreatment of their brothers across the border. The Danish government has not been able to do anything to alleviate the situation. It quickly saw that it could not use force to regain this lost territory; the only outcome would probably be further humiliation. However, the government has quietly worked to arouse the interest of the nations in the moral issues of the question, hoping that there would come a time when the attention of the world would be directed toward the solution of this problem on the basis of justice. So now, when Germany faces a reckoning on all sides, it is not surprising that the King of Denmark, according to press reports, has requested Germany to correct the injuries of half a century by living up to her treaty obligations of 1866.

Although the Danish government could do nothing to help the unfortunate Danes, private citizens of Denmark have done much to keep alive the national spirit of their brothers across the border. Many open-air meetings have been held in southern Denmark and the people from Slesvig have gone over in large numbers to hear addresses by Danes and other Scandinavians. Organized societies have sent libraries of the best Scandinavian literature into Slesvig. Many scholarships in Danish technical schools and in the University of Copenhagen have been awarded to talented young men and women of North Slesvig. Cooperative societies have been formed by the Danes to secure help for those farmers whose Danish laborers have been banished at critical times during harvest season. Through these Danish agencies the seriousness of this Prussian interference has been greatly lessened.

The Political Blunder of Prussia

Prussian treatment of North Slesvig has yielded fruits no different from those in Alsace-Lorraine and Posen. The policy of Germanization has merely intensified the Danish national feeling. In 1895 there were 143,000 people in North Slesvig; of these only 8,000 were Germans, and many of these were Prussian officials. The second generation of German immigrants usually speak Danish, and even among the first generation one third learn to speak Danish.[4] Prussia has not only

[4] Warming, *op. cit.*, VIII., 311. In 1905 there were 148,000 inhabitants of North Slesvig and only 9,000 spoke German. "Encyclopedia Britannica," XXIV., 340.

failed in her policy of Germanization in Slesvig; she has also estranged all three of the Scandinavian countries, not merely Denmark, but Sweden and Norway. If Pan-Germany would ever have been practicable, if the Scandinavian countries ever could have been included of their free will, the mistreatment of the Danes in Slesvig would have kept out Norway and Sweden as well as Denmark.

The Attitude of the German Liberals

German liberals, both in Prussia and elsewhere in the empire, have often criticized Prussia for her mistreatment of the Danes. But these liberals do not wish the application of the plebiscite as promised in 1866. They do not wish to have Prussia lose territory, they merely urge that the repressive measures be stopped and the Danes given greater freedom. But that solution will never satisfy the Danes in Slesvig or in Denmark. The North Slesvig question has never been prominent during the Great War, but the recently reported action of the Danish King has brought the matter to the attention of allied statesmen, and if there is to be an application of the spirit of justice and fairness to small nations everywhere there must also be a reconsideration of the wrong done Denmark in 1864, and the people of North Slesvig must be given the right to vote on their political destiny. There can be no question as to the outcome; North Slesvig will vote to return to Denmark.

THE DEMOCRATIC BACKGROUND OF CHINESE CULTURE

By BENOY KUMAR SARKAR

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IN spite of the generally acknowledged importance of historic tradition as a pre-disposing force in the political developments of a people, it may be safely asserted that the democratic ideals and republican institutions of Asia in ancient and medieval times, such as they were, can, for all practical purposes, exert no influence on her present-day experiments in nationalism and democracy. The political achievements of the Old Orient are, in fact, of no greater efficacy to the New Asia than the Periclean city-state of twenty thousand free men served by two hundred thousand slaves, the Roman *jus gentium,* the "law of nature" of the Stoics, the Patristic doctrine of spiritual equality, the Frankish *Champs de Mars,* the Visigothic *officium palatinum,* the *Vehmgerichte* of the Teutons, or the Council of Toledo can possibly be in helping modern Eur-America solve the problems of universal suffrage, the ethics of representation, referendum and recall, public ownership, and sovietic governments. But now that world-reconstruction is being consciously attempted on all hands, and old values are being revalued in every line of human endeavor, it is of the deepest import to practical statesmen and students of culture-history to recognize that the political psychology of the Orientals has been pragmatically uniform with that of the Occidentals both in its strength and limitations. In approaching the East, therefore, in the future the West should not attitudinize itself as to an antithesis, as it was the custom during the last few decades, but as to a "double" or replica and analogue.

The points of affinity between Asia and Eur-America do indeed lie on the surface. Let us confine ourselves to China for the present. On this sub-continent, a veritable museum of humanity, no traveller could have failed to notice, here and there and everywhere, the little nuclei of sturdy self-rule, the so-called village communities. The local authorities of these rural communes entirely administer the affairs of the village or township, metropolitan or provincial officers being conspicuous by their absence. The village council is composed of all the heads of families. Sometimes its constitution is based on the choice of elders by lot. These folk-moots often exercise the greatest influence in "national" politics. Thus when in 1857 the Imperial Government of China opened the port of Canton to the British it had to encounter the utmost tooth-and-nail opposition of the city council to the measure.

The Chinese have been used to this system of local self-government since the earliest times. The elementary details of such municipal or rural institutions are given in the "Chouli," the text-book of politics compiled from still older sources in the twelfth century B.C. All through the ages the elders of Chinese communes have been elected by local meetings and have held office during good behavior. Even to-day the salaries of these officials are fixed by their peers of the neighborhood, and they are removable whenever the principal persons of the community are displeased with their conduct.

The alderman of the townships has, generally speaking, twofold functions to discharge. First, he is the connecting link between the local people and the higher authorities in matters of administration. He supervises the police, is responsible for the common weal, and enforces the necessary regulations in regard to streets, tanks, markets, festivals, collection of taxes, etc. Secondly, he is a judicial officer, the lowest in the rung of the system for the whole country. The Manchu code provided that all persons having complaints must address themselves in the first instance to the lowest tribunals of justice in the district. The petty questions arising between the men of the locality are thus attended to by the headman, and he is authorized to mete out the proper punishments.

Not less remarkable as testifying to the age-long capacity of the Chinese for collective life in order to promote joint interests are the religious fraternities, secret revolutionary societies, industrial gilds, and trade corporations. The constitution of some of the modern gilds of China is democratic with vengeance. Thus, for instance, the tea-gild at Shanghai has at its head an annually elected committee of twelve. Each committeeman acts in rotation for one month as chairman or manager. No gild member may refuse to serve on this committee. Another gild, that of the millers at Wenchow, is composed of sixteen mill proprietors. A committee of four is selected by them in such a way as to bring each member in his turn on the committee. But the ruling price of the flour each month is settled by the entire craft in conference.

The gilds make their own rules and modify them whenever necessary. And since they are all voluntary associations owing their origin to no charter or governmental license, one can guess from the gild-rules to what a powerful extent the merchants of China are willing to be bound by the laws of their own making. One of the rules of the tea-gild at Shanghai is thus worded: "Pending litigation with a foreign firm, members of the gild shall transact no business with the delinquent firm; relations are not to be resumed till the case is adjudicated." These ultra-democratic corporations do not in reality stop short of enforcing on their members the greatest possible solidarity of interest. "It is agreed," as we read among the rules, "that members having disputes about money matters shall submit their case to arbitration at a gild meeting, where every effort will be made to arrive at a satisfactory settlement of the dispute. If it prove impossible to arrive at an understanding, appeal may be made to the authorities; but if the complainant resorts to the courts in the first instance he shall be publicly reprimanded, and in any future case he may bring before the gild he will not be entitled to the redress."[1]

The autonomies and immunities enjoyed in this way by the trade-gilds and rural communes of China in matters of legislation and adjudication would be easily recognized as some of the privileges and liberties of the craft gilds and gemots of medieval Europe. One must not suspect, however, that the political genius of the Chinese displayed itself solely in the administration of such parochial entities, the atomistic units of government. The *forte* of the people lay in centralization and unified control as well. In the study of Chinese polity we are familiar not only with the phenomena of feudalistic disintegration, provincial autonomy, *laissez faire,* and home rule, but also with pan-Chinese nationality, *federation de l'empire,* and real *Weltherrschaft.*

Solid political homogeneity was achieved on the Chinese continent on several occasions. The "Son of Heaven" did then become *de facto,* as he always was *de jure,* the *hwangti* or Bartolus's *dominus omnium,* of the whole empire. The supreme government of the Manchus, for example, consisted of two Imperial Councils of deliberative character and six administrative boards. One of the councils, called the general council, organized first about 1730 was composed of any grandees, as princes of the blood, chancellors, presidents and vice-presidents of the six boards, and chief officers of all the other metropolitan courts.

[1] *Journal of the North China Branch of the Royal Asiatic Society,* 1886, New Series, Vol. XXI., pp. 133–192.

The various branches of government were consolidated and their harmonious action facilitated by this agency. It served further to make up for the shortcomings of a degenerate ruler and act as a check on the arbitrary measures of a tyrant. The government and direction of the entire civil service of the Manchu empire were left to the care of one of the boards, called the Board of Civil Office. Similarly the other boards were entrusted with duties concerning all the people of the empire. All this contributed no doubt to administrative unification.

The eighteen provincial governments had, as Williams calculates in the "Middle Kingdom," about 2,000 officers above the rank of the assistant district magistrate. Personal touch with the supreme government was ensured by the rule that every high grade officer had to report himself in writing twice every month. Appeals from the lowest courts of the village elders to the higher tribunals of the provinces and the empire served also as strong centripetal influences. Besides, the system of literary examinations by which all officers were appointed to important posts was thoroughly imperialized. The hierarchy of teachers and examiners from Peking to the villages was complete. The "literary chancellors" of the provinces were, like the civil and military governors, appointed by the emperor himself. Altogether, we have here the picture of a France centralized under the Intendants of Richelieu for an area five or six times as large.

It must not be surmised, however, that the king's power in China was a pure despotism. The Chinese polity was never without a conciliar element, the acts of the king being always subject to the control of the chief ministers. No individual could be appointed to a high post by the emperor alone. The ministers had the right to recommend or present a fit person. The king might indeed reject him, but even this prerogative appears to have been controllable, as may be gathered from Werner's "Chinese Sociology" (p. 52), by the united voice of ministers.

The restraints on the power of the king and the value of the council of ministers in the constitution of the state are strongly borne out by Chinese tradition which can be traced back to hoary antiquity. Thus from the earliest times it has been taught, both by examples and precept, says Meadows in "The Chinese and their Rebellions," that no man whatever had a hereditary divine right to the throne, nor even any son of its last occupant. The "five legendary rulers" (B.C. 2852–2255), whom Confucius has immortalized for his countrymen in the

"Shooking" (Book of History), treated the kingdom as belonging to the nation. The doctrine of the state as public property was forcefully demonstrated, as is known to every Chinese of all ages, when Yao (B.C. 2356–2255), one of the "model kings," selected the worthiest from among the people as his successor.

The political psychology of China is likewise nurtured on the democratic imagination fired by the exemplary conduct of Shoon (B.C. 2255–2205), another of her model kings. He had a tablet placed outside his official residence whereon any one could criticize his administration. Public opinion was thus brought to bear upon his own work. He used also to put questions to the people in the Ming Tang, a sort of national assembly, with special reference to the names of bad characters or undesirable citizens. Participation of the people in the function of government entailed necessarily a check on the royalty itself.

Further, as Simcox makes it clear in "Primitive Civilizations,"[2] it is treated almost as a constitutional principle that when the king of China misbehaves it is the duty of the most virtuous and powerful of the provincial princes to depose and succeed him. There is, for instance, on record the actual confinement of the sovereign Tai Chia by the minister I Yin in a palace at Tung near the ruins of the former king "until he gave proof of reformation." With reference to this incident Mencius (B.C. 373–289), the great Confucian sage, was asked whether worthies being ministers might banish their vicious sovereigns in this way. The reply was given to the effect that if they had the same purpose as I Yin, they might, otherwise it would be usurpation.[3]

To an American whose mentality is normally as far removed from Dante's "De Monarchia" as the modern spectroscope is from Aristotle's optics or the Harveyan circulation of blood from the Galenian physiology, all this is but a poor preparation of Asia for the responsibilities of the modern democracy. True, but the fact remains that monarchy, absolute even when "enlightened" and benevolent, has been the most tenacious and persistent form of government in the occidental world also. Indeed, if Napoleon III. had not been defeated by the Prussians at Sedan, it is an open question if there would have been a republic in France to-day.

Institutionally speaking, then, the political experience of

[2] Vol. II., p. 18.

[3] "Mencius," Book VII., Part I., XXXI.

Asia has not been essentially distinct from that of Europe. What about political theorizing?[4] Here again we find the same parallelism and identity between the East and the West. For instance, to take only China, no political thinker could be more radical than the "superior men" of the Confucian classics. It is often said that Chinese culture is but Confucius "writ large." We need not accept the statement as implying that one abstract word "Confucianism" sums up and explains the whole mentality of entire China. But it may still be maintained that like the "Iliad" and the "Odyssey" of the Hellenes, the "Shooking" and the "Sheking" (Book of Odes) have furnished the *mores* of the Chinese people for over two thousand years. The "Divine Comedy" has not been the bible of Catholic Europe to a far greater extent than the Confucian texts and their commentaries to the upper ten thousands as well as the dumb millions in China.

What, now, are the political tenets of the Chinese classics? The idea of the position of the people as supreme is the cornerstone of the *Shooking* politics. We are told:

> It was the lesson of our great ancestor:
> The people should be cherished;
> They should not be down-trodden;
> The people are the root of a country;
> The root firm, the country is tranquil.[5]

Interests of the people are carefully safeguarded in another advice: "Do not oppose the people to follow your own desires."[6]

Passages like these have been handed down from generation to generation, and to-day they are on the lips not only of intellectuals like General Li, Premier Tang and Foreign Minister Wu, but also of the rickshaw coolie and the junk sailors. They know also the maxim that "of all who are to be feared, are not the people the chief?"[7] This is the Chinese version of the saying: "The fear of the people is the wisdom of the lord."

What, again, could be more conducive to the "dignity" of the people than the oft-quoted proverb?—"The great God has conferred even on the inferior people a moral sense, compliance with which would show their nature invariably right."[8] The "Shooking" can be cited also in a campaign of popular sover-

[4] Vide "The Doctrine of Resistance in Hindu Thought" in the author's article on "Democratic Ideals and Republican Institutions in India" in the *American Political Science Review* for November, 1918.

[5] Part III., Book III., Ch. II., 1.

[6] Part II., Book II., Ch. I., 6.

[7] Part II., Book II., Ch. II., 17.

[8] Part IV., Book III., Ch. II.

eignty. As might be naturally expected, the newspaper men of recent times have succeeded in bringing to the forefront the conduct of the king who followed the principle of limited monarchy when he admitted: "I consulted and deliberated with all my ministers and people and they are of one accord with me."[9] There is thus no place for arbitrary rule in the political consciousness of China.

Indeed, *vox populi vox dei* is the first postulate of Chinese political philosophy. A popular maxim was given by Chang in his commentary on Confucius's "Great Learning." It runs thus: "By gaining the people the kingdom is gained, and by losing the people the kingdom is lost" (Ch. X.). The origin of this doctrine of the will of the people is to be traced, as was done by Mencius, to the ancient "Great Declaration," which says: "Heaven sees according as my people see; Heaven hears according as my people hear."[10]

Mencius himself can be cited by advocates of active resistance. For he openly discussed the question, "What fault is it to restrain one's prince?" and his answer was clear: "He who restrains his prince loves his prince."[11]

Mencius is likewise an authority in a case for the deposition of a ruler. According to his advice, if the prince have great faults the relatives ought to remonstrate with him, and if he does not listen to them after they have done so again and again they ought to depose him.[12]

Like Milton, Mencius is a defender of regicide too. The king asked: "May a minister then put his sovereign to death?" Mencius replied:

> He who outrages benevolence *proper to his nature* is called a robber; he who outrages righteousness is called a ruffian. The robber and the ruffian we call a mere fellow. I have heard of the cutting off of the fellow, Chow, but I have not heard of the putting a sovereign to death *in his case*.[13]

The logic of Mencius here is similar to that of the most outspoken anti-imperialist of the eleventh century, Manegold of Lautenbauch, who defended the expulsion of Tarquin from Rome on the ground that kingship ceases to be legitimate when it ceases to promote justice. In fact, the Mencian creed is Rousseauesque in its radicalism. "The most important element in the state," declares this protagonist of Chinese democracy, "is

[9] Part II., Book II., Ch. II., 18.
[10] Mencius, Book V., Pt. I., Ch. V., 8.
[11] Book I., Pt. II., Ch. IV., 10.
[12] Book V., Pt. II., Ch. IX., i.
[13] Book I., Part II., Ch. VIII., 2, 3.

the people; next come the altars of the national gods; least in importance is the king." Further, "By observing the nature of the people's aspirations we learn the will of heaven." In Chinese ethics the divine "sanction" is thus subordinate to the sanction of the demos.

A cynic may reasonably ask: "How much of this philosophical radicalism or intellectual Bolshevism was embodied in actual institutions of the Chinese polity?" The answer would be furnished by a parallel situation in Europe. According to the theory of the lawyers, *e. g.*, Ulpian (second century A.D.), the source of political authority was the people. But from Hadrian to Justinian (117–565) the emperor's will was law. And in the fourteenth century Bartolus (1314–57), the "prince of jurists," was but maintaining the trend of traditional jurisprudence when he affirmed that the Roman Emperor was "*Deus in terris*" and "*sempiter nus*," and that to dispute him was sacrilege. Similarly the modern ideas of natural equality, freedom, justice, etc., can be carried, as has been done by Carlyle in "Mediæval Political Theory in the West," back to Cicero (106–43 B.C.) through the Church Fathers and the Roman jurists. But, for two thousand years slavery was recognized as a lawful and legitimate institution, privileges and inequalities were the norm in socio-civic life, and the divine right of the king was an established fact. It was not until the French Revolution that a legalized constitutional measure was adopted to give effect to the doctrine of natural equality which was first promulgated by the Stoics in opposition to the theory of the Aristotelians. The discrepancy between theory and practise in the political sphere is thus not less occidental than oriental, after all.

PRINCIPLES AND PROBLEMS OF INTERNATIONAL RELATIONS

By Dr. P. G. NUTTING

THE behavior of one nation toward another is in accord with those principles of biology relating to all life and growth. During extended periods of peace, amity and equity, growth and development are more or less continuous and uniform. Interspersed with these normal periods are intervals of violent readjustment of interrelations, periods of extremely rapid development along special lines and of general reformation of objectives, practises and habits. A similar statement would apply to the life of an individual and with slight modification to each living cell composing the individual.

There is little to discuss in this simple biological principle, interest centers rather in the details of its operation; factors in development, the influence of race, religion, education, climate, natural resources and great leaders on growth, rational international law and ethics, the part played by component individuals and organizations, the rationality of selfishness and of altruism and the proper balance between strong and weak components. Finally, in the consideration of a rational world state may be found a criterion of rationality in international relations.

In the last analysis, those rules of international relations will prevail which are backed by the greatest bulk of resources; natural resources and resources in intellect, in capital, in labor and in incentives to action. Even such fallacies as the idea that mere military might makes right and that the end justifies the means would be established, but that they are backed by but a small fraction of the world's strength in resources. We are now witnessing some titanic appeals to worldwide public opinion, and there is no doubt whatever but that the final decision will be in accord with the concensus of that opinion. Let us therefore examine some of the more important and characteristic international problems on the basis of the fairly certain estimates of the judgment of the world's voting power in resources.

The right of an established nation, however small or weak, to exist and work out its own destiny in its own way has been almost universally recognized. The right of powerful nations to expand at the expense of neighboring small nations has been claimed, but has been repudiated by the majority. The love of fair play is so nearly universal that whenever a decision is forced, the result is assured. Nearly every one detests a bully and loves to see him humbled. The gobbling up of smaller nations by larger is abhorred as a species of cannibalism.

A closely related problem is that of the right of a nation to conduct its own internal affairs as it sees fit. This right is quite universally claimed and quite as generally conceded—within limits. Properly speaking, the political right has been conceded, but the moral right has been denied, in particular when the rights of subject races, colonies or other components have been violated. The problem is comparable with that of the right of a family to settle its own affairs. Within certain limits this is conceded; without those limits police interfere and courts decide. The Spanish-American War was brought on by the treatment of Cuba by Spain and the same love of fair play at the root of the moral interference that led to the blowing up of the *Maine*, caused us to leave Cuba to work out her own destiny. Doubtless in time international politics and courts will enforce properly devised international laws defining and setting limits upon the rights of nations to handle their own internal affairs.

A similar problem concerns the right of any sovereign state to treat any other state as it pleases; to restrain trade with or to make war upon it, for example. No limitations have heretofore been recognized as binding on any nation, but international public opinion is overwhelmingly in favor of such limitations. Happily the nations are but few which will claim the right to break their own treaties or to make destructive warfare upon whom they will. A somewhat analogous case would be the assumed right of one individual to fight another. Certain kinds of fighting are tolerated within certain limits, but beyond those limits is forcibly prevented. It is to be hoped that the time is not far distant when just laws shall define and delimit the rights of nations in their dealings with each other and an efficient international police see that such laws are enforced. These laws will be such as will meet the approval of the bulk of the human race and such as that majority is prepared to back up with all its resources. They can not recognize either special privilege or divine right and must be such as will effectually inhibit attempts at world hegemony. They must define moral rights, but in no way interfere with legitimate growth and development, nor permit the interference of one nation or race with the development of another. Moral right must be the basis for international law, not because it is moral, but because no other basis will make for the stability and progress of all nations and all races. An unfair law would be doomed for lack of general support.

That group of problems centered about colonization is varied, complex and difficult except from a certain point of view. The degree of association of one people with another varies from equality of sovereignty down to colonial relationship and at the limit the more or less complete subjection of almost unimportant subject races. Evidently these problems cover the entire field between international and internal problems. The determination of the rights of sovereignty of one people over another has thus far, in most cases, been the natural one of the ability of the one people to establish control over, or, conversely, independence from the other. If either is not done by reasonably humane methods and within a reasonable time, the internal problem becomes an international one and subject to outside interference. The moral principle is vague but simple; within the bounds of fair play all is permissible, without those bounds revolt and interference are to be expected. A colony fairly treated gives the mother country her choicest trade and choicest sons in return for protection and prestige. That Great Britain's colonies have voluntarily made great sacrifices to assist her in the world war we regard as complete proof that she had been treating them fairly. The Anglo-Saxon is a successful colonizer the world over because of his innate love of fair play and his ready recognition of the rights of others. Several nationalities are notoriously poor colonizers for lack of those very qualities; they are too selfish, too long on authority and too short on equity to win the respect and confidence that are essential.

The problem of proper relationship between mother country and dependencies is capable of a clean cut solution from the biological viewpoint. The treatment which a dependent state or race should receive should be measured in terms of its resources, natural, intellectual, manual and financial, and the activity of those resources—the sum of its total potential and kinetic energies, to use a mechanical analogy. Great Britain learned this principle when she lost the bulk of her American colonies a century and a half ago. Her present relations with Canada, South Africa and Australia are evidence of her ability, not only to correctly apply the principle, but to keep pace with rapidly changing conditions in her dependencies. Autonomy in proportion to strength measured in general resources as stated above is the only fair policy and therefore the only policy which will work in the long run. The greedy anxiety of one state to forcibly establish or retain authority over another would be fine comedy, were it not so tragic. If a nation desires leadership and has the natural resources, it should bend its energies to the development of its utmost intellectual, manual and financial resources and to the establishment of a record for fair dealing, leadership will follow as a matter of course. Trade, intellect, labor and capital will flow in from outside of their own accord. The resort to arms or to secret propaganda by any nation in order to extend its authority is merely a confession of failure to recognize, or inability to use, legitimate and therefore effective methods. Such policies are comparable with merely "lifting by the bootstraps" in order to raise one's self. A nation, like an individual, has but to live up to its possibilities to safeguard its future.

The biological principle of relative bulk and activity in the four chief kinds of resources has been stated to be necessary and sufficient as a guide in international relations. Why this is so it would be of interest to inquire, but such a problem is not so much one in engineering as in metaphysics. The answer is not far to seek in the theory of evolution, since it makes for the ultimate good of the entire human race. The reason why the ultimate good of the whole human race is to be provided for is the outside limits of this discussion.

The solution of the problem of war from the fundamental biological viewpoint has been merely indicated above and is worth a more complete analysis. From that point of view wars are harmful according to their aggregate effect on the human race. "Good" wars stimulate or otherwise cause development which outweighs the concomitant exhaustion of resources. Wars which relieve from repression and misgovernment are such. All attempts at world hegemony have failed and nearly all wars waged to that end have caused a loss in exhaustion of resources far outweighing all gains by stimulated development. The mere establishment of authority over other nations, as Napoleon did, is but an empty honor and does no good to be compared with the evil of draining a great nation of its best manhood nor with the far-reaching good of a great scientific discovery. Good wars, on the other hand, are such as throw off restraint seriously interfering with development or establish rights and principles of far-reaching human value. Wars of conquest and attempts at world hegemony are now so thoroughly discredited that it is not unreasonable to hope that there may never be another. Whenever national activities run strongly counter to the biological principle of the greatest good to the greatest number, however, wars are to be expected and even hoped for. To oppose such warfare would be to take a narrow and selfish view unless the same end may be attained by peaceful means. It is probable that a league of powerful nations will enforce the principles of equality of rights and of fair play, making further wars to secure such unnecessary.

A world state would more than justify itself if it secure international stability and progress. To accomplish this it must stand squarely for the abolition of special privileges among all nations, races and classes. It must have supreme authority and means of maintaining that authority in order to be stable and effective. It must leave to individual nations the entire management of their internal affairs so long as that management is in accordance with the principles of equity. It must have tribunals to decide upon questions of equity and a legislative body to formulate just international laws and keep those laws abreast of development. Legislative authority and administrative expenses may well be apportioned according to resources, but executive and judicial officers might well be selected without regard to resources or even nationality, demonstrated ability and fitness being sufficient.

Aside from political functions, such a world state might well concern itself with many international problems in general warfare. (1) It might conduct surveys of world resources; natural resources, financial resources, organized knowledge and labor, examining into means of enhancing and utilizing such resources. (2) It might well assume the care of public health, particularly as affected by transmissible diseases, plant and animal as well as human. (3) International commerce, banking, communication and labor movements might well be given considerable assistance in the nature of directive and stimulative influence by such a world state organization.

The advantages to be anticipated from the formation of a world state are quite similar to and of far greater magnitude than those accruing from the union of our own states in a strong central government. If such an international organization is formed, it is to be hoped that it may be so well organized as to receive the loyal support of all peoples and be given such authority as to command the respect of even the strongest and most perverted of nations.

ADAPTATION IN BONE ARCHITECTURE[1]

By Professor R. M. STRONG

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WE recognize two types of bone: compact and cancellous. In flat bones we have the latter as the diploe between two layers of compact bone. In long bones there is a tubular structure of compact bone with a varying amount of cancellous bone inside.

For instance, in the human femur, the shaft portion is a tube with a wall of compact bone which is thick except near the ends; here the compact bone becomes thin and is continued over the swollen ends of the femur as a thin layer. In the shaft region of the femur, the cancellous portion is represented by relatively few and widely separated bone trabeculæ. The space inside the tube of compact bone is occupied mostly by marrow. In the enlarged end portions of the femur, a complicated system of crowded trabeculæ produces a spongy structure with small interspaces.

The enlargements at the ends of the femur furnish needed surface for the attachment of muscles, tendons and ligaments. They are also important in the joint mechanism. The spongy structure permits an enlargement without increased weight.

The central spaces, even though occupied by marrow, give the bone some of the architectural advantage of a tube over a solid rod, *i. e.*, greater rigidity or resistance to bending strain than is possessed by a solid structure of the same length and weight of material.

In many birds, and especially in some larger forms, this architectural advantage has been carried still further, and we have decidedly hollow bones with no heavy marrow. Even the bone trabeculæ have disappeared more or less completely, and the hollow spaces are occupied by evaginations from the lungs, the air sacs. The extent of this pneumatization of the bones varies, but in a bird like the albatross it is extraordinary. The vertebræ with all of their intricate contour are hollow, and these air spaces extend into the smallest processes. There is no solid bone much thicker than writing paper except in the

[1] An address at the University of Illinois Summer Graduate School of Medicine, Aug. 30, 1917.

leg bones. The skull may be said to have thin layers of compact bone separated by an extensive diploe which has its bony elements often reduced to slender spicules with very large air spaces instead of marrow. The bones of the albatross are consequently exceedingly light in weight.

Bones containing air spaces are not confined to birds. In mammals, we have air sinuses in the skull which are connected with the respiratory tract and are lined with membranous extensions from the respiratory passages. Such sinuses are especially well developed in the skulls of the larger ungulates, and they are familiar structures in man. In a group of fossil reptilia, the Dinosaurs, pneumatization of the skeleton was apparently developed as far as in any of the birds, and possibly more.

In spite of their apparently frail structure, I have found albatross bones surprisingly strong and capable of withstanding relatively severe tensile and compressive strains. Their factors of safety are large. Thus the articular processes of the vertebræ resist bending strains of great severity. Though the amount of real bone tissue present is small, and the bulk of the vertebra is air space, a pull of 28 to 42 pounds applied in the most critical direction was necessary to produce fracture. This strain was, furthermore, not in any direction that tensile or bending strains would be likely to take in nature. Pressures of twenty to thirty kilograms applied to the vault of dry skulls from young albatrosses of a small species produced a crack in the sphenoidal region, but no rupture of the vault. These figures underestimate the strength of most parts of the albatross skull in spite of its great lightness and pneumaticity.

Tests of fresh normal human compact bone by Hülsen[2] and by Rauber[3] indicate its very great strength and are illuminating here. Thus a tensile strength of 9¼ kilograms per square millimeter, or 13,000 to 17,000 pounds per square inch, was found. The compressive strength is still greater, the figures varying from 12½ to about 19 kilograms per square millimeter or 18,000 to nearly 20,000 pounds per square inch. The following factors of safety for various parts of the human femur in running are given by J. C. Koch in an excellent paper on bone architecture.[1] For tensile strength, the variation is between 5.68 at the weakest point in the neck to 53.6 in the head. For compressive strength, the figures vary between 5.1 in the neck

[2] Jahresber. d. Anat. u. Entwick, 1898, Bd. I, p. 146.

[3] Elasticität und Festigkeit der Knochen, Leipzig, 1876.

[1] *Am. Jr. Anatomy,* March, 1917.

to 119.5 near the proximal end of the femur. These figures are doubled for walking, but are very much less in the case of impact due to jumping or falling. However, there are of course compensatory movements of muscle contraction and flexing of joints which offset the effect of impact more or less.

The strains due to muscle contraction are ordinarily much less than those due to loads or to impact. Thus Koch states that the greatest possible contraction of the thigh muscles would "develop only about one seventh of the strength of the femur." He also says that the tensile strength of bone is about 230 times that of muscle. In various tests that I have made, using a steady pull, I have found that muscles and tendons will break before any significant strain is placed on even such slight structures as the cervical ribs of an albatross vertebra. I have not found any way of measuring the strains which muscles and tendons actually exert in normal activity, but they must be far within the factor of safety.

Nevertheless, there are some curious contradictory facts in clinical records. Thus Stimson in his book on "Fractures and Dislocations" mentions various fractures which were the result of muscular action. An athletic man broke the humerus of his throwing arm just below the insertion of the deltoid, in throwing a stone. The femur has been broken in attempts to kick, to avoid a fall, in drawing on a boot, or in turning over in bed. A primipara broke her sternum in labor, trying to assist the action, rising on her heels and elbows. Fractures of the patella from muscular action are not uncommon, and they also occur at the tuberosities of the long bones where powerful muscles are attached.

I recall a fracture of one of the long bones of the wing of a gull struggling to free itself from my grasp. My hold happened to slip to one wing for a moment. Ordinary tests of the wing-bone resistance to bending strain do not suggest such a possibility.

Apparently, sudden and violent contractions of groups of muscles may produce strains greatly in excess of our measurements. Surprising feats of strength are performed under the influence of strong emotion or mania. The large factors of safety indicate provision for unusual as well as normal strains, but it is also obvious, as Stimson says, that "Nature's precautions are as a rule calculated upon the basis of the probable, not of the exceptional." These fractures evidently involve abnormal strains.

My tests have been made with dead tissue. I have used both fresh and fixed material, and I know of no data concerning the relative strength of living and dead tendons or muscles. These cases of fracture of bones from muscle contraction and the unusual feats of strength just mentioned suggest that muscle tissue may possibly have in life a greater strength than immediately after death. The tests I have made were simple and involved tying a string about the muscle or tendon, with the other end fastened to a spring balance which was subjected to a steady pull. The following tests were made with albatross tendons from formaline fixed specimens. Tendons of the longus colli muscle inserting on cervical ribs at about the middle of the neck broke under a pull of four to five kilograms. A biventer cervicis tendon ruptured under a strain of about two and one half kilograms. A small species of albatross, *D. nigripes*, was used. Fresh longus colli tendons attached to cervical ribs at about the middle of the neck of a gull, ruptured under a pull of one and one half to two and one half kilograms. Such results indicate large factors of safety for these structures. Most of the albatross cervical vertebræ, for instance, receive a pair of longus colli tendons. Neither the weight nor the habits of the albatross would seem to require, even in emergencies, such large factors of safety; yet they are probably not larger than is necessary for occasional but not very rare strains.

Much has been written about the remarkable adaptations in the human femur to its functions as well as those of other bones. We may mention especially the publications of Roux,[4] Julius Wolf[5] and J. C. Koch. The paper by Koch mentioned earlier in this paper puts the subject on a sounder and more mathematical basis than it was.

Longitudinal sections have demonstrated that the trabeculæ of the proximal end of the femur, for instance, are arranged in series which cross each other at right angles. Furthermore, these trabeculæ have been shown to have the direction of the lines of maximum tensile and compressive strength. They are arranged to meet the severe strains which the femur experiences, normally, and they involve a great economy in material. The efficiency of such a bone is well indicated in the following quotation from Koch: "The various parts of the femur taken together form a single mechanical structure wonderfully well adapted for the efficient, economical transmission of loads from the acetabulum to the tibia; a structure in which

[4] Biol. Centralbl. 1881, Bd. I; also Zeitschr. f. orthopaed. Chirurgie, 1895–6, Bd. 4, p. 284.

[5] Das Gesetz der transformation der Knochen, 1892, Berlin.

every element contributes its modicum of strength in the manner required by theoretical mechanics for maximum efficiency."

The publications of Wolff and of Roux have given us a large amount of data illustrating the possibilities of bone adaptation under exceptional conditions. In cases of fracture with imperfect coaptation and in disease, remarkable rearrangements of bone structure to meet new conditions occur. Thus Wolff has described cases of extra-capsular fracture of the femur through the neck and greater trochanter. In one case, some of the medial cortex of compact bone belonging to the upper fragment was driven into the cancellous bone of the lower fragment. In the union that followed, adaptive rearrangements of trabeculæ to meet tensile and compressive strains occurred. Likewise in another case where compact bone from the lower fragment on its medial side was driven into the cancellous bone of the upper fragment, adaptive rearrangements of trabeculæ followed. Local thickenings of the cortical compact bone also occur in such cases.

In fractures which involve widely separated fragments, bony bridges are formed. These involve large readjustments of both external form and internal architecture.

In a remarkable case described by Roux,[6] a false joint developed as a consequence of imperfect union of a fractured bone. The fracture was of the tibia at the juncture of its upper and middle thirds. This was followed by an extensive hypertrophy of the fibula which became larger than the tibia and took over its functions. The tibia suffered an actual reduction in size. The fibula also increased in length so that it formed an articulation with the lateral condyle of the femur. The enlargement of the femur is said to have involved the formation of normal healthy bone.

Other fractures have been studied in such detail, and the results have been similar in demonstrating transformations to meet new conditions.

In anchylosis of joints, a remarkable unbroken continuity of the trabeculæ of the two fused bones, may be established. This involves a reorganization of the cancellous bone. Changes in the thickness of the compact bone take place at points far removed from the anchylosing joint.

The well-known effects of unusual or excessive strains or loads upon developing bone involve deformities which have also been shown to undergo changes in architecture. From this

[6] Biol. Centralbl., 1891, Bd. I, pp. 241–51. See also Julius Wolff, 1892, Das Gesetz der Transformation der Knochen, Fig. 49, Taf. VII.

knowledge has arisen the practice of orthopedic surgeons of removing a deformity producing load or strain and the use of corrective treatments involving artificially applied loads or strains.

This adaptiveness of bones to new conditions has not been generally realized by biologists, I believe. It was not known to me until very recently, and it has suggested to me some reflections concerning the origin of bone architecture. Let us review briefly the principal doctrines of evolution and discuss the bearing of bone adaptation on them.

Though natural selection has undoubtedly been an important factor in the evolution of the skeleton, it is likely that other factors have been more potent. Recent opinion holds natural selection insufficient to account for the enormous progress of evolution. Many believe that it does not originate characters, but simply favors more suitable variations while rejecting the unfit.

It is difficult to conceive of all the complex organization of the femur for its functions as a consequence of sudden changes or mutations, even though we grant the possibility of more than one mutation in the same direction.

In orthogenesis, we have an interesting viewpoint. It is easy to think of continuous variation in a definite direction as potent in evolution when we see fine series of intermediate stages. Unfortunately, there has been much vagueness about this hypothesis. Various opinions have been expressed as to what the motive principle may be. We have had various kinds of orthogenesis with intimate relationships to other evolution doctrines. The hypothesis of Nägeli is generally classed as orthogenetic. Greater perfection, more complex organization, greater division of labor, perfection of adaptation were believed to be principles of the organism. A perfecting principle carried by the germ cell was the central idea. The germ plasm has an organization which tends to produce variation in the direction of the most advantageous structure which is compatible with its degree of structure, of complexity and division of function.

The late Professor Whitman was much impressed with Nägeli's conception and he worked out a hypothesis not very different from that of Nägeli. According to Professor Whitman, the germ plasm may contain some condition of its organization which is responsible for continuous cumulative variation. In breeding experiments with pigeons, for instance, he obtained evidence that variation has been in the direction of a barred pattern from an originally checkered pattern. Professor Whitman was sceptical concerning the possibility of environmental changes being effective. He had been for many years an embryologist and was naturally influenced by the ably supported doctrine of Weismann: the continuity of the germ plasm.

Unfortunately for orthogenesis, we have no data, and in fact hardly even a guess, as to what the germ plasm attributes may be which would be responsible for orthogenesis.

Since the announcement of Weismann's continuity of the germ plasm, there has been a curious division among biologists concerning the so-called Lamarckian doctrine of evolution as the consequence of inheritance of acquired characters. We know that much of this disagreement has been due to a failure to agree on what constitutes an acquired character. There has been some loose thinking and much quibbling. Furthermore, viewpoints have been too limited and data too meager. Accepting the embryological viewpoint that an acquired character is somatic, we have biologists with a large embryological horizon referring all evolutionary progress to the germ cells. On the other hand, paleontologists with the marvelous adaptations of the skeleton constantly before them have remained defenders of the importance of environmental factors, of use and disuse.

To a certain extent, it must be admitted, the paleontologists have been ignorant of, or oblivious to, the exceedingly strong evidence which supports the conception of continuity of the germ plasm. On the other hand, I believe that this doctrine has been too sweepingly asserted by the embryologists, and I think that the truth lies between these viewpoints.

Of course we can not deny that in sexually reproducing organisms the fertilized egg must contain all the factors for characters not actually acquired by the individual in ontogeny. The question is can a somatic change, for instance an alteration in the femur, be transmitted to the offspring. To provide for the germ cell equipment that must be involved we recall various hypotheses of pangenesis involving ultra microscopic particles, gemmules, etc. So far, at least, these attempts have not emerged from the field of pure speculation.

Sounder conclusions are to be expected from work in experimental evolution, but the dangers of false interpretation are great. There are confusing intricacies and numerous uncertain factors to trip up the investigator. Long periods of time are apparently necessary for significant results.

"The brilliant progress in heredity of recent years, beginning in 1903 with the rediscovery of Mendel's law, should not blind us to the four broad deductions from paleontology, that transformation is a matter of thousands of years, that to the living observer all living things may be delusively stationary, that invisible tides of genetic change may be setting in one direction or another observable only over very long periods of time, that discontinuous mutations or saltations may be mere ripples on the surface of these tides."[2]

Until very recently, experiments testing the effects of environmental changes have mostly given doubtful evidence of transmission of new characters to the offspring. Usually, each generation has apparently had to start where the parents began. Nevertheless, the results have not all been negative. Thus Tower has obtained inherited alterations in pigmentation of potato beetles as the consequence of changed environmental conditions during the period of germ-cell development. Experiments on the effects of alcohol on the offspring when given to the parents, MacDougal's work with plants, and other experimental work recently done, all indicate susceptibility of the germ cell to external stimuli. One clear undisputed case alone of such susceptibility to external stimuli which is potent in inheritance, *i. e.*, results in new characters for the offspring, should be sufficient to overthrow the dogmatic assumption that the germ plasm can not be affected by changes in the environment so far as heredity is concerned.

The germ cells are not hermetically sealed in the gonads. There is no evidence that they are not reached freely by the blood stream with its contained internal secretions and various unknown elements. We have had much new evidence recently of the intricate and extensive relationships of tissues to each other, physiologically. The form in which influences reach the germ cell is unknown to us, but so are the agents of many other biological phenomena which we know exist. It is not improbable that the factors which are responsible for changes, in the femur, for instance, are associated with the cell organization.

Adaptation phenomena are more numerous than we often realize. Temperature control, regeneration and regulation processes are examples of adaptation. The activities of phagocytes and some of the wonderful phenomena of immunity are also illustrations. If a bone is broken, osteoblasts inactive for years and ordinarily destined to remain idle resume inactivity, and other bone-forming processes begin. We do not know what are the agencies which start these activities, but the results are obvious enough.

[2] H. F. Osborn, *Am. Nat.*, April, 1912, pp. 185–6.

Possession of an adaptation does not insure supremacy or survival. Another competitor may have a better adaptation. Not all advantages in the struggle for existence are possessed by a single organism. Many individuals of various species and groups are in complex competition with each other. Adaptations are furthermore subject to the limitations of heredity and environment. An automobile can not fly nor can a locomotive swim, yet both are highly adapted to their functions.

The occurrence of apparently useless or even disadvantageous characters has been used as an argument against characters being adaptive. Characters apparently highly adaptive have been explained as accidents of development or of evolution. All such arguments are beside the mark. They involve a failure to consider other forces and principles in their relationships to adaptiveness as a characteristic of protoplasm. Adaptive tendencies may be handicapped by other tendencies or forces. Heredity may preserve a character past the period of its usefulness.

We have had much new evidence in recent years of the amount of adaptiveness possessed by lower organisms. Even the ameba has been shown to be more resourceful than was at one time suspected. The more elaborate the organization, the more varied and effective are the adaptations.

The problem of explaining the origin of adaptation is made difficult because changes beyond what may be acquired in a single generation are inhibited by the *conservative forces of heredity*. In the germ cell we find permanency. There are located all those forces involved in heredity which preserve the type. Germ plasm tends to beget the same plasm. Ultra Mendelianists have even gone so far as to deny the possibility of any evolution except by recombinations or losses of germ plasm units. The mutationists account for mutations as the result of small spontaneous germinal changes. These writers, and especially the Mendelianists, are over impressed with the precision and scope of heredity. They fail to recognize the *interplay between heredity and adaptation.*.

It is not easy for the organism to break away from its inheritance, especially in certain characters. Furthermore, it is conceivable that adaptations reach limits or that heredity may become too strong for a change to occur, even with great environmental changes. In fact, it is difficult to explain the failure of lower organisms to have evolved further than they have on any other basis. I believe that there is much significance in the old idea of varying degrees of plasticity with regard to susceptibility to environmental changes. Some adaptations are doubtless easier than others, and changes in certain directions may be easier than in others. The strength of heredity may increase when the environment remains relatively constant for long periods of time.

It is quite unnecessary and entirely unwarranted to ascribe a teleological basis for adaptation. It does not make the situation clearer to talk of entelechies or to assume a so-called vitalistic principle. We have no evidence that an adaptation is the consequence of any entities or properties different essentially, except possibly in complexity, from the characteristics of simple chemical compounds. Bone architecture may be said to be the consequence of physico-chemical processes which include among other *competing* activities, adjustments to the needs of the organism.

Summary

Skeletal structures are capable of much greater changes than biologists ordinarily realize. Bones are highly adapted to their functions. Their architecture may be greatly altered as the consequence of accidents, new strains or disease.

The viewpoint is maintained in this paper, that the organism and its constituent cells have as a condition or principle of their organization adaptiveness to new conditions. This involves susceptibility to stimulation effective in heredity. There is evidence that this capacity is possessed by the germ cells as well as by the somatic cells. The doctrine of absolute isolation of the germ cells from stimulation by somatic cells which may be effective in heredity, is untenable. Much of this apparent isolation or lack of susceptibility may be due to the power of the conservative forces of heredity.

The balance in power between heredity and environmental influence may be considered to vary for different characters and organisms, very likely also for periods in activity. In the course of time, a character may become fixed, or mechanical limits may be reached for adaptation.

The architecture of the skeleton is regarded as the consequence, to some extent at least, of inherited adaptations.

The phenomena of bone architecture development and adaptation do not appear to support the ultra-Mendelian conception that new characters can arise only by recombinations of unchangeable germ-plasm units or by the loss or addition of such units.

FISHING IN VENEZUELA

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FOR those reared in the temperate parts of the earth, the tropics appear as fairy lands which have a never-ending charm. To be sure, there are some stay-at-homes who worry about the heat, dread the noxious animals, and long for city-made sanitation, but to the real traveler the tropics can never be anything but delightful. It was with pleasure, therefore, that the writer boarded the good ship *Caracas* last June, bound for La Guaira.

The object of the journey was to investigate the fishes of a tropical lake, and the "Laguna de Valencia" in the northern part of Venezuela had been chosen as being the most suitable one in America. Lake Valencia is thirty miles long and, as the Venezuelans love to say, "possesses twenty-two islands, receives the waters from twenty-two rivers, and is twenty-two leagues in circumference." It is said to be fifty meters deep in some places and contains an abundance of fishes.

In the United States, the newspapers have led us to believe that Venezuela is rather pro-German, and the writer was pleasantly surprised to find that ninety-nine per cent. of the people are very much interested in the success of the allies. The officials were always very courteous and obliging. Whatever shortcomings the Spanish peoples may have, no race can excel them in courtesy. The president's son, Coronel Ali Gomez, loaned a boat, furnished a man, and did everything in his power to make the expedition a success. The Coronel is a great fisherman and went on a number of expeditions himself (Figs. 1, 2). Dr. H. Pittier, an American, Mr. Charles Lazzari and Dr. Juan Iturbe also rendered invaluable assistance. The greatest obligation, however, was to my constant companion, Agapito—expert fisherman, crack shot, philosopher and true friend. In a strange and thinly populated country one appreciates a reliable and thoughtful companion more than anything else.

The lake proved to be very interesting. It was large enough to give some variety of habitats and was inhabited by a number of strange fishes. The islands had rocky beaches, but the shores elsewhere were muddy and grown up with a dense thicket of

FIG. 1. CATCHING CORONCHOS IN THE RIO CASTANO.

rushes which stood eight to ten feet above the water (Fig. 3). The rushes were the home of the beautiful *galletas*, a sort of a rail which subsists on aquatic vegetation. There were also solemn *chiquaquos* (herons) and several smaller birds. A saber-beaked gull and a little tern hunted along the shore.

In the rushes lived the *bavas*, and we had great sport shooting them from the boat (Figs. 4, 5). Gliding along the margin

FIG. 2. COLONEL GOMEZ USING A CAST NET AMONG THE ROCKS OF THE RIO CASTANO.

Fig. 3. A Boat Brought from France in Separate Parts, Carried a Hundred Miles Over Mountains into Venezuela, Lake Valencia.

of the rushes, we strained our eyes for sleeping individuals on the rushes or watched for the four slow-moving objects above the water which marked the eyes and nostrils of a sneaking *bava* that had sighted us first. "*Alli esta una*"—Pedro and I held our breath. Then Agapito's rifle cracked and our paddles

FIG. 4. PEDRO AND A BAVA.

lashed the water in order that we might get the specimen before its death struggles lost it in the rushes. If it sank before we arrived, faithful Pedro (Fig. 4) stripped and dived down into the mud after it.

Fig. 5. Agapito and Three Bavas.

None of the *bavas* in this lake were more than seven or eight feet long, but in some of the Venezuelan rivers there are caimans that reach fifteen. I had always supposed that the alligator tribe lived largely on fishes and was surprised to find that

Fig. 6. Cormorants on an Old Boat Shelter.

the *bavas* ate all sorts of aquatic animals. One had consumed a number of snails and a frog; the stomach of another contained nothing but ten "*cuchirachis*"—flat water bugs about an inch long.

Cormorants were abundant. They sat on objects alongshore (Fig. 6) and took to the water at our approach. These birds subsist on the abundant sardinas, their great diving ability enabling them to capture these with ease. The cormorants were of considerable scientific interest, as they contained the adult stages of some of the parasites which were found as larvæ in fishes. One individual examined had fifty-seven trematode

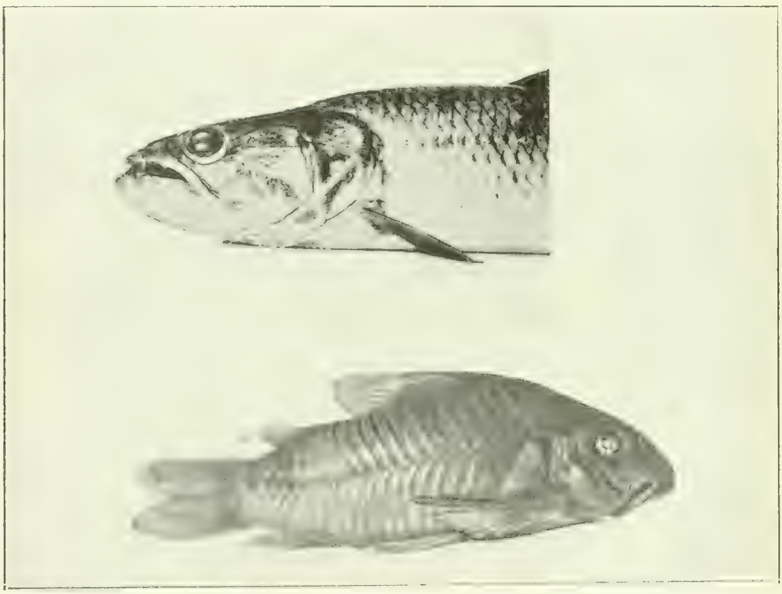


FIG. 7. A GUABINA.
FIG. 8. A PLATED NEMATOGNATH, A BEAUTIFUL LITTLE SCALED CATFISH.

worms clinging to the inside of its esophagus and about fifty nematodes in its stomach.

Sixteen or more species of fishes were found in the lake and its tributaries. In shallow water everywhere were myriads of little sardinas. These were of several species—some fed on snails, others ate algæ or microscopic, floating plants and animals. Among the larger fishes the dominant one was the "*guabina*" (Fig. 7), a fish-eater somewhat like a pickerel, but more fierce and aggressive. Its razor teeth often cut the nets to shreds, and woe to the unwary finger that came near them!

There were several kinds of strange catfishes at the mouths

A *B*

Fig. 9. Two Species of Sucker-like Fishes: *A*, Barbon; *B*, Panaque.

of the rivers. The common species was much like those in the United States, but had "whiskers" nearly as long as the body. Sometimes in the creeks we caught the beautiful little plated nematognaths. These rare creatures are unique among catfishes in possessing two rows of scales on each side of the body (Fig. 8).

There were three kinds of eels. One was a gymnotid—a close relative of the famous electric eel which occurs in the Guianas. Another little species we caught on two occasions in the mud dredge at a depth of fifteen meters below the surface of the lake, where it was buried in the soft bottom mud.

Once in deep water we caught a "*panaque*" (Fig. 9, *B*), a strange armored creature reminding one of Devonian times. This fish is a sort of a sucker which is often found in rivers. In northern Venezuela the sucker-group has attained considerable diversity and is widely distributed. In the rivers there are several types—one species with soft barbs on the front of the head. another with a long protuberant snout, etc.

One of these sucker-like fishes, the "*coroncho*" (Fig. 10), is abundant in the Rio Castano near Maracay. We had great

Fig. 10. A Coroncho.

fun fishing for them "*con mano*" and with cast nets. The coroncho lurks under stones, huddled down into the sand in crevices, and firmly attached by means of its sucker-like mouth. The fisherman must lie on his belly in the water and reach at arm's length under the rocks to secure the fish. The cast net is circular and has weights all around the edge. Its use requires considerable skill (Fig. 2). It is grasped in the center and thrown so as to spread. After it has covered an area of bottom, long sticks are poked under the stones within it, and the fishes are caught as they rush from their hiding places.

Some limnological work was done in Lake Valencia. Temperatures were taken and the gaseous content of the water was determined to a depth of twenty-six meters. On July 17 the temperature of the water was as follows:

Depth in meters	0.5	1	2	3	4	5
Temperature	27.6	27.5	27.5	27.5	27.2	27.2
Depth in meters	7.5	10	12.5	15	20	25
Temperature	27.16	27.15	27.15	27.15	27.01	26.25

A slight stratification is shown, and this was also evident from the gas determinations. There was less oxygen and more carbon dioxide in the deeper water.

Catches were made at various depths with a mud dredge. The little clams (*Sphæridæ*) and dipterous larvæ, so characteristic of the bottom of the lakes in temperate regions, were absent and in their places were thousands of minute snails. A little towing was done which indicated that the plankton was less varied than that in the lakes of cooler regions.

Fishes were more abundant and varied in shallow water and few were caught below twelve meters. All the species occurring in deep water were mud-, snail- or fish-eaters.

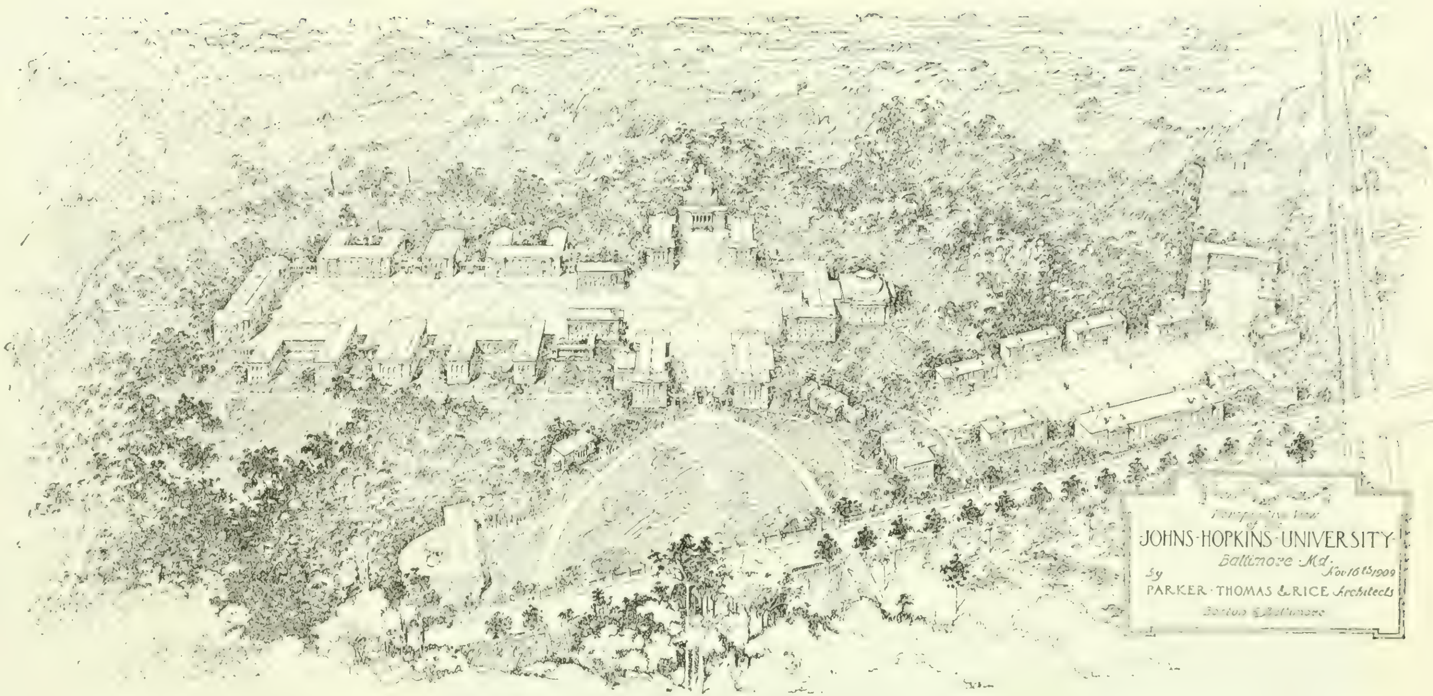
In closing the writer wishes to point out that Venezuela is an admirable country for the naturalist. The people are hospitable and good-natured, the country is reasonably healthful, the scenery is magnificent, the fauna is varied and interesting. The writer ventures to give two admonitions to those who may plan to do scientific work there: (1) Get the backing of the government officials and you can do anything. (2) Keep in mind that those who travel in strange countries expecting to make new friends will find them. Where people are superlatively hospitable and polite, the only way to do business is with or through friends.

PROFESSOR THEODORE W. RICHARDS.
Retiring President of the American Association for the Advancement of Science.

THE PROGRESS OF SCIENCE

CONVOCATION-WEEK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE American Association for the Advancement of Science and the national scientific societies affiliated with it meet at Baltimore during Christmas week. The meeting was transferred from Boston in order to reduce as much as possible the need of travel and to be near Washington, where so many scientific men are now assembled in the service of the Government. It was necessary to set an early date for the meeting, as it was expected that the rooms of the Johns Hopkins University, used by the Students Army Training Corps, would be occupied after January first and that college and



ARCHITECT'S PLANS FOR THE DEVELOPMENT OF THE BUILDINGS OF THE JOHNS HOPKINS UNIVERSITY.

GILMAN HALL.

university teachers would be compelled to resume their teaching on that date. Though the association meets officially through the week the occurrence of Christmas Day on Wednesday has led to placing the sessions on Thursday, Friday and Saturday.

The formal opening exercises are on Thursday evening, when after remarks by the president of the meeting, Professor J. M. Coulter, head of the department of botany in the University of Chicago and President Frank H. Goodnow, of the Johns Hopkins University, Dr. Theo-

THE CARROLL MANSION AT HOMEWOOD, built in 1803, the architecture of which has been taken as the keynote for the buildings of the Johns Hopkins University.

LABORATORY OF MECHANICAL AND ELECTRICAL ENGINEERING.

dore W. Richards, director of Wolcott Gibbs Memorial Laboratory and Erving professor of chemistry, Harvard University, gives the address of the retiring president, his subject being "The Conservation of the World's Resources." Professor Richards's classical researches on atomic weights have given him distinction throughout the world, he and Professor Michelson being the two Americans who have been given the international recognition of Nobel prizes in science.

Regular meetings of the sections of the association will be held from Thursday morning to Saturday afternoon. The addresses of the retiring vice-presidents, to be delivered on those days, are as follows:

Section A.—Henry Norris Russell. "Variable stars."
Section B.—William J. Humphreys. "Some recent contributions to the physics of the air."
Section C.—William A. Noyes. "Valence."
Section D.—Henry Sturgis Drinker. "The need of conservation of our vital and natural resources as emphasized by the lessons of the war."
Section E.—George Henry Perkins. "Vermont physiography."
Section F.—Herbert Osborn. "Zoological aims and opportunities."
Section G.—Burton E. Livingston. "Some responsibilities of botanical science."
Section H.—Edward L. Thorndike. "Scientific personnel work in the United States army."
Section I.—George Walbridge Perkins. (In France.)
Section K.—C.-E. A. Winslow. (Section not meeting.)
Section L.—Edward Franklin Buchner. "Scientific contributions of the educational survey."
Section M.—Henry Jackson Waters. "The farmers' gain from the war."

About twenty affiliated societies meet in Baltimore, a somewhat smaller number than usual owing to war conditions. Among them, however, are many of the more important national societies, including those devoted to physics, geology, geography, zoology, botany, entomology, anthropology and psychology.

The meetings were planned before the signing of the armistice and were largely intended to contribute to the solution of war problems. The changed situation makes it possible to take up the immense service of science to the nation in time of war and its dominating place in the problems of reconstruction.

The American Association met in Baltimore in 1858 and then allowed fifty years to elapse before again visiting the city. In the meanwhile the Johns Hopkins University had been founded and had created in Baltimore one of the great centers for scientific research of the country. Since the meeting of 1908 the university has moved to its new site at Homewood where the picturesqueness of the situation gives admirable opportunity for architectural development. The Carroll Mansion, built on the grounds in 1803, has been used as the key-note, and the buildings already erected house worthily one of our great universities.

AMERICAN EXPERTS AT THE PEACE CONFERENCE

ACCOMPANYING President Wilson on the *George Washington*, which sailed for France on December 4, were a number of scientific men, scholars and specialists, who, under the direction of Colonel E. M. House, have been engaged since November 10, 1917, in the offices of the American Geographical Society at Broadway and 156th Street, New York, gathering data to be used at the Peace Conference. Dr. Sidney E. Mezes, president of the College of the City of New York, is director of the inquiry and has associated with him many of the best qualified men in the nation.

In September, 1917, as a result of conferences between Colonel E. M. House and President Wilson, Colonel House was authorized to organize forces to gather and prepare, for use at the Peace Conference, the most complete information possible, from the best and latest sources, for consideration by the Peace Commissioners. Colonel House held preliminary conferences with Dr. S. E. Mezes, president of the College of the City of New York; Professor James T. Shotwell, of Columbia University and Professor A. C. Coolidge, of Harvard University.

The inquiry has had a personnel of about 150 people. Among them are: Director Mezes; Dr. Isaiah Bowman, director of the American Geographical Society; Allyn A. Young, head of the department of economics at Cornell University; Charles H. Haskins, dean of the graduate school of Harvard University, specialist on Alsace-Lorraine and Belgium; Clive Day, head of the economics department of Yale, specialist on the Balkans; W. E. Lunt, professor of history, Haverford College, specialist on northern Italy; R. H. Lord, professor of history at Harvard, specialist on Russia and Poland; Charles Seymour, professor of history at Yale, specialist on Austria-Hungary; W. L. Westermann, professor of history at the University of Wisconsin, specialist on Turkey; G. L. Beer, formerly of Columbia University, specialist on colonial history; Cartographer Mark Jefferson, professor of geography, Michigan State Normal College; Roland B. Dixon, professor of ethnography at Harvard.

In addition there are eleven assistants and four commissioned officers of the Military Intelligence Division assigned to the inquiry for special problems on strategy, economics and ethnography. These officers are: Major D. W. Johnson, Columbia University; Major Lawrence Martin, University of Wisconsin; Captain W. C. Farabee, the University Museum, Philadelphia; Captain Stanley Hornbeck, author of "Contemporary Politics in the Far East." The above named, together with map-makers and other assistants, sailed with the Peace Commission on the *George Washington*.

Base Hospital in France sheltered by Oaks.

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EVACUATION HOSPITAL IN FRANCE.

USE OF THE METRIC SYSTEM IN THE UNITED STATES

MORE extensive use of the metric system in the trade and commerce of the United States is recommended in a resolution adopted by the United States section of the International High Commission, of which Secretary McAdoo is chairman.

The commission has regarded this subject as of particular importance in the United States. It is, of course, unnecessary for the United States section to recommend to the Latin-American sections of the commission anything in connection with the metric system, which is exclusively in use throughout Latin

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BASE HOSPITAL IN FRANCE.

America. One of the main obstacles to documentary uniformity as between the United States and Latin America is to be found in the fact that the United States does not make the use of the metric system obligatory, and consequently its consular documents have to allow the use of that system merely as optional. Any uniform system of classifying merchandise, however, will require on the part of the United States thoroughgoing and complete adherence to the metric system.

Of more importance than statistical and administrative questions is the use of the metric system in trade. Now that the United States is obviously being drawn into closer and more vital commercial relations by the rest of the world, and particularly with Latin-America, our manufacturers and exporters will be obliged to meet the demands of their prospective customers in a somewhat more accommodating frame of mind than hitherto. Only the English-speaking nations still have to adopt the metric system of weights and measures, and among them the British Empire, or at least Great Britain, seems to be giving serious consideration to the necessity of making a change. Those who read the Commerce Reports of the United States Department of Commerce know how numerous are the opportunities necessarily allowed to pass by because of our inability to supply goods and machinery constructed in accordance with the metric system. The subject has now assumed a most practical character in the minds of those who are planning for post-war trade expansion.

SCIENTIFIC ITEMS

We record with regret the death of George F. Atkinson, head of the department of botany at Cornell University; of Volney M. Spalding, formerly professor of botany in the University of Michigan; of Sir Henry Thompson, professor of physiology and later of medicine at Dublin, and of H. E. J. G. du Bois, professor of physics at Utrecht.

An Inter-Allied Scientific Conference has met in London under the auspices of the Royal Society, and in Paris under the auspices of the Academy of Sciences, to consider international cooperation in science. The American delegates are: Dr. H. A. Bumstead, Colonel J. J. Carty, Professor W. F. Durand, Dr. Simon Flexner, Dr. George E. Hale, and Professor A. A. Noyes.

The Swedish Academy has awarded the Noble prize for physics for the year 1917 to Professor C. G. Barkla, professor of natural philosophy in the University of Edinburgh, for his work on X-rays and secondary rays. The prize in physics for 1918 and that in chemistry for 1917 and 1918 have been reserved.—The Royal Society has awarded its Darwin medal to Professor Henry Fairfield Osborn, president of the American Museum of Natural History, in recognition of his research work in vertebrate morphology and paleontology. The Copley medal goes to Professor H. A. Lorentz, late professor of physics in the University of Leyden, For. Mem. R.S., for his researches in mathematical physics; the Davy medal to Professor F. S. Kipping, F.R.S., professor of chemistry, University College, Nottingham, for his studies in the camphor group and among the organic derivatives of nitrogen and silicon; and a Royal medal to Professor F. G. Hopkins, F.R.S., professor of bio-chemistry in the University of Cambridge, for his researches in chemical physiology.

THE SCIENTIFIC MONTHLY

FEBRUARY, 1919

SCIENCE AND THE AFTER-WAR PERIOD[1]

By Dr. GEORGE K. BURGESS

BUREAU OF STANDARDS

SOMEWHAT more than a year ago it was my privilege to address the Philosophical Society of Washington on the subject, "Science and Warfare in France,"[2] in which I endeavored to indicate in some small measure the rôle science was playing in the war we all hope has just been brought to a close.

At this time may we not consider the transition period into which we are entering and ask ourselves what will be the effect of war on science, the men of science, and in the relations of science to the community and the state? What are some of the lessons this war has taught? And what plans have been made here and elsewhere to apply them?

A scientific man would hardly be so rash as to pose as a prophet, yet he may nevertheless try and assemble and pass in review some of the tendencies of the time; and it is only by an intelligent examination of the underlying changes which are being produced in science and in its relation to society that he is enabled to see his way ahead a little more clearly into the mist of the future; and he may thereby be enabled, at least in some small degree, to chart his course and take advantage of the various currents that have been set in motion by the war.

The question may here be asked, can we not see from previous wars what this war will bring forth, or at least the broad lines along which progress will be made, in science and in its relation to mankind? But with what previous war shall we compare this? Surely not with the short Franco-German war of 1870 in which but two nations were engaged; and if with the world-wide wars of the French revolution and Napoleon

[1] Address of the President of the Philosophical Society of Washington, January 4, 1919.

[2] SCIENTIFIC MONTHLY, October, 1917.

we have a duration of twenty-five years as compared with four; and if any war prior to that epoch is considered the development of science was hardly in a state to form a basis of comparison.

Again you may be asked, does war, did this war, stimulate scientific progress? Viewing the wealth of application of science in modern warfare, you will probably unhesitatingly say "Yes," but if you undertake to make a list of fundamental, new scientific principles developed as a war reaction I believe you will be embarrassed to name even a few of them, although there have been, of course, hundreds, nay, thousands, of applications of known scientific principles to new uses. It is still too soon, however, to estimate the scientific advance during the war and as caused by the war and such, even though I were competent, is not my purpose here. It will evidently be impossible to treat adequately the subject of "Science and the After-War Period" except in a most summary manner and I shall have to limit myself to certain phases in which I have been interested, paying particular attention to the physical sciences and the relation of science to industry.

What is the effect of the war on scientific production, is not an easy question to answer. Many men have been killed, including a few who are scientific producers, and many more young men who might have become distinguished in science; furthermore, not a few scientific centers have been destroyed. Thus viewed, there would appear to be a net loss to science in the world, but at the same time there have been stimulated to greater endeavor a considerable number of men of scientific ability and many new laboratories established. I believe that, for the United States, the effect of the war will not be detrimental to scientific production, as our losses in young men of scientific attainments have been relatively insignificant, and also I firmly trust the country has in part learned the lesson of the advantage to the nation of generously supporting research.

For a country such as France, which has borne the brunt of the fighting for four years, and not until after the first battle of the Marne was any effort made to conserve her scientific men, the matter appears to be much more serious; but who dares to predict that the United States, with nearly three times her population, will lead France as a producer of original ideas in science a generation hence? It is well to remember that many of the master minds in science of the nineteenth century were born during the Napoleonic wars, and that it is quality and not quantity that counts in scientific progress.

Finally one may ask, is the after-war period to be one of great scientific activity or one of relative quiet, and what will be the lines along which development will take place? This brings us to a consideration of the nature and permanence of war activities in science. Never before have science and scientific men been used to such an extent, both relatively and absolutely, as the servants of war both in the military establishments proper and in the not less important industrial supports. It is evident that what is beneficial in these relations should be maintained. In addition to the advancement in scientific knowledge, much of which is not yet generally available, brought into being by the war there has also been worked out for war purposes, in a more or less satisfactory way, schemes of cooperation of scientific men with each other, with the state, with industry and with the military. Some of these are transitory in character, others are serviceable for both peace and war, and some have been devised especially for the after-war period.

One might perhaps expect a certain relaxation of effort, even among scientific workers, following the strenuous efforts of the war, but one must not forget the natural zest of the scientific man to get back to his chosen field, which he will want to cultivate in his own way and not under the more or less arbitrarily imposed conditions of military requirements. Although much of the scientific work of the war has been done individually, probably by far the greater part has been by collective efforts of groups of workers usually under the guidance of some responsible committee or executive. Although this is no new phenomenon in scientific research, yet this cooperative method of attacking difficult problems has been, under the stress of war, developed to a hitherto unheard of degree. It is probable that the naturally individualistic traits of scientific men will tend to cause a lessening of this type of common endeavor, although in the distribution of investigation. between groups or individuals, there will probably be a greater number of groups than before the war, the habit of working together having been fostered, and its advantages appreciated in certain cases. For scientific research carried out in the interest of industry, this group method will very likely be greatly developed.

One of the fundamental factors of the greatest economic importance, which the exigencies of the war have brought repeatedly to the fore both in battle and in workshop, is what one might almost call the crusade of standardization. This has taken on innumerable aspects and has constantly been recurring in conservation programs, economic production, and in the elimination of waste, time, materials and men. The savings that may be accomplished by the scientific application of what we may call the principles of standardization in production, manufacture and distribution of many, if not most, of the more usual commodities of commerce and industry is so great that I believe that it is not an exaggeration to say that by this means alone our national debt could soon be paid off both interest and principal. An indication of what can be done along this line has been ably demonstrated in our own country by the War Industries Board and in particular its Conservation Division working in cooperation with the various industries.

This cooperation between government and industry has been made most effective by the enforced revival of the guild organization in industry; the fact that an industry has been represented successfully as a whole during the war by an elected committee in treating with the government and among themselves on matters of common interest, is charged with great possibilities for like action along voluntary lines during peace times. Although of course many of the questions thus treated may be considered as outside the realms of science, nevertheless the scientific men can not be separated from this development which, it is most urgently desired, may be continued, although along less arbitrary lines than were necessary in time of war.

A closely related matter is that of preparing satisfactory specifications for materials and manufactured articles. Washington might almost have been called a specification factory during the past eighteen months. This is economically one of the most important of subjects, and too great emphasis can not be given to the desirability, not merely for materials of military interest, but for all uses, of being able to define adequately and sufficiently—not too loosely nor yet too rigorously—the materials and articles that form the basis for practically all purchases. There has been and still is in many fields great confusion, uncertainty and differences of opinion as to facts, and most of this is, in the last analysis, a direct result of ignorance of the scientific data regarding properties and materials on which the specifications are based. The nation has undoubtedly suffered untold losses on account of this ignorance, and endeavors should be made on a sufficiently comprehensive scale to eliminate as much as possible the waste arising from this cause.

Innumerable instances could be cited of the harmful and costly effects of too rigid specifications and of course we all know some of the dangers of too loosely drawn specifications. I will cite two of the former in my own field of metallurgy—a foreign government had a limitation, dating some thirty years back, of 0.05 per cent. copper in a certain grade of munition steel being made here. All the steel made from certain ores in this country necessarily carried four or five times the stipulated copper. Although at first insisting on the rejecting of the steel, the government in question finally accepted it after overwhelming evidence was submitted showing that ten times the amount of copper was not detrimental merely but of actual advantage in this steel. This single contract involved several millions of dollars; the total cost of all the experimental work ever done the world over on the effect of copper on steel would be at most a few thousands.

The second illustration is given by another government which desired to purchase steel here for aircraft parts with a phosphorus and sulphur content together of less than 0.03 per cent. They could buy no steel, and if they had been able to place an order it would have been at an exorbitant price. The fact that all the other allied countries were using a much less rigid specification with safety finally convinced them that theirs was too severe. Incidentally this latter case shows the evident advantages of interchange of ideas and experience in such matters.

Not a little of the delays in production of many materials for war purposes was due to the multiplicity of specifications insisted upon by the various independent purchasing departments of the government. Some progress is being made toward unity in standardization and specifications in the War Department and it is highly desirable that there be constituted a central body with authority for all departments. A single board, for example, to frame metal specifications for all would make for economy and efficiency.

That the technical public is now ready for such simplification and uniformity is evident by the recent creation, somewhat on the British model, of the Engineering Standards Committee. The Germans are also said to be forming a similar organization and the French and Italian governments have organized standards committees. It is to be hoped that this is one of the after-war activities to be pushed. It is not too much to say we have entered an era of standardization. It is not necessary before a group of scientific men, however it may be elsewhere, to state that standardization necessarily involves research, often very elaborate and costly.

The relation of science to industry has been a fruitful subject for discussion in recent years, both here and abroad, and nowhere has the question of industrial research, as it is often called, been cultivated more intensively and made more progress as a direct result of the war than in Great Britain; and it may be of interest to mention briefly some of the steps in the progress.

Following the economic congress of the Allied Nations at Paris, there was formed in July, 1916, a committee presided over by Lord Burleigh on commercial and industrial policy after the war and the reports emanating from this body and its auxilaries cover the whole field of the economic aspects—industrial, commercial, technical and scientific—of the after-war period, and lay particular emphasis, for example, on the protection and development of "key" or "pivotal" industries, most of them requiring the highest grade of scientific and technical skill for their maintenance and advancement, such as sympathetic drugs, optical glass, chemical glassware and porcelain, dye stuffs, magnetoes, high explosives, etc.

It is of interest to note in passing that the questions of decimal coinage and the compulsory use of the metric system of weights and measures were also considered and their adoption not advised. The arguments advanced for this conservative stand, if valid, are of a nature that would seem to make it difficult ever to make the metric system universal. A transition period like the present has precedent for the establishment of such a simplification of units and standards; for the metric system originated during the French Revolution and the International Bureau was founded at the time of the war of 1870.

There has since been established in England a Ministry of Reconstruction to deal with the numerous problems the transition period presents. A Department of Scientific and Industrial Research with a Parliamentary Secretary has also been created and has been active for nearly two years: (1) Encouraging firms in well-established industries to undertake cooperative study of the scientific problems affecting their processes and raw materials, and has at its disposal a sum of one million pounds for grants on the basis of an equal subscription from industry; (2) the department has further prepared to undertake at the public cost investigations of general interest; (3) the importance to industries of the establishment of standards of a scientific basis is recognized and the financial control of the National Physical Laboratory has been taken over, with provisions for pensioning the staff; (4) efforts are being made to increase the numbers of trained research workers which had reached a dangerously low ebb in 1915, as recognized by Lord Burleigh's committee, who found but forty qualified unattached persons available for research in the United Kingdom.

Very substantial results have already been achieved in these several fields and hardly a copy of *Nature* can now appear which does not record some new grant, technical committee, industrial research association or other advance in the interdependence of science and industry under governmental supervision. It is also especially significant to note that some of the industries are also standing on their own feet and establishing their own research laboratories along cooperative lines.

There is also the recently founded British Science Guild with a distinguished membership, which maintains lectureships and does much to foster the dissemination of the aims of research among the public.

This spirit of organized research has been contagious throughout the British Empire and there are being established similar associations, institutes and laboratories in Canada, Australia, South Africa and elsewhere.

Rather curiously enough in the democratic British communities, it is the government that appears to be taking the lead in the stimulation of scientific research, particularly in its relation to industry. It is probable that the reasons for governmental initiative are in part a result of the abnormal conditions of the nation at war, during which time individual efforts are much more difficult of effective expression—the community in the time of danger is thinking and acting as a unit under military stress and military methods predominate. As normal times return we may expect the state to relax its vigilance and the individual person, society or industry to reassert to a greater degree their qualities of initiative and independence. It is not improbable, however, that there is a genuine, conscious effort for the more generous support of research by the British public as a national asset, which support will be maintained in peace times on a much more extensive scale than in pre-war times.

Another incident significant of the trend of the times is the formation in October last of The British National Union for Scientific Workers with five hundred members, whose main objects, most worthy of repeating here, are: (1) to advance the interest of science as an essential element of the national life, (2) to regulate the conditions of employment of persons of adequate scientific training and knowledge, (3) to secure in the interests of national efficiency that all scientific and technical departments in the public service, and all industrial posts involving scientific knowledge, shall be under the direct control of persons having adequate scientific training and knowledge.

The question that every scientific man in America naturally and perhaps unconsciously asks himself on hearing of such an organization is, of course, why not form such a union here? Indeed, the matter has been discussed in some centers and it would probably not be difficult to organize in the United States a similar union of scientific workers. Bodies somewhat similar already exist among various educational and professional groups. It should be borne in mind, however, in considering this matter that in addition to the general objects stated above, the scientific workers of England were almost compelled to organize in order to have representation on the so-called Whitley Industrial Councils, having to do with matters affecting labor and management relations in industry, and one of the creations of the reconstruction program.

Forming what is perhaps the natural corollary to the foregoing, there has been some serious discussion in Britain of the desirability of having representatives of science as such in Parliament; certain of the universities have had representation for a long time, but it is doubtful if the matter of representatives of science is pushed seriously. If science, why not literature, the arts and so on?

While we are considering the question of the scientific man himself, there is one phase of his relation to science and to industry that I can not pass by, which will need perhaps even more serious consideration in this transition period than it has had in the past. I refer to the bidding for his services by technical industries. A man who leaves the university or professional school and enters the research department of an industrial concern is not the man I mean. Is not the case different for a man who has chosen his career of scientific investigation in a university or other scientific institution independent of or under state control? This man, if taken from his environment by offers of financial gain, goes to enrich most certainly some special interest with his science and is still a valuable member of the community; but generally speaking, is it not of advantage to the community to keep that man contented in his, what I am tempted to call, more natural environment? Natural, for he chose it and adapted himself to it. When the staff of an institution like the Geophysical Laboratory, to cite a most striking example, is largely absorbed by industry, does not the matter become of serious concern? Should not the industries rather be encouraged to take their scientific men when they are young and not break up growing scientific concerns? No doubt a certain amount of interchange in scientific personnel is to be encouraged, but it should be interchange and not bleeding practised by industry. Providing an adequate supply of scientifically trained men for the needs of industry and defining the proper relations between industrial management and scientific centers are questions meriting the most serious concern of the community. Our supply of scientifically and technically trained men is all too meager and if, as many expect, there is now to be a period of expansion in the foreign trade of the United States involving possibly the establishment abroad of numerous branches of highly technical industries, the demand for such men will become more urgent than ever, particularly with men of scientific training with engineering experience.

This brings us to the question of the education of scientific men, which subject it is possible to mention but briefly. Here again the interruption, disorganization and readjustment of educational training in America have been insignificant as compared with the disturbances in education brought about by the necessities of war of the European countries, but even in this country experiments with intensive training and shortened courses have been tried on a large scale, but, it must be borne in mind, for a limited period only. Our educational institutions will undoubtedly be able to preserve some of the beneficial characteristics brought out by such speeding up, but for the most part there probably will be little effect on the kind of training our scientific men will get.

It would appear to be highly desirable that as large a proportion as heretofore of our scientific men pass a portion of their preparative period abroad amid cultural surroundings different from those in which they grew up. As a beginning it is to be hoped that many of our young men now in France will be given the opportunity to take advantage of the generous offer of the French Government for instruction in the schools and universities of France. This, if carried out on a considerable scale, will have far-reaching effects, the benefits of which can hardly be overestimated. It is also to be hoped our universities will not only encourage the coming of foreigners more than heretofore, but also render easier the migration of American students from one American institution to another. The establishment in Washington of schools framed on lines similar to the Ecole des Hautes Etudes and the Collège de France, which are devoted exclusively to research, would go far toward making more generally available the research facilities and scientific men of the capital.

During the war the scientific men of the country have been thrown into close association with each other, perhaps even closer in many instances than in pre-war times in spite of the decrease of attendance at scientific meetings and in the number of such meetings; in addition, there has been developed, as never before, acquaintance and cooperation of the men of science of this and the allied countries; and not only the men of one science have been thrown together but representatives of what we ordinarily consider very diverse sciences have been brought into close personal and professional contact. All this makes for the unity of science and the broadening of scientific men. It would seem desirable to make an effort to perpetuate this habit of association of scientific men from different countries. You will recall that in 1914 there were projected several international congresses in science and engineering. Would it not be well, as soon as circumstances permit, at least to revive these projected congresses with such limitations as comply with the conclusions reached recently in London by representatives of the national academies of the Inter-Allied Nations?

A very important matter that has been held generally in abeyance by the war and which will soon again require the serious attention of scientific gatherings is that of the policies regarding scientific publications. Very definite proposals have been discussed recently in England looking particularly to the avoidance of duplication, confusion and other anomalies in scientific literature and to its more effective distribution. This question again is a variant of the standardization problem and is further complicated by interests or prejudices, both national and professional, of numerous societies representing often if not competing, yet overlapping fields of science. For any particular branch of science, there are also the international aspects to be considered, including the question of language; and it is within the bounds of possibility, for example, that there will occur a revival of the more concerted efforts for the use of an auxiliary international language such as Esperanto, or if you will a standardized, international form of expression in science.

If I have dwelt with less emphasis on some of the recent, strictly American tendencies of scientific development, I trust it fair to assume you are acquainted with most of them. The great work of the National Research Council is certainly familiar to us all and it is good news to hear that plans are being developed toward reorganizing the Council to meet the conditions of the reconstruction period. There is great need in the United States, with our relative geographical isolation and great distances between many scientific centers, for an active, scientific body devoted to the initiation, stimulation and correlation of scientific research.

Furthermore, by emphasizing the recent British developments in the relations of state, industry and science, I by no means desire to imply that we have not been active in America. These matters are being freely discussed here and many plans are being formulated and some are in operation, for cooperative research in various branches of science, particularly as applied to industry. The weekly and monthly scientific press are full of them. It is to be noted that in contrast with the British experience, in America less expectation is being placed on governmental aid to new research projects; an exception to this is of course the Smith-Howard bill now before Congress for promoting engineering research in the several states.

In America, individual initiative in the past has on the whole been more potent than the state in providing the funds for maintaining research. In the prosecution of the war now drawing to a close, however, the federal government has spent huge sums on projects requiring scientific investigation and development, and in order to carry out the scientific projects of military urgency, has mobilized the scientific men of the country. Is it well during the after-war period to demobilize completely this army of scientific men? No one would yet think of having no organized military force in peace time, and there is in every well-organized state always at least a skeleton army with all branches represented, including a competent staff, arsenals, depots, surplus munitions and supplies.

The great scientific bureaus of the government are organized for the problems of peace and, although they can give a good account of themselves under war conditions, yet would it not be well, at least until the millennium is more clearly in sight, to retain more than a nucleus of an organization of scientific men in the service of the state and especially in the military and naval establishments? We can all name branch after branch of each of these services which before the war contained almost no scientific personnel but to which have been added during the war scores and hundreds of scientific men; and in some cases it was no easy matter to gather and coordinate this personnel.

What, therefore, appears to me as one of the very important problems of the transition period, namely, the proper balancing and distribution of the scientific forces of the country as between the military and civilian activities of the state on the one hand, and the industrial and academic activities of the country on the other, is even now undergoing the process of being solved. The readjustment will go on largely unperceived at the moment and the changes will be accompanied by the usual quiet but significant struggles. The more rapidly the world settles down to more stable conditions, the more promptly shall we reach this dynamic equilibrium of the distribution of scientific men and the balancing of competing fields in scientific research.

ENTOMOLOGY AND THE WAR

By Dr. L. O. HOWARD

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RATHER frequently during the past eighteen months, meeting friends, they have said, by way of casual conversation, "I imagine that the war does not affect your work especially." They did not stop to think of the very great importance of insects in the carriage of certain diseases, the ease and frequency of such transfer becoming intensified wherever great bodies of men are brought together, as in great construction projects, and especially in great armies. They did not realize, entirely aside from the especial diseases of this character met with by the troops in Africa, Mesopotamia and in the region of Salonika, that even upon the western front, in a good temperate climate, warfare under trench conditions was rendered much more difficult by reason of the prevalence of trench fever which investigations during the latter part of the war showed to be carried by the body-louse.

Moreover, with the same lack of thought which leads people to ignore the importance of the officers of the Quartermaster's Department as compared with those of the fighting arms of the service, they failed to consider, not only how damage by insects to growing crops influences the food supply of armies, but also how greatly grains and other foods stored for shipment to the front or on the way to the front may be reduced in bulk by the work of the different grain weevils and other insects affecting stored foods. In addition, they did not think of the damage done by insects to the timber which enters into the building of ships, into the manufacture of wings for the airplanes, and that which is used for oars, the handles of picks and spades, and which even occurs in such wooden structures and implements after they have been made—in the implements, not when in actual use, but rather in the period of storage and shipping. A striking example of this latter damage is seen in the history of the Crimean War, when England, after a long period of peace, provided the army which she sent to the Crimea with long-stored tools for the sappers and miners, and it was found that the handles crumbled through the work of *Lyctus* beetles.

As a matter of fact, war conditions have intensified the work of the entomologists and have enabled them to make the importance of their researches felt almost as never before.

Long before this country entered the war, the warring European nations had met with many of these problems in force. We know of the early ravages of typhus in the Balkans; we know of the loss through other insect-borne diseases in the eastern expeditions; and it is most interesting to realize that, although the need for the services of trained entomologists with the troops was not realized at first, later every sanitary unit in the British Expeditionary Forces carried two entomologists. Few people know that as early as 1915 there was a conference of all the principal official entomologists of Russia to consider the vital question of the loss to stored grains by weevils. Later this same matter was taken up by the British government, and her best economic entomologist was sent out to Australia to endeavor to safeguard Australian wheat accumulating at the seaports for shipment to San Francisco, to be milled in this country to replace the milled grain which this country had sent to England (this route of shipment being chosen to avoid the long sea haul from Australia to England with possible added weevil damage during the journey, to say nothing of submarine dangers).

The story of the early efforts of the European governments to control the body-lice which carry typhus, and, as found out later, trench fever, is interesting. Shipley in England published early papers and a book entitled "The Minor Horrors of War," in which everything that was known up to that time about lice was mentioned. In France, Houlbert published a pamphlet covering the same ground, and the women of France made an enormous number of camphor sachets for the troops to carry next their skin in order to deter lice. In Germany, Haase, stationing himself near a camp of Russian prisoners where living material was, to say the least, abundant, made, with that infinite attention to detail characteristic of the Germans, a careful study of the body-louse, and published a sizable book giving the results of his investigations. Attention to important details is admirable, but when a writer devotes several illustrations and a minute description to the method by which a louse, accidentally finding itself on its back, resumes its normal position with the back upwards, as Haase did, the practical reader is inclined to smile.

Later, however, much practical work was done by all these nations. Delousing stations were established; an admirable investigation of all aspects of the subject was carried on by Nuttall at the Quick Laboratories in Cambridge, England, and conditions were much improved before the United States troops began to mass and to be shipped across the Atlantic.

As will be remembered, one of the earliest matters taken up by the Congress of the United States after the declaration of war in April, 1917, was the consideration of appropriations for the stimulation of crop production, and in this consideration, naturally, one of the points was the control of the principal insect enemies of staple crops. Prior to any congressional action, however, the Bureau of Entomology started a country-wide reporting service on the conditions concerning these principal insect enemies, and engaged in excellent cooperation, not only all of the state entomologists, the entomologists of all of the agricultural experiment stations and the teachers of entomology in the colleges, but also the demonstration agents, the statistical agents, both state and federal, the weather observers, and the field men of the Forest Service. The idea was to bring about as far as possible almost a census of insect damage and prospects, so that the earliest possible information should be gained as to any alarming increase in numbers of any given pest and that this information should be received at a common point (Washington) and distributed where it should be of the most good, and that it would enable repressive measures to be undertaken at the earliest possible moment in order to check the threatened loss. All reports received in this way were digested and were distributed all through the growing seasons of 1917 and 1918 to the official entomologists of the country.

Soon after this service was instituted, the funds for food crop stimulation became available, and trained men were employed for demonstration work, to act in connection with the Extension Service of the Department and of the different state colleges of agriculture. These men were assigned to different localities, and took care of the demonstration work against the principal pests of staple crops all over the United States. Some of them were specialists in the insects which attack truck crops; others in those which damage field crops; others in those which affect orchards, and so on. Especial attention was given to the control of the grasshoppers which damage grain and forage crops and to the sweet-potato weevil, an insect which bids fair to seriously affect the output of the South of this important vegetable.

Aided, it is true, to a considerable extent by the winter of 1917–1918, which from its unprecedented cold had a destructive effect upon many important insect pests, and to a lesser extent by the character of the winter of 1916–1917, which also was a hard one for injurious insects, the economic entomologists, including the demonstrators, accomplished much. Owing to peculiar weather conditions in the early spring of 1917, certain insects not hitherto notably conspicuous appeared in great abundance and added new problems to the production of certain crops. A notable example of such insects was the potato aphis, a species which previously had done almost no damage, but which appeared in countless numbers throughout certain of the middle western states in the early summer of that year. Notable work was done with the destruction of grasshoppers by the poisoned bait method, and it is safe to say that many hundreds of thousands of dollars, perhaps millions of dollars, worth of food crops were saved in this unusually intensive work. A single instance among many may be given in more detail.

In the State of Kansas the season of 1918 was remarkable for one of the worst grasshopper outbreaks that have occurred in that state since 1913. The danger of this outbreak was recognized during the fall of 1917, and a grasshopper-egg survey was instituted in cooperation between the State Agricultural College and the Bureau of Entomology. The results of this survey showed that without doubt a great hatching of grasshoppers was imminent, and extensive cooperative plans were immediately made. Winter meetings were held throughout many of the counties in the western one third of the state, and the farmers were organized and plans matured for the purpose of purchasing bran in large quantities, and then prompt distribution of poison was made as soon as the grasshoppers began to hatch. In eight counties of the state 36,000 pounds of white arsenic in 366 tons of wheat bran were used in the preparation of poison bait, which was distributed in an amount exceeding 900 tons. The counties cooperated in most cases financially. As a result of this general application of the bait, it appears that some 113,000 acres of wheat were saved from destruction. Estimating fourteen bushels per acre, which is considered a full crop in western Kansas, with wheat at two dollars per bushel, this represents a value of approximately $3,000,000 saved in Kansas. This figure is considered conservative, according to the officials of the State Agricultural College.

In addition to the control work on grasshoppers affecting wheat fields, it is estimated that 25,000 pounds of poison bait was used throughout Kansas for the purpose of protecting alfalfa and sugar beets, and it is estimated that 100,000 acres of alfalfa in western Kansas was saved by this application. With alfalfa selling at $20 per ton, this represented $2,500,000.

It should be mentioned incidentally that all this control work bids fair to be greatly hampered by the derangement of the insecticide situation in this country, due to war activities. Not only was the importation of arsenicals stopped, but their production was greatly limited by the fact that the smelters, from which arsenical compounds are gained as byproducts, were so rushed in the production of urgently needed metal that by-product industries were largely stopped, and by the further fact that more than a third of the actual production under these limitations was, toward the end, used by the Chemical Warfare Service. Nevertheless, the entomologists and the chemists and the insecticide manufacturers held frequent conferences as to how best to utilize the reduced quantity of arsenical insecticides to insure the protection of crops to the greatest extent possible, and it resulted that, although the amount of arsenic available was really insufficient to meet normal demands, yet by conservative use and better distribution the requirements of the farmers, fruit-growers, gardeners and others were met.

There might be mentioned also another side activity entirely due to war conditions. The extensive use of castor oil in airplane work made it necessary to grow the castor bean plant in great acreage in this country, since practically none was to be had elsewhere, the large Mexican crop having been bought up and sent to Spain, probably to secret German bases. Therefore, under government contract, thousands of acres of this crop were planted in Florida and elsewhere. Now, although the castor-bean plant had not hitherto been known to be subject to serious insect attack, the planting of these large areas was immediately followed by the increase of certain injurious insects and by serious damage to the growing plants by the southern army worm and other species. Entomologists were at once called in, and through rapid and able work much of the threatened damage was prevented.

In the meantime the entomologists were able to be of service to the country, and especially to the military forces, in other ways. The damage to stored grain and to grain in shipment, which has been previously referred to, soon came to the front. Enormous quantities of grain and other materials were accumulated at the port of New York for shipment to Europe. The immense warehouses at the Bush Terminal in Brooklyn were centers of accumulation of such material. The Bureau of Entomology was called upon for advice by the War Department, and a laboratory was stationed at this terminal where men experienced in the study of insect pests of this character were stationed, where competent inspection was made, and where arrangements were made for the proper fumigation or other treatment of stored products found to be infested with insects.

In addition to this work at the Bush Terminal in Brooklyn, experts on the Pacific Coast and in the South were engaged in the inspection of many warehouses and mills where food supplies were stored, and throughout the entire period large supplies of food that were being seriously affected by insects were located. The owners of such supplies were advised of the necessity of prompt action in order to avoid further losses, and were shown how to prevent losses of newly acquired supplies that were free from insects.

The same sort of work was done in regard to insects affecting lumber and stored wooden implements. Early in 1917 a conference was held with representatives of the branches of the War and Navy Departments, Shipping Board, etc., which were responsible for the supplies drawn from the forest resources of the country. The object of this conference was to offer the services of the entomologists and to explain how they could help, through special investigations and advice, towards preventing serious losses of forest resources and damage by wood- and bark-boring beetles. Investigations of logging and manufacturing operations in Mississippi to meet the demand for ash oars, handles and other supplies required by the war service showed, for example, that one company had lost more than one million feet of ash logs through failure to provide for prompt utilization after the trees were cut, thus preventing the attack of the destructive ash-wood borers. Serious losses to seasoned ash and other hard wood sap material from "powder post," it was pointed out, could be prevented through the adoption of certain methods of management by the manufacturers and shippers with little or no additional cost.

The urgent demand for spruce for the construction of airplanes led to an exceptional effort by the Spruce Production Board to utilize the great resources represented by the Sitka spruce of the Pacific Coast. It was soon realized that damage by wood-boring insects to the logs was a serious matter and that the advice of the expert entomologist was essential to prevent losses of the best material.

The problem was investigated by the entomologists and it was found that the prevention of the damage and loss was a matter of methods of management in the logging operations and prompt utilization during a short period in the year when the insects were abundant.

Early in the war and especially after the United States issued its declaration, the shortage of sugar made necessary an increase in the supply of supplemental sweets, and, since none of these could be increased more economically and more promptly than honey, and since none of them have a higher value as food than honey, great efforts were made by the bee experts of the Bureau of Entomology to increase the honey production of the country. It was known that there was nectar available annually to provide for a profitable increase of ten or more times the then present honey crop, provided beekeepers were instructed in matters like proper wintering and disease control. So all apicultural investigational work, except that on bee diseases, was discontinued, and intensive extension work was begun. Specialists were sent out, held meetings, addressed more than 25,000 beekeepers, visited the apiaries, and gave personal instruction, with the result that the honey crop was greatly increased. Our exports of honey to allied countries have increased at least ten times over those of any period previous to the war, and in the meantime the domestic consumption of honey has greatly increased.

Returning once more to the important subject of medical entomology: During the period of the war the Bureau of Entomology has maintained a thorough cooperation with the Office of the Surgeon General of the Army in the matter of experimental work on insect problems. Under the National Research Council's Committee on Medicine, a sub-committee on medical entomology was established, of which the Chief of the Bureau of Entomology was made chairman, and Doctor Riley, of the University of Minnesota, and Doctor Brues, of the Bussey Institution of Harvard University, were the other members. Important work on the louse question was done by Doctors Moore and Hirschfelder, of the University of Minnesota, the former an entomologist and the latter a chemist, and by Doctor Lamson, of the Connecticut Agricultural College. Under this committee an enormous amount of experimental work was done with the different health problems in which insects are concerned.

For example, every suggestion that came to the War Department in regard to the control of the body-louse was referred to the entomological committee, or to the Bureau of Entomology, and those which were promising were experimentally tested, either at Washington or at Minneapolis, or, for a time, at New Orleans, where a branch laboratory was instituted. At the request of the Army War College and the medical department, as well as the chemical warfare service, tests were made of a new poisonous gas. This led to extensive experiments in cooperation with the chemical warfare service leading to the possible utilization of the gases used in warfare as fumigants for the control of insects and diseases. At the request of the Quartermaster's Corps a complete investigation was made of all of the processes of the American process of laundering adopted by the Army, and also of the dry-cleaning processes and the hat-repair processes. In these investigations the cooperation of the entomologists of the Bureau of Entomology with chemists of the Quartermaster's Corps resulted in the perfecting of the laundry processes so that it is now possible to guarantee the complete control of vermin in the laundry if the laundering is carried out according to the methods recommended, which are very slightly different from those in common use. It was found that the laundry machinery gave ample means for any sterilization of clothing necessary. In the investigations of the dry-cleaning processes it was found that the entire process gave complete control of vermin, but that gasoline treatment alone was not a perfect control. This discovery led to a long series of important studies of the effect of various densities of oils on insect eggs. At the request of the Chemical Warfare Service various substances and impregnated clothes devised for the protection of soldiers against gas were also tested as to their effects upon vermin. By a special request of the Electro-Therapeutic Branch of the Office of the Surgeon General of the Army, investigations were made of a high frequency generator as a control means against the body louse, and as a result of these investigations suggestion was made as to the possible application of high frequency electric treatment for the control of scabies and other skin-infecting parasites. Cooperative investigations along this line are about to be taken up.

Among other problems investigated were the size of the meshes in mosquito bar necessary for the protection of cantonment buildings from disease-carrying mosquitoes; reports on the insects likely to be found injurious to troops sent to Siberia; investigations of the protective qualities against lice of furs dyed in various colors, and so on.

A series of lectures dealing with important sanitary problems from the insect side were mimeographed and were sent to persons in the Army, Navy, Public Health Service, and in civil life who were preparing themselves for, or who were actively engaged in sanitary entomology.

Aside from this extensive cooperative research, entomologists were actually used in the Army, a number of them being given commissions while others acted as non-commissioned officers, assisting in the camp work on the control of insects that carry disease. The commissioning of expert entomologists for this kind of work was difficult, owing to the organization of the Army, but had the war continued, it is safe to say, more and more entomologists would have been employed in this important work, whether commissioned or not. The records made by a number of these men were admirable and met with well-merited praise in Army circles. In great concentration camps in several instances entomologists were placed in entire charge of matters of mosquito and fly control, under medical command or under sanitary engineers.

In addition to this cooperation with the Army itself, the Bureau of Entomology has also cooperated with the Public Health Service, which had the extremely important work in charge of the health control of areas immediately surrounding the concentration camps, and has held itself ready to assist in this work whenever called upon.

This statement of the work of the entomologists during the war might be extended very considerably. Many additional instances of the value of their labors might be detailed; but perhaps the impression which will be left by what has just been said will be quite as strong as if more facts were added and more time used.

Perhaps this is an opportunity, however, to call attention in a striking manner to the work which the economic entomologists are doing all the time. While all this other intensive work was going on, for example, the federal entomologists were making a great fight in Texas by which the pink bollworm has apparently been absolutely wiped out in the districts in the United States infested last year and at the same time there has developed a system by which damage done by the cotton boll weevil can economically be greatly reduced, which may be said to be the culmination of the work of many years.

Incidentally it may be mentioned that the preeminently practical men who have, under the state and federal governments, been working for years in this extremely practical and important field, had supposed that the value of their work was generally recognized and that they were known to be scientifically trained and competent investigators whose advice and help meant everything in the warfare against insect life. But they were surprised and chagrined to find that even in certain high official circles the old idea of the entomologist still held—that he was a man whose life was devoted to the differentiation of species by the examination of the number of spines on the legs and the number of spots on the wings. The economic entomologists are thus evidently still unappreciated. Shall they change the name of their profession to avoid the survival of the old association with trivial things, or shall they work steadily on with the ultimate hope of gaining the confidence and respect even of the old-fashioned element of the people?

THE NEXT STEP IN APPLIED SCIENCE

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IT was long ago that Plato taught that science should not be applied to the mechanical and industrial arts, but to education, social culture and social health. And a century and a half have passed since Rousseau's celebrated essay, in which he tried to show that the arts and sciences had done nothing to advance human happiness. From our modern view-point these were the pathetic mistakes of great men, so richly, as we think, has science vindicated itself in its practical applications.

Consequently, when the term "applied science" came into use not many years ago, it was heralded with great joy, for we were weary of Plato's theoretical ideas about justice and truth, and skeptical about his plan for racial culture, and we longed for something practical and immediate. We welcomed, therefore, the direct application of science to our every-day needs, and when, in response to this demand, science began to shower its practical applications upon us, it seemed to many that a kind of golden age had come at last. It revealed to us the only god worthy of our worship—the god of social welfare, social welfare being generally interpreted to mean the comfort, happiness and convenience of the present generation.

While we may not question the almost unlimited possibilities in the application of science to social welfare, nevertheless, we may raise the question whether science has thus far been applied to the right things. The war has shaken the foundations of so many of our accepted opinions that even our faith in applied science may receive a rude jolt. Since we are now entering upon a period of reconstruction, which many believe will involve not only our social and political ideals, but also our ethical and religious beliefs, it is legitimate enough to ask whether applied science has vindicated itself by its results and what place it is to occupy in the coming order.

Our first thought is that applied science has been not only a stupendous success, but perhaps the crowning achievement of the human mind. The story of its triumphs is known by heart to every school girl. Applied science has made the world over, making it a decent and healthful place to live in. We press a button and our houses are filled with light. Scientific heating, ventilation, drainage and sanitation have made our homes places of cheer, comfort and health. The motor car, smooth, noiseless and swift, saves our time and our nerves. Time-savers too are the typewriter, the dictograph, the multigraph and the adding machine. Communication is facilitated by the wireless telegraph, the telephone and the aerial mail.

It is needless to go through the familiar list. Lest, however, it should be thought that applied science has given us only comforts, conveniences and time-saving devices, we are reminded of its triumphs in the conquest of disease, in public sanitation, in surgery, dentistry and preventive medicine, and in the application of chemistry to agriculture. And, most manifest of all, are the countless applications of science to the industrial and mechanical arts, increasing the efficiency of labor, thereby shortening the hours of the laborer, as well as ministering to his comfort and health. Certainly applied science has made the world a tidy place to live in and contributed an untold sum to human happiness and welfare. Surely, had Rousseau lived in the twentieth century he would never have written, even for the sake of a brilliant paradox, an essay questioning the value of the arts and sciences to civilization.

We may not, indeed, question the potential value of applied science, nor even its actual value in countless directions. What we may question is whether there has been a mistaken conception of the general end to which science should be applied in respect to real social welfare. To what extent has science, as it has actually been applied, contributed to human good?

First, applied science has surrounded us with comforts, conveniences and luxuries of every kind. But just what will be the effect upon a race of men, disciplined through a hundred thousand years of hardship, of this sudden introduction to comfort? This question puts the whole subject of applied science in a new light. Perhaps we have been applying science to the wrong ends. Possibly science should never have been applied to making man comfortable, but to making him perfect. It may be that there is great danger in comfort. The biologist holds it in grave suspicion. Degeneracy is its sequel. It was through struggle and warfare and the overcoming of obstacles that man fought his way up to manhood. With infinite effort he gained an upright position the better to strike down his enemies. Strong legs and stout arms were the correlates of his growing brain, the latter itself finding its necessary support in a powerful heart and vigorous digestive system. There is an especially intimate connection and interdependence between the brain and the muscular system, making the latter indispensable to the proper functioning of the former. Now, applied science has shown us how machinery may take the place of the stout arms and the motor car may be a substitute for the strong legs, while science itself and the applications themselves draw more and more heavily upon the powers of the brain. The harder the brain has to work in the pursuit of science and the mechanic arts, the more it stands in need of the physiological support of the muscular, digestive and circulatory systems. But, for maintaining the health and integrity of these, our present manner of living is not well adapted.

"Oh, well," it is replied, "there are no signs of physical degeneration yet. Look at our armies. Finer physical specimens never marched out to meet an enemy." This is true and we may add—braver ones never went to war and they were 100 per cent. efficient. Yes, but they were picked men, the very flower of a vast nation. They were from the upper tenth physically. They were the young males. They were the 65 per cent. of the young males not rejected by the examining boards. The germ-plasm of the best of our race could not suffer deterioration in the short time of the "comfort" régime. But upon biological grounds we must believe that the disastrous consequences of such a régime upon society as a whole may be serious in the highest degree.

Another of the most brilliant triumphs of applied science is seen in our countless and wonderful labor-saving devices. The effect of these is either to decrease the amount of labor or by increasing its efficiency to increase the products of labor. But we simply *assume* that increased wealth and decreased labor are human blessings, although both may be quite the opposite. It has been seriously questioned whether civilized man has gained enough moral and physical poise to be trusted with the immense wealth which applied science, working upon our suddenly acquired store of coal and iron, has supplied. The war did not count the poverty of the nations among its causes, and if greed is the root of most modern evils, it has not been shown that increasing wealth and increasing comforts have lessened it.

Again, just why has it been assumed that *labor-saving* devices are a human benefit? Work, and indeed physical work, is a blessing, not a curse. During the past history of man, which we may reckon in hundreds of thousands of years, Nature has said to him, "You must work or die." Labor-saving devices, discovered at a recent moment in this vast history, may enable one half the members of society to live without work and reduce the working hours of the other half, with results most pleasing for the moment, but perhaps most disastrous in the end.

Is it not conceivable that applied science might be used not only to reduce the hours of labor of those who are now crushed with *excessive* labor, but to devise means of preventing the disastrous biological consequences which must follow the cessation from healthful labor among a considerable portion of society?

And then there are the time-saving devices. It is no doubt because of the temper of the day that so few of us have ever questioned their intrinsic value. But with all these time-saving devices it is not quite apparent that we have any more time than formerly. Sometimes it seems as if we have less. Leibniz lived before the time of typewriters and dictographs, yet he is said to have had a thousand correspondents and in addition to his duties as court librarian, diplomatist and historian, he found time to discover and perfect the differential calculus and to write great works on philosophy. In any case the value of time-saving devices will depend upon the use of the time that is saved. As it is, it appears to be used very largely for carrying on more business, to make more money, to buy or invent more time-saving devices. Even if there results a certain amount of leisure, much depends upon the manner in which the leisure is spent. If it is spent in sitting quiescent in a darkened moving-picture room, gazing spell-bound at a tawdry drama, the gain is not great.

In all our plans for improved economic and social conditions, it is uniformly taken for granted that leisure, resulting from a shortened working day or from time-saving devices, will be an unmixed good. Leisure in itself is not good; it may be dangerous. There have indeed been epochs in history when men, released from labor by wealth or otherwise, have turned their thoughts to beautifying their environment and surrounding themselves with works of art. At such times, too, poetry, music and the worthy drama have flourished. Is it quite certain that we are now living at a time when mankind can be trusted with leisure?

To all such arguments as the above it will be replied that modern science has nevertheless made the world a decent and comfortable place to live in and that there has never been so much happiness in the world as at present. But, for the last four years Europe has not been a decent nor comfortable place to live in nor has there been general happiness, although Germany excelled in its development of science and in the application of science to the mechanic arts. A good civilization must insure some degree of stability.

In this connection we are reminded that there is one field in which science has distinguished itself beyond all others, and that is in the art of war. To the exquisite perfecting of this art every science has been called upon to contribute its very best and latest results—mathematics, engineering, physics, chemistry, metallurgy, mechanics, optics, radio-activity, electro-dynamics, aeronautics, economics, zoology, psychology and many others. An immeasurable weight of the best and keenest thought of the world has been expended in the application of science to the paraphernalia of war, resulting in an amazing progress in the development of this art to the highest conceivable degree of perfection.

If in defence of this kind of application of science one should say that by this art civilization has been saved, it would only be because by this art it was threatened. Given an unscrupulous nation dreaming of world dominion and harassed by the need of commercial and industrial expansion, that nation would never have dared to venture on this ambitious project, had it not been for the fact that she found herself in possession of such an arsenal of cunning devices as to make success apparently certain—submarines and superdreadnaughts, mines and torpedoes, airplanes and monster dirigibles, titanic cannon and marvelous machine guns, secret formulæ for super-explosives, poison gases and liquid fires—these are some of the implements of war which applied science had put into her hands.

The results, whether one choose to regard them in terms of sorrowing homes, of outraged and degraded morals, of the loss of the best young blood of all the nations, of enslaving national debts, of the disorganization and ruin of world commerce and industries, or of the destruction of art treasures, are equally appalling.

If, as many believe, one of the prominent causes of the war was the urgent need which Germany felt for commercial and industrial expansion, we seem in this very fact to have an indictment of the mechanic and industrial arts, when viewed in the light of the leading motive in the social order. Nowhere else in the world had science been applied so extensively and successfully to the satisfaction of human wants as in that country. Yet these wants were not satisfied and Germany had to fall back on the age-old method of the exploitation of other nations. But we are evidently coming to the time when this method will not work. Perhaps it may be a long time before it will again be tried. Each nation must satisfy its own wants by peaceful means, and thus the question faces us whether any possible development of the mechanical and industrial arts, upon which we rely so fondly, will satisfy the desires of man.

In former times wars acted to purify racial stocks by eliminating weak races. Modern wars have precisely the opposite effect, owing to the fact that a modern war kills or disables the best young men of all the warring nations, and so, by destroying the most valuable germ-plasm of the race, causes irreparable damage to society. Applied science has devised every conceivable means to make the destruction complete. Would it not be well, therefore, in the years to come for science to apply itself directly to the problem of preventing wars? It is idle to say that they can not be prevented or that science has nothing to do with this problem. It lies distinctly within the field of such sciences as biology, psychology, sociology and education. For applied psychology it offers a most alluring field. It may be an immense problem but the possibilities of science are immense.

At present we are depending too largely upon political readjustments to prevent war. The strong arm of international law is to be invoked to repress any aspiring belligerent nation. This is no doubt well, and may put a check upon wars between nations, but the menace of civil war will be ever present. A great nation may be torn asunder by a dispute about slave labor or a quarrel over religious creeds; mere rivalries between families, clans and classes may cause the streets of great and beautiful cities to run with blood, or a whole nation may simply lapse into civil war as a result of the disintegration of outworn political institutions. Any of these causes seems less promising for war than the conflict of labor and capital which is facing us.

We have thus in the preventing of war a real problem for applied science, especially for applied psychology. Let us, by all means, make over our laws and our international relations to the end of preserving order, but let us direct our main endeavors to making over our men and citizens so that they will have sense enough to settle all their disputes and controversies in some more rational way than by blowing out each other's brains with high explosives or by dropping bombs from aeroplanes to destroy buildings that they have erected with infinite labor. Education will be efficient here, but it is an especially attractive field for applied psychology. The source of war is in the human brain, where the instincts of combat lie deeply imbedded, sanctioned through the warfare of thousands of years of human history. To eradicate these instincts may be difficult. To substitute some other form of expression for them may be possible. At any rate it would be worth while to turn in these directions a fraction of the brain power which has been expended in the invention and circumvention of the submarine boat or in the transmission of messages by means of the ether.

But it may be said, if applied science has not contributed as much to human welfare, as first appears, in the field of mechanic arts, nevertheless there are other fields in which its contributions are unquestioned, notably in hygiene, sanitation and agriculture.

The deep obligation which the world owes to applied science for its work in social and domestic hygiene, in applied bacteriology, in surgery, dentistry and preventive medicine, is appreciated by everybody. But the question arises whether even here science has been applied in just the right direction.

Let us take dentistry as a convenient illustration. This highly perfected modern art has given us beauty and symmetry of the teeth, replacing the deformities which formerly were so unsightly, particularly among older people. But obviously we have here not a remedial art, but a patching-up process. Crowns and bridges and artificial substitutes, themselves often the sources of infection disturbing the health of the whole body, have replaced the sound white teeth which nature should supply. At one time in our racial history sound teeth were necessary to the survival of an individual. They are scarcely so at present, for with artificial teeth and soft prepared foods one may get along very well and one's children may inherit the inner defects. This process can not go on forever. Under the old régime, before the rise of modern dentistry, there was at least a force, powerful if not always effective, working to the end of sound natural teeth. The dentist's art has to a large extent displaced this force. Is it too much to conceive of a new dentistry which shall have for its object not to make people look better, but to make them really better? If it is replied that this is precisely what the most recent dental art aims at in its teaching of oral hygiene, it is still true that this work relates largely, if not wholly, to the individual, for such acquired characters are not inherited, so that dental degeneration may be going on unchecked, as has been shown to be the case in England. The problem may be a difficult one, but not necessarily beyond the power of applied science.

Then there is the conspicuous instance of the apparent triumphs of applied science in the conquest of modern diseases, particularly those of bacterial origin. Science has discovered, for instance, the cause and cure of tuberculosis. What greater boon to humanity could there be than this discovery, with its keen diagnostic technique, its therapeutic methods and its fresh air cult? It would appear, however, from no less an authority than Professor Karl Pearson that the death rate from tuberculosis has been decreasing as far back as our records go and that since the introduction of the new methods of treating this disease, which date from about 1890, the decrease in the death rate has been less rapid than before. Neither is this startling situation due to an increase in urban or factory life, as is shown by the recent rapid ravages of this disease in rural districts. Even though the accuracy of Professor Pearson's statement may be questioned and even though it be true that many diseases are now diagnosed as tuberculosis which were formerly classed under other names, nevertheless it is becoming clear that this branch of applied science has not been so sweepingly successful as was at first hoped, and that it may be well to supplement nature in her efforts to produce a degree of immunity to this disease by strengthening constitutional resistance. Methods of accomplishing this end are well understood now, since the Mendelian laws of heredity became known. It is only necessary to *apply* this branch of science.

In respect to general social hygiene, the benefits conferred by applied science seem certainly at first sight to be unimpeachable. One thinks immediately of our clean houses and our clean cities, of our comparative freedom from the scourges of smallpox, cholera, typhus and malaria, which in former times decimated the people. One thinks, too, of the marvelous triumphs of sanitation in the Panama Canal Zone and in our colossal national army, army camps and cantonments, both at home and abroad. One thinks of our efficient and sanitary hospital service, of our wonderful restorative surgery, our orthopedic art, and our discovery and application of anesthetics to the relief of pain.

The benefits, at least to the present generation, of this social hygiene are so patent that few of us have stopped to question whether it is strictly speaking social hygiene at all, or, if it should be so called, whether it is the highest kind of social hygiene. Social hygiene must have as its end a really healthy people, not a weakened race which at every turn must be corrected and protected by artificial means. Our method of combating epidemic diseases has had for its two main objects the protection of the individual from infective agencies and the discovery of neutralizing antitoxins. Little attention, one might say almost no attention, has been given to making the individual constitutionally resistant to these agencies. It is perhaps a losing game to try to protect the human race from toxic and infective agencies. Brilliant temporary results may be gained, but a new swarm of microscopic enemies will ever be on the scene to take advantage of their weakened victims. So while we gain control over smallpox and typhus by constantly repeated devices, epidemics of infantile paralysis, influenza and pneumonia cause us to renew our Sisyphean labors.

In the meantime, while we are making headway against typhus and malaria and perhaps against tuberculosis, we hear of the increase of cancer, venereal diseases, diseases of degeneration, diseases affecting the heart and arteries, diseases of the digestive and eliminative organs and of mental diseases and diseases of the nervous system. We are perplexed to hear that the percentage of mothers who are willing or able to nurse their own babies becomes yearly smaller. While applied science has shown us how to quadruple our wealth and increase indefinitely the fertility of our soil, it has shown us how to decrease the fertility of our women, and since the new art is becoming fashionable among our best people but not among our worst, we have the unhappy prospect of actual racial deterioration, already evinced by the increase of poverty in a world teeming with wealth and by an increase of feeble-mindedness, insanity and crime. When bank robberies flourish during a time of unlimited prosperity, at a time when almost any person can get work at almost any wages, it would appear that the trouble is not in our social institutions but in the convolutions of our brains.

Nature seems to have discovered many ages ago that the way to make any race of animals or men strong and hardy was not to shield them from their enemies, but to give them power of resistance against their enemies.

Is it too much to hope that in the period of reconstruction to which we are looking forward, science may be applied less to shielding us from all manner of dangers and evils and more to making us strong to overcome evils; less to the production of comforts and conveniences and more to the encouragement of hardihood and vigor; less to the increase of efficiency and the piling up of wealth and more to the production of racial health and stability?

Science has always been applied, and successfully, to our immediate needs as they were understood. The immediate needs of our present time are not more wealth and more luxury and more efficiency, but more racial and constitutional power of resistance to physical disease and more individual power of resistance to every alluring immediate joy which threatens the permanent welfare of society. We need steadiness and self-control and the limitation of our desires. The centrifugal motive which has ruled the world for the last fifty years has gone far enough. The world is small and there are limits to the expansive opportunities both of the nation and the individual.

Germany complained before the war that she was bound by a surrounding iron ring. To be bound by an iron ring is irksome. She longed for expansion. Hereafter expansive nations will understand that they can expand upward or downward at will but not sidewise, because other peoples also have rights. But individuals will have to learn the same lesson of limitation and self-government, and classes within a nation will have to learn it, else international troubles and even civil wars may take the place of collisions between states.

This, of course, will be applied science in a broad sense, applied psychology, applied ethics, applied sociology, applied biology, applied philosophy—and the growing interest in these sciences is one of the fine things of the present time.

Specific directions in which science may be applied to human welfare are found in conservation and education, and in eugenic control. Science has already been applied to the conservation of our soils and forests. It must be more widely applied to the conservation of all our physical and mental resources and particularly to the conservation of racial values. It may be feared, however, that both these forms of conservation imply a degree of self-control and limitation of desires which is foreign to the spirit of this individualistic age.

In the reconstruction era which we are approaching, the danger is that in the spirit of the times we shall attempt to solve the profound social problems which confront us mainly in two ways, first, by the further development of the mechanical and industrial arts, and second, by the manipulation of political institutions. We shall try, by means of new labor-saving and time-saving devices and new mechanical appliances, to multiply still further the wealth of the world. We shall try, by means of some form of socialism or syndicalism, to provide that this wealth be more equitably distributed than it is at present. We shall try by the further extension of democracy and by equal votes for women to provide that justice prevail more widely than now. We shall try by sumptuary laws and by a league of nations to see that drunkenness and child labor are prohibited and wars between nations abolished. And, then, when all these things are accomplished, we shall look for peace, happiness and plenty to reign on earth. Just here is the source of possible defeat. It is not that socialism and votes for women and extension of democracy and a league of nations are not proposals of the very highest value. It is only that we shall depend too much upon these things for the salvation of society, and shall insist too little upon such other factors as conservation, self-control and the limitation of desires.

A good society will depend more upon the materials of which it is composed than on the forms in which these materials are put together. It does not take many laws or many social institutions to make a good society out of good men but it is doubtful whether laws and political and social institutions can make a good society out of evil men, and if this saying seems as trite as it is true, we must remember that the evil in men has a physiological basis and that its cure is not wholly beyond the possibilities of applied science. Suppose, for instance, that this problem were attacked with the same magnificent confidence as that displayed in the giant task of linking two oceans at Panama, or navigating the air, it would yield to the limitless power of the human intellect.

A BOTANICAL TRIP TO MEXICO. I.

By Professor A. S. HITCHCOCK

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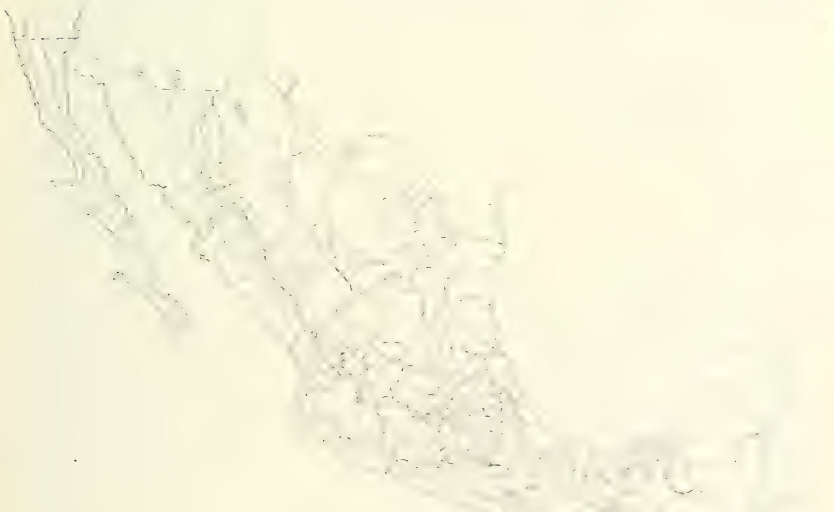
DURING the summer of 1910 the writer made a trip to Mexico for the purpose of investigating the forage conditions and collecting specimens of the grasses. He was accompanied by his son, Frank H. Hitchcock, as assistant. The technical report upon the grasses has already been published.[1] A brief statement of the topography and climate of Mexico and a record of some general botanical and agricultural observations were also prepared but were never published. The following account is adapted from that manuscript.

General Remarks

In its general aspects the character of the flora of a country depends chiefly on the climate, and this in turn is greatly influenced by the topography. It is therefore advisable to outline briefly the topographic and climatic features of Mexico.

Topography.—The portion of Mexico lying north of the



Map showing the approximate location of the 500-meter interval contour lines. The 1,500-meter line outlines roughly the plateau region which culminates in the vicinity of Mexico City where there is a considerable area above the 2,500-meter line.

[1] Mexican Grasses in the U. S. National Herbarium. Contr. U. S. Nat. Herb. 17: 181–389. 1913.

The Maximilian Chapel in the outskirts of Querétaro. Erected by order of the Austrian Government in 1901 to mark the spot where Archduke Maximilian was executed in 1867.

A desert scene near Aguascalientes.

Isthmus of Tehuantepec consists of a plateau, mostly 3,000 to 8,000 feet in altitude, with a strip of low land along each coast. Upon the plateau are numerous mountain ranges and mountain peaks rising above the general level. The most important range is the Sierra Madre, a continuation of the Rocky Mountain system of the United States. Certain peaks rise to a considerable height, and form conspicuous landmarks over a wide area. Among these may be mentioned Orizaba (18,225 ft.[2]),

A DESERT SCENE NEAR TEHUACÁN, SOUTH OF PUEBLA. Cactuses, agaves and thorny shrubs abound, giving the region an aspect similar to that of southern Arizona.

Popocatepetl (17,782 ft.), Ixtaccihuatl (16,060 ft.), all lying along the eastern edge of the plateau and capped by perpetual snow, Toluca (14,900 ft.) and Nevada de Colima (14,370 ft.) in the states of the same names. The strip of low land along the Atlantic coast varies from about 25 miles wide in parts of the state of Veracruz to over 100 miles wide in the state of Tamaulipas. On the Pacific coast the coastal plain is narrow except toward the north where it widens in Sonora to about 100 miles. The coastal region up to about 1,500 feet altitude is known as the *tierra caliente* or hot country, though the region up to about 3,000 feet, in the southern part, has essentially a tropical climate. On the east side the low country near the coast is dryer than the eastern slope of the plateau.

[2] The altitudes are taken from Terry's "Mexico," p. cxxvi, 1909.

MAP SHOWING THE DISTRIBUTION OF THE ANNUAL RAINFALL (IN INCHES). The rainfall increases toward the south and reaches a maximum in the Isthmus of Tehuantepec. Yucatan is drier.

Climate.—The winds from the Gulf deposit a portion of their moisture on the coastal plain but the maximum precipitation is reached only in the cooler altitudes. This is well shown by the annual rainfall of Veracruz (1,725 mm.) and Córdoba (2,867 mm.). After passing the eastern slope of the plateau the winds are comparatively dry and the interior is in consequence an arid region. The rainfall of Puebla, about 80 miles west of Córdoba, is only 923 mm. A similar but more striking contrast is shown by the conditions upon the eastern and western slope of Mt. Orizaba, though the rainfall data are not available.

Rainfall.—The northern portion of Mexico is arid, the annual rainfall being less than ten inches (25 mm.) The precipitation increases southward and reaches its maximum in the southern part of the state of Veracruz and in the coastal portion of Chiapas. The accompanying map shows approximately the distribution of the annual rainfall.[3]

Over most of the plateau region the rainy season lies in the months from May or June to September or October.

Hann[4] gives a table showing the average annual rainfall in

[3] "Distribution de las lluvias en la Republica mexicana," Carta formada por el Twg. Geographo Guillermo B. y Puga. At the Weather Bureau, Washington, D. C.

[4] Hann, Julius, "Handbuch der Klimatologie," 2: 324. 1910. Another source of information on the rainfall of Mexico is Memorias de le Sociedad Científica "Antonio Alzate," Vol. 16, 1901.

millimeters by months for several stations in Mexico. From Hann's table have been selected the following representative stations:

TABLE I

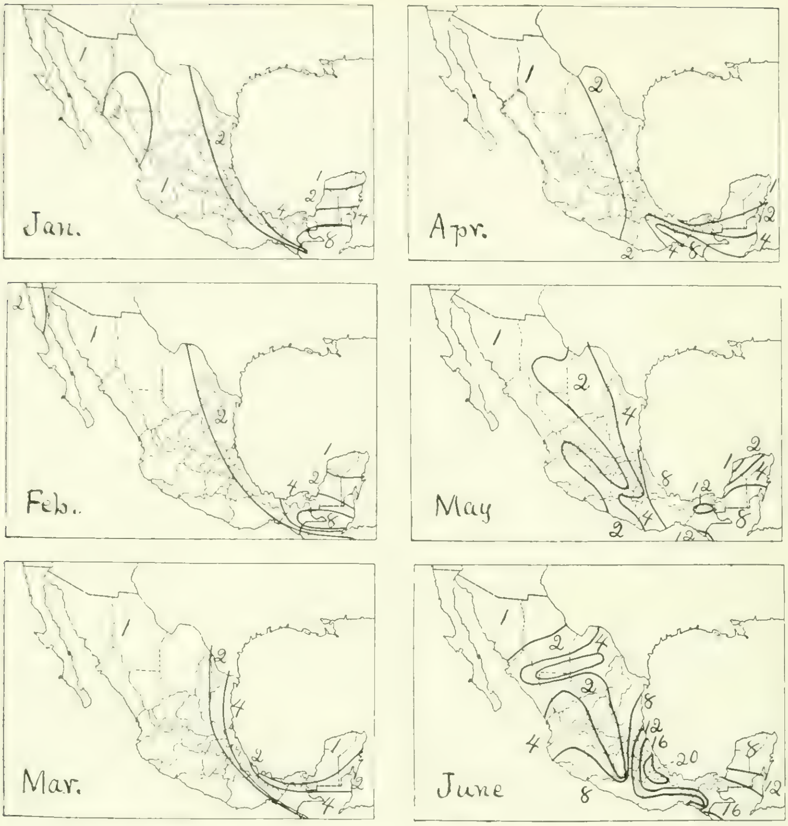
ANNUAL RAINFALL OF REPRESENTATIVE STATIONS IN MEXICO

Station.	Annual Rainfall Millimeters.	Annual Rainfall Inches (approximate).
1. Chihuahua	616	24
2. Matamoros	931	37
3. Monterey	677	26
4. Saltillo	601	24
5. San Luis Potosí	277	11
6. Zacatecas	578	23
7. Colima	870	35
8. Mexico City	588	23
9. Puebla	923	37
10. Córdoba	2867	114
11. Mérida	841	33
12. Mazatlán	796	32
13. Oaxaca	813	32
14. Veracruz	1725	69

The accompanying map shows the location of these stations.

Hann's table gives the monthly rainfall for nineteen stations. In all cases there is a marked increase for the months of summer and autumn over those of winter and spring. At Chihuahua, in northwestern Mexico, two thirds of the precipitation occurs in July, August and September. At Zacatecas, further south on the plateau, nearly half the precipitation is in June and July. At Mexico City 428 out of a total of 588

MAP SHOWING THE ANNUAL RAINFALL (IN MILLIMETERS) FOR SEVERAL STATIONS IN MEXICO. The figures refer to Table I.



MAP SHOWING THE ANNUAL RAINFALL BY MONTHS.

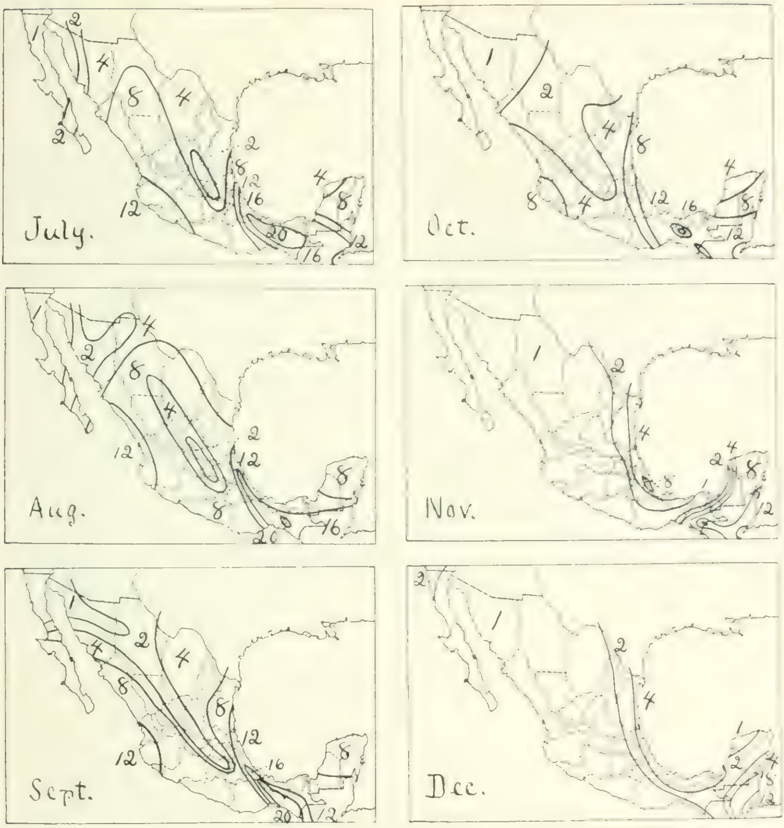
millimeters come from June to September. At Veracruz, on the Gulf Coast, there is a precipitation of 1,550 millimeters from May to October and only 175 millimeters for the other six months. The distribution of the rainfall by months is shown graphically by the following maps.[5]

Temperature.—As indicated in the preceding paragraphs the average temperature is dependent largely upon altitude. The seasonal variation is comparatively small except for the northern cities, Matamoros and Monterey.

Hann[6] gives a table showing the average monthly temperature, centigrade, for several stations in Mexico. No records are given for the northwestern portion of the Republic. For the cities of the plateau region from Zacatecas to Oaxaca, the records show a fairly uniform range through the year, the maxi-

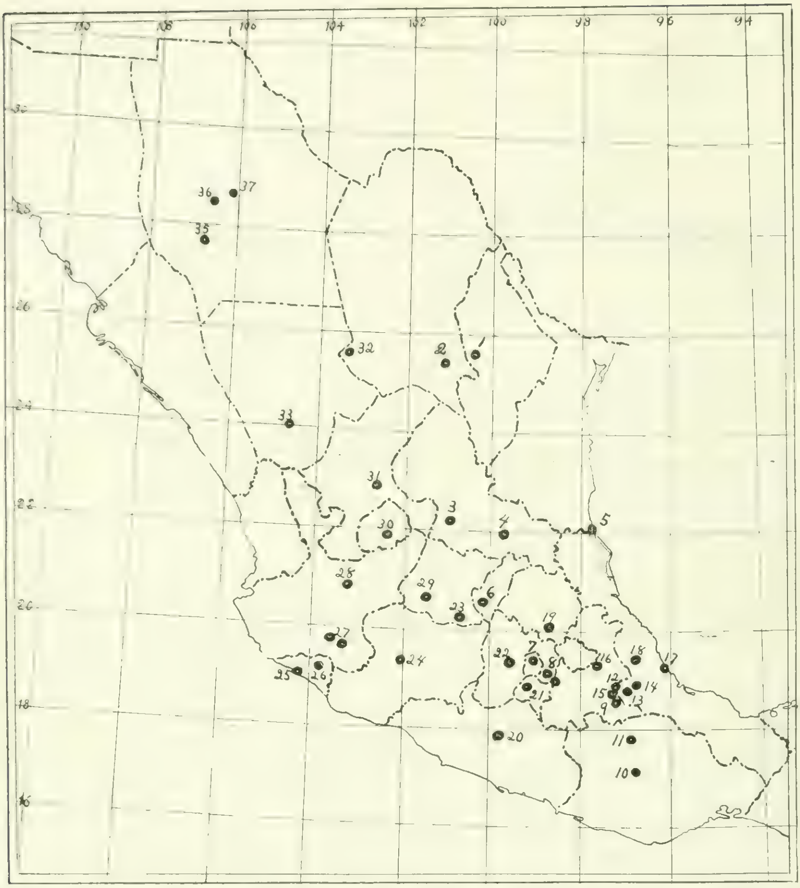
[5] From "The Distribution of the Rainfall over the Land," by Arthur J. Herbertson, London, 1900, an extra paper published by the Royal Geographical Society.

[6] *Op. cit.*, 321.



Maps Showing the Annual Rainfall by Months.

mum in May and the minimum in December and January. At Zacatecas, Mexico City and Puebla the average temperature for May is about 18.5° C. (65° F.). The average for December and January is about 12° C. (54° F.) for Mexico City and Puebla, and slightly lower, about 11° C. (52° F.), for Zacatecas. At Real del Monte, a city located at a higher altitude than those mentioned, the average for May is only 14.8° C. (59° F.) and for December only 10° C. (50° F.). The cities of Jalapa, Mirador and Córdoba, lying along the eastern slope from the plateau and about the latitude of Mexico City, show annual fluctuations about the same as those for the plateau but the temperatures are higher. At Jalapa, with an altitude of about 4,600 feet, the average for May is 20.4° C. (69° F.), and for December and January is 14.5° C. (58° F.). At Mirador (3,600 ft.) and Córdoba (2,700 ft) the average for May is 23° C. (73° F.); for January, 16.6° C. (62° F.) for the former, and 18° C. (64° F.) for the latter. At Veracruz, situated on the Gulf Coast, at sea level, in about the same latitude,



MAP SHOWING WHERE COLLECTIONS WERE MADE DURIING THE SUMMER OF 1910. The numbers refer to the stations given in Table II. In 1908 the writer visited Guaymas and Hermosillo in the state of Sonora which lies west of Chihuahua and is the northwestern state on the map.

the average temperature is considerably higher. The five months from May to September show monthly averages of 27–27.7° C. (80–82° F.), while the comparatively cool months of December and January show averages of nearly 22° C. (71° F.). Tuxpan, a more northerly coast town, shows even higher averages, and Tampico, a coast city still further north, shows a summer temperature about the same as Veracruz but a winter temperature somewhat lower. Mérida, in Yucatán, shows a maximum average in May of 28.5° C. (83° F.) and a minimum in December of 22.4° C. (72° F.). The monthly averages for Mazatlán, on the Pacific Coast, show a gradual maximum from June to September of 27–28° C. (81–82° F.) and a minimum in January of 19.3° C. (67° F.). The temperatures increase during the dry season, reaching a maximum

A VIEW ON THE PEDREGÁL, NEAR MEXICO CITY. This is an extremely rough lava area about six miles long and three miles wide. The flora consists mainly of desert plants.

THE FLORA OF THE PEDREGÁL. The aspect of the Pedregâl is similar to that of the aa or rough lava streams in the Hawaiian Islands.

just before the beginning of the rainy season which is usually in May or June.

Itinerary.—Investigations were made at about forty localities in nearly all the states of Mexico north of the Isthmus of Tehuantepec. The route of travel was, in general, from Laredo to the City of Mexico, returning to El Paso, with side trips to Tampico, Veracruz, Oaxaca, Balsas, Uruápan, Manzanillo, Durango and other points. The following table shows the places visited, and the numbers of the specimens collected:[7]

TABLE II

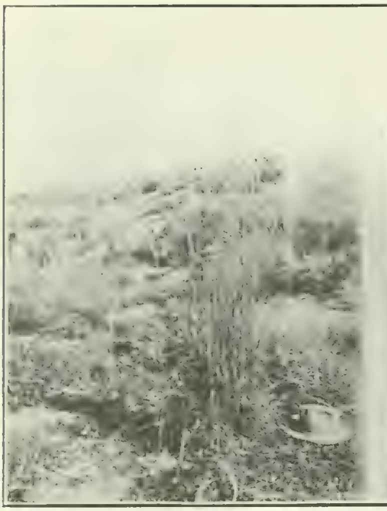
LOCALITIES VISITED WHILE COLLECTING GRASSES

Locality	State	Approximate Altitude in Feet	Date	Field Numbers of the Specimens
1. Monterey	Nuevo León	1,500	July 6–9	5517–5578
2. Saltillo	Coahuila	5,000	" 10–14	5579–5652
3. San Luis Potosí	San Luis Potosí	6,300	" 15–18	5653–5711
4. Cárdenas	San Luis Potosí	3,000	" 19–20	5712–5778
5. Tampico	Tamaulipas	sea level	" 21	5779–5799
6. Querétaro	Querétaro	6,000	" 24–26	5802–5870
7. City of Mexico and vicinity	Distrito Federal	7,400	" 27–Aug. 2	5871–5960
8. Popo Park and Mt. Popocatepetl	México	7,600–14,000	Aug. 3–7	5961–6029
9. Tehuacán	Puebla	5,500	" 9–10	6030–6095
10. Oaxaca	Oaxaca	5,000	" 12–13	6096–6190
11. Tomellin	Oaxaca	2,000	" 14–15	6191–6249
12. Chalchicamula and Mt. Orizaba	Puebla	9,000–14,000	" 16–22	6250–6309
13. Orizaba	Veracruz	4,000	" 24–25	6310–6394
14. Córdoba	Veracruz	2,700	" 26–27	6395–6462
15. Esperanza	Puebla	8,500	" 28	6463–6504
16. San Marcos	Puebla	8,500	" 29	6505–6546
17. Veracruz	Veracruz	sea level	" 30–Sept. 1	6547–6556
18. Jalapa	Veracruz	4,600	Sept. 2–4	6587–6685
19. Pachuca	Hidalgo	8,000	" 6–7	6700–6770
20. Balsas	Guerrero	1,500	" 9	6772–6816
21. Cuernavaca	Morelos	4,500	" 10–11	6817–6885
22. Toluca	México	8,800	" 13	6886–6921
23. Acámbaro	Guanajuato	6,300	" 14	6924–6954
24. Uruápan	Michoacán	5,600	" 16	6957–7005
25. Manzanillo	Colima	sea level	" 19–20	7026–7046
26. Colima	Colima	1,500	" 21	7054–7110
27. Zapotlán and Nevada Peak	Jalisco	5,000–14,300	" 22–25	7111–7259
28. Guadalajara	Jalisco	6,100	" 27–29	7260–7386
29. Irapuato	Guanajuato	5,800	Oct. 1	7387–7438
30. Aguascalientes	Aguascalientes	6,300	" 2	7439–7494
31. Zacatecas	Zacatecas	7,500	" 3–4	7495–7537
32. Torreón	Coahuila	3,800	" 5	7538–7564
33. Durango	Durango	6,200	" 6–8	7565–7660
34 Torreón	Coahuila	3,800	" 9–10	7724–7729
35. Sanchez	Chihuahua	8,000	" 12	7661–7723
36. Miñaca	Chihuahua	7,000	" 13	7731–7769
37. Chihuahua	Chihuahua	4,600	" 14	7770–7803

[7] Missing numbers were collected at intermediate stations along the railroad.

MT. POPOCATEPETL NEAR THE SNOW LINE. The tracks of cattle are seen in the sandy barrens. The white spots are the remains of the snow from a recent squall.

Epicampes macroura ON MT. POPOCATEPETL. The roots, obtained by prying up the large tussocks, are used in the manufacture of scrubbing brush.



Epicampes macroura. A single small cluster along a railway embankment at San Marcos, near Puebla. The flowers are in a dense spikelike inflorescence at the ends of the stems.

Mt. Popocatepetl. The upper part of the mountain is bathed in clouds. At the lower edge of the cloud cap can be seen spurs descending from the snow fields. The sandy waste in the foreground is the home of *Festuca livida* a bunch grass about six inches high with large purple spikelets.

Botanical and Agricultural Observations

The observations here recorded are very elementary and emphasize unduly the group of plants which I was investigating, but they may be of interest because, though Mexico is our next-door nieghbor, its characteristics are unfamiliar to the average scientist who has not visited the country.

Floral Regions.—The great central plateau is an arid region, the flora of which is similar to that of southern Arizona, New Mexico and Texas. The flora of the Great Plains extends through Texas into the northeastern Mexican states, while the desert flora of southern Arizona extends into the states of Sonora and Chihuahua. The former flora is characterized especially by grasses; the latter especially by cactuses, agaves, yuccas, and various thorny shrubs. In a more or less modified form this desert flora is found on the plateau as far south as the state of Oaxaca. The upper part of the higher mountain ranges are usually wooded, the Sierra Madre range supporting extensive areas of coniferous forest. The rainfall in the mountain areas is greater than in the adjoining plains. The hills and the more isolated mountain ranges are usually rocky sterile wastes devoid of timber.

The low land along the eastern coast between the Gulf of Mexico and the foothills which mark the beginning of the as-cent to the plateau is covered with a low forest which becomes toward the south a tropical jungle. The coastal plain of the Pacific coast is similar, but not so well marked, the hills in many places extending to the very coast. In Sonora the rainfall is not sufficient to support a forest. In all this low land, the *tierra caliente,* or hot country, the grasses are usually poorly represented both in species and individuals. At Veracruz the sandy plains immediately back of the coast are covered with an abundance of certain species of grasses, but in general such areas represent a very small proportion of the total.

The central plateau supports a desert flora, the density of which is largely dependent upon the amount and distribution of the rainfall. In the northern portion, north of the isohyet marking the limit of twenty inches annual precipitation, the grass flora is that of the desert regions of Arizona and New Mexico. The grasses are in bunches, known to stockmen as bunch-grasses, scattered over the surface of the mesas or of the lower hills. In the more arid places the bunches are at intervals of several feet, while in moist spots the bunches may be separated by only a few inches. Only under especially favorable conditions do the bunches approach one another to

Orizaba from the hill lying just to the west of the city.

Two fern fronds from the tropical jungle around Jalapa.

form a continuous mass or sod. Grasses with creeping rootstocks are not so common. In the northeastern states, where the Texas flora intrudes, may be found areas of sod formed by the buffalo-grass (*Bulbilis dactyloides*), curly mesquite (*Hilaria cenchroides*) and allied species. During and shortly after the rainy season the grasses of the mesa thrive and produce their flowers and seed. Later they become dry and brown, and retain life only in the crown and underground parts. The mesa grasses belong chiefly to the large genera, *Aristida, Bouteloua, Muhlenbergia, Sporobolus* and *Stipa.*

The region in which the grasses occupy the most important and conspicuous place is the slope from the central plateau to the coastal plain. This slope is characterized by an extremely irregular topography, being cut by numerous deep ravines, or *barrancas.* The rainfall increases rapidly toward the coastal plain, especially along the southeastern slope in the state of Veracruz. At the higher elevations there are extensive prairies with a rank growth of grass. Many of the hillsides and the slopes of the deep barrancas are covered with grass. As the altitude decreases the proportion of forest-covered area increases and the grassy areas are confined to the hills. In this region the grasses are more tropical, and the genera *Andropogon, Panicum* and *Paspalum* are well represented.

On the upper slopes of the high mountains the grasses are often conspicuous. At moderate elevations, 9,000 to 11,000 feet, the large bunches of certain species of *Festuca* and *Epicampes* may cover large areas of treeless or sparsely wooded slopes. One species, *Epicampes macroura,* is used commercially, the strong roots furnishing material for coarse brushes. At the upper elevations, near or above the timber line, are found several kinds of tussock grasses belonging to the genera *Festuca, Deschampsia* and *Agrostis.* Upon the alpine summits, or the alpine belt below perpetual snow of the highest peaks, occur scattered dwarf alpine grasses belonging to the three genera just mentioned, together with certain species of *Poa, Calamagrostis* and *Trisetum.*

A LITTLE MOTHER CARRYING HER BROTHER WHO IS HALF AS LARGE AS SHE. The picture was snapped as she was trying to escape from the dreaded camera.

In the valleys upon the plateau agriculture is carried on with the aid of irrigation. Along the irrigation ditches may be found representatives of the native flora of the region even during the dry season when the plants upon the mesa are passing through their resting stage. The collections made by the writer in the arid northern portion of the plateau were chiefly from the vicinity of irrigation ditches or irrigated fields. In cultivated soil the species of grasses occurring are mostly weedy annuals, but along the ditches or the edges of the fields

A STREET IN ORIZABA, showing the characteristic Spanish architecture.

are found portions of the original vegetation which includes many species in flower, although the mesa may be brown and sere, presenting no grasses in flower.

Range Conditions.—Stock-raising is an important industry throughout the plateau. The grazing conditions are similar to those of the southwestern United States. Cultivated fields on that portion of the plateau north of about 22° latitude are confined to the vicinity of the water courses of the valleys that can be reached by irrigation ditches. Outside of such areas the agriculture of the country is confined chiefly to stock raising. Cattle, sheep and goats roam over the land, living upon the scattered herbage, the grazing radius being limited by the distance to water. Though grazing animals feed on a variety of plants, there is no doubt that the grasses form the most important part of the available forage. It not infrequently occurs that the grass vegetation has been almost entirely removed from an area by grazing animals, the original grass flora being preserved only within the protection of clumps of cactuses or other thorny plants, or upon inaccessible rocky cliffs.

The ranges include the highest mountains, and cattle were observed feeding far above timber line upon the snow-clad peaks of Orizaba and Popocatepetl, their tracks or evidences of grazing extending to snow-line.

Forage Crops.—So far as observed all forage that is cut is consumed green. By far the most important forage crop is corn or maize. This plant is grown primarily for the grain but large quantities are cut green for fodder. As the crop nears maturity a portion of the foliage may be stripped or the part of the stalk above the ear may be removed for forage. Much green feed is obtained by the poorer classes by pulling up weeds from cultivated fields or by cutting rank grass or weeds along the roadsides, the railroad right of way, or any other available source.

Alfalfa is commonly grown upon the plateau, but usually in comparatively small patches. One field was observed near Toluca which consisted of more than one hundred acres, the plants being grown in rows and cultivated. Throughout much of the plateau region the crop requires irrigation during the dry season. Ordinarily the alfalfa is sown broadcast and irrigated by the check system. The field is divided into several small plots, twenty to fifty feet square, by low ridges or dikes. The crop is cut by hand with sickles or knives, often close to the surface of the ground. The green alfalfa is placed in small heaps and later tied in bundles to be loaded on burros for delivery. Some of the larger ranches or haciendas are adopting modern methods and machinery.

At low altitudes, especially in the coastal plain, are cultivated Pará-grass and Guinea-grass (pronounced in Spanish, Guinay'-a). Pará-grass (*Panicum barbinode*) is cultivated chiefly for pasture. It produces a tangle of rootstocks and stolons which soon bind the soil into a firm sod. It is propagated by planting cuttings of the creeping stems.

Guinea-grass (*Panicum maximum*) is a perennial rootstock-bearing bunch-grass, cultivated chiefly for green forage. It grows to a height of five to eight feet or even more. The grass is propagated by planting pieces of the crown, or the creeping rootstocks. When growing isolated the stems may be more or less decumbent, but under field conditions the growth is upright.

EDUCATIONAL PUBLICITY

By Professor ULYSSES G. WEATHERLY
INDIANA UNIVERSITY

THE rapid growth of attendance and equipment at American universities in the quarter century since 1890 has necessitated a readjustment of educational methods and a sweeping revaluation of educational ideals. Perhaps nowhere else in the whole range of social activities has occurred a more conscientious attempt to realize what Nietzsche calls a transvaluation of values. The college curriculum of the last generation was a fair expression of the mid-Victorian intellectual attitude. Whatever valid objections are now to be raised against it are founded on the fact, not that it was fundamentally unsound in principle, for on the whole it met vital needs and met them adequately, but rather that it virtually ignored large sections of human experience which this age has come to consider important. Particularly did it fail to include in proper measure the field of modern science and the wide range of vocational techniques, two sets of interests which transfer the center of attention from subjective to objective reality. Because of the magnitude and complexity of these interests the task of making a revaluation which should properly place them in the educational system has been a tremendous one, and furthermore it has been thrust on the universities rather suddenly. It is only within the last three decades that economic transformation has begun to very profoundly affect the structure of American society. That the lower grades of education as well as the universities are still in a stage of transition is evidenced by the chaotic situation in vocational education and by the unsettled curriculum of the high school.

That the success of the universities in shaping themselves to these new conditions should have been uneven is not to be wondered at. While grappling with intricate problems and honestly trying to seize a multitude of novel opportunities they have botched the job in some instances and achieved brilliant success in others. Higher education has still to get its bearings in an environment as yet largely alien. It has thus far neither accomplished a masterful evaluation of all its new materials nor successfully articulated them with the old. And the end is not yet. Every year new undertakings and new applications of effort are brought to its attention. New types of students, also, hitherto unknown to academic circles, crowd university halls. Whether this irruption be regarded as a barbarian invasion or as the opening of a new world of opportunity, the fact remains that the traditional standards of academic life are gone for good and all.

A corollary of the new student types is a radically changed body of alumni. The phenomenal increase in numbers has brought it about that a considerable majority of living alumni are still comparatively young. They are pervaded by the spirit of this age of economic and educational upheaval rather than the static ideals of an older college era. Whereas the colleges used to train men primarily for the so-called learned professions, the present university body is large chiefly by reason of the throngs who expect to enter technical or business careers. Thus in 1797 forty-two per cent. of the Yale graduates became lawyers, thirty-nine per cent. clergymen, eight per cent. physicians, and only six per cent. entered business. Of members of the classes in the decade ending 1908 twenty-four per cent. became lawyers, five and one half per cent. physicians and three per cent. clergymen, while forty per cent. entered business. In 1908 a study was made of the occupational distribution of former students of Oberlin, an institution which has always had a strong religious bent and which was a pioneer in coeducation. It was found that but eleven per cent. were ministers or missionaries, and twenty-four per cent. were in business. Of the thirty-two thousand persons who have ever been connected with the University of Illinois, one of the largest but also one of the youngest state institutions of the Middle West, nine per cent. are now engaged in some kind of business, nine per cent. in engineering and eight per cent. in agriculture, while less than four per cent. are lawyers, one per cent. are physicians and less than three tenths of one per cent. are clergymen. Only eighty-three persons belong to the last-named class, which is exceeded in numbers by accountants and musicians.

A group of men whose interests and outlooks are dominated by the spirit of acquisitive business would naturally wish to see the standards to which they are habituated prevail in academic management. The scholar's leisurely indifference to proximate results and devotion to ultimate truth are irksome to minds accustomed to evaluate an enterprise by the amount of "pep" it exhibits and by its capacity for "punch." In proportion as education has assumed the function of preparing for acquisitive vocations, it has itself become assimilated to the business ideal. Now two prime elements of present-day business are the competitive principle and the cult of bigness. To the business man success means the mastery of his field, which in turn implies beating his competitors. The commercial mind has little comprehension of or respect for an enterprise devoid of the fighting spirit. Casual observers, whether native or foreign, who think they perceive in dollar-hunting the sole incentive of American business mistake a symptom for the fundamental motive. The joy of battle is the lure, as it is the guerdon, of business activity.

Generous and dynamic loyalty which an institution is able to command from its alumni, while one of its richest assets, is at the same time liable to become a source of embarrassment unless turned to proper ends. If it aspire to excellence of ideal and achievement it is a source of real strength; if it expend itself in good-natured ambition for material prosperity it is at least useful; if it stop at pugnacious eagerness to overtop pet rivals in athletic or social prestige, it becomes a thing to be accepted with such patient endurance as can be mustered. In any case the alumni spirit is certain to be a potent factor in determining the trend of university policy. The preponderance of business interests tends to throw the emphasis increasingly on mere bigness. Just as a commercial concern which is unable to exhibit an annual increment in its volume of business is adjudged moribund, so the institution which does not, with each recurring autumn, report the largest freshman class in its history is branded as an academic lame duck. Growing assimilation to business standards is also tending, through selective fitness, to shift the qualities of administrative leadership from those of the educational statesman to those of the captain of industry accustomed to the problems of corporation management.

Still another corollary of the commercial trend is an anti-intellectual pose within the university itself. It may not be particularly surprising, although it is certainly significant, that a revulsion from the rarefied intellectual ideal should manifest itself among present generations of students in the guise of repugnance to "high-brow stuff" and dogged insistence that culture as an educational *motif* is played out. Vastly more significant is a somewhat similar trend among university teachers. Some part of this arises from a natural reaction against the extreme form of the old ideal, some part from an aspiration to get into closer touch with reality. The Zeitgeist has decreed that reality is to be interpreted in terms of utility, which in education connotes vocational technique. But a more tangible element is the growing preponderance in the larger university faculties of men connected with technical and professional education. The question at this point is, of course, not one of the comparative worth of vocational and cultural disciplines, still less is it one of scholarly proficiency. All that is implied is that the old academic group type no longer exists. The ancient ideal of sheer intellectual excellence and beauty of spirit has been profoundly weakened even among its traditional exponents by the vocational drift.

Little penetration is required to perceive that educational tendencies pretty accurately reflect social changes. To say that education has shifted from the classical-cultural to the industrial type is to intimate that society itself has undergone a radical economic transformation. The characteristic elements of this change are outgrowths of the eighteenth century Industrial Revolution, now finding somewhat belated expression in America in the current social readjustment. Two of its outstanding features, the money economy and the machine-production economy, have made possible an almost incredible expansion of productive capacity which has slowly shifted the social center of gravity from the use of goods to their production. By far the larger part of the social resources are thus shunted toward the productive process. The result is a one-sided valuation of functions which has thrown our whole modern life out of gear, by so thoroughly absorbing our faculties in production that appetite turns to the process rather than the product. No corresponding elaboration of technique has occurred in the field of consumption. The contemporary world is immensely more proficient and more interested in creating goods than in using them intelligently.

Production is primarily competitive and dynamic, consumption emulative and static. The one develops, under modern conditions, a constantly improving technique, while the other changes but slowly. Production uses the social machinery freely and thus reacts directly on society; consumption pertains chiefly to the individual or small group and affects the social machinery but little. Now, the classical type of education, by which, of course, is not meant any particular set of studies but their fundamental purpose, is directed toward the promotion of appreciation and valuation, which are the basic elements of consumption. It has thus, like consumption, suffered a depression coincident with the overlordship of the productive interest. In addition it has had to bear the imputation that it is a mere luxury, that it centers on individual excellence rather than social worth, and that it breeds a culture caste inconsistent with democratic ideals. This latter indictment was never sound in logic, and in practise is true only to the extent that in an over-industrialized society the materials of culture are not socialized to the same degree as are productive agencies. A social readjustment in the interest of balancing-up the consumption technique will go far toward wiping out whatever stigma now attaches to cultural ideals. For after all culture is essentially social. Although beauty may possibly be its own excuse, no one has ever seriously contended that intellectual excellence can validate its existence except as it ministers to the unity and solidarity of the general life.

Somewhat distinct from the industrial tendency, which is of external origin, is a form of revolt against classicism entirely from within. Any classical system, whether of art, music, literature or education, sooner or later reaches a stage where further increments of achievement must be small because its larger potentialities have already been exploited. There is thenceforth little outlet for surplus energy. Original creative spirits will at this point break away into those revolutionary innovations out of which new systems arise. From such a revolt in education in the second half of the nineteenth century came the influences which have carried into the universities their scientifice and professional schools. That this innovation was a genuine advance is now held by no one more firmly than the classicists themselves, who have profited by it to an extent that half a century ago would have been deemed incredible.

But there is a species of revolt which does not lead to original creation. It springs from the mere *ennui* of stagnation, and may manifest itself variously in a taste for the exotic or in mordant craving for extremes of novel or bizarre sensation like cacophonous music, or delirious art, or invertebrate drama. Among educators it is more likely to show in efforts to ease the irk of academic seclusion. Our modern system of minute specialization hems into a narrow range of activity minds which by their training are peculiarly fitted for elaborate self-expression. There is a steady pull toward a throwback to the unspecialized type of the average mind. Especially keen is the hunger for action, notably for those varieties of action which are most remote from the specialized routine. The old common-lands of knowledge and vocation have now been pretty well fenced in, but the academic mind grudges to recognize artificial metes and bounds. Business undertakings, practical politics and radical popular movements, entirely apart from their technical content, have a peculiar fascination for university men. To this discontent with artificial limitation and to passion for adequate self-expression is to be assigned one source of the current academic radicalism. It is true that the cult of democracy in the universities has other roots, some of them even more elemental and permanent, but there is none which so much affects specific courses of action. At its best academic radicalism functions as a dynamic idealism such as moved Arnold Toynbee and his fellows at Oxford a generation ago. On a somewhat less exalted plane it is inspired by a hunger for opposites, as when men of cultivated leisure throw themselves into popular enthusiasms for pure love of novel experience. Men of this cast are not content, with Matthew Arnold, merely to "*see* life steadily and see it whole"; they would fain master life's action-content as well as its idea-content.

In such desire for broader self-expression, whether in the form of humanitarian zeal or individual gratification, the university extension movement also had one of its two sources. The scholarly instinct of workmanship is as yet imperfectly adjusted to the straitened technique of specialization. In a wider range of educational effort lurks the alluring promise of contact with a stimulating variety of people and activities. When the extension idea was first propounded in England, now more than sixty years ago, scholastic exclusiveness was still the rule. At both Oxford and Cambridge many classes of students were excluded by religious or other tests, nor was there anywhere adequate provision for the higher education of women. This was also before the day of free and general lower schools. In America these obstacles then existed in a much smaller degree, and to-day they exist hardly at all. Carrying the university to the people—the formula then popular—is not to be lightly dismissed as a grandiloquent phrase, for it holds a worthy and practical idea, although, like many another great idea at its inception, it fails to put things in proper perspective. It is now becoming clear that, apart from the rather limited number of persons who are prepared to profit by extra-mural work of university grade, the larger need is one which other educational concerns, and not the university, are best calculated to meet. General educational extension is verily demanded, and the universities deserve credit for some necessary pioneering work in a field which they can not wholly or permanently occupy. As a mode of large-scale academic self-expression, however, the extension movement has turned out to be a Dead Sea apple in the hands of idealistic reformers.

While, therefore, the idea of universalizing educational opportunity is no romantic illusion but a very sound reality, and while the university for some time will probably hold a commanding though constantly diminishing share in it, to agencies outside of higher education must in the end fall most of the task of putting it into action. It is unfair to say that the original idea of extending the university itself has gone bankrupt; it is more accurate to say that, since most of the ends to which its originators looked forward are found to be better reached through other agencies, the name and form have been appropriated to ends which certainly were never contemplated by the first promoters. Despite the present overtaxing of academic capacities, the extension system has lately come to be used as a means of augmenting the volume of academic business. It is fair to say that this aspect of the subject may not in all cases have consciously influenced the welcome which the newer extension projects have received. One may find plenty of verifiable merits in the extension idea, but at the same time it does make a magic formula to insert in the plea for material support. For institutions dependent on private donations it offers a substantial basis of appeal to potentially benevolent wealth, combining as it does the claims of education and philanthropy. Publicly supported institutions, having to make their case with a larger and more miscellaneous group, accept the extension system as a quick and easy method of ocularly demonstrating their general and practical worth. Certain phases of extension work in the agricultural or engineering schools, and latterly also in the new colleges of commerce, can be shown to yield direct pecuniary returns to the state. Used as a sort of protective coloration these features shield or promote the general body of subjects which, by reason of their non-pecuniary character, have little popular appeal and would be accorded but grudging support.

For the opportunity which it offers to the limited number who are prepared to profit by work of university grade, and for the part it has played in quickening educational activity in general, the extension movement is entitled to generous recognition. On its miscellaneous activities which are based on the theory that there is or can be an easy road to higher learning a less favorable verdict must be rendered. It ought not to be necessary to prove, although it is sometimes seriously denied, that sound learning can never, by any process of softening, be made other than a rigorous discipline. Any attempt to offer it on other conditions is both specious and conducive to mental and moral slovenliness. Pushing people indiscriminately into higher education without regard to taste or capacity will send into the universities, as it has to some extent already done, many who do not even under the most liberal interpretation belong there. Exactly because of its superlative worth higher educational opportunity is wasted on those whom the urge of intellectual hunger or militant ambition does not propel to meet it. The plea that extension activities may possibly stimulate this hunger is sound so long, and only so long, as the lower schools fail, by reason of their inefficiency, to search out and quicken the latent talents scattered through all levels of society.

A form of extra-mural activity which has wide present vogue is the direct participation of universities in public service. The Wisconsin Idea, now somewhat bedraggled, has been extensively copied near at hand and still more admired at a distance. There can surely be no controversy about the desirability of higher education's reacting dynamically on industrial and social life. The only question is as to methods of making the results of science available in and for social action. It happens that in the United States as contrasted with England of the last generation most of the men who are devoted to pure science are connected with universities. Any influence which deflects them from research toward the application of science to the detailed processes of industry or administration weakens their capacity for original work and correspondingly lessens their ultimate social value. The outside pressure on university experts is always strong and in the state universities it is almost irresistible. To this cause may probably be attributed the undeniable poverty of scientific achievement which Americans have to lament in the same breath which glorifies our more material achievement. A historian of music has remarked that Italy is a land of singing but not of music. If America can be called a land of schools rather than scholarship the reason may possibly lie in our requiring science to earn its daily bread in the mill instead of the laboratory or study.

If the idea that the process of higher education may be made easy is fallacious, the assumption that there is a facile and burdenless mode of supporting it is no less misleading. As learning is a process calling for both talent and boundless application, so the task of maintaining it is one that society must assume in serious and understanding mood. To inculcate the idea that the university, or for that matter any other educational venture, may show immediate profit in a pecuniary sense is to misinterpret its intrinsic purpose. As well maintain that a city park or a public library should yield a profit. Nobody denies that these are profitable undertakings, and, equally, nobody misunderstands why they are so. The university is not so fortunate in the judgments accorded to it.

Whatever may be the ultimate status of the extension system as a whole, some of its miscellaneous undertakings which are now utilized chiefly for publicity purposes can have no permanent standing in their present form. Holding conferences on matters under popular discussion, exploiting the more appealing features of the uplift movement, or assuming the rôle of lion-provider to the curious public, are admittedly effective methods of keeping an institution in the spot-light. They may even be shown to be useful functions which under proper control have legitimate educational value, but they deserve no place among serious academic interests so long as they are tinged with the spirit of vaudeville or dominated by the ideals of educational impressionism. Essentially different is, or ought to be, the position of the summer session. At Oxford first, and a little later at Cambridge, the summer meeting was an integral part of the extension plan, and it has shared the vicissitudes of the extension system. The American summer session is an appendix of regular intra-mural activity, although it has always partaken of some of the features and objects of the extension system. Inaugurated to meet the needs of exceptionally serious types of students, it has the additional merit of keeping the educational plant in productive use during a season when it formerly was stark idle. The students who avail themselves of it are predominantly of a class that require few tawdry attractions. By them, if by any, the institution may hope to have work judged on its intrinsic merits. If there is, here and there, a growing tendency to turn the summer session into an educational Coney Island, it must be attributed to influences that originate primarily on the side of the university itself and not on the side of the students or in their needs.

The course of recent educational history has demonstrated that university expansion has been stretched almost to the breaking point. The inexorable alternative is now presented of continuing with the policy of scatter and smatter, or of concentrating on clearly delimited undertakings which can be efficiently managed within the limits of available resources. The choice of field ought not to be a difficult one. Beneath all specialized vocations and techniques are the bodies of fundamental knowledge which make them possible. Of such knowledge the university is the clearly designated exponent, for here it has no competitor. It obviously can not hope to find place in its curriculum for any considerable number of the strictly vocational interests that are clamoring for educational recognition. These must be provided for in special schools. That basic knowledge which must constitute its staple product is what John Stuart Mill had in mind when he said:

> The state of knowledge at any time is the limit of the industrial improvements possible at that time; and the progress of industry must follow, and depend on, the progress of knowledge. The same thing may be shown to be true, though it is not quite so obvious, of the progress of the fine arts.

Two perils of the scatter-and-smatter policy stand out conspicuously. The first is the crude fact of fiscal and material unwieldiness. The second is the crippling of scientific achievement through distraction and dissipation of effort. Expert scholarship is little likely to prosper where academic specialists are required to be concerned with a multiplicity of extraneous interests, or where any considerable share of their attention must be given to immediately utilitarian concerns. Genuine scholars who have the capacity for original work are not only within their rights, but are performing their highest duty both to their institutions and to science, in resolutely refusing to be drawn away from productive work to promote undertakings in the interest of ephemeral publicity.

Those forms of public activity which look to increase of size and numbers have all the less excuse at present because many of the institutions most active in publicity ventures are already becoming unwieldily large. In 1914 twenty-eight universities of standard grade had over four thousand students, and seven had over six thousand. At the same time fourteen enjoyed an annual income of more than one million dollars, and nine had more than two million dollars. Even commercial enterprises may reach a point beyond which additional business becomes a drawback and the principle of diminishing returns begins to operate. Up to a certain limit there is a genuine educational advantage in a large student body, just as there is in variety of student types. Inordinate numbers, on the other hand, are an impediment to effective teaching, and weaken that organic group coherence which is so fruitful a factor of institutional life. Moreover, it is a notable fact that over-population of the universities, which enforces mass treatment, has developed in exactly that period when the value of individualizing instruction has come to be most distinctly recognized.

As the larger institutions approach the limit of manageable numbers the wisdom of selecting the student body by qualitative instead of quantitative standards becomes increasingly plain. To be satisfied with docile mediocrity is to miss the transcendent educational opportunity. That mediocrity tends to be the outcome where numbers are taken as the ideal was admirably shown by President Schurman of Cornell in his annual report for 1910:

> The colleges and universities of the United States address themselves to the average student, and in a democracy there will always be a strong feeling, which is also perfectly natural and just, that higher education should be open to all the boys and girls of the country who are able to pass the requisite examinations. The practise of this theory necessarily tends to make the college or university of the country revolve about the *average* student with a strong pull in the direction of mediocrity. But the student of superior endowments is apt to be sacrificed to the general average. Now it might be possible to retain the advantage of universal higher education for all who are qualified to enjoy it without sacrificing those youth of superior or extraordinary endowments among whom will always be found the men who advance civilization, who move the world forward in the course of progress. Those glorious "sports of nature" (to apply Darwin's botanical phrase to corresponding human beings) have in their unique endowments the possibility of higher things for their species, provided only it is developed by favorable environment and suitable training. Why might not Cornell University become the peculiar nursery of such promising spirits? A seminary for the aristocracy of talent would be the highest and noblest institution in the world. And no other service to democracy could compare with this; for to form the mind and the character of one man of marked talent, not to say genius, would be worth more to the community which he would serve than the routine training of hundreds of average undergraduates.

Isolation, selection and concentration are the urgent calls on present educational statesmanship; isolation from the routine details of vocational or administrative processes; selection of the most productive lines of effort and the most promising students; concentration of resources on the fields and students so chosen. Such a program seems at first blush to smack of detached and self-centered exclusiveness. But, rightly understood, academic isolation has nothing in common with ivy-clad cloistral seclusion. Between the serene aloofness of the cloister and the vociferous publicity of the market place is a zone of quiet industry where the best of the world's goods are created. Here the expert scholar takes his place with others of the labor group. Perhaps more than any other he has preserved the ancient pride of craftsmanship. If he is a little finicky about the quality of his work it is because he expects to have that work judged by fellow-craftsmen who know good product when they see it.

Something was said before about the pathological reactions of specialization. Granting that a too narrow range of activity breeds a natural discontent, it is still true that only by giving himself unreservedly to his chosen work can the scholar be either permanently satisfied or really useful. The academic scholar's objections to garish publicity may be compressed into two. Through it he is distracted from congenial work, and where it is insisted on he is forced to advertise by means of his poorer rather than his better achievement. It ought normally to be one of the peculiarly fine attractions of the academic career that men may work at what they can do best, and that they shall be required to turn out only work of a quality which approaches as nearly as is humanly possible their own ideal of excellence. Herein the artist or the literary man are often more hampered, in that they may have to consider the exigencies of the commercial market upon which their livelihood depends. Scholars must, indeed, reconcile themselves to falling a little short of Goethe's transcendental ideal,

> Uns vom Halben zu entwöhnen,
> Und im Ganzen, Guten, Schönen
> Resolut zu leben,

but unless overborne by importunate outside pressure they may fairly aspire to dodge Carlyle's growling malediction on cheap and nasty products:

> No good man did, or ever should, encourage cheapness at the ruinous expense of unfitness, which is always infidelity, and dishonorable to a man. . . . They are not permitted to encourage, patronize or in any way countenance the making, weaving or acting Hypocrisy in this world.

Forty years ago Johns Hopkins began the publication of scientific series wherein appeared such results of scholarly research as might not have been commercially profitable if published through the ordinary channels. More than thirty institutions have since followed this lead with series of varying grades of excellence. It is true that President Gilman in his later years expressed a fear that the Hopkins example has not proved a wholly fortunate one in that too many series have been started, but the fact remains that, besides their service in making scientific results more generally available, these series have appreciably stimulated research. In this case the universities are turning out a product which is both characteristic and dignified.

Outside of this purely scientific activity, designed for a public composed chiefly of scholars, there are many features of academic life which, because they have legitimate and general news value, are calculated to bring the institution to public attention in a truly representative light. By holding resolutely to these the amount of publicity would certainly be lessened, but it would be of a quality calling for no apology. Self-respect is the only sure and permanent guarantee of public respect. The difficulty about special feature stories and similar methods of attracting public attention is that their appeal is made through non-essentials, and the interest they arouse must be continuously prodded with fresh stimuli. Like the less solid type of journalism, educational self-exploitation dare not for a moment relax for fear of bankrupting interest.

Of course it is not within a university's power to control the whole output of its news or to greatly modify public demand for the more trivial sorts, for news has become a commodity with market value. What is possible in the way of regulation is the withholding of official sanction from those news-making enterprises which do not fairly represent what the university stands for. Intercollegiate athletics offers a case in point. Who, for example, is responsible for the fact that the press gives three inches to an intercollegiate debate or a scientific congress and three columns to a football game? The university casts the blame on the press, the press passes it over to the public, the public professes to believe that the university wants this kind of advertising, and so the vicious triangle is completed. No reputable institution does in fact rank athletic prowess on a par with, let us say, love of good literature, but very few have seriously attempted to do away with the public's nonchalant skepticism on this point by formally annexing and rigorously governing this troublesome border province of Philistia.

Even such intrinsically wholesome publicity as comes through publication of scholarly work does not entirely escape the danger of deterioration. The quantitative measure of publication, as also the frequency measure, is in itself hardly an accurate test of academic fitness. To appoint or promote a man solely on the quantity theory is, for one thing, to discount teaching efficiency, which even to-day may still be held to take high if not premier rank as an educational asset. That the publication test is as a matter of fact responsible both for impoverished teaching and for much shoddy and immature work getting to press is a fact of academic life hardly to be denied. The man who must "advertise his university" by constantly appearing in publishers' announcements will naturally turn out work which he knows to be short of his best, but which he dare not withhold. Education has occasionally, and not always to its advantage, taken lessons from business; here it has strangely ignored a pertinent example. Hasty production, and quick marketing with a rapid turnover, are sometimes bad business policy. Some goods require a deliberate process of production and some acquire augmented value through storing and seasoning.

In both purpose and method educational publicity must differ from commercial advertising because the central purpose of education is impartive and not acquisitive. Unvexed by the need of immediate gain, the educational process can hold over its accounting until such time as the larger audit of social progress is made. Unless it renounce its high mission of preparing and storing the instruments of progress the university must often be an apostle of the useless. It must at times become the home of unpopular causes and the warehouse of unmarketable goods, for science is usually born before its time so far as market values are concerned. To it falls the task, hardest of all for egoistic human nature to accept, of laying subterraneous foundations upon which in after time will rest visible structures in which it can claim no conspicuous share of credit.

Despite clamant protests from the commercial mind on the one side and pearly visions of the utopian cloud-treader on the other, the university must remain frankly academic. It must do this because thus alone can it save itself from disintegration and conserve its organic efficiency for the service of society. It is possible to conceive of an educational agency which might devote itself wholly to promiscuous public activities, but it is not easy to imagine such an institution as long retaining capacity for worthy scientific achievement. Once for all higher education must choose its contacts and outlooks, which are not at all the contacts and outlooks of the general store or mail-order house. As the present chaotic situation in higher education gradually clears up many undertakings now stridently urged for its acceptance will doubtless be found unable to show cause, and others will have been definitely assigned elsewhere. Nor is it especially likely that present refusal to go over to the Philistines will in the long run turn out to have been either very perilous or very unprofitable, for the mass of men do yet instinctively respect learning and wish it prosperity.

MOTIVES FOR THE CULTIVATION OF MATHEMATICS

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THE fundamental motives for its cultivation mathematics shares with the other sciences; for they and it are equally creations of the mind and derive their characteristic qualities from the mind, subject to varying color due to the differing materials. Motives which are special to the science of mathematics, if they exist, are less fundamental and are personal rather than general in their nature. In the light of the subject matter of mathematics the basic motives may exhibit a different color or a different mutual relation from that to be observed in the light of another particular discipline; and this variation may be worthy of special consideration. In a particular age or country the general motives may operate in unbalanced proportion so that an analysis of the situation may reveal improper tendencies which demand correction. It is for the purpose of ascertaining what changes, if any, are desirable in the distribution of motive as it now operates in the cultivation of mathematics in America that the considerations of this essay are presented.

It may be possible to classify motives into logically distinct groups so that there are no omissions and no overlappings; but it serves better our purpose to divide them into classes not mutually exclusive, classes among which there are vital connections analogous to those among the various parts of a living organism. It appears also that this is the better way to exhibit the science in its true aspect as a thing of life, growing under the action of ever-varying forces and impulses.

Probably the most fundamental impulse for the advancement of knowledge is that which grows out of the pursuit of truth for truth's sake. We are fundamentally so constituted that we delight in knowing for the sake of knowing. It is hard to describe this motive, or even to conceive it, in other than a vague way. It is our most abstract and our most general motive. It actuates most powerfully our choicest spirits, moving them sometimes with a fervor akin to that of religion. A marvelous curiosity to know creates a longing which can be satisfied only by knowledge. It projects itself into the unknown and leads the researcher in ways yet untrodden to a goal which can not be foreseen. At the outer boundary line of knowledge, faint glimmerings may be detected in the darkness of ignorance beyond. What beckons us forth we do not know. Whether it can bring us any good we have no means of foretelling. It may lead us to a tragical something which will make it necessary for us, in much pain, to cast away some of our most cherished prejudices. But, whatever lies beyond in that which is concealed from our present vision,

We work with this assurance clear,
To cover up a truth for fear
Can never be the wisest way;
By every power of thoughtful mind
We strive a proper means to find
To bring it to the light of day.

Delight in the beauty of truth is a central incentive to its study and creation; and this operates with a unique and peculiar power in the cultivation of mathematics. In some respects its beauties are peculiar to itself and require the trained mind to perceive them, just as the deeper beauties of music (for instance) are perceived only by the practised ear of the musician. A much larger proportion of the excellencies of mathematical truth can be enjoyed by cultivated people in general than is usually supposed; but we still lack the exposition suitable to make this manifest. Both for the individual mathematician and for mankind at large a second fundamental motive for the cultivation of mathematics is that which grows out of the pursuit of high esthetic interests.

The leading characteristic of man is the power to think. There is nothing of higher esthetic interest than to determine whether we can think consistently. This fundamental question can be answered in the affirmative only by exhibiting the result of consistent thinking. The existence of mathematics gives the spirit of man leave to believe in itself, since here admittedly is a body of consistent thought maintaining itself for generations and even for millenniums.

But man is not all spirit. We can not live by intellectual delight alone. We have to get around in a world which has trees and stones and mountains and rivers, and shifting currents of force, and even living things which dispute with us the possession of the earth or are used by us for food or beasts of burden. Many of these opposing forces are physically far stronger than we. If we are to control them it must be through a superior knowledge of them and of our common surroundings. This knowledge is necessary to our welfare. Thus as a third fundamental motive for the cultivation of mathematics we have that which grows out of the pursuit of means for interpreting and understanding our environment.

It is obvious that a single piece of mathematical work may be undertaken from considerations arising at once from two or from all of these three fundamental motives. There may be involved simultaneously the pursuit of means for interpreting and understanding our environment, the pursuit of high esthetic interests, and the pursuit of truth for truth's sake. But it seems that there is no other motive of fundamental importance which is not included in these, either separately or conjointly. That which finds its place here least naturally, perhaps, is the play motive which has certainly operated with considerable force among a few persons who have cultivated mathematics in the spirit of amateurs. But so far as a thing of this sort has been a fundamental motive in the general development of mathematics it may be associated with the delight arising from esthetic considerations or from the desire to know merely for the sake of knowing.

Even such an ideal motive as that arising out of the pursuit of truth for truth's sake has in it elements of danger, owing partly to the lack of clear definition of what is involved in it. It is easy to give it glibly as one's fundamental motive and so conceal from oneself a lack of thought on the matter or the lack of deep reality or genuine sincerity in one's motives. On account of its vagueness it may give rise to a sort of mysticism which does not consort well with scientific ideals. It runs the risk of becoming a fetish, an object of excessive devotion, and of drawing the veil over necessary distinctions in the values of truths. A catalogue of all the truths in the universe would probably be useless to limited beings like ourselves. The totality is so vast that we can not comprehend it or get about among its parts. We need some means of ascertaining what truths signify something for us, as we should otherwise be lost in the maze of all that is true and be unable to extract what is of value to us. In the pursuit of truth merely for truth's sake there is danger of giving attention alike to what properly concerns us and to what is without distinct relation to any of our needs. We require other motives to operate in the way of helping to direct our activities.

The demand for simplicity and elegance in the pursuit of esthetic interests in science may tend to render labor effeminate. Mathematicians must attack difficult problems with the zest of red-blooded vitality. They must not be repelled by complexities and inelegancies. The problem which is confronted in the search for truth must be solved, even though it be by tedious means and with results hard to understand. To be sure, "a thing of beauty is a joy for ever;" but nothing is a thing of beauty which is merely so. That beauty is not permanent which is its own entire excuse for being. In scientific truth there is a need of sincerity and high purpose back of the creation of anything of beauty. To pursue truth merely and solely for the sake of esthetic delight tends to induce in one an admiration for the tinsels of knowledge and a joy in its more superficial elements. The greatest delight in the beauty of truth flows from its unfolding as an incident to the creation of values of profound import to mankind.

Gross utilitarianism is the obvious danger which arises from the pursuit of means for interpreting and understanding our environment. If we start out to create truth for the sake of its applications we take a one-sided and narrow view of it. By circumscribing our vision we fail to see the connection of related parts and our progress is soon brought to an end. Nature does not yield her secrets to him who seeks them to supply his immediate grosser needs; she rewards only a more idealistic purpose.

Worse than any of these dangers incident to an improper emphasis on the general motives is that arising in the case of an individual or a nation from false or selfish motives. From the ore of thought important truth can usually be extracted only under the heat of a glowing zeal, when the mind is surcharged with that determination which arises from strongly motivated activity. Work which proceeds not at white heat is coldly done and possesses not the fire of vitality. The mind can be brought into this fit attitude and activity only by means which are in accordance with its fundamental ways of working. A motive growing out of the desire for selfish values inspires no such state. Only minor results may be achieved under such a spur to activity. The young researcher who looks forward to a career of useful discovery should regard the cultivation of high motives in his own mind as one of his primary and most important duties. If he is not already moved by the higher considerations, there is little hope for him; if these now operate powerfully in his thought, let him seek means to develop them more fully, let him meditate upon the things of higher importance and more profound value so that these shall ever renew and build up in him ideals of the nobler sort. One can not successfully woo the science of mathematics (or any other science) except under the inspiration of high motives. She refuses to consort with sordid aims. She can be happy only with him of high ideals who cherishes her nobler qualities; and only to him will she yield her increase for the blessing of mankind.

Over against the dangers arising from an unbalanced emphasis on the fundamental motives are the peculiar advantages due to those activities which are inspired primarily by each of them separately. In pursuing truth for truth's sake we solve hard questions by the best methods we may; but we solve them, or else we keep them before us as an ever-present incentive to the creation of new methods of conquest and power. Difficulty never turns us aside, except temporarily while we seek new means of progress or investigate adjacent fields. The absence of apparent esthetic satisfactions is no bar. If we can not find the truth which delights us with its elegance and beauty we will ascertain the best possible. We shall brood over its incompleteness until we find a way of bringing it to perfection. If the matter connects with things which appear to us vital we shall pursue it to the end regardless of practical utility of any sort. An inner spring, a necessity of our being, impels us in this direction. We are fortified in the desire to follow up our inclination here by the observation that our predecessors in laboring under a like impulse have often found results necessary to the realization of other desired ends. The unknown is too mysterious to be charted in advance. For the best means of penetrating it we must trust largely to our blind instincts, modified perhaps by past experience but still maintaining their central characteristics. In this way we not only acquire new truth, but we also develop new methods of discovery, the most elusive thing in scientific progress. A method discovered in one field under the fire of a blazing zeal enables us to surmount elsewhere other difficulties of more immediate concern, perhaps, but lacking an element which brings us in the consideration of them to the highest state of concentration and creative activity.

In pursuing esthetic satisfactions we create a beautiful theory for the sake of our delight in it, as in the case of the theory of numbers or of abstract groups. Working in such fields with the simpler elements of mathematical thought we make progress of a sort not at first possible with the more complex materials. We bring the theory to a higher state of perfection; there are fewer lacunæ; the connections of the various parts are exhibited with clarity; we have a sense of having seen to the root of the matter and having understood it in its basic characteristics. The theory thus developed becomes an ideal in the light of which we get a new conception of what should be attained in other fields where the labor and the difficulty are greater. Results in one field of mathematics may thus become of great value in a totally different range of mathematical ideas or even in other disciplines altogether. Moreover, when such progress is attained we often find that the tools employed in bringing it about are sufficient for dealing with more difficult matters, so that the one completed theory furnishes us not only the ideal, but also the means for further valuable progress.

A characteristic delight in mathematical truth is that which arises from economy of thought realized through the creation of general theories. When we develop the consequences of a set of broad hypotheses we find that our results, which are attained by a single effort, have applications at once in many directions. Thus we see the common elements of diverse matters and are able to contemplate them as parts of a single general theory pleasing for its elegance and comprehensiveness.

Whether we like it or not, the evolution of humanity is a part of the cosmic process. Investigation shows that it has been so in the past. All the means by which we explain development point to the conclusion that it will remain so in the future. Since we are a part of the cosmic process, our greatest good comes with our best understanding of it. Our direct and unaided intuition does not lead us far toward comprehending the complexity of our environment. We have not the power to see directly into the explanation of things or even to devise representations of phenomena. We must seek means to assist our weakness in overcoming the difficulties of understanding. We can afford to omit none which yields, or which promises to yield, useful assistance.

Mathematics has shown itself a valuable tool in the interpretation of phenomena. It has been successful to a marked degree. It is marvelous what sorts of things come within its scope and what connections it exhibits among them, as, for instance, in celestial mechanics, rational mechanics, kinetic theory of matter, and the theory of electricity and magnetism, to mention only a few. Through the help of mathematics we gain an increased control over nature, to our comfort and perhaps to our happiness. Through this we are able to supply our bodily wants more readily and therefore have greater freedom for meditation on the deeper things of existence—those things which we have not yet been able to bring under the domain of exact science, however vital they are to our general and to our individual development.

This contact with nature gives mathematics itself a fresh strength and a changed direction. Excursions into the domain of applications enrich the science with new conceptions, new problems and new methods. This is borne out by the history of the past, both the remote and the more recent. It is especially noticeable in the creation of some of the most important disciplines and in the activity of some of the most renowned mathematicians.

It is instructive to consider the distribution of motive in the work of certain of the greatest mathematicians. We select a few from different ages and fields of mathematical activity and of varying temperament. The list of course might be greatly extended; in fact, this is done to some extent in our later consideration of certain specific topics. Those here chosen may perhaps be taken as representative of the class of mathematicians of leading importance.

We begin with Euclid. To what extent he was an original investigator is unknown; but he must have made important contributions, since otherwise his *Elements* would not so quickly have supplanted the work of his predecessors. He gave his writings a good form from the point of view of logical connection and also of pedagogical excellence. It is clear that he took delight in the beauty both of the content and of the form of his work and that he developed it primarily from the love of truth for its own sake. But his geometric postulates are what he believed to be the obvious properties of space, either of experience or of contemplation; and this part of his work may therefore be looked upon as a contribution to the study of that space in which all phenomena have their being. Still it is certain that our three general classes of motives did not operate in balanced proportion in actuating the work of Euclid, at least if we agree that the normal situation is that in which they should receive approximately equal emphasis.

Archimedes was probably the greatest mathematician of antiquity. He was inspired primarily by the love of pure science, rejoicing in the truth because it is the truth and feeling a certain contempt for the applications of truth in the way of supplying our grosser needs; and yet he was a great practical inventor and had a wide range of knowledge of phenomena, and frequently gained new strength by his contact with nature. He founded the theory of hydrostatics and contributed effectively to the initial development of mechanics and of astronomy, so that he is to be reckoned as an important figure in the history of applied mathematics even though it is true that his leading title to fame comes of his work in pure mathematics. In him we have another instance of contributions of high value associated with an unbalanced emphasis on the fundamental motives.

Fermat seems to have cultivated certain parts of mathematics for the pure love of their beauty. Probably he was hardly conscious of motive at all, since his activity was so nearly spontaneous. He made important contributions and inspired great advances, primarily in the way of new impulses to certain isolated studies.

Newton was undoubtedly moved primarily by a desire to understand and interpret natural phenomena. To this motive therefore we owe his invention of the differential and integral calculus (shared with Leibniz), the founding of celestial mechanics and rational mechanics in general, and the consequent development of applied mathematics in many fields of science.

A very few individual men have stood out among their contemporaries as admittedly the greatest mathematicians of their respective ages and have had the good fortune to have this verdict sustained by later generations. Euler was one of these. His prodigious activity and the penetrating character of his ideas have been alike the admiration and the inspiration of his contemporaries and successors. He has touched almost every department of mathematical science and most modern subjects in mathematics (both pure and applied) are affected by one or more streams of influence from his genius. He was actuated by all three of our general motives. From his memoirs one may select typical cases of work actuated primarily by any one of our three classes of motives or any combination of them. Taken as a whole his work holds a just and balanced proportion among them. No man before him seems to have given so nearly equal emphasis to each of the three fundamental motives, and no one has ever maintained a more vital and vigorous enthusiasm enduring over so long a career of investigation. It is significant that this balance of emphasis was coupled with discoveries of the greatest range and magnitude and influence and importance.

The case of Gauss affords another instance where the three motives worked in proper proportion, and also another instance of one holding a place of preeminent importance and influence. He was inspired by the beauty of pure truth as exhibited, for instance, in the theory of numbers; he sought a deep and penetrating understanding of things for its own sake, as in his meditations on non-Euclidean geometry; he devoted much attention to the interpretation of natural phenomena, as in his study of electricity and magnetism. The range of his influence on the further development of mathematics has been as great as the variety of motive inspiring his work. He, as well as Euler, teaches us the value of balanced emphasis in motives, at least for those who are prime movers in the development of modern mathematical science.

Poincaré is the latest example of one to stand out definitely and admittedly as the greatest mathematician of his time. He was actuated by all three motives in balanced proportion. He made fundamental contributions in many fields both of pure and of applied mathematics. No one can look at his work without seeing how he rejoiced in the beauty of truth. He has left on record a statement of his profound delight in science as the means of seeing, of knowing, and he has emphasized the fact that after all it is knowledge and insight alone which count. In the introduction to his first note on Fuchsian functions he says: "The aim which I propose . . . is to ascertain whether there exist analytic functions analogous to elliptic functions and suitable for the integration of linear differential equations with algebraic coefficients." It is known that his interest in differential equations was largely affected by their use in applied mathematics, so much so in fact that he was depressed when certain recent physical theories seemed to imply that differential equations are not so fundamental to the understanding of phenomena as he had supposed. Moved by the most profound motives and of the widest variety, operating over an extremely wide range of material, employing ideas of the most penetrating character, and applying his results in many directions, Poincaré stands out as the leading creator of mathematical truth in the past half century and one with few equals in the history of mankind.

Poincaré exhibited also a tendency, more marked in him perhaps than in any other mathematician, to consider a range of ideas which should probably receive increased attention owing to the growing complexity of modern mathematics (and science in general), namely, the tendency to analyze the elements of our progress in the light of broad philosophical principles. What we believe concerning the nature, the meaning, and the value of the truth with which we are concerned has a profound effect upon the operation in us of the motives for its creation.

If the illustrative cases which we have adduced are to be taken as typical of the best work in mathematics—and we have tried to make them so—they would seem to teach, among other things, that with the growth of mathematics there is a growing necessity for a proper distribution of motive in the work of the individual thinker if it is to maintain a place of preeminent importance in the development of the science. In the case of a nation or a people the same thing appears to be true in general. Early in its history a science may develop in parts in a one-sided and unproportioned way. But when it attains to maturity and each new advance must rest on a large body of results previously derived it is of increasing importance that a balanced distribution of motive be maintained.

It is instructive also to examine the distribution of motive in some of the most important subjects of recent progress, following the development without reference to the individuals by whom it has been brought about. To me it appears that the greatest recent advances have been made in the domain of analysis—in territory either directly belonging to it or closely connected with it by association—and that in this field are likely to arise our most fruitful investigations in the near future. Here we have a wealth of outstanding problems of broad character and of far-reaching importance. If it is so in algebra or in geometry, I am not aware of what these problems are. For this reason I have chosen the following illustrative topics primarily from the field of analysis.

Nothing is more characteristic of the modern element of rigor in mathematics than the theory of point sets. Viewed in its relatively completed state, it seems to be well removed from all considerations pertaining to an interpretation or understanding of our environment. In some aspects it seems almost to be merely a set of logical exercises created for themselves. In every way it has the appearance of a body of truth developed for its own sake under the impulsion of a desire to see the inner meanings and beauties of things where the intuition is in a large measure helpless. But a study of the chain of causes which led to the development of this theory carries us back to Fourier's investigations in the distribution and flow of heat and the fundamental function-theoretic questions which were brought into prominence in the discussion of his work. Thus we find all three classes of motives operative here, though one of them appears in a concealed form which is brought to light only by an examination of the history of the subject.

The extraordinary activity manifested a few years ago in the rapid development of the theory of integral equations was brought about by the conjunction of all of our classes of motives. The theory is elegant, and the body of truth developed is pleasing in its character and in its relative independence as a unit together with the many connections between it and other disciplines, and it has numerous direct applications to the interpretation of physical phenomena.

Many influences have operated to compel mathematicians to enter upon a study of functions involving an infinite number of variables. Our most simple means of representing general classes of functions of a single variable bring us to consider at once an infinitude of elements. The power series representation of a function, for instance, exhibits it as depending upon the infinite number of coefficients in such a representation; and it is natural to consider how its properties depend upon and vary with those of these coefficients. A like problem arises in connection with the Fourier expansion and with many others. When one is embarked upon the study of functions of an infinite number of variables he cannot avoid the extension of his geometric conceptions so as to involve an infinite number of dimensions. The two things go together and afford mutual illumination. It is pleasing to see properties first developed for the finite case carried over to the infinite case, and our conception of the beauty of the system of truth is greatly enhanced when we see it in all the reach of its validity holding at once for all finite cases and for the infinite case. Naturally there are properties which distinguish and separate the finite from the infinite, so that some of them may be thought of as characteristic of the one and some of the other. We understand each of them better by seeing their analogies and differences, and thus we penetrate into a more satisfying realization of the nature and significance of the truth developed.

It is easy for one who has not meditated upon this matter to suppose that these are merely intellectual exercises with no other value than what is incident to the intellectual delight in them. But this is far from the truth. In fact, the phenomena of our environment have pressed these things upon us for a long time. Physical considerations brought us against the problem of an infinite number of variables long before we had any mathematical methods suitable for dealing with it. Let us take the intuitionally simple case of the motion of a uniform flexible string of given length and weight. This can be specified only by an infinitude of variable quantities, or coordinates, each depending on the time. In fact, physical phenomena usually depend in this way on an infinite number of variables. Lagrange's generalized coordinates furnish us one of the best and most remarkable means of studying motion—and it is to this that we try to reduce our interpretation of all physical phenomena. The Lagrange coordinates are finite in number for the simpler cases, but are infinite in number in the more general situations of nature.

For the development of the theory of functions of an infinite number of variables, both in the past and in the future, we have therefore the strongest sort of motives growing out of the beauty of the theory, the love of truth for its own sake, and the desire to understand better the environment in which we live. For this reason we may be sure that workers will be attracted to this subject and that it will have a great development, notwithstanding its inherent difficulty. We shall find after all that much of it is elegant and many of its complexities will disappear in the light of the leading results which we shall attain.

Other progress in the same direction and under like impulses has been realized recently in the development of a theory of functions of curves and spaces. Again it is the physical considerations which have forced the problem upon our attention. This time it is the mathematical physicist who has formulated the new problem and laid the foundations of the consequent theory. If he seeks to study the potential due to an electric current in a fine wire—to take a simple case—it is clear that he has to do with a quantity which depends upon the shape of the wire and is varied by changes in the relative position of its parts. It turns out that there is so much of novelty connected with this new type of functions that some of the fundamental notions, such as that of derivative, for instance, are to be defined in a way not at first obvious. We are thus forced to a fresh analysis of the basic ideas of function theory in the light of a new body of material in which they are to find their use. This will certainly lead to a deeper understanding of these ideas and a more comprehensive view of the body of truth in which they are significant. To an unusual degree our curiosity is piqued to know the lay of the ground here and the direction in which the subject will develop. Already we are assured of its value owing to its many connections; and the concourse of all fundamental motives in a marked degree assures us of workers for the field and consequent progress of far-reaching character.

It is desirable for us to consider also the distribution of motive at certain periods of great mathematical advances in the more remote past. If we choose typical instances we shall be able to get some conception of the change of emphasis in motive and shall be able to see how the earlier is related to the more recent as put in evidence by the instances which we have just examined.

So far as mathematics was developed at all among the Egyptians it is clear that it was done in a crude way and essentially for its immediate practical uses. Such a spirit could not release a penetrating study and the consequent insight. It remained for the Greeks to rise to the higher motives associated with the love of truth and beauty and to lay the broad foundations of the science in the spirit which animates it to the present day. Due either to revulsion from the short-sighted vision of the Egyptians or (more likely) to the temperament of the Greeks themselves, the latter too largely ignored mathematical science in its aspect of usefulness in understanding the environment, giving their attention almost entirely to other matters.

The new point of view brought with it wonderful advances, but involved also certain elements to stand in the way of a continued and unbroken development.

The discovery of the existence of irrational magnitudes marks a significant event in the intellectual history of mankind. It was a matter of grave concern in the philosophical system of the Pythagoreans and for a long time they kept to themselves the awful and astonishing secret. In pursuing our study of these quantities (even down to the present day) we have been actuated primarily by the love of truth and beauty. No actual measurements of objects can reveal the presence of these irrational quantities, though it is easy to satisfy ourselves logically of their ideal existence. Only a part of our general motives are operative in their study.

The establishment of a vital and close connection between algebra and geometry was, in the mind of Descartes, a part of his search for a universal mathematical science which was to be only the prelude of a universal science of an all-embracing character. It grew out of a love of truth for its own sake. In geometry we seem generally to have emphasized this motive. It was so with the ancient Greeks, with Descartes, with the rise of modern pure geometrical methods, and with much of the recent development of the geometrical sciences. It is due to the inherent nature of this field of thought.

In the rise and development of the infinitesimal calculus we have a different state of affairs. Here there is scope for the vital activity of all three classes of motives and they have ever been conjointly in evidence. This is due in part to the extreme breadth of reach of the fundamental ideas of the calculus and in part to its peculiar fitness for the interpretation of motion, the basic element in terms of which we seek to interpret natural phenomena. That which grows out of the calculus and is intimately related to it is the most characteristic portion of modern mathematics and is primarily that which gives to it its large measure of importance. It is significant that it is also just the portion of modern mathematics in which our three classes of motives operate in the most nearly balanced proportion.

In the theory of functions of a complex variable, which is essentially an outgrowth and extension of the infinitesimal calculus, we have a field of truth which is rich in extent, in beauty, and in the quality of furnishing a means to interpret natural phenomena. In its initial rise, in its main features of interest, in the introduction of new ideas into it, and in its widening ramifications, we find constantly that activity which grows out of an intimate blending of the three general classes of motives.

It is the choice part of the most typical field of mathematical activity and illustrates beautifully the proper union and emphasis of motives.

The foregoing analysis of the work of a few mathematicians and the distribution of motive in the development of certain topics brings to notice three facts which are significant in this study: in the more recent mathematical work we have a definite tendency toward a more nearly equal emphasis on the three general classes of motives than is to be found in the earlier stages; this tendency is most marked in the more characteristic portions of modern mathematics; and this is true particularly in the case of the greater recent developments, especially of those in connection with broad general conceptions such as are present (for instance) in the theory of functions of an infinite number of variables and of functions of curves and spaces. This doubtless reveals a growing necessity incident to the greater complexity of the problems and the larger body of known truth on which the new discoveries must rest.

In our brief survey we have noticed how the greatest mathematical workers and the most important fields of mathematical thought have had an intimate connection with the interpretation of natural phenomena. England and France and Germany are the countries in which the most important and preeminent mathematical progress has been maintained for a long period of time coming up to the present. They have had workers actuated by all three of our fundamental classes of motives and a fairly well-balanced emphasis has been maintained among them. The cooperation of each with the others seems to have been essential to the progress effected. So far as mathematical research is concerned the English have leaned strongly towards its practical aspects, so much so in fact that they have suffered somewhat in their contributions; but in the last years there has been a growing tendency among them to correct the evil. In Germany all motives have operated strongly. Owing to the fact that the German university system teaches not only knowledge, but also research, no other country can show so many individual workers nor such a tendency to congregate into schools. Naturally, this is associated with much attention to minor problems and the doing of a large proportion of the drudgery incident to scientific progress. Fruitful ideas do not arise there as spontaneously as in some other countries, but no other people have shown a greater genius for developing the detail in connection with a leading fundamental idea once introduced. Mathematical progress in France during the past century has been of a most pleasing sort. All motives have worked in beautiful cooperation and spontaneity of effort has led to the creation of many fundamental concepts. Here we see the best balance among the various motives and at the same time the most steady stream of progress. Each generation has been effective in a marvelous degree and their labors have not only enriched their own discoveries, but have also fructified mathematical thought throughout the world. Their experience and success seem to counsel the holding of a just balance among the three fundamental classes of motives.

So far, in America, we have realized progress in the pursuit of mathematical truth for truth's sake and in the pursuit of high esthetic satisfactions; but we have hardly realized anything in mathematics from the pursuit of means for interpreting and understanding our environment. This is strange in view of the distinctly practical turn of our people as a whole and suggests the opinion that we probably have an unused reservoir of strength which might become effective in the progress of applied mathematics. It is not to be supposed that a people of a practical turn of mind can produce mathematicians interested in the pursuit of ideal truth and of esthetic satisfactions and yet not have a source of strength for the development of the more practical aspects of the science. Some of our studies up to the present are adjacent to the field of applications; others are far removed from it; but very little of all that our mathematicians have done lies in the direction of a better understanding of natural phenomena.

We can not expect to maintain healthy progress by an unproportioned and one-sided development such as has characterized our work to date. Fortunately there is now a rising interest in America in applied mathematics. This should be developed and be guided into the best channels so that the work ultimately shall become of vital and far-reaching importance. By the nature of their previous work some of our mathematicians are definitely excluded from a leading part in this new development. They have devoted themselves to those fields of investigation which are far removed from the sciences of natural phenomena and therefore cannot turn their knowledge and experience to use in this direction. It is no cause for regret that this is so. In order to maintain as a people a balanced emphasis on motives we need to have individuals in which each fundamental class separately is dominant. But there are those whose labors have already led them to the borderland where pure and applied mathematics have a common boundary line. Some of these at least may step over into the adjacent field. For them to do so would seem to afford us our best and readiest means of correcting the patent defect in our mathematical progress. We have already a young national tradition of high ideals in pure mathematics; let us as soon as possible realize the creation of a worthy tradition in applied mathematics.

A survey of the character of our contributions up to the present would probably suggest that our best point of entry is into the field of celestial mechanics, where in fact we have already done something, or into the theory of the partial differential equations of physics. Our previous labors in pure mathematics seem to have furnished us with tools suitable for use in either of these fields.

Every living science has two existences: one of them is objective, as in the body of scientific literature; the other is subjective, as in the minds of thoughtful persons and students of the particular science. The first is like a material body; the second is like the spirit. The first is enduring, like a stone or a mountain; the second is like a living organism, delicate in structure and highly susceptible to environment. Both of these existences are necessary to the progress of a science; indeed, necessary to its continued existence. The primary business of the researcher is to afford science its objective existence in the body of scientific literature. It is the business of the teacher to see that science has the second type of existence. Modern mathematics is now the heritage of a select few. We ought to make its great cultural elements a common property of cultivated people. But now it is notorious that they are unashamedly ignorant of this science. Nor is the fault to be laid entirely or even primarily at their door. We teach too much the mechanical aspect of mathematical reckoning and emphasize too little the great basic and fundamental notions which give to the science its vitality.

In each generation the most important labor that can be done is that expended in the creation or discovery of new truth. But this fact must not prevent our realization that the heritage of the past is to be preserved intact and transmitted to the future, not dead as in books, but living as in the minds of men and women. Not only must the line of progress be unbroken but many collateral branches must run out in all directions into the body of society, where scientific truth may bear fruit for the nourishment of mankind. A few persons will not suffice in this work of disseminating truth; many must be provided, if the truth is to be vital in the lives of our people generally.

As far as possible each individual should give his life to labors in which his spirit delights. This is necessary to the higher sort of intellectual achievement as well as to happiness.

Unless one rejoices in the realization of the general motives already treated there is no compelling reason why he should devote himself to mathematics; at most he can be only a weary plodder, whatever station he takes. Again, unless the matter of mathematical truth in its broader aspects exercises a deep influence over his meditations his labor in that field can not be particularly useful. To devote himself to it would be to waste his life, to spend in fruitless endeavor the energy which might be valuable if employed in more congenial pursuits. But the enthusiastic man or woman of merely moderate training has a place of importance in making mathematics live in the lives of the young and thence in the lives of the older. This is a labor in which one may take delight and through which one may project an influence into the future that shall work for permanent good.

A few can go further and render a more vital sort of service. A mere modicum of creative work of fair quality is of great value in the way of increasing the vitality of the teacher. The fact that he has created will illuminate the subject for him and give a different color to his teaching. His emphasis becomes better proportioned to the relative importance of the various topics and he is able to light his subject with the glow of personal fire and touch.

A significant measure of research is particularly important in the case of the teacher who prepares text-books for use in the more advanced undergraduate courses and for the first year of graduate work. It is unfortunate when embryo mathematicians are led over the basic portions of fundamental disciplines through the guidance of a dead exposition such as will usually emanate from one who has not himself advanced the subject in question or made use of its main ideas or results in some researches of his own. In America we stand now in danger of an increased number of these expositions lacking vitality. This is due to the concurrence of two or three causes. We have now a keen realization of the fact that there is among us a dearth of elementary expositions of the fundamental subjects. Our research men are engaged so zealously in their own investigations that they have usually not taken the time to prepare expository treatments; but this is an evil which seems to be in a state of progressive correction. In many of our institutions—especially among those which have lately aspired to positions of the higher importance—there is a peculiar (and sometimes an even dangerous) pressure upon the members of the faculty to produce publications of a professional sort. Some of the persons involved have not the training or the aptitude for research.

There is a danger that an increasing number of these will seek an outlet for their activity in the production of text-books. Already we have too much of this, so far as the more elementary texts are concerned. Let us hope that we shall be able to prevent the spread of the evil to the field next higher. One satisfactory way of offsetting this danger would be afforded by a greater willingness on the part of our research men to prepare introductory treatments, each one in his own field.

It is only when one is able to devote a large share of his energy to research and is successful in the creation or discovery of important new truth that he may rejoice in the fullest glow of delight through a realization in himself of all three general classes of motives. However important the work of instruction may be in itself and however far-reaching its stream of influence flowing in hidden ways in the minds of men and women, it can not be placed in the same category with that creative work which guides instructor and student alike and teaches generations what to think. He who discovers a fact or makes known a new law of nature or adds a novel beauty to truth in any way makes every one of us his debtor. How beautiful upon the highway are the feet of him who comes bringing in his hands the gift of a new truth to mankind!

No voice I raise to magnify the man
That forms again the thought whose living fire
A palpitating spirit nobler than
His own first warmed; his toils no zeal inspire.
Of him, more worthy far, with joyful lyre
I sing, whose precious bit of novel truth,
Revealed through labors long or hardships dire,
He lays before the feet of man. In sooth
Through him the aged world retains undying youth.

No tragic note inspires this quiet song.
Abiding joy in truth is its deep spring,
And such delight as comes in labor long
To him who learns by thinking everything
His powers can clear of its dark covering.
When we the mind itself for truth entreat
Or seek the hidden laws of happening,
By worthy labors make we conquests sweet—
Conquests of one without another's pained defeat.

No danger gives the keen Researcher zest;
His languor no excitement can forestall;
No pain stirs deep emotion in his breast.
He finds delight in truth or large or small,
In those whom interest or pleasure call
Our ambient environment to scan,
In fresh control of nature's forces all

Through better understanding of her plan,
In glimpses new into the growing soul of man.

How grew the keen Researcher? How? He grew
In common ways of life to manhood's state
And felt with gladness strength to strength accrue
As each new-found experience lent its weight
To serve the old or novel thought create.
The constant play of THINGS upon his soul
Remade in him whatever was innate
And moved him with the sense of deep control
Wrought out in him by forces centering from the WHOLE.

Into his inner thought these forces come;
They bring the flavor of the world outside;
And in his inmost heart, no longer dumb,
They speak in gracious accents to confide
Their meaning, blessing him as yet untried.
Not long with him alone a truth remains;
But, redirected, moves from this new guide,
And as it leaves a greater strength attains,
But holds new character the chief of all its gains.

Thus the Researcher early learned the truth
Which entered more and more into his thought
As manhood's state in time succeeded youth
And years grew longer decades while he brought
All power of mind to bear on what he sought:
Whatever comes beneath the busy hand
Of man, on which with power it has wrought,
Goes forth transformed in newness to expand
To what it was not, gladly doing his command.

The life of man is wrought of various parts
Which hold together in complexity;
No hand is skilled in divers proper arts
To draw the line of truth upon the sea
Where waves of change surge forth in full degree.
A separated part must one procure
Where change is not too vast for him to see
Its secret, if he makes a conquest sure
Which through the ages of the future shall endure.

'Tis this the watchful, keen Researcher sees:
It guides him to a bounded field of thought;
It teaches him the need of new degrees
Of power by which his conquests may be brought
To bear on widest realms with blessing fraught.
A zeal arises in his inmost heart,
A consecration by deep purpose wrought
Absorbs his strength, his life he sets apart
To bless mankind by streams of truth which from him start.

INSECTS WHICH ATTRACT PUBLIC ATTENTION

By Professor HARRY B. WEISS

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CERTAIN species of insects are more or less continually attracting the attention of people and, while the following remarks apply particularly to the New Jersey public, there is no reason why they should not hold good for many other eastern states where conditions are somewhat similar. The entomologist of a state or experiment station is perhaps more likely to be familiar with such insects than any other agency, inasmuch as one of the duties of his position is to furnish insect information upon request and by reason of his official position, a large percentage of such requests naturally fall into his hands.

In view of the fact that 10,530 species of insects have been recorded from New Jersey, it might appear that out of this large number three or four hundred would attract attention annually, but such is not the case, as the following condensed tables will show. These tables have been compiled from the reports of the entomologist of the New Jersey Agricultural Experiment Stations,[1] for the five years 1913 to 1917, containing lists of the insects about which information was requested during the year. Such lists reflect public interest in entomology and should be fairly accurate for the purpose. The species mentioned in such correspondence naturally fall in the following groups—those injurious in the household and to stored products, those injurious or annoying to vertebrates, those injurious to vegetation and predatory species. A few additional groups could be added, but for the sake of simplicity and on account of the slight public interest in them these have been placed together in the miscellaneous columns of the tables. These tables also give the names of the orders to which the insects belong, the total number of species involved and the number of inquiries received.

It will be seen that species in orders such as the Thysanura, Thysanoptera, Odonata, Isoptera and Neuroptera attract very little attention, due to the fact that such groups contain only a

[1] Headlee, T. J., Repts. Dept. Ent. N. J. Ag. Exp. Sta., 1913–1917.

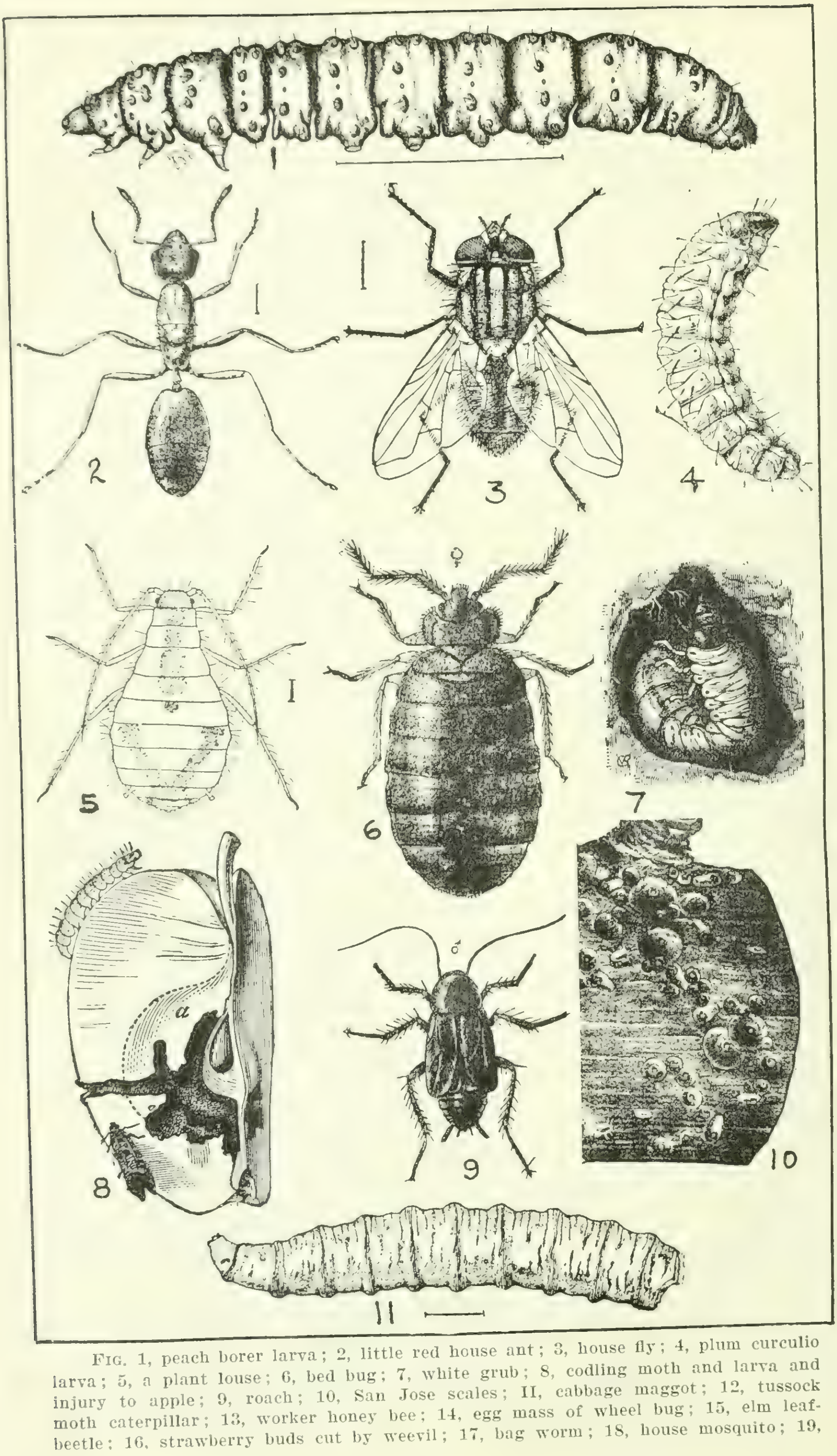
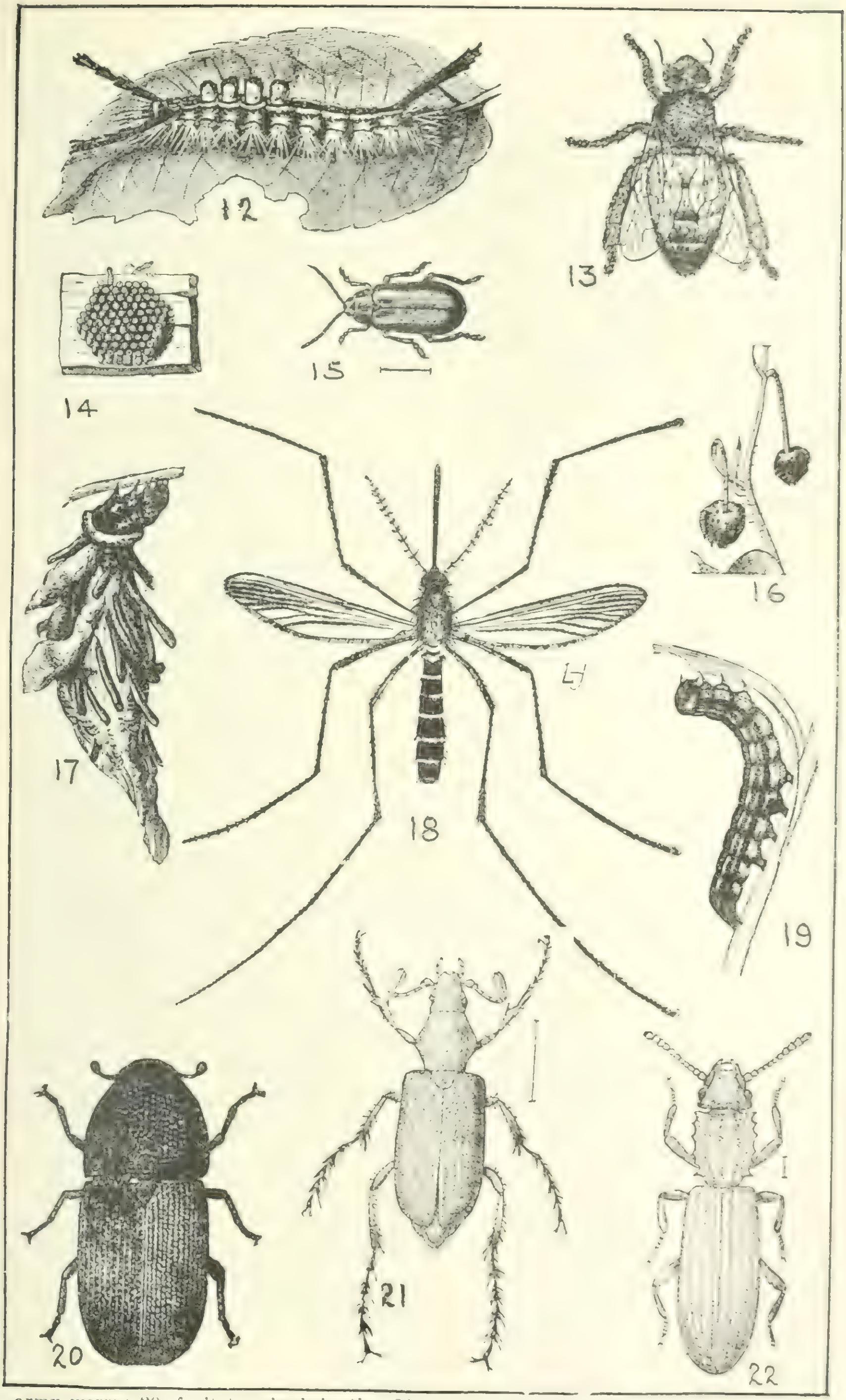


FIG. 1, peach borer larva; 2, little red house ant; 3, house fly; 4, plum curculio larva; 5, a plant louse; 6, bed bug; 7, white grub; 8, codling moth and larva and injury to apple; 9, roach; 10, San Jose scales; 11, cabbage maggot; 12, tussock moth caterpillar; 13, worker honey bee; 14, egg mass of wheel bug; 15, elm leaf-beetle; 16, strawberry buds cut by weevil; 17, bag worm; 18, house mosquito; 19,



army worm; 20, fruit tree bark beetle; 21, rose chafer; 22, saw-toothed grain beetle.
(Figs. 1, 5, 18, after Smith; Fig. 11, after Smith and Dickerson; 13, after Carr; 3, after Howard; 20, after Forbes; 10, from Bull. Virginia Exp. Sta.; 7, 19, 12, after Riley; remaining figures from Bur. Ent. U. S. Dept. Agric.)

TABLE I. 1913

Order	Total No. Inquiries	No. Species Involved	Injur. to Household and Stored Products	Injur. to Vegetation	Injur. to Vertebrates	Predatory Species	Miscell. Species
Thysanura	2	1	1				
Isoptera	2	1	1				
Neuroptera	1	1					
Thysanoptera	2	2		2			
Homoptera	158	41		41			
Hemiptera	12	5		3	1	1	
Orthoptera	7	5	1	4			
Coleoptera	84	35	7	26		2	
Lepidoptera	71	33	2	31			
Hymenoptera	16	9	1	7		1	
Siphonaptera	1	1			1		
Diptera	54	12	2	7	2		1
Total	410	146	15	121	4	4	1

TABLE II. 1914

Order	Total No. Inquiries	No. Species Involved	Injur. to Household and Stored Products	Injur. to Vegetation	Injur. to Vertebrates	Predatory Species	Miscell. Species
Thysanura	1	1	1				
Thysanoptera	1	1		1			
Homoptera	106	33		33			
Hemiptera	11	8		6		1	1
Orthoptera	8	8	3	4		1	
Coleoptera	101	49	2	44		3	
Lepidoptera	106	38		38			
Hymenoptera	16	13	2	6		2	3
Siphonaptera	3	1			1		
Diptera	27	14	2	9	3		
Total	380	166	10	141	4	7	4

TABLE III. 1915

Order	Total No. Inquiries	No. Species Involved	Injur. to Household and Stored Products	Injur. to Vegetation	Injur. to Vertebrates	Predatory Species	Miscell. Species
Isoptera	2	1	1				
Odonata	1	1					1
Thysanoptera	7	2		2			
Homoptera	125	39		39			
Hemiptera	10	7		4	1	2	
Orthoptera	14	5	2	2		1	
Coleoptera	92	36	7	28		1	
Lepidoptera	120	36	1	35			
Hymenoptera	36	11	1	6		1	3
Siphonaptera	3	1			1		
Diptera	65	19	2	12	4		1
Total	475	158	14	128	6	5	5

TABLE IV. 1916

Order	Total No. Inquiries	No. Species Involved	Injuries to Household and Stored Products	Injur. to Vegetation	Injur. to Vertebrates	Predatory Species	Miscell. Species
Homoptera.....	79	31		31			
Hemiptera	7	4		3	1		
Orthoptera	4	4	2	2			
Coleoptera	80	32	6	26			
Lepidoptera	75	32	1	31			
Hymenoptera...	26	11	1	7		1	2
Siphonaptera ...	4	2			2		
Diptera........	54	17	1	14	2		
Total........	329	133	11	114	5	1	2

TABLE V. 1917

Order	Total No. Inquiries	No. Species Involved	Injur. to Household and Stored Products	Injur. to Vegetation	Injur. to Vertebrates	Predatory Species	Miscell. Species
Thysanura	1	1	1				
Thysanoptera...	1	1		1			
Homoptera.....	190	36		36			
Hemiptera	10	6		4	1	1	
Orthoptera.....	17	8	1	5		2	
Coleoptera	110	33	5	28			
Lepidoptera	150	48	1	47			
Hymenoptera...	40	11	3	3		2	3
Siphonaptera ...	6	2			2		
Diptera........	67	21	1	16	2		2
Total........	592	167	12	140	5	5	5

comparatively small percentage of the total number of species in all orders and because of the relatively few injurious species in them. Most of the species which attract the attention of the people are found in such orders as the Homoptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera, with the first three leading. These three groups include a large percentage of forms which feed upon vegetation, while in the Diptera and Hymenoptera the percentage of injurious species is smaller.

The striking thing shown in all of the tables is the small number of species involved, considering the number of injuricus forms in each group. Thus of the Homoptera, with a total number of recorded species in New Jersey of 507, with all of them feeders upon vegetation, only from 31 to 46 species attracted attention. The number involved in the Lepidoptera varied from 32 to 48 and this order contains at least 2,000 species, which are feeders on vegetation in a recorded number of 2,120 in New Jersey. Of the Coleoptera, with its 3,000 recorded species, 1,200 of which are injurious to vegetation, the number attracting attention varied from 32 to 49. The same thing is true for the remaining orders.

TABLE VI

	Total No. Inquiries	No. Species Involved	Injur. to Household and Stored Products	Injur. to Vegetation	Injur. to Vertebrates	Predatory Species	Miscell. Species
1913	410	146	15	121	4	4	1
1914	380	166	10	141	4	7	4
1915	475	158	14	128	6	5	5
1916	329	133	11	114	5	1	2
1917	592	167	12	140	5	5	5
5-yr. average . . .	437	154	12	129	5	4	3

Table VI. is a partly summarized account of the preceding tables and shows the five-year averages. Thus from a five-year average of 437 inquiries only 154 species were involved, 129 of which attracted attention because they were injuring vegetation, five because of their annoyance or injury to vertebrates and twelve because of their trouble in the household or to stored products. The average number of four species in the predatory column probably attracted attention because they were thought to be injurious and the same is true of most of the three species in the miscellaneous column, these representing wasps, bees and parasitic forms in both Hymenoptera and Diptera.

The relationship between the number of inquiries and the number of species involved for the five-year period is shown in Chart I. The "species involved" curve shows very little variation, while the "inquiry" curve is very irregular. This is due to the fact that an outbreak of a certain species or several species will add materially to the number of inquiries but not increase the number of species very much.

Among the species involved in each group, a small number attracts most of the attention. In the Homoptera they are plant lice and scale insects, the plant lice being those infesting orchard trees and garden plants, the scales being those found commonly on fruit, forest and ornamental trees. In the Hemiptera, the bed bug and squash bug appear to be popular, with several species of leaf bugs holding second place. The eggs of the wheel bug (*Arilus cristatus*) and one or more species of assassin bugs, which also are predatory, usually receive some slight attention, due to the fact that they are thought to be injurious. More species are involved in the Coleoptera, but the public favorites are white grubs, wire-worms, plum curculio, bean weevil, potato beetle, potato flea beetle, elm leaf-beetle, rose chafer, strawberry weevil, asparagus beetle and fruit bark beetle. Similar conditions exist in the Lepidoptera, the species attracting most attention being the corn-ear worm, apple tree tent-caterpillar, peach borer, cut worms, tussock moth, bag-worms, codling moth, cabbage worm, army worm

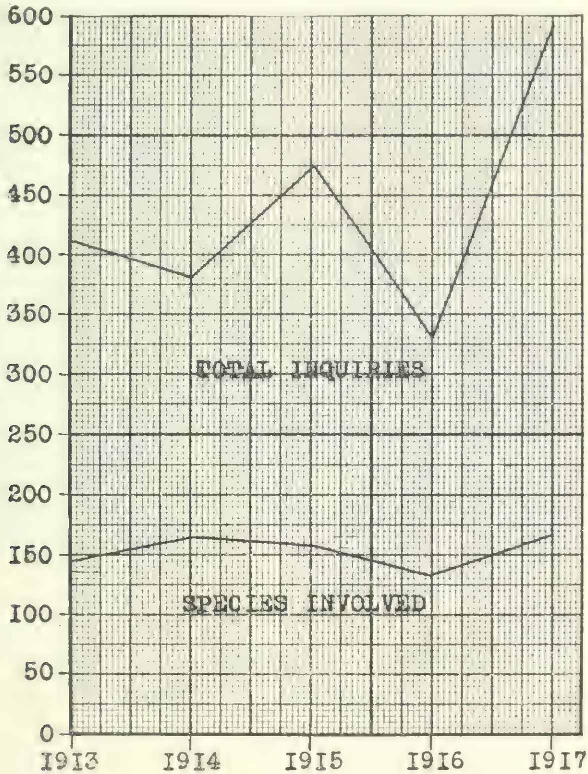


CHART I.

and squash borer. In both Hymenoptera and Diptera a smaller number of species is involved. In the former order, ants, saw flies and bees are the most important from a public viewpoint, while in the latter we have the house fly, mosquitoes, Hessian fly and cabbage and onion maggots occupying first place. On the accompanying plates may be found illustrations of some of the species which are more or less constantly in the public eye. To the entomologist they represent well-known pests, but the public is always demanding information about them.

Briefly summarizing, the insects which ordinarily attract public attention are those which annoy or injure man or those which destroy or injure his personal belongings, crops and live stock. Certain supposedly harmless species and certain species destructive in some areas but not in others have attracted widespread attention, but only by reason of the advertising which they received. In such cases public attention was directed to them and not attracted by them.

The average number of inquiries received during a year compared with the total population (2,800,000) of a state like New Jersey appears to be exceptionally small, and to some might indicate little public interest in insects. This, however, is not unusual when one considers the varied industries in the state and the fact that "75 per cent. of all the people are found in communities of over 2,500, occupying less than six per cent. of the whole area."[2] Except for such creatures as flies, mosquitoes, certain household and shade-tree pests, the city and town dweller is not likely to have his attention attracted to insects. In New Jersey, considerable public interest is centered around a few rather than many species. As outbreaks of pests are simply responses to environments, so public interest in insects is a response at least in part to environment, whether it be natural or artificial.

[2] Ann. Rept. N. J. Dept. Conservation and Development, 1917.

PROFESSOR JOHN MERLE COULTER

Head of the Department of Botany of the University of Chicago, Retiring President of the American Association for the Advancement of Science.

THE PROGRESS OF SCIENCE

THE WORK OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE Baltimore meeting of the American Association for the Advancement of Science and the national scientific societies affiliated with it was unusually and unexpectedly successful. Owing to war conditions, the place of meeting had been changed from Boston to the neighborhood of Washington, and it was planned to hold a small meeting devoted primarily to war work. The signing of the armistice altered the situation, and the meetings of the association and of those affiliated societies which had not postponed their meetings were largely attended and full of interest.

The association was fortunate in meeting at Johns Hopkins University, the original home of academic research in the United States. Professor Theodore W. Richards, director of the Wolcott Gibbs Memorial Laboratory of Chemistry at Harvard University, the retiring president, Professor John M. Coulter, head of the department of botany at the University of Chicago, the president of the meeting, and Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, the president-

Dr. Simon Flexner

Director of the Laboratories of the Rockefeller Institute for Medical Research, President of the American Association for the Advancement of Science.

elect, are admirable examples, in their own work and on account of the sciences in which they lead, of the contributions of scientific research to the welfare of the nation.

To chemistry we owe in large measure the successful conduct of the war and the maintenance of our manufactures; to botany our agricultural products which have saved the world from starvation; to pathology the low death rate from disease in the army. If chemical research and its applications are given what they need, the material primacy of the nation is assured; if botany and related sciences are adequately supported, the productivity of our farms and gardens can be doubled; if pathology has more men of the type of Dr. Flexner, 5,000,000 deaths such as have been caused by the epidemic of influenza can not recur.

It was realized by all present at the Baltimore meeting that science and the scientific men of the country were leading factors in bringing the war to a quick and favorable conclusion. The applications of science have enabled the country to amass the immense wealth which could be devoted to the purposes of the nation; our scientific men were able to meet on terms of equal performance those of every other nation. In like manner it was agreed that science and scientific workers have a great part to play in the reconstruction period in which we are entering. The whole future of the nation rests on the proper development and distribution of our resources in natural wealth and in men. We must now decide to lead in scientific research and in the applications of science for the welfare of the people of the country.

Science, education, democracy and organization are the four corner stones on which our civilization is based. Science may properly be placed first, for the applications of science have made it possible to provide education and equality of opportunity for all. The debt of education and democracy to science for its past service, their dependence on science for their further progress, are so great that no support given to science can repay their past obligation or sufficiently strengthen its hands for its future work.

There is probably no other association in the world that represents so completely as the American Association for the Advancement of Science, the four fundamental bases of modern civilization, science, education, democracy and organization. Its object is the advancement and the diffusion of science, perhaps the most important of all educational work. It has a special section devoted to the scientific investigation of educational problems. Not only is its work essential for democracy, but it is itself a democratic institution. It welcomes to fellowship all scientific workers and to membership all those interested in science. Its council, on which all the national scientific societies are represented is a democratically elected body that can speak and legislate for the scientific men and scientific work of the country. The association now has some 14,000 names on its membership list. with the affiliated societies, some 25,000, or 100,000 if physicians and engineers represented on the council are included.

This great body should be used effectively for the advancement and diffusion of science. In a democracy we must depend on the knowledge and good will of the people for the opportunity to do the work that is of such surpassing value for them. We must make the scientific career so attractive that able men will be drawn to it, and we must then give them the best possible opportunity to do their work.

This requires education and or-

An American Field Signal Battalion Telephone Switchboard in Operation on the St. Mihiel Salient. Some of the equipment had been captured from the Germans which is indicated by the German Eagle, stamped on one of the telephones in the background.

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WIRELESS SET MOUNTED ON A TRUCK OF A FIELD SIGNAL BATTALION IN FRANCE.

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MEMBERS OF A FIELD SIGNAL BATTALION SIGNALLING BY WIRELESS TO AEROPLANES.

ganization. Every scientific worker and all those who appreciate the fundamental place of science in national welfare should unite to do their part through our scientific organizations. They should be members, and active members, of the special society in their field, of their local society or academy, and of the American Association for the Advancement of Science.

The next meeting of the American Association and its affiliated societies will be held in St. Louis, beginning on December 29, 1919. The occasion should be taken to strengthen the association and its work in the central states, which have in recent years assumed such leadership in scientific research. We may be sure that the scientific men of Washington University and the City of St. Louis will do their part. It would be well if the meetings might be celebrated by the affiliation with the association of the strong state and city academies of the Central States and the organization of a central branch of the association on the lines that have proved so successful on the Pacific Coast.

THE INTERALLIED CONFERENCE ON INTERNATIONAL SCIENTIFIC ORGANIZATION

At a meeting of representatives of scientific academies of the allied countries and the United States, held in London on the invitation of the Royal Society in October, a committee of enquiry was formed, which met in Paris at the end of November. The delegates in attendance were: *Belgium*—MM. Lecointe, Massart, de la Vallée Poussin; *Brazil*—M. de Carvalho; *France*—MM. Painlevé, Guignard, E. Picard, A. Lacroix, Lippman, E. Perrier, Roux, Haller, Bigourdan, Baillaud, Lallemand, Moureu, Flahault; *Italy*—Sen. V. Volterra, Professors Reina, Nasini, Ricco, Fantoli; *Japan*—Professors Tanakadate and Sakurai; *Poland*—M. L. Mickiewicz; *Rumania* — MM. Soutzo, Hurmuzeco, Mrazzee, Marinesco; *Serbia*—MM. Zujovio, Petrovitch, Jopovitch; *United Kingdom*—Professor Schuster, Mr. J. H. Jeans, Sir Frank Dyson, Sir E. Sharpey Schafer, Professors Frankland, Sherrington, and Starling, Col. Lyons, Dr. Knott; *United States of America*—Professor Bumstead, Col. Carty, Drs. Durand, Flexner, Hale, Noyes.

An International Research Council was formed, and a committee of five was elected consisting of MM. Picard (chairman), Volterra, Lecointe, Hale, and Schuster. The seat of the bureau is to be in London. It is understood that the organization and arrangements are provisional, to be confirmed later by the academies and societies which enter the movement.

One of the organizations planned is an International Geophysical Union, which is intended to be controlled by an international committee consisting of representatives of international councils and of delegates appointed by the governments. The number of delegates is to be proportional to the size of the nation, as is the contribution by each. Only those nations that have been at war with Germany may enter the union, but arrangements may later be made for the admission of neutral nations.

SCIENTIFIC ITEMS

We record with regret the death of Wallace Clement Sabine, professor of physics at Harvard University and formerly dean of the Lawrence Scientific School; of Rossitier Worthington Raymond, the well-known mining engineer, and of Robert John Pocock, director of the Nizamiah Observatory, Hyderabad.

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SOURCES AND TENDENCIES IN AMERICAN GEOLOGY

By Professor JOSEPH BARRELL

YALE UNIVERSITY

AMERICAN leadership in invention and engineering is generally acknowledged, but what is our position in the various fields of science? It has been customary to look to Europe, and, in the last half century, especially to Germany as the leader in scientific achievement. In some lines this is no doubt true, but in other lines it is not true. The present, as the smoke of battle subsides, is an appropriate time to question old traditions now shaken loose before they settle again into fixed ideas. A study should be made of the contributions of the several nationalities both as to quantity and quality of productivity in each field of learning. The results of such a study of the progress of geology are given in this article and the conclusion is reached that for the past generation America, under which name should be included both the United States and Canada, has held a position of world leadership in that science. The order of importance of the other nationalities before the great war, taking the progress of the last half century as a measure, would be second, the British empire; third, Germany; fourth, France; but Italy, Scandinavia and Russia have also made notable contributions. If the place in geology held by the different nations be evaluated for the entire nineteenth century the order, in the opinion of the present writer, would be Great Britain, France, America, Germany; Great Britain being easily the leader.

In approaching this subject at the present time we must of course be careful in weighing the past contributions of Germany not to govern the verdict by the natural tendency to "trample them, they're down." The subject can, however, be tested in part by impersonal standards. Scientists are, as a class, unemotional creatures, and although those of the allied countries unitedly condemn the criminal acts of the paranoiac among nations, those from whom the writer has secured data have shown a marked freedom from emotional bias. The conclusions expressed in this article are not new with the writer. In July, 1914, he had occasion to discuss the superficiality of the work of several German scientists on a certain geological subject and to point out their ignorance of the fact that English scientists had reached different and far sounder conclusions a generation previously. Yet the prestige of a German professorship had apparently blinded many American readers to obvious trivialities of argument.[1] On the other hand, the work of certain other German geologists should freely be recognized as of the highest grade, and their writings have marked notable advances in thought.

The broad attitude taken by von Zittel in 1899 is to be commended, as expressed in the following quotation:

> Although the present author of the "History of Geology" (von Zittel) was asked to depict chiefly the history of the growth of the science in Germany, the nature of the subject is such that it could not be successfully treated along national lines. All civilized nations have shared in the development of the natural sciences, the history of any one of which must be to a certain extent the history of a scientific freemasonry. The questions of the highest import in geology and paleontology are in no way affected by political frontiers, and the contributions to the progress of these studies made by members of any nationality can only be appreciated in their true values when held in the balance with the general position of research at the time, and with the discoveries and advances made by other geologists irrespective of nationality.[2]

Although the history of a science, as von Zittel states, can not be written with reference to any one nation alone, it is quite possible to recognize the relative contributions of the several nations.

In discussing the subject of the sources and tendencies of American geology, the first question which arises is as to the present content of geology. Every reader will feel sure that he knows what geology is, yet it is safe to say that few, except active geologists, are aware of the present scope of its subject matter and the lines along which research is now being pushed. The value of such a review as this may lie as much in giving a better perspective of the content of geology as in pointing out the relative contributions of different nations.

Popular ideas of a science are apt to lag a generation be-

[1] Joseph Barrell, "The Status of Hypotheses of Polar Wanderings," *Science*, Vol. XL., pp. 333–340, written July, 1914, published September 4, 1914.

[2] Karl A. von Zittel, "Geschichte der Geologie und Paläontologie bis Ende des 19. Jahrhunderts, 1899," English translation, pp. v, vi.

hind the real stage of advancement. In the popular imagination, geology is still supposed to consist largely on the one hand in collecting and naming rocks and fossils, the placing of these in proper sequence, and, on the other hand, theories of a rather speculative and uncertain character on the origin of the earth, its internal nature, and its history. As a matter of fact, there is but little in modern geology at its best which partakes of these characters. It has been said that a science in its growth passes from embryo to adult through the speculative, qualitative, quantitative, to predictive stages of development. Geologic research in the past generation has been passing out of the qualitative stage and has partaken notably of the quantitative character.

Geology, the science of the earth, is exceedingly broad in its scope and has developed into many branches, each of which rests more or less heavily upon some other science. From a division of natural history, whose early workers had little in the way of qualification other than powers of observation, acquisitiveness and a love of life in the open, it has passed into a group of special sciences. The elements of geology can be taught with advantage to students who have had no training in other sciences, being from the cultural standpoint one of the most broadening branches of knowledge, but research in the several fields now requires a thorough grounding in other sciences and such advanced training as is given in graduate schools.

Mineralogy has expanded into petrology. The form, composition and identification of minerals is of less interest than the broader questions which rise out of them. Leading toward physics, the orderly arrangement of the atoms in the crystal has been found to form a diffraction grating incomparably finer in spacing than any which could be made in the laboratory. The physicist, utilizing this, has solved the nature of the X-rays, and in turn this leads to a better knowledge of crystals. On the physico-chemical side, the crystallization of minerals from molten rocks is a problem of mutual solutions at high temperatures and is being investigated in the geo-physical laboratory. On the more strictly geological side, a mineral is a measure of the physical and chemical environment under which it originated. The secondary alterations taken in connection with the limits of stability of a mineral record the subsequent physical history of the rock of which it is a part. Minerals are thus geological thermometers and dynamometers. Their relations to each other, as seen under the microscope, show the order of crystallization; the assemblage, constituting the rock, gives a definite record of environment and subsequent history. The mapping of rock types over the earth's surface proceeds, and out of it grow studies on differentiation—the changes through geologic time in the nature of molten rocks erupted in the same region. The fundamental relationships found within one region constitute the problems of consanguinity; by contrast, the unlikeness of different regions in earth composition mark out petrographic provinces. What are the meanings of differentiation, consanguinity and petrographic provinces? Such are the larger problems of petrology.

Paleontology, the ancient life history of the earth, was characterized a generation ago by the description and naming of species. There was a keen rivalry for priority and explorations were conducted to obtain new faunas. Almost no attention was paid regarding the associations of the fossil with the nature of the enveloping rocks, and but little to the exact stratigraphic level from which it was taken. To-day, in the hands of leaders, the description of new species is but an incidental task. From a keen study of the fossil, the form and habits of the living animal are inferred. The nature of the rock is used to restore the ancient environment, whether marine or terrestrial, swamp or arid plain. Fossils are collected and recorded foot by foot through a stratigraphic section, permitting the stages in the geographic shifting and geologic advancement of faunas to be followed. The areal limits of a fauna and the geographic distinctions serve as a means of delimiting ancient lands, seas and climatic zones. The study of the changes of life with respect to changes of environment and the passage of time throws valuable light on the causes and character of organic evolution. The perspective over long intervals of time gives a line of attack which is not possible to the student of living animals and plants. Thus the fossil, like the mineral, has become a means to an end;—those ends look toward a knowledge of the thing, a knowledge of its environment, a knowledge of causes and effects through vast periods of time.

Stratigraphy formerly consisted in but little more than measuring the thickness of sedimentary formations and mapping their areal extent. Formations of different regions were correlated by means of fossils and the sequence of the periods established. All sediments were assumed to be deposited in the sea, except such as contained remains of terrestrial organisms and were entirely devoid of those of the sea: such formations were regarded as deposited in lakes, although the fossils were commonly those of land plants and animals. This stage of development is now looked upon as merely having laid a groundwork for the investigation of broader problems. The interpretation of the mode of origin of the sediments was narrow and conventional. At the present time, by contrast, the terrestrial deposits on broad river flood plains and deltas are seen to constitute an appreciable part of the geological record. Glacial débris in many older formations shows the recurrence of cold since very early geologic periods. At other times beds of salt and gypsum show widespread aridity. Each type of climate and topography is seen to be reflected in the nature of sediments. Through stratigraphy is thus built up the succession of past environments which paleontology peoples with living plants and animals. Between them these branches of geology are re-creating the geography of all the yesterdays, a subject taking form under the names of paleogeography and paleoclimatology.

During the past quarter century structural geology has grown to be a branch of large importance. It comprises several fields. That best known deals with the results of the forces of deformation acting upon older rock masses. Joints, faults, folds, schistosity are the expressions seen in a limited exposure. The merely descriptive stage of investigation is past. The faults must be classified into systems, their displacements ascertained and the position of severed portions of valuable ores located. Folds are analyzed into different orders of magnitude and the determination of the folded structures has led to the opening of iron deposits valued at many millions of dollars. The theories of deformational geology must thus meet the tests of verification and this necessity has stimulated the development of a quantitative accuracy. But this division of structural geology is the smaller part of the field, that dealing with details in the outermost crust. Passing to a larger scale, the nature of mountain structures has been greatly elucidated. In the past twenty years French geologists have given a new interpretation to the Alps based on great horizontally acting overthrusts. Vertical forces, uplifting faulted blocks, or warping upwards tracts which had acquired their mountainous structures long previously are found to be also fundamental as causes of mountain growth. The reasons for the existence of continents and ocean basins and the amount of their changes through geologic time is a still larger field of theory on which only a beginning has been made. Finally, geophysics is that field of structural geology in which precise geodetical and astronomical measurements are throwing light upon the distribution and character of density and rigidity through the crust and the deeper body of the earth. The ultimate causes of earth structure are thus to be sought through the character of the insensible vibrations from far distant earthquakes and through precise measurements obtained by observations on the stars.

Physiography is a division of the new geology which had only feeble representation in the previous generation. This, the science of the earth's surface, consists of a study of forms and causes. It embraces the effects of surface activities, a field known also as dynamical geology, and seeks through them the causes of the forms of the lands from the smallest to the largest features. In the middle of the last century valleys were still supposed to be determined by rifts and depressions in the crust, although Hutton and Playfair had shown clearly long before that the valleys were carved by running water. The existing mountain ranges were regarded as elevated at the close of the period of the youngest formation entering into their structure and were thought capable of enduring in subdued form through all of geologic time.

The beginning of the present development rested on the recognition that erosion by rain and rivers carried to the limit would result in a surface nearly plane cut across all rock structures and developed near the level of the sea. Davis, thirty years ago, named such an ultimate land form a peneplain. Distinguished by a name, they were then recognized, though now uplifted and in various stages of destruction, in many mountain regions. A new means had been found of studying mountain history. Uplift initiates a new cycle of erosion with respect to a new baselevel. Applying this principle, a landscape is now interpreted as but one stage in a sequence of forms, passing from some initial stage of uplift toward a featureless plain of erosion lying at the level of the sea. Geologic time is seen to be so long in comparison with the time needed to level the loftiest mountain range that folding and uplift must have occurred again and again since the earliest ages in order to provide sources for the sediments which have built up the stratigraphic series. The present upland and valley forms show in every continent from the youth or early maturity of the present erosion cycles that the world is girdled with very young mountains, even where their rocks and structures are very ancient. The present geologic period is consequently seen to be one of profound terrestrial revolution, a conclusion of high importance in our understanding of the earth and the relations of man to his dwelling place and the causes which gave him birth.

Lastly there has grown to high importance the branch of economic geology. This was formerly regarded as consisting in a description of ore deposits and building materials accompanied with statistics of production. That original field has become only one section of the subject. Economic geology has recently been defined by the director of the United States Geological Survey as "useful geology." Another definition expressive of its content and purpose is that economic geology is applied geology. Pure science, the search for new knowledge for its own sake and without thought of its applications, becomes applied science in the most unexpected ways. Every division of geology has contributed to the advancement and expansion of economic geology. Petrologic and chemical geology, stratigraphy and physiography, all lead to the study and conservation of soils, the basis of agricultural wealth. The working out of stratigraphy and structure permits intelligent search for the stores of underground water, the most valuable of minerals in many parts of the national domain. A knowledge of the structure and character of the foundation rocks can be given by the geologist to the engineer and military chief, of great importance toward the success of foundations, dams, roads, canals and military works. A knowledge of stratigraphy and structure has led to the discovery of coal basins concealed beneath younger strata. Hundreds of young geologists are now being employed by the great petroleum companies to study the stratigraphy and structure mile by mile over great areas of country in the search for mineral oil. Mining geologists are now retained permanently on the staffs of many large companies to study and map in detail the relations of complex ore deposits as a guide to more intelligent development in mining. Physiography also is making its contribution to the location of copper, manganese, and other deposits; since where these have been concentrated through the agency of circulating underground waters the recognition of the former stages of erosion serve as a guide to present location. Other geologists are employed on state and national surveys, classifying lands, discovering and mapping the areas of valuable deposits such as coal, iron, potash, and phosphates for the benefit, now and in the future, of all the people of the nation. A higher field of economic geology is that of the conservation of national wealth. It is not an overstatement to say that the future welfare of mankind through unnumbered centuries yet to come depends upon the spread of education in regard to the limitations of mineral wealth and the development in the national consciousness of the creed that each generation holds the treasures of the earth in trust for the future, to be used but not squandered by the temporary trustees.

Let us turn from this survey of the present viewpoints of geology to a review of its growth and note whence have come the fundamental ideas which from generation to generation have expanded its fields of theory and usefulness.

Speculations on the origin and history of the earth once formed a favorite theme for philosophers. Omitting from consideration the ancients, such men as Descartes and Leibnitz devised theories of cosmogony which represented advances in thought; but such systems of philosophy, not founded on field observation and inductive reasoning should be sharply distinguished from the science of geology. A science rests upon careful observation, classification of observations, framing of hypotheses to relate the facts to each other, and testing of the hypotheses by further observations. There must be both induction and deduction, for the groundwork of geology to justify its name must rest on a patient study of the earth. The grand schemes of the cosmogonists, notwithstanding their stimulation to thought, perhaps served more to retard than to aid the development of real science. In the latter half of the eighteenth century geology became firmly established on a groundwork of fact as a result of the labors of a few men in France, Italy, Germany and Great Britain, of whom the philosophers took no recognition. Guettard, Demarest, Arduino, Lehmann, Füchsel, Smith and Hutton are the men who stand forth, but the greatest of these was Hutton.

Hutton, regarded as the founder of modern geology, was born in Edinburgh in 1726 and died there in 1797. He held no university position but pursued his investigations solely from their inherent interest. He did not publish his views until 1785, and beyond the circle of his friends they attracted little attention until after Playfair in 1802 published his classic volume, "The Huttonian Theory of the Earth," in which he condensed and clarified the work of his friend into much more readable form. Hutton saw the evidence that the great masses of granite which so commonly underlie the stratified rocks had originated by crystallization from a melted state and had risen in molten form into the outer crust from the depths of the earth. The folding, upturning, mashing and crystallizing of the sedimentary rocks he saw was due to the vast forces within the crust aided by internal heat. Great crust revolutions resulting in the uplift of mountains were followed by prolonged weathering and erosion of all rocks above the level of the sea. New sedimentary formations from the débris of other lands were then laid down across the eroded edges of the rock formations of an older world. The forces now in operation he held were capable through unlimited time of effecting these stupendous results, time and time again. Back of each older world were the ruins of a world still older. In Hutton's words, "we find no vestige of a beginning—no prospect of an end."

These magnificent conceptions were not cosmogonic speculations, but were founded on close and prolonged observations. They were generalizations which had been seldom glimpsed and never before clearly seen or proved through two thousand years of intellectual endeavor. Because the Huttonian theory of the earth was distinguished by giving an important place to the heat and deforming forces of the inner earth, those who accepted Hutton's ideas were called Plutonists.

Twenty-three years later than Hutton the mineralogist Werner was born in Prussian Silesia. In 1775, at the age of twenty-six he was appointed inspector and teacher of mining and mineralogy in the Freiberg Mining Academy. For forty-two years he continued in this position and was throughout that time enthusiastically regarded by those who listened to his lectures as an oracle on the history and rock formations of the entire earth. To this subject he gave the name of geognosy and his students went forth with the fervor of disciples to spread his doctrines. With a personal knowledge limited to Saxony and Silesia he nevertheless advocated with dogmatic conviction the idea that the rock formations shown there were universal in their extent and occurred everywhere in the same definite order. He did not believe that any rocks originated from the molten state. Volcanoes were to him nothing more than local and superficial outbreaks, the results of the burning of coal beds. The oldest and underlying rocks, showing a crystalline structure such as granite and gneiss, were classified as Primitive and asserted to be the precipitates from a primal universal ocean. Their crystalline nature was held to be a proof of this aqueous origin. Above the Primitive came the Transition series, followed by the Flœtz rocks, partly of chemical origin but in which mechanical sediments began to dominate. Coal, basalt, obsidian, porphyry, etc., were included in the Flœtz series as chemical deposits. Werner offered no reasonable explanation as to what became of the primeval universal ocean and he opposed all conclusions which rested upon the action of internal heat or deforming forces. He would not admit that mountains had been elevated or strata folded. From the disbelief of the Wernerians in the internal agencies of the earth and their assertion that all crystalline rocks had been precipitated from ocean waters they were named the Neptunists.

One of Werner's pupils, Robert Jameson, became professor of natural philosophy in Edinburgh, the very home of Hutton and Playfair, whose work Jameson treated with contempt. For several decades, up to the time of Werner's death in 1817, his system of geognosy was dominant. A bitter warfare was waged between Plutonists and Neptunists, characterized on the part of the latter by provincial ignorance, dogmatic assertion, arrogance in place of demonstration. But the accumulation of incontestible facts undermined the morale of the system, showed that it was false from the foundation upward, and within a few years after Werner's death the whole had collapsed like a house of cards. Von Zittel in his excellent and impartial "Geschichte der Geologie und Paläontologie" states that the erroneous views held by Werner appreciably retarded the progress of geology, and in Germany after the collapse of his system the science of the earth seemed for a time to make no progress.[3]

Werner's real contribution lay in his orderly classification of minerals and rocks. Hutton's contribution on the other hand was nothing less than the establishment of the broad science of geology on a secure foundation.

The wide proclamation of Werner's system contrasted to the lack of advertisement of Hutton's is perhaps significant of the difference in national characters and is seen to show a certain parallelism to the developments of science and to the German propaganda a century later. The diverse racial stocks which made up the German empire, notwithstanding their belief in racial unity and superiority, have resulted in a wide range of temperament and ability, but Werner the Prussian is typical of the dominant national tendency to classify, to systematize, to consider this as the field of science, and with arrogant dogmatism to either discount or appropriate fundamental ideas originating elsewhere. A similar spirit has been sporadically manifested by individuals of other lands, but never with that frequency which would permit its development into a dominating national characteristic.

Near the close of the eighteenth century and opening of the nineteenth an era of scientific exploration set in. Three Germans—Pallas, von Humboldt and von Buch—were most noteworthy, Pallas being employed by the Empress Catharine of Russia, von Humboldt and von Buch being men of independent means. The energy and ability of these men contributed very much to a knowledge of the world, but to geological theory they themselves added comparatively little. The real growth of geology in the first third of the nineteenth century was largely in Great Britain and France. The advance is represented by the

[3] Pp. 48, 427, English translation.

appearance of manuals in French, German and English, culminating in the English works of De la Beche and Lyell, books which may be studied with profit even at the present day. The work of Cuvier and Brongniart had in France established paleontology during this same interval as a progressive branch of science.

With the opening of the second third of the nineteenth century the United States began to make notable contributions to geology. The initiation of state geologic surveys between 1830 and 1840 and of the Canadian surveys shortly afterward began an era of systematic and detailed scientific exploration in North America which in this regard led the world. In this same middle third of the century Darwin went on the voyage of the *Beagle,* and Dana as geologist and zoologist on the Wilkes exploring expedition. The geologic history of India, South Africa and Australia began to receive attention. In England Sedgwick and Murchison established the larger divisions of the Paleozoic era and in New York the detailed stratigraphy was worked out, with the result that locality names from England and New York dominate in the nomenclature of the Paleozoic.

In the field of theory Lyell established beyond controversy the principle which lies at the basis of all geologic science, that the past is to be interpreted by the study of causes now in operation. Elie de Beaumont in France, Dana and Hall in America, placed the theory of mountains upon a secure foundation. Bischof in Germany in his admirable text book of chemical and physical geology, published in 1846, made that country a leader in the division of geo-chemistry. From 1850 to 1858 the British geologist, Sorby, developed the methods for the microscopic examination of rocks. This through the German geologist Zirkel led to the great development of modern petrology which for the following twenty-five years, transplanted from England, became a distinctively German branch of science. Last, but not least, is to be mentioned the work of Charles Darwin which established the existence of organic evolution upon an unassailable basis.

In the last third of the nineteenth century appeared from Vienna the great work of Suess on "The Face of the Earth," welding into one treatise the geologic literature of the world and developing new views on the nature of continental and mountain-making movements. In Scotland the existence of great overthrust faults was demonstrated by British geologists, it being proved that ancient crystalline rocks had been shoved for more than ten miles over younger stratified formations. In France, before the end of the century, a new interpretation of the Alps, of wide application over the earth, began to be conceived. Folding was seen to have passed into great overthrust sheets and erosion to have later cut these into remnants, leaving on the north side of the Alps mountains whose rocks had been deposited in previous ages far to the south, mountains without roots as they have been picturesquely called.

It was in America, however, that from 1867 to 1900 the greatest expansion of geology took place. After the close of the Civil War, under the auspices of the government, a group of young men of remarkable energy and ability began the scientific exploration of the western United States. The names of Powell, Dutton and Gilbert stand out above a worthy company and came to be known to geologists through both hemispheres. Their work laid the basis for the new science of physiography, developed so largely by Davis, which for the latest geologic epochs reveals the detailed history of the lands as the sequence of stratified rocks does for earlier ages. In the central part of the continent Chamberlin was establishing during this period the complexity of the Pleistocene, Irving and Van Hise were applying new methods and by them unraveling the structure of the ancient iron-bearing rocks of the Lake Superior region. In the field of paleontology Cope and Marsh explored the Tertiary and younger Mesozoic rocks of the west and brought forth from their stony tombs a legion of extinct vertebrates whose march across the stage of time made visible beyond question the story of their evolution.

Measured by the activity of its workers, by the immensity of its field, by the contribution to new ideas, it appears that by the year 1890 North America had taken a place of world leadership in geologic science. In the twentieth century, through many able workers in Canada and the Lake Superior region, our knowledge of the earlier geologic ages previously grouped under the name Archean has become expended into a complex history comparable in number of events and in duration to all subsequent time. A corresponding history has been worked out for their portion of the world by Scandinavian geologists.

With the increased knowledge of terrestrial processes as exhibited in continental interiors it has been shown by British, German and American geologists that the character of the topography influences the nature of the sediments, important formations are laid down in river basins and in deltas as terrestrial deposits. The first recognition of this importance of terrestrial deposition is to be credited to the British geologists in India. Wind has been shown by von Richthofen, Pumpelly, Walther and Passarge to play an important part in transportation, but some time before Darwin made note of the enormous quantities of dust swept into the Atlantic from the Sahara. The winds on the Indus delta were shown half a century ago to be as important as the river currents. Desert dunes are the waves of a migrating sea of sand. Eolian transportation and deposition is now given a large place in geologic theory. Climate is seen to be a major factor in controlling the character of even fluviatile and marine sediments, determining their structure and their content of iron and carbon. This more precise knowledge of the present has made possible a revision in that interpretation of the past which is derived from the study of the stratified rocks. Frequent breaks in sedimentation have been shown, chiefly by American geologists, to occur throughout the stratigraphic series, the larger of these, representing oscillations from sea to land and back to sea again, give rise in the strata to unconformities and disconformities. All of this new knowledge, most largely of American origin, is giving a clearer view of the oscillations of land and sea, of humidity and aridity, of heat and cold, and is establishing, as previously noted, two new divisions of historical geology—paleogeography and paleoclimatology.

The application of geology to the service of man, the field of economic geology, has undergone also a great expansion during the past generation, chiefly in America. Recognition of the usefulness of geology must result in advantage to the entire subject. It tends to draw more men into its ranks, it brings to the work a greater political respect, and from the ranks of the younger geologists who are able to win a living in useful geology will develop those capable of advancing the theoretical aspects of the subject.

Having given this survey of the past progress of geology, let attention be turned toward its probable future. The center of the greatest advancement during the next generation should be in North America. The preliminary survey of this continent has already been made. To men of limited vision it may have seemed that nothing of a large nature remained to be done. As a college student once said—he did not care to go into geology because since Dana had written his manual nothing remained to do except to fill in the details. Those engaged in research on the larger problems, however, are thankful that the continent has been studied and mapped to the present degree, since this preliminary work paves the way for an ever-expanding field of higher research. Such investigation must go hand in hand also with a more detailed and critical mapping which in the United States alone bids fair to engage the energies of geologists for a century to come.

Another large field for the employment of geologists is as teachers in the universities. In the larger institutions of learning geology is recognized as of high cultural value, comparable to biology, serving to expand the mind of the student as do few other subjects. The history and nature of the earth and its inhabitants is an appropriate background for the understanding of the history and nature of man.

But although the preliminary geological survey of North America has been made, a considerable part of the land surface of the world is as yet imperfectly known. South America, especially, is a continent regarding which there is much to learn. Geological instruction in our graduate schools should be elastic and comprehensive enough to serve as training for men to work in other lands. Modern languages must be insisted upon as prerequisites for the higher degrees, not only as means of gaining access to the literature of other nations, especially France, Germany and Italy; but also as a means of facilitating research beyond the bounds of the English-speaking world, in such lands as South America, Siberia and China. The limitations of time forbid the requirement of more than two modern languages, but some knowledge of three or four would for those of natural linguistic abilities be of distinct advantage.

Another region which is as yet almost a *terra incognita* but which is open to future research is the great interior of the earth. A beginning has been made through geodesy, seismology, the geophysical laboratory, the nature of igneous rocks, and the forces which express themselves in deformation of the crust, but there is as yet much difference of opinion as to even the major conclusions. No secure knowledge can be had, however, as to the larger problems of the earth, such as its mode of origin, the source of igneous rocks, the causes of continents and ocean basins, until more is known with certainty and in detail of the earth's interior. This perhaps is the most difficult field of geologic science, requiring organized attack through the funds of institutions for scientific research, but it is a field whose tillage will yield rich returns.

This survey of the present standing of geology has been necessarily brief. Important subdivisions and fields of research have been wholly omitted, but the purpose of the article has been accomplished if it has shown in true perspective the contributions of different nations to the growth of geology, the branching out which has taken place from the parent trunk, and the resultant wide scope for future research in the science of the earth.

THE PRINCIPLES AND PROBLEMS OF GOVERNMENT

By P. G. NUTTING

IN living up to its possibilities, the chief ends to be secured by a sovereign state through the national government are national stability, strength and progress. Its chief problems relate to ways and means of securing these objectives. Some of these problems have been fairly well solved, others cry aloud for solution. Let us examine them from the standpoint of the engineer—applying fundamental principles to the general problem and to the more vital individual problems.

1. *National Stability.*—National stability requires that national authority be absolutely supreme over that of any individual or organization—political, commercial, religious or protective, within its jurisdiction. Each such organization or individual must regard the interests of the nation above its own. No mere confederation of states can possess stability unless individual states recognize the supreme authority of the nation. No nation can be stable if a strong commercial organization, such as a food trust, is so powerful as to be able to defy its authority. The same is true of a labor organization. Some few religious organizations have not always subordinated their interests to the interests of the nation, or else have wrongly identified their own interests with those of the nation. Many political organizations have placed party interests above those of the public at large. All such conditions constitute a menace to the stability of the nation as a whole.

While a nation can not be inherently stable without supreme authority, it can not attain the maximum of stability without denying every special privilege to every class, individual or organization. Not only must every organization, class or individual recognize the supreme rights of the nation, but equality of rights with its fellows. Any preferential treatment anywhere must lead to instability. From time to time aggregations of wealth have claimed special privileges, causing threats of upheaval. At present, the greatest menace to the nation appears to be in certain labor organizations which claim special privileges by encouraging and defending such crimes as murder, theft and the destruction of property when committed by their own members against outsiders. The very attitude of one law for us, another for the outsider, can not be tolerated. The abolition of special privileges means equal rights and privileges to all and the enforcement of law without regard to wealth, class, race or organization. While equality of rights, in this sense, was expressly recognized and guaranteed in our constitution, it has never been completely established. Its establishment to the very letter offers many serious problems, but is essential in securing stability. In their attitude toward authority, efficient democracy and autocracy are alike, but in relation to special privilege they stand at opposite extremes as they do also in regard to the source of authority.

Every nation has its own peculiar problems in special privileges to solve, for in no nation have these been entirely eliminated. In some cases it is inherited class privilege, in others race and in still others organized labor—all more or less interwoven with special privilege exercised by wealth or political machines. Church domination has been a burning issue in the past and still is an issue in some nations. Both labor organizations and capitalists quite generally claim special privileges and each class is desperately striving to reduce and circumscribe those of the other class. American, British and Russian labor organizations fail to understand each other or to act together since the issues before each are essentially different. Each would be a tower of strength to its national government if each aimed and strove merely for the entire abolition of privilege.

While the complete abolition of special privilege is clearly a necessary and sufficient condition for national stability as a principle, yet the application of that principle in separate cases is not so obvious. Individual equality of rights before the law is one of the simplest and earliest recognized. Whether to workman or millionaire, master or servant, Jew or Gentile, black, yellow or white, party henchman or opponent, the law must be administered without personal or class favor. The principle is nearly as old as the human race, but even to-day, in America, the police and the lower courts are not entirely beyond the reach of personal influence. Equality of rights between corporations and between individuals and organizations has not yet been so clearly defined as between individuals, yet the same principle applies.

A very difficult problem of the near future in practically all nations concerns the abolition of special privilege in *property rights*. Labor is everywhere disputing with capital the assumed right and privilege of the latter to the sole disposition of profits. Strikes, walkouts and widespread socialism are evidence that no rational, acceptable general solution of the problem has been reached. Labor desires remuneration without responsibility, hence requests a higher wage and shorter hours. Capital has generally accepted responsibility for profits, but in most large corporations is amply safeguarded against loss. But profits depend primarily upon good management and where such management is vested in salaried experts, these are entitled to such consideration as is accorded labor and capital. Equity in this case evidently demands that profits go to those who must shoulder responsibility for losses, but since that responsibility is variously apportioned in different organizations, no general solution of the problem appears possible.

The special privilege of one class to live in idleness at the expense of another class—an inheritance from feudal times—is still assumed in many countries and is the basis of widespread unrest. Such a privilege has not even a biological foundation since statistics show that leaders are born practically equally in all classes. A partial solution of the problem involves the abolition of hereditary titles, a high tax on incomes not under the expert direction of the owner and a very high or confiscatory inheritance tax on inheritances not going to dependent heirs.

2. *National Strength.*—While national stability comes largely from the elimination of misdirected static forces, national power is due largely to bulk of resources and to efficient administration. The resources that are effective include not only natural resources such as mineral and agricultural, timber and fisheries, but financial and intellectual resources and labor. The strength that lies in each may be great or little according to its conservation, development and utilization. These of course depend largely upon wise administration, direct in some cases, and through commercial and industrial organizations in others. It is the essential function of administration, in securing the general welfare, to see that the most possible is made of resources of all kinds. Comprehensive surveys determine resources while other departments regulate utilization, economic readjustments being made from time to time when necessary. Any one of the classes of resources above mentioned may range in value from absolute waste up to at least many times its worth at the present time, according to how it is handled.

The vital factor in making the most of our resources is of course expert direction. A poorly managed industrial organization will rapidly decline, but a poorly governed country may persist through its sovereignty. However, if a country is to live up to its possibilities, it must adopt the methods of successful industrial plants and have every important department managed by an expert. Administration consists essentially in solving an endless series of special problems. It calls for the services of engineers of all kinds, men who are at once thoroughly versed in the fundamental principles of their respective lines and experienced in the practical application of those principles. Some of these applications involve only routine repetition of previous applications. Others require study and investigation to determine which principles are applicable. Still others involve the most difficult research by master minds into the very fundamentals of the subject to uncover new principles. Hence the labor of administration ranges in quality from mere clerical and statistical work to fundamental scientific research in biology, psychology, geology, chemistry and physics. The experts required must be for the most part developed within the service itself after receiving a thorough preparatory training in the best appropriate educational institutions. Obviously, selection for the higher positions should be on the basis of fitness alone.

Both strength and stability require the coupling of authority and responsibility in proportion. The fatal defect in the so-called representative system of government is that while it may delegate authority it does not fix responsibility. Our office holders are not in office as a life work, with success or failure in life depending upon the wisdom of every decision. They have little to lose by mistakes and little to gain by a wise and faithful performance of their duties since they are quite likely to be superseded at any election. It is obviously the wise course to put the best experts available in every position of authority, place entire responsibility for their work upon them and leave them there until called to a higher position or until replaced by one more fit. It is doubtless possible to secure all the advantages of an autocratic government together with those of an efficient democracy by the wise selection and promotion of experts in administration. Democracy requires only that the *ultimate* authority rest directly with the people. A government with experts in authority, each assuming full responsibility for his work and subject to the ultimate authority of the people, represents the highest ideal of a republic.

Before proceeding to the discussion of factors in national progress, it may be well to consider a few of the greater national problems involving stability and strength, assuming that special privileges have been abolished, that the best available experts are in authority and that each is saddled with a responsibility that will bring forth his best efforts. One of the greatest of these problems concerns the relation of the government to national means of communication, information and transportation. The objective in each case is of course the maximum of public service at a reasonable expense. Efficiency depends in each case upon good management and wise expenditure. The matter of ownership has little to do with either. If better results have been attained under private ownership, it is to be attributed rather to better administration by better executives secured by means of higher salaries and better systems of selection and promotion. On the other hand, government administration has secured better coordination of effort. The interests of the public doubtless demand national control and control of a more intimate nature than the occasional exercise of ultimate authority.

Another great national problem relates to the best means of exercising ultimate authority by the people. In this problem are involved radical modifications of our present law-making and executive systems. Useful and effective laws could doubtless better be drafted by small bodies of well informed, experienced specialists in law drafting, men capable of correctly analyzing conditions to be remedied and of devising and framing laws for their alleviation than by unwieldy bodies of inexperienced delegates. For purposes of ratification, it is possible that Congress and the various state legislatures would serve better than frequent general elections in carrying out the will of the people. With administrative offices filled by appointment, partisan politics would largely disappear. The natural political parties are the conservative and the progressive and these are sufficient for all practical purposes in determining whether or not to take any new step contemplated. In our individual policies, the question constantly arising is whether or not to undertake some suggested line of activity and we are progressive or conservative according to the resultant of the political forces influencing us. The origin of each suggestion is of very little moment.

Representative government, as at present constituted, is but a weak and inefficient makeshift at best. It secures ultimate authority for the people, but in avoiding the evils of class autocracy has left us at the mercy of political bosses and machines. We have clean elections as a rule, but no means of securing the best men available for the positions to be filled. Although open to objection, it would seem far preferable to have executives selected by some higher executive or board by promotion according to demonstrated ability than to childishly leave that selection to self-seeking politicians having no delegated authority and entirely without responsibility to the state. If it will but purge itself of special privilege—whether of birth, wealth or political organization—democracy is sure to exhibit administrative strength far in excess of that of the best devised imperialism.

3. *National Progress.*—The administration of the affairs of a nation should not only secure a maximum of stability and strength, but should direct the utilization of resources toward the greatest advance along all lines worth while. Obviously, if we are to make the most of our resources, those resources should be surveyed and studied with a view to their development for the greatest ultimate good of the nation as a whole. If we are neglectful of means of progress, we are sure to be outdistanced in time by nations which are progressive.

Our great administrative departments and bureaus have been created in recognition of just these national requirements. While leaving something to be desired in coordination and efficiency, in the main they fit our needs and render excellent service. A few, such as the Census Bureau, the Geological Survey and the Coast Survey, are engaged mainly in *gathering information.* The majority are concerned chiefly with the conservation and *development of resources.* Others look after *general welfare* through safeguarding public health, providing communication, national defense and transportation and regulating immigration, commerce, labor, banking, industrial organization and finance.

It is patent to every one that this work calls for the services of specialists and that greater results will be more efficiently obtained the greater the technical knowledge, skill and application of those specialists and the less the interference with their work by laymen. The nature of the work ranges from the purely administrative and clerical to scientific work of the most advanced and difficult nature. A considerable part of it has to do with the application of fundamental scientific principles to difficult technical problems and this involves a vast amount of research work. The government machinery should be such that the services of the greatest specialists in the country could be obtained and retained to carry on this work.

As it is, quite a number of the departmental bureaus are headed by civilians chosen for their fitness alone and retained for their competency. These are doing excellent service. Others are headed by political appointees or staffed by henchmen and are examples of what should never be tolerated. Some have clear-cut fields of activity while others are sadly in need of reorganization and of coordination with bureaus engaged in similar lines of work. Some lines of government work urgently needed have never been undertaken at all. Some bureaus engaged in technical work lose annually to the industries from twenty to fifty per cent. of their staffs—as large a percentage as a university. To meet this condition it would seem advisable to organize such departments as a sort of great national university to draw greater numbers of choice research students, providing more timber from which to make up losses and from which to choose specialists for the higher positions.

A serious defect in many bureaus, resulting in far less than the best possible service to the public, comes from lack of direct contact with the public needs. Many industries, for example, would call on the government for expert advice and assistance but for the fact that it is not obtainable. On the other hand, the government has not made provision to meet such demands, chiefly because they were not made. It is precisely the dilemma of the repairs to the leaky roof. The government should provide for actual rather than expressed needs by building up strong, consistent, well-coordinated departments.

A number of important fields of general welfare, nearly or quite neglected by the government, might well be under its supervision and control. Conspicuous among these is education—mental, physical and moral. Common school education, now left to the several states, is in fairly good shape but higher education has been left to a large number of independent colleges and universities with but little even of unity of plan or purpose and to a considerable extent competitive. It is the obvious duty of the government to assume the leadership in this matter, retaining in its services the greatest specialists in the country, setting standards and conducting researches in methods of instruction and management. The practical education of the public through newspapers, magazines, lectures and motion pictures is left entirely to the private enterprise of money seekers. Physical education is left almost entirely to the instincts of the individual. Moral education is left to parental instruction, widely varying in quality and quantity, and to various religious organizations more or less at war with each other.

With the national welfare as its avowed objective and with ways and means fairly obvious to those responsible for securing it, the really difficult problem is the judicious limitation of governmental activities to avoid stultifying paternalism in the regulative functions and interference with private interests in assisting the industries. In the past we have undoubtedly erred in doing too little, partly from principle but mostly through lack of expert knowledge. But with the pioneer period past and marked general tendencies developed in accord with conditions as they exist and are likely to persist, the time has come for a firmer grasp of our national destiny. We must do more than merely safeguard constitutional rights and trust to individual initiative. We must exert ourselves to the utmost to secure our national strength, stability and progress. In dealing with immigration, public health and education, for example, we must not be too tender of individual rights and privileges. In its relation to the agricultural, mining and manufacturing industries, the rôle of the government is not only that of the leading authority but of technical adviser, stimulator and regulator as well. Industrial development will mainly follow the lines of commercial interest with little regard to either the general welfare or to the distant future.

Among the most difficult of national problems are those concerning the relation of the nation to organizations—industrial, financial, political, religious, labor and racial—within it. National stability requires that national authority be supreme over every internal organization, whether that organization be a state or group of states, a power trust or group of related interests, a religious or racial organization attempting divided allegiance or a protective association of individuals. National strength requires that all such organizations be devoted to the general welfare rather than to selfish class interests. National progress requires that their activities be carefully directed, either by their own officers or by the national government and freely regulated by the government whenever necessary.

To secure such results, very little efficient constructive legislation has been enacted. While laws regulating the activities of individuals are abundant and effective, the corresponding laws dealing with organizations are few and ineffective. The Sherman Law, dealing with industrial organizations, is a conspicuous example. This law aimed to protect the people from extortion by monopolies. Secret agreements have nullified all attempts to restore competition. Efficient production has been hampered and the public has not been protected against overcharges. Natural and useful combinations have been driven to secretiveness and evasion. The nation should welcome the formation of strong effective commercial and manufacturing organizations, provided only the government keep a firm hand on the helm and secure for the public a reasonable proportion of the benefits derived from organization.

Another class of organizations are striving not so much for material advantage as to dominate the nation for the advantage of a particular race, religious sect or class. These are the most insidious and the most difficult to deal with. This nation was founded on the principles of complete civil, religious and political freedom, tolerance and equality. That very freedom has been taken advantage of by those protected by it in an attempt to pervert those principles by securing a strangle hold upon the throat of the nation. We have nursed a brood of reptiles and the sooner we rid ourselves of them the less difficult will it be. No simple regulative Sherman Law is indicated in this case, but a searching test of loyalty with drastic penalties attached.

The various means of securing a maximum of national stability, strength and progress are utilized when individual ability is developed and utilized to the utmost. Perhaps our greatest weakness is too great a tolerance of incompetence in high places. Efficiency demands that not only competent but the *most* competent men available fill all positions of importance. In a pure autocracy no attempt is made to select the fittest for high places. In a pure democracy every place is in theory open to every one, but in practise the higher positions are clogged with incompetents and there are only occasional opportunities for clearing them out of the way. The principle is clear, but the best means of putting it in effect is one of the larger problems of the future.

A BOTANICAL TRIP TO MEXICO. II

By Professor A. S. HITCHCOCK

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The Common Wild Grasses of Mexico

THE general botany of the country is not here elaborated, but the ecologist will readily coordinate the flora upon the basis of the grasses.

Eastern Coastal Plain.—The grasses of this region are illustrated by the specimens collected at Tampico and Veracruz. At the former locality the grass flora is poor in species and individuals. Only about twenty species were found, and many of them represented by single or scattering specimens. Along the brackish mudflats were found certain common marsh grasses, such as *Monanthochloe littoralis,* a creeping wiry grass with clusters of awl-shaped leaves about a quarter of an inch long; *Sporobolus virginicus,* with stout creeping rootstocks that send up short stems bearing conspicuously two-ranked leaves and a close cylindric flower head; *Paspalum vaginatum,* with numerous leafy stolons, the upright flower stems bearing a pair of slender flower spikes; and *Spartina spartinae,* a conspicuous marsh grass, growing in large tussocks, the leaves long, slender and sharp-pointed, the narrow flower cluster raised above the numerous leaves. On the sand dunes and sand flats along the beach one finds, besides the ubiquitous sand-bur (*Cenchrus carolinianus*) and crab-grass (*Syntherisma sanguinalis*), a species of *Eragrostis* (*E. secundiflora*) with erect stem about a foot high and a close, somewhat interrupted inflorescence. This grass is common in sandy soil as far north as Kansas. In pools among the dunes is found *Panicum geminatum,* a perennial water grass with smooth stems, creeping rootstocks and a narrow flower head several inches long.

At Veracruz there is a series of sand dunes separated from the sea by a wide sandy flat. Upon this flat are found several species of grasses in great abundance. Among these may be mentioned *Trachypogon Gouini,* an upright plant about two feet high with a conspicuous feathery flower head; *Sporobolus indicus,* a bunch-grass with long filiform leaves and very small flowers in a long narrow panicle; *Eragrostis Elliottii,* in

Tropical Jungle near Jalapa.

spreading clumps with a diffuse stiff panicle of long spikelets, a species of the southeastern United States; *Bouteloua filiformis,* a common species on the plateau. At the foot of the sand dunes there was an abundance of *Panicum Gouini,* a creeping plant with short upright stems, bearing an oval cluster of flowers. Among the other interesting grasses found at Veracruz may be mentioned *Eragrostis prolifera,* an unusually large species of the genus, with stout erect stems as much as seven feet high and a long loose panicle a foot or more in length. This species was evidently relished by stock, as it was found only when protected by the clumps of bull's-horn acacia or other thorny shrubs. Along the wagon road through the moist lowland there is a rank growth of Pará-grass. This grass is abundant in moist open protected places in the lowlands of tropical America, but does not appear to be a native of Mexico. It is introduced probably from Brazil. Veracruz is an interesting locality to the botanist because it was here that a French physician, Dr. Gouin, made a valuable collection of plants during the French occupation of Mexico. Several species are named for Dr. Gouin and the specimens collected by him at Veracruz are the types. Among these are the two species mentioned above, *Trachypogon Gouini* and *Panicum Gouini.*

Western Coastal Plain.—Collections were made at Manzanillo and Guaymas but the plants of the latter place are es-

A MODERN RAILWAY CROSSING THE ANCIENT HIGHWAY FROM VERACRUZ TO MEXICO CITY. This road is said to have been built by Cortez.

sentially the same as those of the Sonoran plateau and will be discussed under that head. The country around Manzanillo is hilly and the grass flora is meager, as the hills are covered with forest. On the cliffs and shore facing the ocean were found several kinds of grasses among which may be mentioned three. The rare *Bouteloua repens* was first described in 1816, under the name *Dinebra repens,* from the collections of Humboldt and Bonpland in the latter part of the eighteenth century on the seashore at Acapulco, Mexico. The species had remained unknown since that time, botanists having concluded that the original collection was probably a peculiar form of the common allied species *B. filiformis* (*B. bromoides* of many authors). The specimens collected by myself at Manzanillo, in the sand near the ocean, in the same habitat as those collected by Humboldt and Bonpland at Acapulco only a short distance to the south, correspond perfectly to the original description and plate of *Dinebra repens* upon which *Bouteloua repens* was founded. The second species is *Panicum molle* Swartz, found along the face of the cliff near the sea. This name has been misapplied to the Pará-grass (*Panicum barbinode*), but an examination of the original specimen in the Swartz Herbarium at Stockholm shows that it is the same as the plant

A STACK OF WHEAT NEAR POPO PARK.

here mentioned. This species, found from Mexico to Colombia and Jamaica, is a bushy little annual with small panicles of velvety spikelets. The third species is *Tripsacum lanceolatum,* a tall perennial with broad leaves and terminal clusters of two or three spikes of flowers, the lower parts of which are pistillate and break up into one-seeded joints, and the upper parts staminate, falling away entire. Single spikes arise also from the axils of the leaves. This species is more characteristic of the barrancas and rocky slopes of middle altitudes.

Except the grasses growing on the sandy flats around Veracruz, which should produce fair forage when young, the species mentioned for the coastal plain are of no particular agricultural importance.

The Plateau.—As stated previously the plateau region includes a large portion of the total area of Mexico and the grasses are correspondingly numerous and diverse. As the rainfall increases southward the grass flora becomes more abundant in that direction.

The Sonoran area is well illustrated by the collections made in 1908 at Hermosillo, Llano and Guaymas in the state of Sonora. The grasses are so numerous that only a few of the more conspicuous sorts will be mentioned here. The genus

A NATIVE LAUNDRY. Clothes are commonly laundered in streams, being beaten upon stones and then spread to dry upon the grass or shrubs. In the cities there are often public laundries in substantially roofed open buildings provided with running water.

Bouteloua, or the grama grasses, is represented by several species: *B. curtipendula* (side-oat grama), a bunch grass with erect culms one to three feet high, the inflorescence consisting of several short spikes on one side of a slender axis; *B. Rothrockii,* a smaller grass with a few longer spikes, also usually turned to one side of the stem; and *B. aristidoides,* an annual, six to twelve inches high, with numerous small and delicate spikes. *Panicum hirticaule* is an annual species with hirsute sheaths and diffuse panicles of small spikelets. *Heteropogon contortus,* found especially on rocky hills, is distinguished by the single scaly spike with several sharp-pointed brown fruits, each with a long more or less bent and twisted awn or tail. *Andropogon saccharoides* is a tall perennial, with hairy nodes or joints, and an oblong inflorescence, white and feathery because of the numerous white hairs among the flowers. *Chloris virgata* is a common annual weed, with several digitate spikes of fuzzy flowers.

The great central plateau, extending from the United States to the state of Oaxaca, is preeminently a grass region. The mesas, valleys and the lower mountain slopes support a large number of species of grasses that are able to thrive under arid or semiarid conditions. The abundance of the growth depends

A TYPICAL SCENE IN RURAL MEXICO. The pointed straw hats with wide brims are universally worn by the peons. The hats with upturned brims often serve in lieu of pockets as receptacles for small parcels.

upon the amount and distribution of the rainfall. As stated in a previous paragraph the annual rainfall increases toward the south. The arid portion of the plateau extends south to approximately the twenty-second parallel, thus including the state of San Luis Potosí. The grasses of this region were studied at Miñaca and Chihuahua in the state of Chihuahua, Torreón and Saltillo in the state of Coahuila, Monterey in the state of Nuevo León, Durango, Zacatecas, Aguascalientes and San Luis Potosí. Attention will be drawn to only a few of the more common species found in this area. Two species of grama grass are common and are important forage grasses, *Bouteloua hirsuta* and *B. gracilis*, both perennial bunch grasses, the inflorescence consisting of two or three spikes at the top of the stems. One spike stands at the end and the other one or two a short distance below, all turning to one side and moved about by the wind like little vanes. Several species of *Aristida* are common, but of little value from a grazing standpoint. The fruit is sharp-pointed and bears three slender awns, whence the names triple-awned grass and spear-grass. The sharp fruits are troublesome to stock, often working into the flesh and causing irritation. The genus *Stipa* is well represented. The fruit is sharp-pointed but bears a single long awn. The buffalo grass (*Bulbilis dactyloides*) and curly mesquite (*Hilaria*

THE FAMOUS IRON MOUNTAIN AT DURANGO, made up mostly of iron ore.

cenchroides) are small sod-forming grasses, propagating by runners. The flowering stems rise to the height of only a few inches. *Sporobolus*, *Muhlenbergia* and *Epicampes* are well represented. Two species of the first genus, *S. Wrightii* and *S. airoides*, called sacaton, form large tough tussocks, the flowering stems bearing a diffuse panicle of small flowers. The first-mentioned species is taller, reaching the height of five to six feet. There are many small species of *Sporobolus* and *Muhlenbergia* that form a considerable portion of the grass flora, the latter genus differing in having awned florets. The species of *Epicampes* are tall coarse grasses with narrow, usually pale inflorescence. Three small grasses belonging to three genera, but resembling one another in general appearance, are common upon dry hills. They are *Muhlenbergia Wrightii*, *Pappophorum Wrightii* and *Lycurus phleoides*, all agreeing in having a spike-like inflorescence, but differing in the structure of the spikelets.

Over the southern half of the plateau the aspect of the grass flora is similar to that of the northern portion, but the species differ slightly. There are other species of *Bouteloua* and of the allied genera *Pentarrhaphis* and *Cathestecum*.

Collections were made at Zapotlán and Guadalajara in Jalisco, Irapuato and Acámbaro in Guanajuato, Querétaro, Pachuca in Hidalgo, Toluca and Popo Park in the state of Mexico, various places in the Federal District, Uruápan in Micho-

A CLUMP OF *Tripsacum lanceolatum* GROWING ON IRON MOUNTAIN, NEAR DURANGO.

acán, Cuernavaca in Morelos, Chalchicomula, San Marcos, Esperanza and Tehuacán in Puebla, and Oaxaca in the state of the same name. Upon the mesa in the state of Puebla certain species of *Stipa* are conspicuous because of the long narrow nearly white inflorescence. They are bunch grasses with narrow leaves (*Stipa Ichu, S. multinodis, S. tenuissima*). Over a considerable proportion of the table land the cactuses and yuccas are a conspicuous and often dominant element of the flora.

Slope from Plateau to Coastal Plain.—Except in the northern part of Mexico the slope from the table-land to the coastal plain is rather abrupt, and in some places, such as in the eastern part of the state of Puebla, extremely abrupt. This slope is marked by a series of foothills and deep ravines. These ravines, fixing the position of the water courses and often 2,000 or more feet deep with precipitous sides, are known by the Spanish word barrancas. This slope with its attendant magnificent scenery may be seen from the railroad in going from San Luis Potosí to Tampico, from Mexico City to Veracruz by way of Orizaba, and from Guadalajara to Manzanillo. In passing from Puebla to Oaxaca the railroad descends to less than 2,000 feet at Tomellin and then ascends through the beautiful Tomellin Canyon to the table-land. About six miles east of Guadalajara and easy of access is another remarkable can-

A SCENE ON THE MEZA OR PLATEAU IN NORTHERN MEXICO. An adobe house at the left. Adobe is made by mixing the clay soil with water and adding straw for binding. The plastic material is shaped into large bricks and dried in the sun. Adobe is much used in the northern states of Mexico where the rainfall is light. It is also used in southern Arizona and New Mexico.

yon, the Barranca de Oblatos, through which passes the Santiago River, the outlet of Lake Chapala. These slopes and barrancas are usually covered with grasses and other herbaceous vegetation. Forest is by no means absent, and the proportion increases toward the lower altitudes, but the tops of the hills and the steeper sides of the barrancas are usually too dry to support woody vegetation, and here the grasses abound. The number of species of grasses is greater in this region than in any of the other floral areas. The following are a few of the more conspicuous grasses observed along the rims and sides of the Barranca de Oblatos: *Heteropogon contortus,* a perennial with spikes of imbricated bracts from beneath which protrude stout brown awns several inches long, the hard sharp-pointed fruit from which the awns spring resembling those of the genus *Stipa; Heteropogon melanocarpus,* an annual with stout stems four to six feet high and awned fruits like those of the preceding; *Muhlenbergia elata,* a tall leafy bunch-grass, with long harsh narrow leaves and a large purple rather diffuse panicle over a foot long, with numerous small long-awned spikelets; *Arundinella Palmeri,* a grass resembling the preced-

THE OUTSKIRTS OF ZACATECAS. Much of the country here consists of rolling barren hills. The houses are mostly adobe. The projections near the upper part are pipes for conductingg away the water from the flat roofs.

ing in general appearance, but easily distinguished by the broad flat blades and the denser panicle of larger spikelets, each with a bent and twisted awn; *Tripsacum pilosum*, a tall cornlike grass, as much as twelve feet high, with broad blades and hispid sheaths, and a terminal tassel, the spikes of which are pistillate below and staminate above; *Tripsacum lanceolatum*, a smaller species than the preceding, usually not more than four or five feet high; *Andropogon perforatus*, conspicuous with its woolly-white terminal inflorescence of clustered spikes, each spikelet provided on the back with a small pit, like a pin hole; *Paspalum virgatum*, with broad flat blades and a terminal brown or purple inflorescence of numerous spikes, the spikelets circular, flat on one side, convex on the other, nearly sessile along one side of the axis.

Guadalajara was visited by the famous traveler Humboldt and is the type locality of many plants collected by his companion Bonpland.

At Alzada, a station on the railroad a few miles above Colima, at an altitude of about 1,500 feet, a number of interesting and conspicuous grasses were seen. *Tripsacum laxum*, a large tall cornlike plant, six to eight feet high, resembles

PINE FORESTS AT SANCHEZ IN THE SIERRA MADRE, CHIHUAHUA.

Tripsacum pilosum mentioned in the preceding paragraph, but differs in having smooth sheaths. All three of the species of *Tripsacum* were found at Alzada and were usually observed growing upon rocky grassy hillsides. *Pennisetum setosum,* also growing upon cliffs and slopes, has slender culms three to five feet high, terminating in long red spikes, one half inch thick and six to eight inches long. *Lasiacis procerrima* is a tall reedlike grass as much as eight feet high, with numerous broad blades, the base heart-shaped and clasping the stem, the panicle large and spreading.

The eastern slope from the plateau was visited at Cárdenas and at three points in the western part of the state of Veracruz. Much of the region between Cárdenas and Las Canoas on the railroad between San Luis Potosí and Tampico is a rolling prairie, reminding one of the prairies of Iowa. Here were found curly mesquite (*Hilaria cenchroides*) and buffalo grass (*Bulbilis dactyloides*), both common in the plains of Texas, and *Paspalum notatum,* a common species in pasture land at middle and lower altitudes in Mexico and Central America, distinguished by its divergent pair of spikes two or three inches long, with two close rows of sessile spikelets flat on one side and convex on the other. *Bouteloua hirsuta* (black grama) and *B. filiformis,* as well as the widely distributed *B. curtipendula*

MT. ORIZABA NEAR THE TIMBER LINE. An alpine meadow in the foreground; a coniferous forest in the background.

(side-oats grama), were found on these prairies. *Panicum bulbosum,* a perennial species with spreading panicle, is recognized by the thickened bulb or cormlike base which suggested the specific name.

Western Veracruz is particularly interesting because this region was visited by well-known botanists many years ago and a large number of new species were described from their collections. Liebmann, a Danish botanist, made large collections here between 1840 and 1843, especially at Mirador, a hacienda on the east slope of the Mt. Orizaba crest and northeast of the peak. Sartorius, the owner of this hacienda, was also a botanist of note. Schiede and Deppe collected in this region in 1828. Galeotti spent six months at Jalapa, about 1835; Botteri collected around the city of Orizaba in 1850; Müller collected between Veracruz and Orizaba in 1853; Bourgeau, whose collections were probably larger than any of the others mentioned unless it be Liebmann, was sent to Mexico in 1865 by the French Scientific Commission and collected especially at Córdoba and Orizaba.

Jalapa, at an altitude of 4,600 feet, presents a mixture of open prairie and tropical jungle. On the side of a clay cut along the railroad were found several species of *Panicum* belonging to the subgenus *Dichanthelium.* These were of in-

A THATCHED HUT. The common style of dwelling in the country of southern Mexico.

terest botanically because this group of plants is represented by a large number of species in the eastern United States but by few species in Mexico and Central America. Here in this one locality were found six species of this subgenus (*P. xalapense, P. viscidellum, P. sphærocarpon, P. multirameum, P. Joorii,* and *P. olivaceum*). *Panicum xalapense* was first collected at Jalapa (or Xalapa as it is sometimes written, the letters j and x representing the same sound in Spanish) but is rare in Mexico, although a common species in southeastern United States. On the prairie were found several tall species of *Andropogon* and allied groups: *Andropogon virginicus* with clusters of delicate woolly spikes scattered along the stem; *A. condensatus*, with short spreading blades and a rather dense inflorescence of numerous spikes; *A. glomeratus*, stiffly upright with a white-topped dense club-shaped inflorescence of delicate woolly spikes; *Elionurus tripsacoides*, with a single terminal spike of rather woolly spikelets; and *Sorphastrum parviflorum* with a close golden-brown panicle of small spikelets. At the edge of the jungle was found *Chætochloa sulcata*, a very ornamental grass with broad plaited blades and a stiff narrow bristly panicle of purple spikelets.

Near Orizaba, just at the western edge of the city, rises a steep rocky hill, much of which is covered with grass. This

WOODED HILLS NEAR COLIMA. A thatched hut with a small patch of corn, surrounded by a fence of interwoven slender poles.

hill, because of its accessibility from the city, has undoubtedly been visited by all the botanists, and there have been many, who have sojourned at Orizaba. This hill is probably the type locality of many species of grasses and the writer is of the opinion that, in some cases at least, he procured specimens from the identical bunch or patch from which specimens had been obtained by these botanists and which became the type specimens of species described by them. *Epicampes Bourgæi,* a coarse rough-leaved bunch-grass with a stiff narrow panicle of pale spikelets was named for Bourgeau, one of these botanists. In the shade of trees at the base of a rocky cliff was found a rare species of *Panicum* (*P. Schmitzii*) described by Dr. E. Hackel from a specimen sent to him as coming from Mexico, but with no data as to locality, collector or date of collection. This grass has broad short flat blades, the shoots being strongly dorsi-ventral, as is the case with many tropical grasses growing in the shade, for example, species of *Oplismenus* and *Ichnanthus.* This rare grass was found again on a shady wet bank at Córdoba, and was collected also by Pringle at Las Canoas, which is also on the slope from the plateau. In the woods at the top of this hill was found a species of woody grass (*Lasiacis sorghoidea*). There are many species of this group in the tropics. They resemble bamboos

A RAILWAY NEAR TOLUCA. On each side are fields of corn, with a fringe of barley. The space between the rails and a little on each side is the highway for peons and burros.

in having woody stems and broad short blades. The flowers, however, show that the group is allied to the great genus *Panicum*, of which it has been considered a section, but from which it is distinguished by the woody culms and and the shape and texture of the fruit. One specimen of *L. sorghoidea* was found growing in an open area where it was free to assume a bushy form. The clump of culms, twenty to forty in number, rose to a height of ten or fifteen feet, the upper portion curving gracefully outward. The small branches were borne in whorled clusters at the nodes. When in flower the panicles terminate these branchlets. When growing among shrubs or trees, as is usually the case, the culms clamber upward through the supporting branches for as much as thirty feet. Another interesting member of this group (*L. rhizophora*) was found along the edge of the jungle at Córdoba. In this species the culms do not climb high, but form an intricate tangled mass of branching rooting stems that remain near the ground, the leafy shoots rising to the height of three or four feet.

High Mountains.—Many mountain ranges traverse the plateau. Those toward the western edge are collectively known as the Sierra Madre, and may be considered as a southward extension of the Rocky Mountain system. Several notable volcanic peaks arise as isolated cones, some of them into the region of perpetual snow. The writer ascended three of these

A STREET-SCENE IN THE OUTSKIRTS OF CUERNAVACA.

peaks, Orizaba, Popocatepetl (pronounced Po-pó-ca-tê-pet'-l) and Nevada peak of Colima, the two former rising above snow line, which is at about 15,000 feet in the late summer. The distinctly mountain flora becomes dominant at 10,000 to 11,000 feet. Above timber line (11,000 to 13,000 or even higher in protected places) the grass flora is alpine or at least subalpine. The first peak to be visited by the writer was Popocatepetl. From Popo Park as a base, taking a burro to carry the supplies and light camp outfit, and accompanied by my son as assistant, I ascended as far as the snow line. This trip was particularly interesting because we made our way on foot without a guide or a map, through a region entirely unknown to us. We soon lost the regular trail and meandered upward through the open forest and later on the vast sand and lava stretches above timber line. Upon these alpine plains and ridges the weather was capricious, but mostly foggy or stormy. There were violent squalls with rain, hail or snow, often accompanied by high and variable winds. The trip occupied three days, the two nights being spent at about 11,000 feet.

A conspicuous grass in the lower mountain belt (9,000 to 11,000 feet) is *Festuca amplissima.* This grows in large bunches or tussocks, the leaves numerous, the culms as much as six feet tall, and the lower branches of the large mature panicle reflexed. These bunches, scattered rather thickly

THE HOTEL AT MIÑACA, a junction point on the road from Chihuahua City to Sanchez. Typical of the buildings in northern Mexico, hot and dry on the outside, fairly cool and comfortable within.

through the open woods, give a dominant character to the vegetation. Another bunch-grass (*Cinna poæformis*), somewhat similar in appearance but in smaller light-green bunches about a foot in diameter, is found intermixed with the preceding. There are also, upon the mountain side in this belt, vast areas of open land upon which the dominant and sometimes almost exclusive plant is *Epicampes macroura,* the roots of which are used in the manufacture of scrubbing brushes. The plants grow in large tough tussocks one to three feet in diameter, in rich soil the tussocks touching one another, the leaves numerous, stiff and harsh, the inflorescence a long narrow stiffly upright spike. The bunches of *Epicampes* are evidently sought by cattle, as the ends of nearly all the leaves were eaten off. Growing within the protection of the *Epicampes* was a species of *Bromus* (*B. exaltatus*) with slender stems and a loose panicle resembling oats. In more exposed places this species was often prostrate. At higher altitudes other species became more prominent. A delicate species of *Festuca* (*F. willdenoviana*), one to two feet high, with soft short leaves and a nodding few-flowered panicle, was common in the upper wooded belt. Here were also *Poa annua,* the common weedy

A PRIMITIVE CONTRIVANCE FOR RAISING WATER FOR IRRIGATION. The horse turns a large horizontal wheel. The vertical pegs on the under side engage a similar series on the side of the vertical wheel, which in turning raises a line of buckets on the circumference. The supporting pillars are of adobe. Near Zacatecas.

Poa of our eastern states; *Poa conglomerata,* a usually prostrate plant with a narrow dense panicle, and *Graphephorum altijugum,* with delicate erect culms and a narrow panicle. Just above timber line in the bunch-grass belt were found *Festuca tolucensis* and *Calamagrostis tolucensis,* originally collected in similar situations on Mt. Toluca, a volcano near the city of Toluca. They both have numerous narrow erect leaves. The latter species extends to snow line and in favorable situations forms a sort of fairy-rings, due to the indefinite expansion of the tussock and the death and decay of the interior, leaving a narrow annular zone of the living grass. These rings may be many feet in diameter, but finally break up into segments and the original ring becomes indefinite or obsolete. Other grasses of this alpine region are *Agrostis Schiedeana, Trisetum spicatum,* common in the high mountains in the United States and extending to the Arctic regions, and *Festuca livida,* a low grass growing in the volcanic sand below snow line, conspicuous because of the comparatively large deep-purple spikelets.

Mt. Orizaba was ascended from Chalchicomula, on horseback with servants (mozos) and guides. Two days were taken

A LARGE ALFALFA FIELD NEAR TOLUCA. In this field of over one hundred acres the alfalfa was grown in rows and cultivated.

for the trip, the night being spent in a cave about timber line. The writer ascended the peak over the snow nearly to the top, but was prevented from reaching the actual summit by the violent gale blowing from the east. Many of the species mentioned above as occurring on Popocatepetl were also found on Orizaba (such as *Bromus exaltatus, Poa conglomerata, Trisetum spicatum, Festuca amplissima, F. livida, F. tolucensis, Epicampes macroura*). Another *Festuca* (*F. hephæstophila*) and a species of *Calamagrostis* were collected. The *Festuca* grows in small tufts, looking like our sheep's fescue. This and *Calamagrostis Schiedeana* grew together in the grassy meadows above timber line, the latter in large bunches like *Calamagrostis tolucensis*. Both have numerous firm involute root leaves, with a papery tawny base peculiar to alpine grasses.

Mt. Nevada was reached on horseback from Zapotlán over a good trail. Two days were taken for this trip, the night being passed in a cabin at about 11,000 feet. The dominant grasses in the upper regions of the timber and extending well above timber line are *Calamagrostis tolucensis* and *Festuca tolucensis*, both found on Orizaba. This is interesting as showing the similarity of the flora of the mountain tops as compared with the diversity in the flora of the lower regions. *Trisetum spicatum* was found throughout the region above timber up to the very summit.

A FIELD OF ALFALFA NEAR SAN LUIS POTOSÍ. The plants are cut by hand, piled in heaps, and then tied in bundles for transport.

The grasses of the northern Sierra Madre were studied at Sanchez, then the terminus of the railroad from Chihuahua to Topolobampo. This is on the continental divide at an altitude of about 8,000 feet, in the midst of pine forest. The species of grasses found here are in the main different from those found in the other regions mentioned, and the flora shows a close affinity with that of southern Arizona. The dominant grasses are species of *Muhlenbergia, Sporobolus* and *Epicampes.* Certain annual species were especially abundant, such as *Sporobolus ramulosus, S. confusus, S. Shepherdii* and *Muhlenbergia peruviana.*

Grasses of Ponds and Marshes.—The grasses of ponds, marshes, river banks and similar situations occupied by water plants are much the same throughout Mexico. The flora of fresh-water ponds is well illustrated by the grasses seen at Orozco, a station twelve miles south of Guadalajara. Certain species were found only in the water, such as: *Panicum paludivagum,* with a long narrow inflorescence of several short appressed spikes, and very long submerged rooting stems; *Panicum sucosum,* with spreading panicle and long submerged stems as in the preceding; *Paspalum longicuspe,* growing in deep water among water-lilies, only the inflorescence emerged, this consisting of numerous flat spreading spikes, the indefinitely long rooting stems submerged, but floating by means of

A FIELD OF PARÁ GRASS NEAR URUÁPAN. This is a common forage grass at low altitudes in Mexico. Mostly cut and fed green. A native of Brazil.

the large masses of roots at the nodes; *Echinochloa holciformis*, a tall erect broad-leaved grass, rising well above the water and bearing a close panicle of large long-awned spikelets; *Homalocenchrus hexandrus*, a small, rather delicate, but wiry grass, with a small panicle of very flat spikelets. Along the edge of the pond, growing in mud or in shallow water, were found *Distichlis spicata* (salt grass), *Paspalum vaginatum*, with a pair of spikes at the summit of the slender culm, *Echinochloa zelayensis*, allied to our barn-yard grass, and *Leptochloa fascicularis*, with several stiffly ascending spikes.

Distichlis spicata, mentioned above, is a common grass in moist alkaline soil and along the banks of ditches. Another common plant in such situations is *Paspalum distichum*, which resembles *P. vaginatum* in having two divergent spikes at the summit. Along the margins of ditches and streams where the soil is not especially alkaline one finds *Polypogon elongatus*, with slender lax stems and a narrow panicle of small flowers turning yellow with age; *Panicum laxum* and *P. pilosum*, small plants with several spikes of small round spikelets, and many species of *Paspalum* characterized by their plano-convex spikelets. *Arundo Donax* is a large reed with broad leaves, stems as much as twenty or thirty feet high, and large feathery

A coconut palm at Uruápan. It is rather unusual to find coconuts growing so far from the coast.

plumes when in flower. This reed, introduced from Europe, often grows in dense masses along the banks of irrigation ditches.

Weedy Grasses.—Many of the weedy grasses of cultivated soil and waste places are introduced from the Old World. Others are natives of Mexico or Central America. The following are the more common and widespread species.

The annuals will be mentioned first, as they are the common weeds of cultivated fields: *Syntherisma sanguinalis* (crabgrass), with spreading stems, hirsute sheaths and slender digitate spikes, common everywhere; *Eragrostis mexicana*, with a diffuse panicle of lead-colored spikelets, very common in cultivated soil, throughout Mexico; *Eragrostis caroliniana*, similar to the preceding but with smaller spikelets, less common; *Eragrostis ciliaris*, with a narrow panicle of strongly ciliate spikelets, a weed of streets in the coastal plain; *Panicum fasciculatum*, with panicles of round reticulate yellow or dark-brown spikelets, the main branches spikelike, common in fields at lower altitudes; *Panicum hirticaule,* with a diffuse panicle, resembling our old witch grass, common at low and medium altitudes on the Pacific slope; *Brachiaria plantaginea,* with a few spreading spikes of roundish spikelets growing in moist cultivated soil; *Leptochloa filiformis,* with many slender spreading purple spikes of small spikelets, common in rich fields in the coastal plain; *Cenchrus carolinianus* and *C. echinatus* (sandbur), the former with a looser spike of burs, common in fields and waste places; *Eleusine indica* (goose grass), a smooth grass with a few digitate spikes, found chiefly along streets and in waste places. There are, of course, many other weedy annual grasses, but the above are the commoner kinds.

The perennials are fewer in the number of the species and are found chiefly in pastures and waste places. *Chætochloa geniculatus* (fox-tail) resembles our northern species, differing in being perennial, one of the few of this class common in cultivated soil. *Holcus halepensis* (Johnson grass) has obtained a foothold here and there, and may prove a serious pest, as is now the case in Texas and other of our Southern States. *Sporobolus Berteroanus* (smut grass) can be recognized by its long slender panicle of small flowers that are frequently blackened by a fungus. Certain species of *Paspalum* are common in meadows, pastures and along roads (*P. convexum, P. plicatulum, P. squamulatum*). *Paspalum conjugatum,* with stolons and a pair of long slender spikes, is very common in tropical America and extends into the lowlands of Mexico.

The grasses obtained on this trip yielded one new genus and twelve new species, and in the study of the collection ten more new species were found among the grasses secured by others.

THE ENGINEER'S PART IN AFTER THE WAR PROBLEMS

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THE engineer—as his designation implies—is the man of ingenuity, the man who has a vision of the future and who, without being visionary, can see and devise methods of producing results by utilizing the forces and resources of nature. His business is to plan and build. During the war his was the task of devising ways of protecting friends and destroying enemies. Now, with peace assured, his task is to make ready and get the machinery of construction and operation into full motion again. His part is also that of the pioneer to explore, to conduct researches into realms beyond our present knowledge and with facts thus secured plan out the safe way for others to follow.

In the countries where war has wrought its destruction, the duty of the engineer is primarily to rebuild, but with us, more fortunately situated, where the disturbance has only been relatively small, our part is to wisely provide for larger and better uses of our resources and prepare for the better communities toward which all of us aspire.

While the war has wrought little destruction to us in Illinois, and in fact has, if anything, increased material prosperity, it has "laid its fearfully vitalizing hand upon our people," and has served to greatly widen their viewpoint. It has made possible the realization of some of those ideals which a few years ago were regarded as impracticable. In other words, the established order has been so far disturbed as to render it wise to urge improvements which before the war seemed to be out of our reach. This has been stated by Winston Churchill, "If for five years after the war the people devoted the same energy, cooperation and self-sacrifice to reconstruction as have been devoted to the process of destruction, there is no social, industrial or economic problem which could not be conquered."

The question confronts us therefore as to how in this present crisis of world affairs the engineer and organizations of engineers, both individually and collectively, can perform their largest service. What are the steps to be taken in order that we may do our full duty as citizens?

It is desirable to emphasize the fact that engineers as a class owe a larger duty to the public than almost any other group. They have been educated largely at public expense and given the opportunity of enjoying a wider outlook upon the forces and activities of nature than have most of our fellows. Because of this fact there rests upon them the obligation to utilize these advantages in the most efficient manner for the general good. They have already shown what they can do under the stimulus of war. Now under peace conditions—which should be even more inspiring—it is for them to demonstrate their continued value to humanity. The question is as to how this can best be performed.

1. *Diffusion of Information.*—Under our form of government any notable advance or improvement must be made largely through the support of the majority of the thinking people. To secure wise action it is obviously necessary that the public be well informed as to the objects to be attained and relative costs and benefits involved. The engineers in short should do everything in their power to diffuse information regarding the matters in which they are skilled in order that the public may be able to act intelligently.

In the past, it must be acknowledged, engineers as a body, particularly as represented by our larger societies, have been remiss in taking the public into their confidence regarding the facts and conclusions to be drawn regarding many important engineering matters. In fact, we have rather prided ourselves upon this condition and upon our close adherence to narrow technical detail. As a consequence not only the public has suffered but the engineering profession even more so in being regarded as technicians; the engineer has been classed in the same group with the engine runner or fireman but without enjoying anything like the influence on public affairs had by the latter.

Our first and foremost part in the after-the-war or reconstruction problems is obviously that of aiding the public through the diffusion of information as to the nature of these problems and their solution since most of them rest upon matters which come mainly within the cognizance of the engineer.

2. *Research.*—Closely connected with the duty of diffusing information is that of encouraging in every practicable way the acquisition of additional information regarding natural resources of the country and the methods of utilizing these. While much is already known there lie in every direction innumerable unanswered or partly answered questions to which

it is necessary to obtain complete and satisfactory replies in order that progress may be made. Here engineers individually and collectively have a duty, namely, that of stimulating continued study and research into those conditions which are often assumed by the public to be facts and yet concerning which comparatively little definite information can be had. Most of these present-day problems relate to transportation and its control, to the movement of persons and goods, to better methods of road construction and maintenance, the restoration of navigation, better water supply for towns and industrial establishment. There are innumerable lines in which the engineers and their organizations should be actively at work either directly or in stimulating others.

3. *Preparation of Plans.*—In connection with the diffusion of information and stimulation of research it is incumbent upon the engineers to use the experience and ingenuity with which they are endowed to make general plans and bring before the public the possibilities of larger health, comfort and prosperity. It is true that the details can only be worked out with safety after adequate funds have been provided, but it is nevertheless possible to outline the picture in a broad way and to keep continually before the people or communities concerned a conception as to what may be done by the use of information possessed by the engineer or which may be had by further study. In reply it may be urged that the busy engineer immersed in the details of his daily work has little time for such matters. Nevertheless, reflection will show that even the busiest must have a certain relaxation and that he will be improved mentally and morally, and possibly gain in a financial way if occasionally he lifts his eyes from his desk and permits his mental vision to take in the larger aspects of the things with which he is familiar. Moreover, the contact with his fellow men in the direction of their vision to the wide scope of engineering possibilities must have a beneficial effect in counteracting the narrowing influences of professional detail.

Reconstruction Problems.—But what are these after-the-war or reconstruction problems? How do they differ from the ordinary routine? In many ways these do not differ but are the culmination and grouping together of many questions which have been before us for a generation but which are now demanding early attention. They take in the whole range of human activity, but may be classified for convenience into three groups in the order of their immediate insistence.

(*a*) Men or man power.
(*b*) Materials or natural resources.
(*c*) Ideals or plans.

(*a*) *Men.*—The immediate and vital question following the war is that of demobilization of the army, providing employment for returning soldiers and war workers and the reconstruction of the crippled or injured men. The latter is being given attention by the War Department and theoretically at least no man is discharged from the army until he is equipped as far as humanly possible to make a living at some suitable occupation.

This reconstruction of men is the first and most pressing duty, one in which the time element is vital. It began with first aid to the wounded and was continued not merely through hospital service but through reeducation activities or vocational training such that the man injured in the service of his country is restored as completely as possible to health and rendered self-supporting through the use of artificial limbs supplied to him. He is aided by the acquisition of a training in vocational or even in engineering occupations which enables him to become a self-supporting and self-respecting citizen after he has done his part in winning the war.

More than this the reconstruction plans involving the return to industry, in the quickest and best way, of the munitions workers and others who have been employed more or less directly in connection with the war and to do this in such a way as not to interfere with the earnings or proper enjoyment of others who have taken their former places in industry.

The present problem is that of finding work immediately for these men and women who are returning to the industries which have been discontinued or which have not yet come into active operation. Here is demanded not charity nor political discussion but immediate practical action. This can come about in many ways.

1. By urging that each and every employer take on as many people as he can and in spite of present high prices incur every reasonable business risk in getting his operations under way.

2. In urging public officers and persons having control of expenditures of public or private organizations to undertake at once the works which have been planned or contemplated such as highways, waterways, water supply, drainage systems, public buildings, parks and all those things which benefit the public. In opposition it is urged that there is scarcity of material

and prices are high. Even though this be true, it is often possible to substitute materials; even though the prices may be high it is a matter of public economy in the long run that the work be performed now and that an outlet be afforded for labor on things which are ultimately of use.

(*b*) *Materials.*—In the reconstruction problems having to do with materials there is a far wider diversion of interests and of methods; the first and most vitally important are those things which have to do with food production and transportation. Next in importance are the fuel problems and then the other natural resources such as raw materials needed in manufacturing. Fortunately, the study of these resources, their distribution and best employment in industry has been the subject of investigation by a group of conservationists and engineers who during the past decade aroused interest in these matters. Due to their systematic efforts there has been made by various federal bureaus a beginning upon the systematic collection of data.

Each and every business man and agency needs to be stimulated to larger efforts and to a consideration of the practicability of putting to full use all of his resources whether of raw materials, agricultural products, manufactured articles, or of human or man power. To do this effectively there must be an agreement upon the larger ideals or underlying principles which result in well-considered plans of action.

(*c*) *Ideals of Reconstruction.*—No far-reaching result can come about from the planning of the use of man power or of raw materials until there has been a general agreement upon fundamental principles. It is true that the working out of these to a form where they will be generally agreed upon may not be accomplished for some months. In the meantime certain details involving employment of men and use of materials may be satisfactorily entered upon. There should be an immediate discussion of ideals even though agreement on the statements of them may not be reached for some time.

On most of the fundamental ideals there will probably be sharp division between two great parties, representing opposing social or political beliefs; it is well that this should be so, and that each ideal should be submitted to the hot fires of discussion.

There are almost innumerable agencies, more or less directly concerned in the practical working out of these ideals. The banking and related industrial interests in general are on the one side—on the other the labor organizations. Each is urging from its own standpoint the adoption of certain policies with reference to the utilization of man power and of materials. Between them is the engineer who must make the plans to put into effect the line of action needed to produce the desired result. He should not be content to be merely the go-between but should guide and direct as may be possible from his relatively disinterested standpoint.

Under the head of ideals or plans may be grouped many problems whose solution depends upon the policy to be adopted by public and private bodies concerned with labor, commerce, industry, education and economics. These ideals and the problems dependent upon them afford a wide range of speculation or of idealism, but among these needs that of a national labor policy stands prominent as the prime requisite for reconstruction; and next to this, land, taxation and raw materials.

Dean Davenport has well stated that we are to address ourselves to the evolution of a real democracy.

> This evolution will submit to society for progressive solution, a series of detailed problems—every one difficult and every one coordinated with every other one, but all conditioned by the one object—the highest possible development of the human race. These issues will include such difficult problems as (*a*) an adequate land policy, (*b*) sanitary and comfortable housing, (*c*) good and abundant food, (*d*) public insurance against preventable or curable diseases for public reasons, (*e*) universal and free education that really educates, (*f*) economic opportunity, (*g*) industry and thrift either optional or enforced, (*h*) adequate provision for the helpless, (*i*) a clean public service, (*j*) a rational conception as between the individual and state, and between public and private ownership.
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> There are a thousand related questions, local, national and international that will thrust themselves upon us for adjustment and more than that for readjustment, for we shall have the power to see only a little way at a time along the road that we shall then be traveling.[1]

Each of these policies is usually considered by the persons interested as a separate entity and one which may be discussed by itself. This is where danger lies to the country as a whole, namely, in that with lack of full information, there is inability on the part of the public to mentally visualize the relative proportions of each topic. For example, the settlement of soldiers upon reclaimed lands, important in itself, may lead to the obscuring of larger needs and to divert attention to the detriment of the best interests of the country as a whole. It is exceedingly important, therefore, that all of these problems be catalogued together and be viewed as a whole—as well as in detail.

It is the engineer who must supply many of the facts and conclusions upon which the policies may be based. Some of

[1] *Country Gentleman*, November 16, 1918.

the subjects above enumerated fall entirely within his cognizance, especially those pertaining to land, to housing and to the discovery and use of the natural resources.

Without the intelligent direction of the engineer, little progress can be made. The great war has awakened Americans to the fact that in their somewhat complacent attitude of mind they had permitted European nations, especially Germany, to far outstrip them, with the result that when war came suddenly upon us, we were compelled to lose time, and directly or indirectly sacrifice thousands of lives and millions of dollars in accumulated wealth because of our short-sighted policy with reference to engineering and to scientific research along engineering lines.

The whole subject of raw materials is also one which can be attacked successfully only by the engineer, including with these materials not only iron, copper, clay, petroleums and other substances from the earth, but also the fuels and other sources of power, such as from the flowing waters.

The engineer's problems of to-day also include that of transportation, not merely the building and operating of railroads, waterways and highways, and the cars or boats moving on these, but also the navigation of the air and all of the matters which lead up to successful performance.

Next in importance comes the means of communication—the telephone, the telegraph, the wireless, and closely connected with these the rapidly increasing number of public utilities, founded primarily on engineering plans and methods. It has been the fashion to leave the larger control of these to business men and lawyers, but the time is arriving when the engineer is appreciated to be the chief factor in their success.

In agriculture also the engineer has entered, and with the increasing demand for food, his skill is being more and more called upon, not only in developing agricultural machinery, but in building irrigation and drainage systems, in clearing lands, and in directing operations in a large way. In housing problems the engineer, as well as the architect, must direct affairs. Even in education and the diffusion of intelligence, the operations are becoming more and more closely connected with the principles of engineering.

In all of these matters which pertain to the conservation and use of the resources of the country, both material and human, and the development of ideals, the engineer should be active; while his profession may not include the direct control of capital and credit, of foreign and domestic trade, of agricultural distribution, and of many purely business questions, yet he is, or should be, such a factor in the fundamentals of these that his knowledge and skill can not safely be neglected.

Assuming that the above statements of the engineer's part in after-the-war problems are approximately correct, then comes the question as to what he and his organization should do in the present crisis of world affairs. The reply seems obvious that as an individual he should take an active part in these world problems. Every engineering society should have its committee on reconstruction, charged with the duty of arranging for effective presentation of one or another of these great subjects of employment of labor, research, study of raw materials, or fuels, power, transportation, public utilities and other matters, all of which are undergoing radical changes. The trend of these should be studied and the influence of the engineer as an individual should be wisely used.

Each society under this conception has a great duty and responsibility to its members and through them to the public. The standing of the engineering profession in the near future must be determined largely by the wisdom of the action taken now in approaching these great problems of reconstruction.

BIOLOGICAL PHILOSOPHY AND THE WAR[1]

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IN these terrible days when all the great advancements and discoveries of scientific achievement seem to be turned by man to the destruction of his fellow man, science itself stands indicted in the minds of many as the greatest curse that civilization has brought forth. While we do not perhaps hear it often voiced in such sweeping condemnation, it is not unusual that the same thought is applied to some particular invention. It was only a few days ago, for example, that I heard some one say it "seemed too bad that the mastery of the air had been achieved, since it could be turned to the bombing of innocent women and children." No doubt many of us unconsciously have had much the same thought when we have reflected on the nefarious manner in which scientific discoveries have in this war been prostituted to the end of accomplishing a desired purpose in contravention of all laws of humanity and of decency. Nevertheless, I wish to assert that this is plainly a prostitution of scientific discoveries and that science, as such, can not be condemned without a careful weighing of the benefits it has conferred on the race as a means of amelioration in the struggle against natural conditions—the elements, hunger and disease—the weighing of these benefits against the harm it has wrought when used as a tool for evil. While we can not perhaps assert that we are any happier than the savage in his ignorance, probably few of us would care to return to his state.

It is not my purpose, however, to make an apology for nor even a defense of science, neither of which is necessary. But it is a part of our scientific method to send our reasoning out ahead of our actual demonstrated knowledge; it is the advance guard which is sent forward to reconnoiter the unknown country in the attempt to find the true path by which the line of march shall follow. The results of this reconnaisance we call hypotheses and theories. Sometimes the correct route is discovered; often not; and more often still only partially, so that when we find ourselves in a *cul-de-sac* counter marches must be made

[1] Presidential address delivered before the Wisconsin Chapter of Xi, May 21, 1918.

and branch roads followed up. The directness and speed of our progress obviously depends in large measure on the correctness of our leads. Our advance is largely by the method so well known to the biologist because so extensively employed by the lower animals—that of "trial and error"; the extent to which it is more direct depends upon the correct reasoning and insight displayed by our hypotheses. Our hypotheses, then, are of very vital importance, since they often determine the course of our activities, and they may even furnish the principles by which we live and order our lives and affairs.

Now no line of scientific thought and endeavor has perhaps been more influenced by theory than that of biology, and the biological theories which have had greatest influence are those relating to the methods of organic evolution. The day is past when the fact of organic evolution is questioned, although biologists are still far from being in agreement as to the means by which it has taken place. But the gradual acceptance and spread of the doctrines of evolution have had an influence far beyond the domain of science—they first took a hold on the educated public, and have since filtered out through various channels until they have produced an appreciable effect on much that we think and do. Particularly have they put their impress on religion—or more strictly speaking on theology—and on sociology. This is as it should be in so far as well established facts are concerned; but if science in her newly acquired leadership should guide us falsely it would be a serious offense indeed.

The Germans are preeminently a people who take themselves seriously. What is more they take their science and their scientific theories seriously as well, and apparently these are playing a large part in the present world conflict, not only in the practical application of the former, but to an equal extent in the way in which the latter are used as a justification of the war and in the manner of its prosecution. This was brought forcibly to my mind in reading the recent admirable essays of Professor Vernon Kellogg published under the caption of "Headquarters Nights." Whatever may be the motives and ambitions of the military leaders, the so-called German intellectuals seem to have a definite philosophy which serves as a basis for their position—a position which they are not only ready to support by argument, but for which many of them are willing to fight. As Kellogg says, "they fight, not simply because they are forced to, but because, curiously enough, they believe much of their talk." And he adds: "This is one of the dangers from the Germans to which the world is exposed; they really believe much of what they say."

Those of you who have read the essays to which I refer will recall that Kellogg, while serving in Belgium and northern France on the Belgian Relief Commission, had abundant opportunity to discuss the German point of view with an old-time friend of his, a zoologist stationed at headquarters as a captain of infantry, whose identity Kellogg hides—though ineffectually to most biologists—under the fictitious name of Professor von Flussen. Kellogg says:

> The captain-professor has a logically constructed argument why, for the good of the world, there should be this war, and why, for the good of the world, the Germans should win it, win it completely and terribly. It is a point of view that justifies itself by a whole-hearted acceptance of the worst of Neo-Darwinism, the *Allmacht* of natural selection applied rigorously to human life and society and *Kultur*.

Kellogg goes on to say that in talking it out biologically they

> agreed that the human race is subject to the influence of fundamental biologic laws of variation, heredity, selection and so forth, just as are all other animal—and plant—kinds. The factors of organic evolution generally are factors in human natural evolution. Man has risen from his primitive bestial state of glacial time, a hundred or several hundred thousand years ago, when he was animal among animals, to the stage of to-day, always under the influence of these great evolutionary factors, and partly by virtue of them.

So far they agreed, but beyond this their ideas were irreconcilably at variance because of inability to accept the same premises for further argument. Accepting the German premises the argument goes on with irresistible logic to the inevitable conclusion. In order to put this before you, I can not do better than to quote again:

> Professor von Flussen is Neo-Darwinian, as are most German biologists and natural philosophers. The creed of the *Allmacht* of a natural selection based on violent and competitive struggle is the gospel of the German intellectuals; all else is illusion and anathema. The mutual-aid principle is recognized only as restricted to its application within limited groups. For instance, it may and does exist, and to positive biological benefit, within single ant communities, but the different ant kinds fight desperately with each other, the stronger destroying or enslaving the weaker. Similarly it may exist to advantage within the limits of organized human groups—as those which are ethnographically, nationally, or otherwise variously delimited. But as with the different ant species, struggle—bitter, ruthless struggle—is the rule among the different human groups.
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> This struggle not only must go on, for that is the natural law, but it should go on, so that this natural law may work out in its cruel inevitable way the salvation of the human species. By its salvation is meant its desirable natural evolution. That human group which is in the most

advanced evolutionary stage as regards internal organization and form of social relationship is best, and should, for the sake of the species, be preserved at the expense of the less advanced, the less effective. It should win in the struggle for existence, and this struggle should occur precisely that the various types may be tested, and the best not only preserved, but put in position to impose its kind of social organization—its *Kultur*—on the others, or, alternatively, to destroy and replace them.

Such is the argument, and it must be confessed that to a biologist familiar with the details of the ruthless "struggle for existence" among the lower forms of life its plausibility is at first most disheartening. Our first revolt against it is from the heart rather than from the head. It violates all our ideas of right and justice and of humanity. But the German philosophy has no room for dictates of the heart where the state is concerned—all principles of right and justice and of fairness are subordinated to the simple power of might when it is a question of the German government against any other people. This is simply the working out between nations of the primary law of natural selection.

Professor von Flussen says that this war is necessary as a test of the German position and claim. If Germany is beaten, it will prove that she has moved along the wrong evolutionary line, and should be beaten. If she wins, it will prove that she is on the right way, and that the rest of the world, at least that part which we and the Allies represent, is on the wrong way and should, for the sake of the right evolution of the human race, be stopped and put on the right way—or else be destroyed as unfit.

Could anything be simpler? That which is, or can be, is right!

Be it said in Professor von Flussen's behalf—and the same no doubt applies to others who share his belief—he is ready to stand by his doctrines.

If the wrong and unnatural alternative of an Allied victory should obtain, then he would prefer to die in the catastrophe and not have to live in a world perversely resistant to natural law. He means it all. He will act on this belief. He does act on it, indeed. He opposes all mercy, all compromise with human soft-heartedness. Apart from his horrible academic casuistry and his conviction that the individual is nothing, the state all, he is a reasoning and warm-hearted man. So are some other Germans. But for him and them the test of right in this struggle is success in it.

Now this reasoning on the basis of biological analogy—making rigid application of the rule of the "survival of the fittest" to human ethnological groups—has enough of plausibility about it to make it very disturbing. For those who are not biologists, or for those of us who feel that man is working his evolution out in a different way from that of the lower animals, it is somewhat difficult to get the coldly practical German point of view. We are inclined to rate the finer feelings and impulses that man has developed as indicating the high water mark of his evolution; but from the viewpoint of German philosophy these are but defects unless they have a definite survival value. To us they seem the things that make life worth living, but what is to become of them if the people possessing them and acting upon them is at the mercy of and subject to destruction by any other nation which prefers to make its way by brute force? Clearly right must have might as well so long as it has to contend with those who recognize only might as an evolutionary factor.

If we admit that man is not beyond the workings of the fundamental laws of evolution, where shall we find the hole in the German reasoning? Kellogg suggests that it lies in the value of altruism, or mutual aid, as he prefers to call it in order to avoid anthropomorphic implications in speaking of it in the lower forms of life. He does not, however, develop the point, and his discussion is far from a demonstration. It is this phase of the subject which I should like to develop a little farther.

Leaving aside the question as to how new characters of form or behavior arise, biologists are in general agreement that the chances of survival are greatest for those organisms which are best suited to meet the conditions of life; in other words, show greatest adaptation to their environment. This means that in the long run such forms will tend to survive and reproduce, and presumably to increase the chances that their offspring will be possessed of the same advantages. The process is slow and bungling, but nature, by a prodigality of reproduction, throwing myriads of individuals into the discard and saving the few, makes her way haltingly but inevitably toward some unknown goal. This process of elimination is natural selection, and in Neo-Darwinian philosophy, which is also the German philosophy, this is the all-powerful force in evolution. The questions for us to answer if possible are: Is man subject to natural selection in the above sense? and what part does mutual aid play in his evolution?

Taking up the second question first, it may be well to give a very sketchy review of the beginnings and course of development of the mutual aid principle in the animal kingdom. In many of the lower animals, such for example as most of the protozoa, each individual is an independent unit which meets its environment and struggles with it alone, having no relation to other individuals of its species. It survives or perishes entirely as its merits or special advantages enable it to cope with the chances besetting its existence. It has no social relation to other individuals except when, as a purely physiological reaction, a portion of its protoplasm may unite with that of another, resulting in new combinations of hereditary factors, and hence increasing the chance that something new may appear which will give some of its descendants an even greater advantage in the never-ending struggle to survive.

In certain groups aggregations or colonies of individuals appear, and these seem to have acquired by their association certain advantages. There is no need to enumerate all of these advantages, but one of the most apparent is the possibility of *specialization*, the taking over of separate functions formerly common to each independent individual by the different components of the colony. Thus we early find special individuals given over solely to reproduction, while the others retain their functions of locomotion, feeding and the like. Further developments of colonial social organization employ almost every imaginable advantage of specialization, such as entirely separate individuals for locomotion or support, for feeding, for apprehension or defense, and for special senses. It is a fascinating field and tempts one to go into details of special and beautiful adaptations, but for our present purpose the point I wish to make is that the colony is a new unit possessed of special advantages in its fight for existence, and superseding the individual. Indeed we may even have colonies of colonies, and no end of complicated adaptations. A second point I would make here is that practically all colonies are really *families*—the component members are all related, being the descendants of single individuals or pairs of individuals which have remained grouped together instead of separating as they were formed.

It has long been recognized by biologists that all many-celled animals—man among them—are, broadly speaking, colonies made up of individuals of a lower order. These individuals are the cells, which reach the extreme of specialization into tissues, having lost completely their power of separate existence and of reproducing the species. They are entirely dependent for their existence on the successful cooperation of the whole aggregate of tissues, each composed of its particular kind of individual cells.

The social relations so far discussed, using the word in its broadest possible sense, have all been between members of the same species. It is very common, however, for similar relations to be established between individuals or groups of different species. Thus we have all degrees of commensalism, in which the advantages of the relation are mutual, and from that a series of relations ranging on the one hand to parasitism and on the other to virtual slavery.

It is easy in the sociological history of mankind to find essential parallels to most of the social relations that have been mentioned in the foregoing. How far back the individual man, or his progenitor, was an entirely independent social unit we have no means of knowing, but, as in lower forms, the family was without doubt the original group, arising naturally from the necessary association accompanying the increasing care given to the offspring, which has been such a potent factor in man's evolution. From the family group as the ethnic unit, we see gradual expansion of the unit to the group of families, or clan with a common descent, then to the village, the tribe, the small state, and finally to the nation as we are familiar with it at the present time. But the evolution of these various ethnic groups has not been in a straight genetic line. There have been the usual ramifications and divergencies that are common to all evolutionary progress. There have been some lines in which essential democracy was the rule, but more commonly specialization of labor has been accompanied by the development of a special governing class, while often at the same time a condition of serfdom, as exemplified in the feudal estates, or of slavery, has been imposed upon the subordinate members of the society.

The philosophy of the German state of to-day appears to be founded on the principle of ultra-specialization. It exemplifies the nation as the extreme development of the unit of evolutionary interaction. The reasoning is simplicity itself—the nation has merely become a greatly magnified individual in the struggle for existence. Its classes are its tissues. Its rulers are the central nervous system which guide and direct the activities of the whole, and just as nervous tissue is the most highly developed in the body, being specially set aside for its one function and incapable of any other, it is easy to see how the "divine right" of the ruling classes arises—it has been so decreed by nature. By the same divine edict, I presume, other classes are destined to remain the "hewers of wood and the drawers of water." And just as one tissue can not change to another, so on this strict specialization principle it is best for each class to develop for a particular function and to perfect that one function to its highest degree. There is no encouragement to advancement from one class to another, and least of all from the laboring class to the ruling.

The analogy might be extended to minute details, but there is no need. Specialization seems to be the key-note to all evolutionary advancement; the highest forms in each line of development are the most specialized, and man has reached his position of preeminence in the animal kingdom as a consequence of the highly specialized state of his nervous organization. If this principle holds for the individual as a unit, why should it not hold equally for the ethnic unit?

The next step is also perfectly logical. We have seen the ethnic unit grow in size until it is now a large nation, but still having in a way the attributes of a single organism in which the various parts, under the direction of a specially segregated coordinating and guiding part, all work together for the common good—meaning by good the survival of the unit. But why should the organization stop here? Why should it not expand on the same lines until we have a mammoth sociological unit—or, speaking biologically, an organism of a super-order—which shall include all mankind and whose rulers shall direct the destinies of the whole world? This is the dream of Pangermanism. And does not the logic proceed with a fatalistic beauty from the first colonial aggregation of one-celled organisms to a German world empire? There is no room for doubt in this argument that the empire must come; the only question is as to whether it is destined to be German, and this point the present war is to decide.

We shall have to admit that it is perfectly good scientific method to forecast future events from the record of the past, and if the foregoing reasoning is correct we as a people, and as a republic, have indeed been on the wrong path. But is it not possible that some pages in the history have been overlooked—pages with a significant importance for any forecast which may be made of the trend of social evolution? I believe this to be the case, and in particular I would call attention to two facts which might well be disturbing to the German viewpoint. The first of these is that nature has in the past ruthlessly condemned to unpitying extermination forms that have become overdeveloped and over-specialized. If we are to reason from analogy, why may we not similarly expect elimination of the over-specialized social organization? But a greater defect in the argument is that it over-stresses the analogy of man's evolution with that of organic evolution as based on principles established for lower forms. In forecasting from the trend of evolution it builds entirely on an academic formalism—an elementary textbook conception of organic evolution—and neglects the modification which man himself has introduced by his mental development. We must not, however, forsake the solid ground of established principles for anything new which smacks of mysticism; we must, on the contrary, be ready to accept the challenge that the surviving line in evolution to-day, as in the past, and in man as in all animals and plants, shall have a definite, tangible survival value.

What I shall attempt to establish is that the most vigorous and promising trend of social evolution has been for some time toward democratic rather than toward autocratic forms of government. If it can be determined with reasonable certainty that such is the case, it will not be necessary to the argument to show *why* it is true any more than it is necessary to show why nature perpetuated the slow-moving tortoise and eliminated its flying relative, the pterodactyl. We simply assume because the one survived and the other died, that the former was for some reason better adapted to the conditions with which it had to contend than the latter.

Now democracies are not new, nor peculiar to recent civilization; they have appeared sporadically from time to time during the past centuries, but were usually short-lived. They commonly died out from one of two causes; either too large a proportion of their constituent peoples were not educated to the point necessary for self government, or the governments themselves were too weak to resist the encroachments of neighboring nations. Nevertheless the principle of participation in their own government by larger and larger classes of the people has been steadily on the increase, until in this day nearly all the larger nations are, to a very great extent, truly democratic. At the same time monarchies have been toppling and kings have retained their titles only by surrendering their power. Are we to believe that this process has reached its zenith and that the course of evolution is going to reverse itself? That is a thing evolutionary processes seldom if ever do. Even if autocracy should win a military victory in the present war, I am convinced that it would be no more than a rock in the way of an irresistible tide; it might retard the flow locally for a time, but it would eventually be surrounded and submerged.

Man no longer reacts by inherited instincts; he is supplied in their stead with a mechanism for reasoning, and this mechanism is generally distributed, albeit in varying degrees of perfection. So long as its development could be confined to one class that class was in a position to govern, and to keep all others in subjugation or slavery. Furthermore, by class marriage, this condition tended to become hereditary, and to produce a society composed of a small intellectual ruling class and a large ignorant proletariat. It is conceivable that this condition might have become an established and permanent one; but a number of factors have worked against it. Time does not permit discussing them all, but two may be mentioned—the development of science and of the spirit of altruism.

The race value of the former is easily seen. Since man has been using his wits to thwart natural selection, he has taken advantage of every invention his ingenuity could suggest for that purpose. It increases the advantage to any social unit if all its members are able to utilize any new inventions, whether an engine of war or an implement of industry. The time has passed when they need be useful citizens only in the way a horse is one, for they must be trained citizens—they must have capabilities beyond those of the horse. To make the story short, as science and industrial development have grown hand in hand, more and more necessary has general education become, and as a people become educated they are almost certain to demand a share in their own government. It may be asked then, why have the German people as a whole been so backward in demanding a real participation in governmental affairs, for their education has been general and nowhere was technical development greater? Is it due to a different hereditary mental equipment on the part of the German, or is it his environment? This is a question on which one now reads and hears very positive statements every day; but the biologist at least should know enough to be cautious in drawing conclusions. In particular the student of heredity knows that the question of the relative effects of heredity and environment presents about the most difficult problems with which he has to deal.

To demonstrate the racial value of altruism is not so easy, but again the very fact that it has not only survived but has developed from insignificant beginnings seems to bespeak for it a survival value. When a mother bird or other animal gives her life in the defense of her young, it is difficult to see how she herself has profited thereby, especially, if, as is apt to be the case, the young are not old enough to care for themselves and consequently also perish. But we must believe that in the long run the behavior on her part which led to death is beneficial to her offspring and increases their chance of survival. Without going into the intermediate steps, it is doubtless the same instinct, highly developed and modified, which impels a man to risk his own life to save another—even a worthless one—and to feel a sense of civic responsibility. We call it the right thing to do—which probably simply means that in the long run it is the sort of action that has had a survival value for the race.

Even the most ardent hater of all things Teutonic can scarcely deny that this type of behavior is developed as a personal attribute in Germany as elsewhere; but we believe it should be carried a step further and applied to nations as well as to individuals. Germany, on the other hand, as a state dealing with other states, has no place for altruism. Are we wrong, however, in believing that even though, as the occasional mother may be destroyed in defending her young, so some nations may be crushed in the present struggle, nevertheless a comity and brotherhood of nations is for the best ultimate good of all, and moreover that its consummation is the real prophecy to be read from the records of the past? At any rate the mother bird has something for which she is instinctively ready to fight, and so ought we to be ready to fight for those broader principles which we believe should govern the relation of man to man; for even though we may suffer individually, we are fighting to preserve the things for which we stand.

SOME PERILS WHICH CONFRONT US AS SCIENTISTS

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TO play the rôle of Cassandra is commonly to invite unpopularity if not contempt. The average, easy-going mortal (which means some ninety per cent. or more of us) is by nature an optimist, and he does not wish his optimistic reveries to be disturbed by forecasts of impending disaster. However, Cassandra's prophesies were true and Troy did fall.

The dangers which I am about to discuss threaten all of us who seek to learn the ways of nature without ulterior motive. To realize these dangers is the first step toward averting them. That they are not generally realized is only too evident to one who reads either the editorial opinions of the daily press or the more learned deliverances of his own scientific colleagues.

The perils of which I am about to speak are all manifestations of one great fundamental Peril, whose source lies deep in our current habits of thought and in our philosophy of life. This has been variously designated as "commercialism," "materialism" and "utilitarianism." Each of these words expresses one aspect of the truth, though each in itself is incomplete. Taken etymologically, the word utilitarianism conveys most nearly the idea which I intend to express, though I do not wish to identify this meaning with the ethical theory which has been known by that name.

This habit of thought is characterized by the glorification of *utility*. Its standards of value are "usefulness," "practicality" and "efficiency," or, in its crassest form, dollars and cents. Its dearest foes are the "theorists," the "idealist" and the "doctrinaire."

The reader may be smiling, perhaps, at my tardy discovery of a conflict of ideals as old as civilization itself, and at the naïve way in which I am uttering these platitudes with all the authority of a Hebrew prophet. Well, let us admit that what I shall say contains nothing very new in principle. But is it not true that all reforms are made possible through the reiteration of more or less familiar ideas, until at last they gain acceptance and are translated into action? Moreover, even if the main theme of my discourse is hoary with antiquity, the present world situation is without parallel in the past, and the dangers of which I speak are particularly menacing at this time. This is the more true because they are not generally recognized as real.

By many it is being joyfully proclaimed that science has at last come to its own. Has not the Great War shown to all the world, and shown with unmistakable clearness, the practical value of science to the nation? Has not the scientist in nearly every field of knowledge—the psychologist and the astronomer, no less than the chemist, the physicist and the bacteriologist—been called upon to play a vital part in the defense of his country and of civilization? That he has answered this call with credit to himself and his profession is one of the outstanding features of recent history. Professors and doctors of philosophy are now majors and captains in the army. The importance and variety of the services which they have rendered can not even be suggested in the space at my disposal. They have been interestingly summarized in various recent addresses and magazine articles.[1]

So far, this is all as it should be. That a scientist whose special training enabled him to aid materially in the national defense should have failed to devote his energies to this task in such a crisis would assuredly have betrayed a lack of elementary patriotism. And the depleted faculties of our universities are testimony enough that the call when it came was not unheeded. Indeed it now seems probable that this outburst of collective enthusiasm led many to drop valuable investigations of long standing and to embark upon unknown seas, in quest of very problematic returns. Be this as it may, the net results of this movement were of great and obvious importance to the nation.

Thus it comes to pass that even the man in the street no longer views the spectacled professor with the undisguised contempt of former years. The "high-brow" has at last made good. He has done something *useful!* So it may well be that within the next few years the professor will be able to meet his classes in garments a little less threadbare than heretofore, and that he will not need to beg quite so hard for the meager allowance upon which to run his laboratory. I even suspect that the legislator will now and then find himself besieged by

[1] For example, the article by Professor J. S. Ames in *Science*, October 25, 1918.

taxpayers, clamoring for the more generous treatment of so useful a citizen.

At such times as this the embarrassed scientist might well have recourse to the prayer: "Lord save me from my friends!" For it is to be feared that in his case, popular favor must rest largely upon a misconception of his real aims, and that it can only be sustained by tenderly nursing this misconception. Herein lies his greatest temptation. Will not the scientist come to listen more often than in the past to those siren voices which promise him financial support and social recognition? The investigator who accepts these with the tacit understanding that direct or indirect practical results are to follow from his labors is likely to find himself confronted by a dilemma. Either he will adhere to these conditions conscientiously, in which case his outlook and freedom of action will be seriously restricted, or he will fail to observe them scrupulously, and thus blunt that spirit of truthfulness which is his most potent instrument of research. Furthermore, he will sooner or later face the inevitable day of reckoning which will follow his failure to "deliver the goods."

At this point certain words of explanation may be necessary. I regard all work in science as being justified by its *value to humanity.* I should apply to it the same standard as to music, art or literature. If there really exists anywhere a scientist who works solely for the gratification of his personal appetite for knowledge, and who glories in the utter uselessness of his intellectual output to mankind, his suppression by society would be altogether justifiable. This is the more true since such a being would not merit the name of scientist. Science is, by nature, a social function. But such a grotesque caricature probably does not exist, at least outside of a lunatic asylum or the pages of comic literature.

Let us repeat then, science must be justified by its value to mankind. But we must recognize the existence of various standards of value. That there are standards far higher than those generally recognized and applied to this question is the main theme of my discourse.

A further word of explanation is desirable. I have no sympathy with the scientist—if such a one indeed exists—who regards scientific knowledge as being *tainted* by its application to the practical needs of life. The task of utilizing the forces of nature to the fullest, whether in saving our labors, increasing our pleasures or diminishing our pains, should be pursued relentlessly. And the student of nature who turns aside from his quest for truth to offer his assistance in the making of any such practical application does not necessarily degrade himself or compromise his scientific ideals.

But here again we are probably dealing with a caricature rather than a reality. However that may be, the caricature is one that has so often been drawn that many in our midst have perhaps been led to believe in its actual existence. The real element of truth in the picture is the recognition by some of us of the dangers which may beset the path of the investigator who endeavors to combine "pure" and "applied" science. One of these dangers, already referred to, is the acceptance of financial support under conditions which must limit the investigator's freedom of action. Another is the insidious impairment of his intellectual honesty which sometimes results from an endeavor to cooperate with those who may entertain widely different standards of value and of truthfulness from himself.

We must now look a little further into this matter of standards of value. There was a time, early in my own life, when I decided for certain reasons to abandon the pursuit of biology as a profession and to study medicine. I well remember the warm approbation with which my decision was greeted by certain high-minded relatives of mine, on the ground that I should henceforth be working for the benefit of humanity. To merely extend the boundaries of knowledge seemed too much like a selfish pastime. Yet it is doubtful if selfishness of motive would have been imputed, had I shown talent along artistic lines and chosen the career of poet, musician or painter. The need of "applying" these latter gifts in any special way to the "benefit of humanity" is seldom insisted upon, at least by educated persons. They are, in themselves, credited with being elevating to mankind, and the artist's only duty in the matter would seem to be to give (or sell!) his creations to the public. Fortunately, as I now believe, I once more reversed my decision and have ever since continued unrepentingly in the humble quest of scientific truth.

In passing, one can not refrain from paying his respects to an educational system which refuses to recognize the cultural value of science, and which treats it—when it does not ignore it altogether—as consisting merely of useful precepts regarding the preservation of health or the basic principles underlying this or that skilled profession.

But in the long run, the scientist himself can not altogether escape responsibility for these misconceptions. He commonly recognizes no obligation to enlighten the public regarding his activities, and when he does so he is only too apt to shamefacedly hide from view the real sources of his inspiration and to talk the same utilitarian lingo as the world around him. And from talking it, he may more and more come to believe in it.[2]

Much of the current defense of science, as voiced by some of its acknowledged spokesmen, and by the editors of some of our foremost scientific journals, seems to me to be sadly one-sided, if not actually disingenuous. We are quite prepared to hear our manufacturers talk of science as the "handmaid of industry," but it gives us something of a shock to find such an utterance as the following quoted with approval by one of our foremost astronomers. "Without the aid of science," we are told, "the arts would be contemptible; without practical application, science would consist only of barren theories, which men would have no motive to pursue."[3]

Let us grant that, other things equal, the scientific discovery which admits of practical application is of greater importance to mankind than one which admits of no such application. In other words, the practical application may bestow a certain added value upon an otherwise important discovery. But this is far different from making practical applicability the sole criterion of the importance of a given bit of knowledge. One might well seek for the *practical applications* of the Copernican theory of the heavens, or the doctrine of organic evolution, albeit both of these hypotheses have revolutionized our habits of thought and our outlook upon the world in which we live.

I can not admit for a moment, indeed I feel it my duty to combat with whatever force and logic I can muster, the contention that practical applicability, in any commonly accepted meaning of the terms, is to be regarded as the fundamental standard of value in judging of the importance of scientific discoveries. If the meaning of these terms is to be so extended as to cover any form of benefits, mental, moral or material, which may accrue to mankind from the growth of natural knowledge, we could, of course, no longer reject this as the all-sufficient standard of value. But such a perversion of meaning would not make for the interests of clear thinking. Far from it, we should confuse an issue which is now a tolerably clear one.

[2] See the quite pertinent remarks of Dr. W. J. Crozier on this subject (*Science*, August 23, 1918).

[3] Quoted by Dr. George E. Hale, in an address under the auspices of the Engineering Foundation (*Science*, November 22, 1918).

In an extremely interesting recent volume, entitled "Science and the Nation,"[4] there are brought together the views of more than a dozen prominent English investigators, chosen from nearly as many different fields of pure and applied science. The writers herein consider this very question of the outlook for "pure" science after the war. Each of them insists upon the necessity for a fuller recognition of science by the nation, if the British Empire is to maintain its preeminent position in the world. Some of them are eloquent in demanding absolute freedom for the investigator to pursue his researches, regardless of their practical consequences. It is refreshing, for example, to hear a metallurgist speak in such language as this: "If the practical spirit—important and valuable as that is in its right place—is permitted to rule our research laboratories, it would be apt to sterilize our investigations and to rob us of the very fruit at which we should be trying to snatch."[5] And again we are warned by the same writer that "'research,' undertaken with a directly practical object, may actually hinder progress rather than assist it."[6]

Throughout all of these pages, however, the practical applications and inventions are treated as the real "fruits of science," which are to be attained in these devious ways.[7] "The game [in this particular case the useful knowledge of disease] has to be stalked from long distances and often by circuitous routes."[8] "Men who prove themselves especially adapted to purely scientific work must be subsidized in order that they may be able to devote themselves entirely to the task of scientific discovery."[9] *Why?* Because it is this "experimental investigation towards abstract ends which has furnished such gigantic contributions to the world's wealth during the past century."

In other words, it would seem that, even to this group of university scientists, the study of natural phenomena derives its ultimate justification from the useful by-products which it yields.

[4] Cambridge University Press, 1917.

[5] Professor Walter Rosenhain, p. 77.

[6] *Ibid.*, p. 56. See, also, similar remarks in address by Dr. C. E. Kenneth Mees, director of the Research Laboratory of the Eastman Kodak Company. (*Science*, June 2, 1916.)

[7] Professor W. H. Bragg, p. 25. This is also the burden of Ex-President Eliot's address on "The Fruits, Prospects, and Lessons of Recent Biological Science," delivered as president of the American Association for the Advancement of Science (*Science*, December 31, 1915).

[8] Lord Moulton, introduction, p. xvii.

[9] Professor W. J. Pope, p. 23.

We must remember, of course, that this volume was written during a great national crisis, when all the forces of the empire had to be mobilized for the purposes of defense. And we must remember too that the stagnant condition of the applied sciences in England was to a considerable extent responsible for her early military reverses. But with all due allowance for these circumstances, it seems to me that science has not received fair treatment at the hands of her own votaries.

The journal *Nature* has, for years past, been filled with stirring pleas for the public support of scientific investigation and scientific education in England. These pleas have doubtless been sadly needed, though there seem to be substantial reasons for hoping that the nation is at last becoming disposed to heed them. It is depressing, though perhaps at this time inevitable, that these appeals on behalf of science should rest their case mainly upon its contributions to the national wealth and national defense.

The friends of knowledge for its own sake will watch with the greatest concern to see whether these utilitarian motives will continue to dominate the scientific life of England now that the hour of peril has passed. For the war has really done nothing more than to accentuate a point of view which seems to have been gaining ascendancy for years past, in our own country as well as in England. We have long been accustomed to justify the comparative freedom which we sometimes accorded to our investigators on the plea that useful results turned up in all sorts of unexpected places, and that one could never tell in advance what lines of research would prove to be profitable. Add to this the unfortunate circumstance that the scientist was known to be an intractable sort of a being, who had to be allowed to gratify his perverse curiosity in order to keep him in the harness at all.

A writer in the New York *Evening Post* has expressed so well my own point of view in this connection that I can not refrain from quoting him rather fully. He says:

> There can be no doubt that the gospel of relentless "efficiency" to which the war has given so great an impetus carries, deeply embedded in it the seeds of hostility to all activities and interests which find their spring in intellectual aspiration or enthusiasm. At best, from the standpoint of the efficiency cult, such endeavors have to be justified by the plea that, divorced as they may seem to be from practical objects, they do conduce to the advancement of the common ends of the nation or of mankind, though the connection may be remote or subtle. The plea can be made good over a very broad area. . . . But the argument is a thorny one; and that is not the worst of it. The mere necessity of resorting to

such a defensive plea, the mere surrender of the proud conviction that the pursuit of truth is in itself a noble end which requires no secondary justification, must immeasurably depress the tone of scientific enthusiasm and impair the energy with which its objects are pursued.

And it has to be confessed that, long before the war began, . . . another factor was working powerfully toward the production of the same effect. For years, and most of all in this country, the idea that "service" is the only justifiable motive of intellectual endeavor had been steadily gaining ground.[10]

Before detailing further the harmful results of such a utilitarian justification of science, let us pause to examine the philosophy which underlies it.

Those who hold this view of the mission of science in the world resort continually to such expressions as "usefulness" or "benefit to humanity." Now we might, it is true, so stretch the meaning of the word "useful" as to cover all of our so-called "spiritual" needs. Thus Professor Gamble tells us that "the function of pure science is to pursue *useful* knowledge," but he goes on to say that "by useful knowledge is meant knowledge which contributes to the moral, social, intellectual, æsthetic, and material welfare of mankind."[11]

Well, this may be what Professor Gamble has in mind when he uses the word "useful," but the world in general will not so understand him. As I have already said, such language merely tends to befog the issue. The "uses" and "benefits to humanity" which the public at large expects to derive from the labors of the scientist are inventions and applications to the practical affairs of life.

It is not at all evident why "fruits" of this type should be acclaimed as benefits to humanity, while weighty contributions to our understanding of nature should be put aside as mere luxuries of the mind. Nor can we comprehend why the author of a useful invention should be hailed as a philanthropist (in addition to the financial rewards which he receives) while the student of basic principles should be looked upon as a selfish recluse.

One is tempted, now and then, to affect an air of Socratic interrogation and to ask the *use* of some of these practical achievements. Suppose that we do, for example, succeed in shortening by six hours the journey from New York to Chicago, or in lengthening by five years the average span of man's life, or in making two blades of grass grow where one grew before. What shall we do with those extra six hours or five

[10] New York *Evening Post* (article reprinted in *Science*, March 2, 1917).

[11] "Science and the Nation," pp. 113, 114.

years, and what will the increased population do which is made possible by a greater food supply? It may all mean a merely *quantitative* increase in the total amount of living—by no means a self-evident advantage, according to my way of thinking. The great mass of humanity is engaged in discharging the purely vegetative functions of the social organism, in keeping alive the individual and the race, and in maintaining a certain low minimum of comfort. To merely increase the total amount of this vegetative activity in the world seems to be widely accepted as one of the chief goals of human endeavor. And this belief appears to underly much of the utilitarian appraisement of science.

Then too, what of all these achievements in the way of adding to our comforts and diminishing our sufferings and superfluous labors? Important as we may grant these to be, their value, after all, is largely of a negative sort. They consist, for the most part, in the removal of obstacles to a fuller life and higher development. They in themselves contribute but little directly to that development. The labors of the scientist, along with those of the artist, the poet, the philosopher and some others, do contribute directly to it. But our utilitarian defenders of science arrogate to themselves the credit for a broader humanitarianism than that which inspires the labors of the mere seeker for truth. The whole issue really depends upon one's conception of what is most worth while. Which is the higher aim—to make room in the world for the greatest possible number of human animals, or to make the world a more interesting and intelligible place to live in: to feed the belly or to feed the brain?

True it is that the alimentary needs must first of all be met, and that they are, for a large section of humanity, still quite inadequately provided for. But let us never forget that alimentation is a means rather than an end, that the consumption of coal is not the real reason for the steam-engine's existence.

I can not leave this subject of the higher services of science without calling attention to an aspect of the matter which has received inadequate attention. Science has frequently been charged, not only with being irreligious, but with being unmoral, if not actually immoral in its tendencies. But strong arguments for the ethical value of science have been presented by various writers. Thus Professor E. P. Lewis, in an admirable recent article,[12] dwells upon the elevating effects of the scientific habit of mind on character.

[12] "The Ethical Value of Science" (SCIENTIFIC MONTHLY, November, 1918). See also address on "The Higher Usefulness of Science,"

The scientist has the same human failings as other people; he may have no better intentions nor be more righteous-minded than they; but he can sometimes act more intelligently in carrying out his good intentions. Science teaches us to seek the truth without prejudice; it develops the habit of disinterestedness; it leads us to consider all known elements in making ethical judgments; it prompts us to seek the amelioration of the health, the well-being, the happiness, of our fellow men; it diverts our vision from the fruitless contemplation of a past in which we can play no part to the present wherein lies our task; and it bids us to consider the future and the welfare of generations still unborn.

Professor Lewis points out, furthermore, the "real danger that too much stress may be laid on [the] material aspects of research, which are not science, but only its by-products." And he holds it to be "important for the interests of society that teachers of science should lay more emphasis upon its intellectual and ethical significance."

Let us consider further some of the baneful effects which may be expected to ensue from the adoption of this narrowly utilitarian view of the mission of science. It is generally agreed that the Great War is likely to have, as one of its sequelæ, a heightened activity along scientific lines. This, by many, is being acclaimed as part of that silver lining which every cloud is supposed to possess. But there are grave dangers in the situation, as I have already tried to indicate. For the kind of scientific activity which was stimulated by the war was inevitably utilitarian in the crassest sense of the word. The ends in view were military, industrial and sanitary. Researches along those lines which we rather inappropriately term "pure" science, suffered from the withdrawal of support and from the transference of the investigator's attention to more urgent needs. To what extent is this shifting of emphasis irreversible? The investigator who continues along the newer paths will doubtless be following the line of least resistance. He will have all the force of public approval behind him. And this is a powerful force when brought to bear upon a social being. The investigator may, to use the words of Dr. Raymond Pearl, come to "supplicate the great goddess Truth with one ear closely applied to the ground."

Again, the Great War has taught us, as never before, the power of organization. German organization came perilously near to conquering the world. It was only the tardy adoption of similar methods of organization by the Allied Powers that finally won the day for democracy. Hence it is that "individ-

by Professor W. E. Ritter, contained in volume having the same title (Richard Badger, 1918).

ualistic" ideas seem to be thoroughly discredited for the time being, and that something like a mania for organization is sweeping over the world, at least so far as we may judge from conditions in England and America.

Says Professor H. E. Armstrong: "Science must be organized, in fact, as other professions are organized, if it is to be an effective agent in our civilization."[13]

The editor of *Nature* tells us that

> in no class of work involving many workers can we dispense with organization. An army is not a collection of armed individuals. . . . The present method of conducting scientific research is a go-as-you-please method, in which each man does what his own inclinations suggest to him or the means at disposal allow him to do. . . . We have to get rid, in every department of work . . . of waste, inefficiency and make-believe or valueless products. We have to get rid of them in scientific research as well. This can only be done by limiting the individual initiative and adopting greater and more carefuly thought-out cooperation.[14]

The Committee of the Privy Council for Scientific and Industrial Research for the Year 1915–1916 voices the opinion that "effective research, particularly in its industrial applications, calls increasingly for the support and impetus that come from the systematized delving of a corps of sappers working intelligently, but *under orders*."[15]

A sub-committee of the Committee of One Hundred on Scientific Research, in our own country, thinks fit to point out, in referring to a staff of investigators in a research laboratory, that "the individual can exert only a very small influence except as a member of an organization or institution."[16] To this last assertion a critic has replied: "One wonders what institution or organization Newton or Darwin belonged to, without which 'they would have exerted only a very small influence.'"[17]

Now I do not intend to stultify myself by calling in question the power and the value of organization, at least when properly applied. The process of evolution, the passage from a lower to a higher state of being, is measured in terms of organization, and in this process the integrating or coordinating factor is no less important than the specialization of parts or of individuals.

[13] *Nature*, October 22, 1914.

[14] *Nature*, November 11, 1915.

[15] *Nature*, September 7, 1916 (Italics mine).

[16] *Science*, January 12, 1917. Such opinions could be multiplied voluminously. Some recently published remarks of Ex-Senator Elihu Root (*Science*, November 19, 1918), might be cited as extreme examples.

[17] *Science*, March 2, 1917 (anonymous).

But, as has often been pointed out, there are limits to the value of the conception of society as an organism. The biological organism acts as a unit, without any agreement of its parts so to act. There is but one guiding intelligence, which dominates the whole. Society, on the contrary, possesses as many intelligences as there are individuals, even though many or all of these may think best at times to surrender their own freedom of judgment and to be guided by the decisions of others. Society may act as a unit, but it can never think as a unit. This is true even in those rare cases when most of its component members chance to be stirred by the same idea. However much one mind may influence another, thinking is an individual and not a collective function. And we are all agreed as to the homage due to the genius, whose mental achievements owe the least to suggestions from his fellow men.[17a]

Intellectual activities may be "organized," of course, in the sense that a group of individuals may cooperate toward the attainment of some specified end. And it may at times further this common cause if the component minds delegate a certain part of their own initiative to some higher "coordinating center." Such an arrangement as this, indeed, may be the most efficient way in which to utilize the activities of a group of mediocre minds. But it is obvious that what is gained in collective efficiency is lost in individual spontaneity. The arguments by which we seek to justify democracy versus autocracy, in political life, apply to a large extent here. Be that as it may, it is significant to note that practically all of the really revolutionary discoveries in the history of science have been made by individuals, working not in solitude, it is true, but likewise not bound by any scheme of cooperative effort, involving others than themselves.

One of the chief risks inherent in any extensive cooperative scheme of scientific research is the fact that one may readily come to spend most of his time in "cooperating," and have little time left for the discovery of facts. Another grave danger has been pointed out clearly by various recent writers. Organization may readily open up the way for the activities of a type of executive whose influence is largely inimical to the true spirit of science. This executive may be a more or less successful man of science who becomes ambitious for wider powers, or he may belong to the purely administrative or business class. In either case, he is likely to be autocratic in his

[17a] I am not aware that any serious attempt has been made to *organize* the creative efforts of our painters, poets or musicians.

temper, and to regard the organization over which he presides as an instrument for carrying out his own ideas. If, as may well happen, these ideas contemplate real advances in scientific knowledge, the chief damage done is to the morale of the investigators, whose powers of original work can not fail to be impaired.

But if we have to do with the purely business type of executive, matters will be far worse. Such a one is almost certain to be a utilitarian, in the sense in which I have been using this term. That is, he will look upon scientific research as justified merely by its direct or indirect practical results. He will apply business criteria in his estimates of the men under his supervision, and will grade them in large degree according to the salaries which they are willing to work for. He will be disposed to assign an undue importance to his own administrative function, and to think of the investigators under him in much the same way as the factory superintendent regards the "hands" who operate the machinery.

So extreme a condition as this is, it is true, probably seldom realized. Such an executive would soon learn by experience, even if his business instincts did not teach him better at the outset, that a state of affairs like this would defeat his own ends. But, subject to such modifications as a higher prudence would dictate, the general situation could not fail to be much as I have outlined it. Indeed, it is safe to say that conditions approaching this have been realized over and over again in our state or national research institutions and even in some of our universities.

Let me quote the words of a man who, as we all know, is no mere doctrinaire scientist, but who himself holds a responsible administrative post. Dean Eugene Davenport, of the Illinois Agricultural Experiment Station, has devoted several pages to a scathing indictment of what he terms the "cult of administration."[18]

"The rate and the intensity with which administration under one pretext or another is coming to dominate research in this country, especially along agricultural lines, is," he tells us, "little short of appalling to any candid observer who takes stock of the situation and who has the courage of his convictions." He then proceeds to narrate in picturesque terms how the investigator's hands are tied and his spirit crushed by the exacting demands of officialdom.

[18] Address of the chairman of Section M (Agriculture) of the American Association for the Advancement of Science (*Science*, February 16, 1917).

In summing up the situation, he insists—this practical man of affairs—that

administration can not vitalize research. Its whole effect is restrictive and hence should be reduced to a minimum. . . . All progress in science is the result of individual interest, initiative, invention and energy, all of which must be resident in the worker. The driving force that brings results is internal, not external, to the explorer after new truth. It beckons from ahead and does not prod from behind. . . . Administration does no work. It is a harness put upon activity. Its purpose is not to actuate, but to restrain and forbid. . . . The effect of too much administration upon the scientific worker is at first one of disappointment, then of discouragement, and finally of disgust. Conditions as they are now developing not only constitute an unhealthy example for our young men in college, but they are deterring thoughtful men from entering the public service.

Modern efficiency standards are not applicable to research. "Under what project," queries this same writer, "did Darwin work? Did Faraday report regularly upon the progress of his mental wanderings after firm resting places?"

Now that much heralded "cooperation in science," which is to regenerate the world, might not of necessity bring in its wake all of these evils of administration which Dean Davenport depicts. But there can not fail to be a strong tendency in that direction. All this may be said with a full recognition of the necessity for that stimulus which comes alone from contact with others having kindred interests. Isolation means intellectual stagnation. "The solitary scientist is likely to put a great part of his life into pathetic futilities" (Elihu Root). It is inconceivable that any group of specialists in allied fields should be thrown together in close association without there resulting much valuable interchange of thought, even if this did not take the shape of actual formal collaboration in their researches.

We may go further and grant that many important problems of science can only be solved through deliberate, cooperative effort, and that the extent and importance of such cooperation is bound to increase with the growth of civilization. But the dangers of this tendency should none the less be fully recognized. In general, it would seem that each case should be decided upon its own merits. Those who contemplate any particular cooperative program should, it seems to me, first ponder well the question whether the increasing degree of administrative routine and the suppression of individual initiative would not more than outweigh any compensating advantages.

In these days of national prohibition, press censorship and espionage acts, I realize that "personal liberty" is no longer a slogan which will arouse much public enthusiasm, and I am quite aware that "individualism" and "*laissez-faire*" have latterly become terms of reproach. But there seems to be a decided danger that we may go to the opposite extreme. I have before me an article in the *Independent*[19] by a prominent university president, and another in the New York *Times*[20] by an anonymous "university professor now in the service of the United States." Both discuss the recent reorganization of American universities in the interests of the Students' Army Training Corps. And both voice the fervent hope that this experiment in militaristic paternalism will be continued indefinitely after the close of the war.

Indeed the writer in the New York *Times* assures us with the utmost complacence that it *will* be continued. Young men —and women too—will henceforth be drafted as paid cadets into our universities, which will remain governmental institutions. The courses pursued by each of these "student soldiers" will be prescribed according to his individual needs and abilities, and "non-essentials," or subjects for which he is not particularly fitted will be stricken from his curriculum. Upon the rating which he scores in his various tests of ability will depend, not only his military rank in the great citizen army, but his preparation for a business or professional career. "Nor will a professor, who [as an army officer] has learned to command and to obey, allow the old easy-going *laissez-faire* doctrine to permeate his lecture hall or laboratory," for military discipline, now that we have learned it, "won't soon be forgotten even in our classrooms." This "all looks like a Utopian scheme," concludes our writer, "but already we are doing it, and acquiring the habit."

Heaven help this Republic if our sons and daughters are to be trained for life as khaki-clad marionettes!

What, then, seems to be the duty of the man of science in the face of these dangers which threaten him both from within and without? To begin with, I should say, he should have the courage of his convictions. There is no question that he has often wavered in his faith in the importance of his own mission. The competent investigator who decides to practice medicine or to undertake elementary teaching for the reason that

[19] October 5, 1918. In a later article (Dec. 14, 1918), President Thwing has, it is true, laid considerable emphasis upon some of the "losses in educational values arising from this revolution."

[20] October 20, 1918.

he "wants to do some good in the world," may be actuated by praiseworthy motives, but he is sadly lacking in appreciation of his own high calling.

Once more, unless his real interests and abilities lie in the field of practical application, the scientist should steadfastly refuse to compromise with the utilitarian spirit, even though he thereby forfeits social recognition and financial support.

> With the reinforcements which the developments of the war have from so different a quarter brought to this tendency, it is more than ever necessary for those to assert themselves who know how precious to the life of us all is that element which is supplied by the devotion of the lives of some to the pursuit of truth for its own sake, or even for the sake of the fame which is the natural reward of signal success.[21]

Let those few fortunate ones who control the disposition of funds given without hampering restrictions sturdily refuse to divert these funds to utilitarian ends. A glance at the budgets of some of the organizations engaged in industrial and agricultural research in this country is conclusive proof that this type of investigation may be trusted to take care of itself.

There are, we are reliably informed, upwards of fifty corporations in this country, the annual expenditures of which on research range from $100,000 to $500,000.[22] The General Electric Company expends annually on research from $400,000 to $500,000, and has a laboratory staff numbering 150. The laboratory of the Eastman Kodak Company cost $150,000, and its annual cost of maintenance is about the same. The Mellon Institute of Industrial Research spends $150,000 annually on salaries and maintenance, and its buildings and equipment cost over $300,000.[23]

Passing to those of our government departments which conduct scientific investigations, the Department of Agriculture, in 1915, spent about $25,000,000, largely for research and education; the Bureau of Standards is said to spend annually about $600,000; the Bureau of Mines a nearly equal amount, and certain other bureaus expend smaller, though very considerable, sums.[24] Our 52 state agricultural experiment stations have a total revenue of some $5,000,000 annually.[25]

How trifling, in comparison with these immense sums, are the amounts which are devoted to the quest of knowledge with-

[21] New York *Evening Post*, quoted in *Science*, March 2, 1917.

[22] *Nature*, March 23, 1916.

[23] *Nature*, August 9, 1917. More recent figures are not accessible to me, but these expenditures have doubtless increased.

[24] *Nature*, May 31, 1917.

[25] *Ibid.*

out ulterior ends! To jealously guard that little from the encroachments of utilitarianism can not reasonably be imputed to any spirit of hostility to the practical utilization of scientific discovery. I think it the only tenable position at present for one who has a proper conception of the worth of science and who realizes the dangers which beset it.

Finally, it is the duty of the scientist to assume responsibility, as never before, for the enlightenment of the public upon the aims, the achievements and the real value of science. In this educational appeal, let him lay his chief stress upon the steady deepening of our insight into nature and life which science has given us. Let him show, as he of all persons should be best capable of showing, the bearing of his own special discoveries upon these wider realms of knowledge. But let him set aside once for all the wretched make-believe that these discoveries derive their real justification from the fact that they may in some remote way help to stimulate invention or put money into some one's pockets!

SOME PROBLEMS OF GAS WARFARE[1]

By Dr. ELLWOOD B. SPEAR

THE initial use of gas by the Germans at Ypres in 1915 and the subsequent adoption of gas warfare by the allied armies introduced a large number of problems of vital importance to the nations involved in the World War. While these problems taxed to a very great degree the ingenuity of the scientist, the engineer, the military strategist and the manufacturer, they by no means lacked that fascination which characterizes all research, an intellectual journey into the unknown. Although this fascination was augmented by the fact that the problems were nearly all new and the field almost limitless, nevertheless the flight of the imagination was circumscribed by the stern condition of immediate practical utility and the necessity for rapid solution.

Another feature especially prominent in the early stages of gas warfare was the unstable nature of the problems. The act on the screen was continually changing. The solutions of yesterday might not meet the requirements of to-day, and the practise of to-day might become archaic by to-morrow. The kaleidoscopic nature of these changes can be best illustrated by a brief account of the tactics of the offensive and the development of the defense, the chief feature of which is the gas mask.

The first object of the use of gas by the military strategist was, of course, to destroy the enemy. With this purpose in view the Germans made their first gas attack by means of poisonous clouds. Chlorine was compressed into cylinders that were placed in their own front-line trenches. The cylinders were fitted with a suitable hose and nozzle so that at the appointed time the valves could be opened and the gas allowed to escape. Chlorine is particularly adapted for this method of attack. It is fairly easily compressible into the form of a liquid, but six atmospheres being necessary at ordinary temperature. It is very poisonous, one to two parts per ten thousand of air sufficing to result in death if breathed for five minutes. It has the additional property of being heavy, about two and one-half times the weight of an equal volume of air. Consequently it does not tend to rise rapidly into the upper air, but, on the con-

[1] Figures 1 to 8 inclusive are published with the permission of the Director of the Chemical Warfare Service.

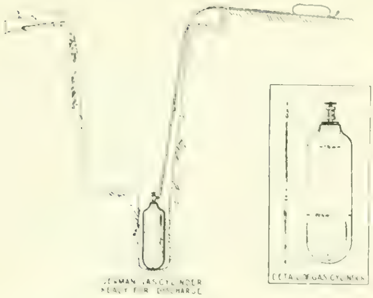


Fig. 1.

trary, rolls along the ground, seeking out and filling all the low places such as trenches, dugouts, shell holes and so on.

The result of the attack is now a matter of history. The French Colonial black troops broke and fled. Who can blame them? The Canadians went into this particular sector twelve thousand strong. When they were relieved five days later but two thousand remained alive. A very large portion of the ten thousand died as a result of the effects of the gas. In fact, had it not been for the presence of mind of some of the officers who ordered the men to put wet cloths over their faces and lie flat on the ground face downwards the entire force would have been annihilated. Fig. 1 shows a German gas cylinder in position in the trench.

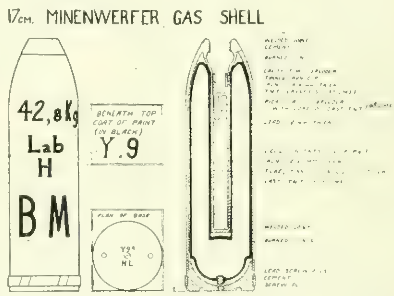


Fig. 2. German Gas Shell.

Although successful at times this form of gas warfare was seldom used in the later stages of the struggle, owing to the inherent disadvantages of the method. In the first place the wind must obviously be in the right direction. It must not be too strong—less than twelve miles per hour—or the gas will be whirled about and dissipated before the goal is reached. It must not be too low or it may change its direction, in which case the offense may suffer more than the defense. In the second place, the greatest concentration is at the wrong end, directly before the trenches of the attacking party. Consequently if the gas is to be followed by an infantry attack the offense must endure more than the defense, or the attack must be delayed until most of the opportunities created by the gas are lost. A much more effective method depending upon the wind was being developed by the

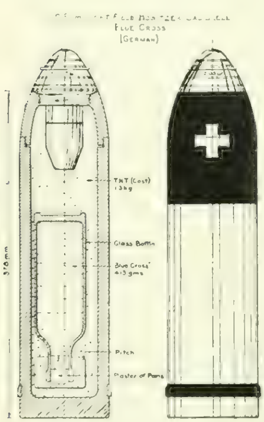


Fig. 3. German Gas Shell.

American gas offensive, the details of which are not yet for publication.

It was soon realized by both sides that some more dependable means must be devised to create an efficient concentration of gas in the enemy's territory and the development of the gas shell is the result of these researches. Figs. 2 and 3 give schematic views of German gas shells. Gas shells are made for both large and small caliber guns. The former may deliver several quarts of the poisonous liquid at a single shot.

For certain kinds of work, gas shells have a great advantage over even the high-explosive variety. The latter may kill by direct hit or by the subsequent explosion. The former may do all this; but in addition the liberated gas may be carried to considerable distance from the spot where the explosion takes place and gas the enemy who has been protected from the high explosive by dugouts, etc.

However, the disastrous effects of both the gas cloud and the gas shell are largely offset by the high efficiency of the modern gas mask, and this brings us to the second object of the military strategist, viz., to annoy and hinder, or in military parlance, to "neutralize" the effectiveness of the enemy. It will be obvious even to the casual observer that the ability of the soldier to serve a gun, to shoot or to transport supplies is greatly reduced if he is obliged to wear a gas mask. In point of fact it is claimed by military men that the effectiveness of artillery is cut down sixty per cent., while the infantry fares scarcely any better, two men being required to perform the functions of one unhampered by this impediment.

For purposes of "neutralizing," ordinary poison gas may of course be employed. An occasional gas shell will prevent the enemy from removing his mask, but his life may be rendered almost unendurable by many substances really not gases in the accepted sense of the term. Lachrymators or tear gases, such as benzyl bromide, are heavy liquids which when sprayed over the ground in small quantities by the explosion will cause a copious flow of tears for hours if the eyes are not protected by the gas mask or other device. Moreover the celebrated "mustard gas," also a heavy liquid, will cause burns on the skin of such a vicious character that the soldier may be incapacitated for months. A partial list of gases that have been employed on the battlefield is given below.

Gas Clouds:

Chlorine.

Fig. 4. An American Soldier wearing a captured German Respirator. The face piece is made of leather.

Shells:

Phosgene.
Sulfur trioxide.
Benzyl bromide, German T-Stoff.
Xylyl bromide, German T-Stoff.
Dichloro-diethysulfide, "Mustard Gas," German Yellow Cross.
Diphenyl-chlorarsine, "Sneeze Gas," German Blue Cross.
Trichlormethyl-chloroformate, German Green Cross.
Monochlormethyl-chloroformate, German K-Stoff.
Nitrotrichloromethane, "Chlorpicrine."
Brominated-ethyl-methyl ketone.
Dibromo-ketone.
Allyl-iso-thiocyanate.
Dichlormethyl ether.
Phenyl carbylamine chloride.

Hand Grenades:

Bromacetone.
Bromine.
Chloracetone.
Chlorsulfonic acid.
Dimethyl sulfate.
Methyl-chlorsulfonic acid.

The Development of the Gas Mask

When the Germans launched their first gas attack they were provided with a crude and inefficient device similar to the one shown in Fig. 6. Later they developed a much more serviceable mask as represented in Figs. 4 and 5. The British, as already stated, first employed a wet cloth. Even damp earth was found to have some virtue as a protection against gas. In a very short time English scientists had devised several types of respirators. These consisted chiefly of cotton wool soaked in photographer's "hypo" and washing soda. The deleterious effect of the latter upon the skin was reduced somewhat by adding a small amount of glycerine. The wool was attached to a cloth that was bound

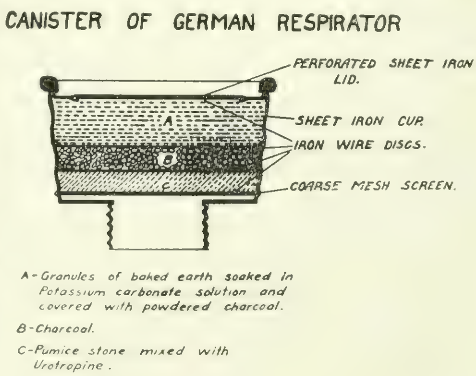


Fig. 5.

around the mouth and nose, as shown in Fig. 6, or it was held in the mouth until the cloth could be placed in position. The wool was then shoved up around the nostrils. These primitive masks would stop a considerable amount of chlorine if properly cared for and adjusted. Unfortunately the soldier too often dipped them in the solution and did not sufficiently wring out the excess liquid. As a consequence he could not breathe freely, thought he was being gassed, and frantically repeated the operation, often equally unsuccessfully. Moreover, the masks were not carried upon the person, but rather were placed in the trenches so that the soldier usually got one that had been worn by some one else. Beside the obviously unsanitary arrangement, another disadvantage presented itself. When the alarm was given several men frequently rushed for the same mask with the inevitable result that some of them were gassed.

FIG. 6. EARLY BRITISH RESPIRATOR.

A very decided improvement was next introduced in the form of the "smoke hood." Fig. 7 shows one of the latest models of these fairly efficient masks. Its great advantage lay in the fact that the breathing surface was large, resulting in a very material decrease in resistance. Another prominent feature was the valve that allowed the exhaled air to escape. It is made of rubber and is called technically the "flutter" valve. So successful is its operation for this purpose that it was subsequently adopted in the latest types of both British and American box respirators.

FIG. 7. BRITISH SMOKE HOOD.

It was soon realized by scientists that while "hypo" and alkalis would take care of chlorine and hexamethylenetetramine would stop large quantities of phosgene, many other gases, such as the chemically sluggish

Fig. 8. The First American Gas Mask.

Fig. 9. The Mouth Piece and Nose Snubbers in place.

chlorpicrine, could not be easily removed by chemical means. It was therefore necessary to combine with the chemicals a universal adsorbent, and carbon, because it has this property to an exceptional degree, was chosen for the purpose. In the meantime the British had invented a mask of extraordinary efficiency. The details are given in Figs. 8, 9, 10, 11, 12. Fig. 13 represents an early French type of mask.

The American Mask

When the United States of America entered the World War the newly organized American Gas Defense had on its hands the enormous problem of supplying every soldier who went abroad with an efficient protection against poison gas, and every soldier in the concentration camps at home with a mask for training purposes. The Gas Defense did not wait to develop

Fig. 10. The Mouth Piece and Snubbers.

Fig. 11. The Canister standing beside its Container.

an ideal device, but wisely chose to adopt the British type of mask. Incidentally this was a fine tribute to the British scientist, because the mask was much superior to any in use at that time by the European armies. However, American scientists did not rest satisfied with the results of their allies, but on the contrary began to develop the existing devices. It has been said that Americans invent and other nations improve upon the inventions while we are resting on our oars. In this particular instance the tables were turned, for in a few months we were producing carbon for gas masks fifty to one hundred times as valuable as any known to our allies and certainly vastly superior to that which the Germans were using. Equally important advances were made in the soda-lime, and the American mask soon became the object of admiration of both friend and foe. It should be said in justice to German chemists that they too succeeded toward the close of the war in greatly increasing the efficiency of their carbon.

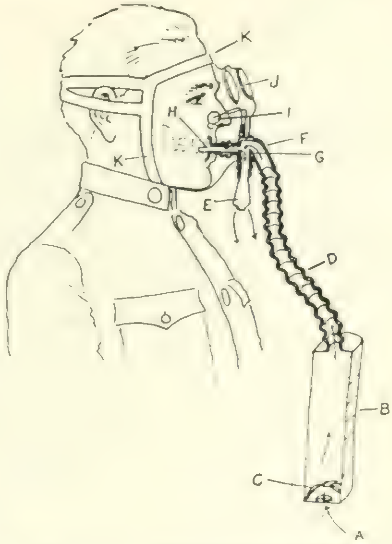


FIG. 12. CROSS-SECTION AMERICAN RESPIRATOR. *A* is the air inlet. *B* is the canister containing granules of soda lime impregnated with sodium permanganate, and carbon granules about one quarter the size of ordinary peas. *D* is a flexible rubber tube the end of which, *H*, is held in the mouth. *E*, is the outlet flutter valve for the exhaled air. *I* represents the nose snubbers. The great virtue of this mask lay in the fact that the soldier could not be gassed as long as he breathed through the tube in his mouth, even if the face piece became punctured or did not fit properly.

FIG. 13. AN EARLY FRENCH MASK.

DEFECTS OF THE MASK

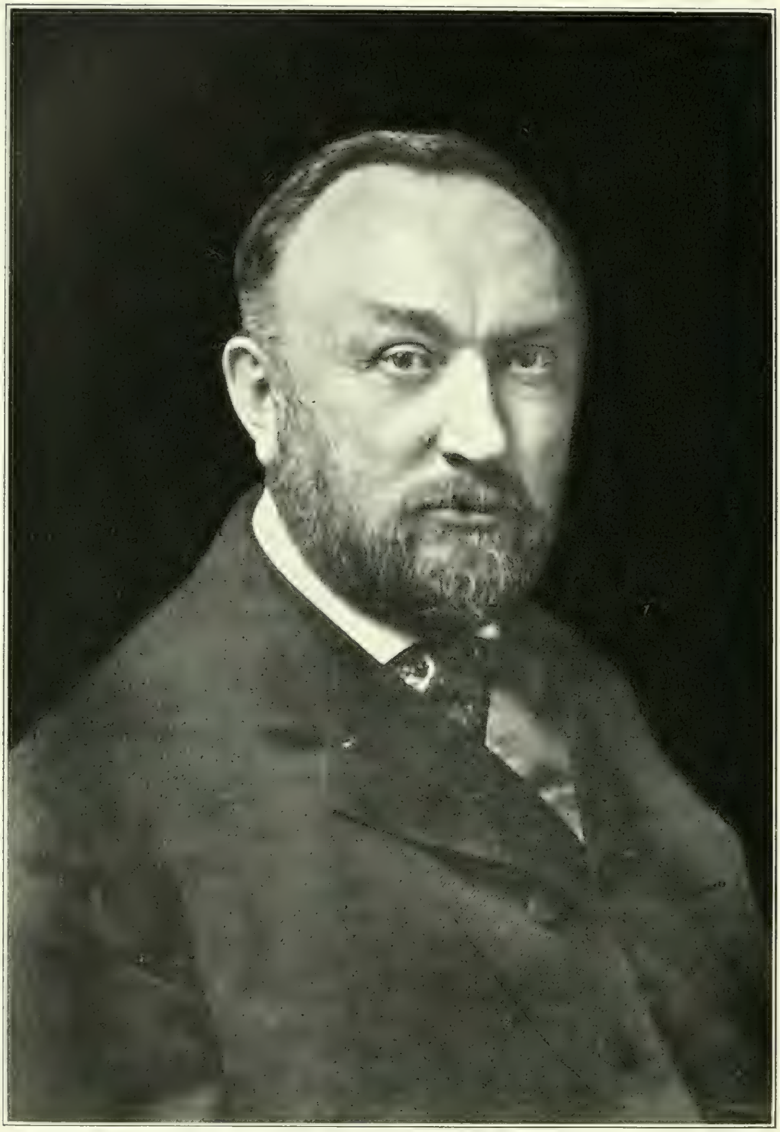
Every driver of an automobile recalls unpleasant experiences with the fogging or clouding of the wind shield in cold or damp weather. The same problem was met with to an accentuated degree in the gas mask. The moisture from the breath or even from the eyes condenses on the eye pieces, causing them to fog. In cold weather the condensation is great enough to create droplets that hang suspended or run down in an irregular manner over the surface. The result is distorted and obscure vision. The Germans partially overcame this difficulty by inserting gelatin-like disks on the inside of the eye pieces. Sooner or later the gelatin-like substance becomes soft and sags, so that the vision is imperfect. Several fairly efficient anti-dimming preparations were compounded by American chemists to be applied to the inside of the lenses by the soldier before the mask was required for use. This problem was largely solved in the latest type of American mask by a very ingenious device. The intake manifolds were carried up to a point directly underneath the eye pieces, so that the cold air played on the lenses, keeping them cool on the inside. As a consequence the condensation was reduced to a minimum and anti-dimming compounds were seldom necessary. The nose snubbers and the rubber tube that was held in the mouth in the old mask were eliminated in the new type. This was a boon to the soldier, for he could now breathe in the normal manner through the nose, thus being relieved to a very considerable extent from the discomfort of the old type mask.

Another defect was discovered in the matter of the construction of the eye pieces. All the armies were using celluloid because it would withstand hard usage. It was found, however, that the surface of the celluloid soon became wavy and the resulting uneven vision caused headaches, indigestion and even nausea. For this reason triplex glass that will withstand a severe shock is employed in the latest American mask.

Experience with long-continued wearing of the gas mask in the field proved that the soldier became exhausted. Some interesting and valuable physiological experiments revealed the fact that if one is obliged to breathe against a resistance equivalent to a column of water two to six inches high, an inadequate amount of air is taken into the lungs to oxygenate the blood sufficiently. The resistance offered to the air by the contents of the canister in the American and especially the British masks was much too high. Consequently the soldier when working hard did not get enough air to purify his blood and partial or complete exhaustion resulted. This is believed to have been a large factor in the collapse of the Fifth British army last March. The men had been obliged to wear their masks for days because of the constant bombardment with gas and were exhausted when the Germans finally attacked.

At the close of the war a new type of canister was being produced in America in which the resistance was reduced below the danger point. The new canister was also designed to meet the requirements of the latest developments of gas warfare, the "smoke" problem. Certain substances, such as sulfur trichloride, were used in gas shells to produce, not gases, but very fine particles that remain suspended in the air often for long periods. In the case mentioned the sulfur trioxide unites with moisture of the air to form tiny particles of sulfuric acid. Many of these small particles produced in this or a similar manner were not removed by the contents of any mask in use on the battle field. The latest American canister gives an almost perfect protection against this insidious form of gas warfare.

With regard to gas warfare the American Gas Offense held the same views as their contemporaries in the field. The best kind of defense is to strike back harder than the enemy can. With this end in view enormous quantities of deadly gases, especially phosgene and "mustard gas," were being produced for our army at the close of the war and preparations were nearly completed to increase the production to several hundred tons per twenty-four hours.



Charles Edward Pickering

THE PROGRESS OF SCIENCE

CHARLES EDWARD PICKERING

THE nation and the world are losing the men of science who in the last generation were its leaders. It may be that among their survivors, increased tenfold in numbers, there are ten times as many men of equal ability and performance. That is for the next generation to decide; for us the men who pass away seem to be irreplacable in their work and most of all in the distinction of their personal qualities.

While America was dependent on foreign nations for research in most of the sciences it maintained a certain leadership in astronomy. This appears to have been due to the fact the observatories were endowed here in which opportunities were offered for research, to which scientific men could devote their entire time and energies. Three outstanding astronomers were Newcomb, Hill and Pickering. They worked by diverse methods. Hill on his farm at Nyack was isolated from all organization. Newcomb used the Naval Observatory and was both aided and hampered by the government's provision for astronomical work. Pickering, the head of a college observatory, made in large measure his own opportunities by his remarkable powers of organization.

John Pickering, who settled in Salem in 1642 founded a distinguished New England family; his great grandson, Charles Edward Pickering, was born in Boston in 1846. He died on February 3 in the house of the director of the Harvard College Observatory, active, until stricken by pneumonia, with the work he had conducted for forty-two years.

Pickering became full professor of physics in the Massachusetts Institute of Technology at the age of twenty-two. He there introduced the laboratory method of teaching physics unknown elsewhere and carried on important experimental work on light and on other subjects related to astronomy. In 1877 he was appointed to be the successor of Winlock as director of the Harvard College Observatory.

Pickering devoted himself and the resources of the Harvard College Observatory in large measure to the then undeveloped science of astrophysics, with the fruitful results described in some eighty volumes published by the observatory. Photometric and photographic work was undertaken by new methods and on a scale not before imagined. For example, in a few years three times as many variable stars were detected there as had been discovered in the whole history of astronomy. Two million measurements of the light of 80,000 stars have been made at Harvard, and the results have been the discovery of three fourths of the known 5,000 variable stars. Two telescopes have taken photographs, the plates of which weigh eighty tons. An observatory was established at Arequipa to obtain corresponding results in the southern hemisphere.

The organization of work on such a great scale with extensive equipment and many observers and computers, controlled by one man, was a development of science comparable with the modern organization of industry in America. It does not supersede the need of men such as Hill or Willard Gibbs, but it gives a new and powerful method for the advancement of science congenial to the genius of organized democracy.

The industrial trusts have obtained control by the suppression of rivals. Here the methods of Pickering were the exact reverse, and set standards which we may hope will ultimately prevail. He not only obtained large endowments for the Harvard Observatory and perfected its methods, but was equally active in assisting and organizing astronomical work throughout the country and the world. He was by common consent the permanent president of the American Astronomical Society. All astronomers and many not astronomers are his debtors for counsel and help. Others will take up and carry forward the astronomical work that Pickering originated and organized. His place as a man with other men will remain unfilled.

A NATIONAL DEPARTMENT OF EDUCATION

A BILL has been introduced in the Senate and the House creating a department of education with a secretary of education and appropriating money for educational work in cooperation with the states. The bill has the support of the National Education Association and the American Federation of Labor. It can not be passed before March 4, but efforts will be made to have the subject considered by the next congress.

Other leading nations have a ministry of education, but here education has been held to be a state function. The present bill is indeed not intended to interfere with the autonomy of the states, but, like the bill that has been adopted to promote vocational education, would distribute money to the states on condition that they appropriate equal amounts for the same purposes. The states and local authorities would retain exclusive administration and control of education within their respective jurisdictions, the federal government exercising supervision only to the extent necessary to see that the amounts appropriated are used by the states for the purposes specified in the bill. The allotments would be paid to the states quarterly and disbursed on the order of the state's chief educational authority, as designated by the state legislature.

The bill authorizes an annual appropriation of $100,000,000, to be apportioned among the states for the following purposes: (1) To encourage the states in the removal of illiteracy, $7,500,000. (2) To encourage the states in the Americanization of foreigners, $1,500,000 (3) To encourage the states in the equalization of educational opportunities, and for the partial payment of teachers' salaries, providing better instruction, extending school terms and otherwise providing equally good schools for all children, $50,000,000. (4) To encourage the states in the promotion of physical and health education and recreation, $20,000,000. (5) To encourage the states in providing facilities for preparing and supplying better teachers, $15,000,000.

In the hearings that have been held before the House education committee, as reported in the New York *Tribune*, striking facts have been brought to light showing the extent to which the illiteracy evil exists in the United States. The selective draft alone brought out the fact that there were 700,000 illiterate males in this country between the ages of twenty-one and thirty-one, unable either to understand the principles for which they were called upon to fight or to read the Constitution they were expected to defend. Altogether, it has been testified by experts, there are at the present time in the United States 8,592,000 illiterates and persons unable to speak English, of whom 1,006,000 live in New York State and 621,000 in Pennsylvania.

Statistics were presented to show that 62 per cent. of the miners employed in this country are of foreign birth and that thousands of them are not only unable to read safety instructions posted up in the mines, but are unable to understand directions spoken to them in English. This fact is held to be largely accountable for the great number of accidents in the mines, where an average of 3,200 men are killed every year and 300,000, or one third of all those employed, are injured.

Of those examined for military service under the selective service act it was found that more than 700,000 were physically unsound and that a large proportion of the physical defects could have been prevented or removed by proper attention in youth. The economic and industrial loss, not to speak of the poverty and misery, attributable to these facts, experts have testified, has been enormous.

The importance of the problem of Americanization, it is held, has been emphasized repeatedly during the war and is self-evident from the fact that there are now 13,000,000 foreign born in this country. Not only many of these, but many of the native born, the committee has been told, are ignorant of their duties and responsibilities as citizens.

Advocates of the bill insist that it is essential in any form of constructive legislation to meet the illiteracy peril, that provision be made for the government to assist the states in paying adequate salaries to teachers, and that more teachers, well-trained, be provided. Referring to the fact that there are 22,000,000 children of school age in the United States, a brief laid before the House Committee in behalf of the American Federation of Labor, the American Federation of Teachers and the National Education Association said:

> The Bureau of Education reports that the average annual salary paid teachers in this country in 1918 was $630.64, which is $243 less per annum than the average wage paid to scrub-women in the United States navy yard. Is there any wonder that results are not always satisfactory? Inefficient schools are almost invariably the result of inadequate support. Low salaries are driving many good teachers out of the profession and filling the ranks with the immature, inexperienced and untrained.
>
> Of the 600,000 teachers in America 100,000 are less than twenty years old; 150,000 have served two years or less; 30,000 have no education beyond the eighth grade; 200,000 have had less than a high school education. Our government has been accused of giving more thought to agriculture and commerce than to education; more attention to livestock than to children.

STORAGE RESERVOIRS IN THE ADIRONDACKS AND WATER CONSERVATION IN NEW YORK

A Bulletin of the College of Forestry at Syracuse emphasizes the fact that the building of storage reservoirs alone will not solve the flood or water conservation problem in New York. The building of storage reservoirs must be combined with general reforestation.

The present interest in the development of water power in New York is emphasizing the problem of bringing about regular flow in streams for both power and domestic use. There is no question of course but that streams must be kept to a certain level throughout the year to be of value in the production of power. Where a stream fills its banks for a few months of the year and then dwindles to nothing, necessitating the use of steam power for the remainder of the year, these streams can be said to be of really little value to the state. There is no question but that the building of storage reservoirs at strategic points on water courses will assist in holding water back and allowing the streams to fill to a higher level through a longer period of the year, but the building of these reservoirs is only solving half the problem. If the forests are stripped off, allowing melting snow and rain to rush rapidly to the streams, this flood water will carry soil that will fill the reservoirs as rapidly as they are cleaned out. That this is the result of building reservoirs without proper reforestation of the headwaters of the stream has been videnced repeatedly in the Alps in France and Italy and in our own western mountains in California.

Forests have a marked influence in conserving the water which falls in the form of rain and snow. The branches of the trees break the force of the rain, letting it fall to the ground and pass into the soil easily. The cover formed by decaying leaves and sticks is a spongelike mass called duff or humus, and this has a great water absorbing capacity. It takes up in proportion to its volume a vast quantity of water and gives it off slowly over a period of several months, thus maintaining springs and even flow in the streams.

General uniformity of stream flow in every section of the country will probably be brought about only as the result of widespread and intelligent reforestation combined with a limited number of large storage reservoirs at the headwaters of streams. If in connection with the reforestation of the barren areas, storage reservoirs are constructed so that the flood waters of spring may be impounded and given off gradually during the dryer seasons of the year, the combination of the two—the forest and the storage reservoirs—will come as near solving the problem of uniform flow in our streams as anything that can be contrived by man. Proper control of runoff is the only thing that will maintain a supply of water in streams upon which manufacturing industries are dependent and insure proper levels for navigation.

While forests act as protectors of the soil and conservers of water, they will be producing a crop of wood that will give increasingly large returns. There are, therefore, both direct and indirect benefits to be obtained from the reforestation of the nonagricultural hillsides and ridges which form so considerable a part of the great state of New York. There should be, therefore, constant cooperation between those who wish to develop the waterpower of the state or cities using water from our forests with the agencies carrying on reforestation. Without proper forest cover there can not be proper water supply.

SCIENTIFIC ITEMS

We record with regret the death of Dr. Brown Ayres, president of the University of Tennessee and previously professor of physics at Tulane University; of Rolla C. Carpenter, professor of experimental engineering at Cornell University; of William Erskine Kellicott, professor of biology at the College of the City of New York, and of Profesor R. Nietzki, professor of chemistry at Bâle.

The gold medal of the National Institute of Social Sciences has been awarded to Dr. Wm. H. Welch, of the Johns Hopkins Medical School. —Dr. J. A. L. Waddell, whose recent articles on engineering fifty years hence will be remembered by readers of this journal, has been elected a corresponding member of the Paris Academy of Sciences.

THE SCIENTIFIC MONTHLY

APRIL, 1919

PAPERS PRESENTED BEFORE THE SECTION OF SOCIAL AND ECONOMIC SCIENCE OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

FRANCE AFTER THE WAR

By the Honorable EDOUARD DE BILLY

FRENCH HIGH COMMISSION

I

IN order to discover what a man will be in the future, it is necessary to investigate first what this man has been in the past. Then, a study of the new environment in which he stands may enable one to determine, with sufficient accuracy, how he may develop.

The same method applies to peoples. I have been asked to address you on "France after the War." And I feel very deeply the responsibility which lies on me in discussing such a question before a body as representative and competent as the American Association for the Advancement of Science.

May I venture to answer your request by trying, in a few words, first to summarize what, from the point of view of the scholar in economic sciences, France has been in the immediate past, and, second, to give you some data which will allow you to realize in what circumstances she stands when, at the close of these fifty-one months of war, she has to face the problems of reconstruction, and that of restarting her economic, industrial and commercial life.

[1] Baltimore meeting, December, 1918, arranged by the Secretary of the Section, Seymour C. Loomis.

II

In this country, everything changes so rapidly, and the growth has been so enormous, that most of the activity and attention are focused on present problems, and there is in many minds some forgetfulness of the past. Moreover, the energies of most of the citizens have been, justly, so devoted to the development of their own country that they have given, until these last few years, but little attention to the activities of other nations on the other side of the water. The consequence is that many Americans do not realize what was the position of France in the middle of the nineteenth century; and many of you who are now listening to me will, I am sure, be rather skeptical if I tell you that, during this period, France was one of the most enterprising nations of the world, and developed, in the economic field, the same spirit of self-confidence and audacity that her preceding generation had shown to the world on the battlefields, during the Napoleonic wars.

Yet this is the plain truth. During the years from 1850 to 1870, which was the period of the first development of railroads, French engineers were not content with constructing the railway systems of their own country. In Austria, in Italy, in Spain, railways were built by French engineers, with French capital. This was also done, a little later, in Russia. Harbors and great public works were also contracted for and built by French firms, led by French engineers.

The Suez Canal was, I think, the greatest French success of that period. It was planned by a great Frenchman, who found, with the help of the French government, French capital to subscribe to the company, and French contractors and French engineers to do the work. May I add that, in this development of French industrial life, the part taken by Alsace and the Alsatians was most prominent.

The war of 1870–71 was, for my country, the greatest blow she had ever received. We were, perhaps, at that time, too proud of our achievements. The fact is that the defeat not only deprived us of two provinces which were as much a part of France as any other French land; in addition, it destroyed, in the minds of those who had been defeated, the spirit of self-confidence, which is as necessary to any human enterprise as is fire to make an engine work.

The recovery of France after this disaster was rapid. I may say that it amazed the world. It angered Bismarck, who thought he had annihilated France forever, and who, had it not been for the personal intervention of Queen Victoria, would have attacked her again in 1875, to crush her to death. But we recovered with the timorous minds of men who, in the course of a successful development, have undergone an unforeseen and terrible disaster. The Frenchmen whom you have known during the last forty years were the sons of men who had been badly defeated. They bore on their shoulders a burden which prevented them from marching lightly to success.

However, two new fields of activity were gradually opened to our generation: one inside our country, the other in far distant fields.

The German negotiators, in 1871, had fixed the boundary so as to annex to Germany all that was then known of the iron deposits of Lorraine. The geologists of that time had a theory that only the outcrops of these enormous layers had a sufficient percentage of iron to be of any industrial use; and these outcrops became German. After a few years, French engineers started a series of borings which showed that, to a greater depth than had been realized, the deposits yielded ore of good workable quality. This was the origin of the development of our iron industry in the east of France. While the production of pig iron in France was 960,000 tons in 1890, it had reached 5,311,000 tons in 1913; and the output of iron ore had reached 23,300,000 tons. This was a success which did not fail to produce its fruit. When the war broke out in 1914, two regions in France—the north, thanks to the coal basin, and the east, thanks to the iron—had been for several years developing in a remarkable manner, new works and factories being built, and a new generation arising, believing in its own possibilities and success.

Some of these young men, anxious to find a wider field of development, had gone to unknown lands, and there they met with greater success and attained a greater sense of self-confidence. Bismarck, who did not care for colonies for himself and only wanted to protect and develop the empire which he had built, thought it very wise to encourage France to enter upon a colonial policy. He was sure it would weaken her, and that besides it would divert her thoughts from her eastern frontier, which Germany wanted to make, on her own side, so utterly impregnable that France would never dream of touching it.

Very wise was Bismarck indeed, but for the benefit of France, and not for that of Germany. The French who went to Indo-China, to Madagascar, to Congo, to Tunis, to Morocco, rapidly discovered, in these new countries, that their endeavors were crowned with success; their energies were exalted, while trade and agriculture developed. They also learned to fight, to subdue dangerous rebellions, and (which has been their most remarkable achievement) they succeeded in making loyal to France, by good administration, those whom they had been obliged to fight. Thus these colonies, instead of weakening France, have been to her a source of moral, economic and military strength. As has been said of Morocco, the colonies have been the anvil on which France forged her sword.

Such was the situation, improving rapidly during the preceding few years, when the war broke out, and found France ready to meet all emergencies.

Next to the military problem, the industrial problem has been, during the last four and a half years, the most difficult to attend to. Our country, deprived of its coal- and iron-producing districts, having almost no further raw materials of its own, and most of its big factories and iron works in the hands of the enemy, had to meet the most extravagant demand for guns, ammunition, powder, explosives, and all sorts of war material. You know what has been achieved. You know to what extent new factories have been erected and equipped, every step being taken in order to make use of the supplies of coal and steel delivered by Great Britain, and of steel, machinery and supplies of every kind sent to France by the United States.

A few figures will illustrate the results obtained. In 1916, the output of our war factories in 75 cm. caliber shells, was 13,000. In 1917, we were able to manufacture 200,000 rounds per day, besides 100,000 rounds of heavier caliber. The monthly production of sulphuric acid, which previous to the war did not amount to 5,400 tons a month, amounted, before the end of the war, to nearly 100,000 tons. The equipment of our factories was such that besides our own needs in guns and air planes, we were able to furnish them to the armies that were fighting with us. General Pershing's report shows to what extent the American divisions were equipped along these lines with material manufactured in French factories by French workmen, from raw materials coming from the United States, using coal received from Great Britain.

This could not have been achieved if the French nation had not been, in August, 1914, in a quite different spirit from that indicated by the figures of her trade during the twenty previous years. Victory will give the development which was already noticeable, a definite and powerful start. In the joy of this immense success, the clouds of the defeat of years gone by will be, as it were, scattered by a healthy breeze. Self-confidence, which was growing slowly, will be exalted, and the rising generation of France will appear with the same spirit of enterprise that animated their grandfathers of the eighteen-sixties. They will need it, for the problem they have to face is most difficult.

III

It has often been said, and it is true, that France will have gained much by this war. She has recovered the two provinces which she lost in 1871, which means that the number of French people is increased by nearly two million men and women of solid character and absolute devotedness. They have shown this by their stubborn opposition, during forty-four years, to their annexation to Germany. They are people also of sound intelligence and good business-like qualities, as you may judge from those Alsatians who, having emigrated to this country and become naturalized Americans, have prospered so well.

The regaining of these provinces also means the recovery of the good agricultural land of the plains between the Vosges and the Rhine, and the addition to the mineral resources of France of the iron deposits of the Germany-annexed portion of Lorraine, and of the potash deposits lately discovered in upper Alsace.

May I add that this victory also means for us the safety of our eastern frontier, the removal of the danger which, to a certain extent, handicapped the development of our industry in that region, because we knew that the Germans were anxious to invade our frontier territories in order to make theirs, as they had hoped to do in 1871, the whole of our iron deposits.

These are precious assets. But, on the other hand, let us consider some of the terrible aspects of the situation in which now finds itself the country that, for four and a half years, has been the battlefield of our coalition. Your war, and England's war, as well as France's war, have been fought in Belgium and in France. Our army had to stand the first rush of the invasion, while the other armies were being prepared. And, however wonderful was the effort of the British, some months later, and afterward that of the American army, the front held by the French has never been less than two thirds of the total line from the North Sea to the Swiss border. Thus our losses were greater than those of any other army. A part of our country has been invaded, its population treated as slaves, their houses looted, their factories destroyed; while on the fighting line the soil of France has been plowed so deep by shells that no agriculture is possible. Some sentimental people have been lamenting over France as bled white. Nonsense! France is not bled white. She has men filled with renewed and splendid energy. But here she stands, facing the problem of recuperating her place in the economic markets of the world, with a part of her industrial and agricultural power destroyed, and with her men killed and maimed to a number that exceeds imagination. May I give you some figures on these subjects?

Our *losses in men*, as you know, have been tremendous. Besides 1,300,000 of our young men who were killed or died of wounds or illness in this war, we have a great number whose physical ability has been seriously impaired. Add to these the number of our prisoners who came back in such a terrible physical condition as to render them unfit for any sustained effort, and we come to a total loss, for the work to be started in France, of about two and a half million men, who were mostly among the youngest, ablest and strongest, as well as the most spirited, of our people—a terrible loss for a country of less than forty million inhabitants.

Our *agriculture* has perhaps suffered more heavily if possible than any other branch of our economic activity.

The following figures will give you a vivid picture of the losses sustained.

	July, 1914.	March, 1918.
Cattle	14,788,000 Head	12,443,000 Head
Sheep	16,213,000	10,587,000
Pigs	7,048,000	4,200,000
Horses	3,231,000	2,283,000
Total	41,280,000	29,513,000

The difference between the two totals, 11,767,000 heads, represents the loss of France during the war.

The number of *cattle*, which in England increased by 4 per cent., has in France decreased by 18 per cent. The production of *milk* has decreased by 63 per cent. The number of sheep has decreased in France by 38 per cent. The number of pigs has decreased by 40 per cent. May I, in addition to these figures, mention that, as regards crops, the soil of France is also in an impoverished condition, having been, for four years, mostly tilled by very young and elderly men, below or above the age of military service, and by women, whose physical strength was not equal to the splendid spirit they have shown in this war.

As regards *industry*, you will realize the terrible blow the war has given to that part of the economic life of France when you know that there were 26,000 mills or factories in that portion of our territory occupied by the Germans, and that most of them have been destroyed or stripped of all their machinery. The invaded districts do not comprise more than 7 per cent. of the whole territory of France, but they represented 30 per cent. of the industrial output of our country, and 25 per cent. of the total returns of taxes. From these districts came 90 per cent. of our iron ore; 83 per cent. of our pig iron, as 95 blast furnaces, out of a total of 127, were in the invaded regions; 75 per cent. of our steel; 70 per cent. of our coal; 94 per cent. of our combed wool; 90 per cent. of our flax; 65 per cent. of our sugar.

The part of France occupied by the Germans produced four fifths of our woolens, and included 80 per cent. of our weaving industry. During the four years of their occupation, the Germans wilfully and methodically destroyed all that was in their power to destroy. They not only requisitioned as at Roubaix and Tourcoing, where they commandeered stocks of wool worth 300 million francs. Requisition is one of the rights of war, and of that we can not complain. But what is against all right, and against all international law and agreement, is the destruction and stealing of property; and this is what the Germans did.

As to our cotton industry in the north, the German invasion has cost us 2,100,000 spindles and 13,200 looms, and in the east, 125,000 spindles and 6,905 looms. This robbery was not carried on in cotton and wool factories alone. Iron works, machine works also, were looted, the useful equipment, engines, rolling mills, machine tools, even structural steel, having been methodically taken away and set to work again in the iron works in Germany. Mines were flooded, the surface plants dynamited, the workmen's dwellings destroyed.

In a word, the Germans did their best to annihilate the power of industrial production in the invaded districts and prevent these regions from resuming, for many years to come, their place in the market of the world.

The industry of transportation has also heavily suffered from the war. The wear and tear on the rolling stock of our railroads has been intense. In the invaded regions, the tracks were badly injured during the German retirement.

As to our *shipping*, the tonnage of our merchant marine in 1914 amounted to 2,285,728 tons. We have lost 757,900 tons through the submarine or other warfare, and 115,000 tons through sea accidents.

Contrary to what has happened in other more fortunate countries, France during the war had neither the labor nor the raw materials to build new ships. The machine shops of our shipyards were used to manufacture ammunition, tanks and other war material; you can draw your own conclusion. We have thus lost 872,000 tons. Taking into account the small amount of 117,000 tons built during the war and a few ships which we have been able to buy, our tonnage had fallen to 1,615,000 tons on April 1, 1918.

Our *commerce* too has suffered most heavily, practically all of our factories being turned to war work, and all our peacetime industries being at a standstill.

Here are the figures for 1913, before the war:

Imports	Exports
Francs. 8,421,300,000	Francs. 6,880,200,000

which compare with the figures for the year 1917:

Imports	Exports
Francs. 16,311,975,000	Francs. 4,095,000,000

And last, let us have a glance at the financial situation of the country.

The war will have cost France, up to December 31, 1918, 130 billion francs, this figure being the total of appropriations granted by the French Parliament for military and exceptional expenses during the war.

If you add to this 11 billion for normal expenses, and 17 billion for interest on the public debt, you see that France has, during those 53 months, spent 158 billion francs.

To meet these expenses, France had taxes and loans. Taxes have been raised to an unprecedented level. While in 1914 the total of our national budget was slightly above four billion francs, the taxes will have given in 1918, without the invaded regions, which were, as you know, by far the richest, over nine billion francs. In 1917, the civilian population in France paid in taxes 38 dollars per capita, as compared with nine dollars paid in 1906 by Americans.

France, before the war, had a public debt of thirty-four billion francs. The interior debt has increased, during the war, by over 100 billions, the last public loan having produced 27 billions. We have received from Great Britain and the United States, loans amounting to 25 billion francs.

So that France starts on this new period of her history with a burden of public debt increased, on account of the war, by over 125 billion francs, a figure which will certainly be further increased in order to liquidate the war expenses.

I had to give you these figures in order to make you realize the seriousness of the situation in which France stands. We are all ready to face our problems with the utmost confidence and will to succeed. But we are aware that they are grave problems.

First, while the whole world jumps into peace work and resumes trade, we have a part of our territory which is unable to produce. We can not maintain our place in the markets of the world. We can not get our own supply of coal. We are obliged to maintain restrictions in order to protect our industry while in course of rehabilitation, and as long as a normal order of things is not reestablished.

Secondly, in order to get from outside markets the raw materials and finished products we need, we depend largely upon foreign ships.

Thirdly, trade and shipping are closely connected. We have to rebuild our foreign trade, which has been stopped during the war on account of lack of tonnage and lack of industrial production. In order to start again, we need ships, and our commercial fleet is reduced to the figures I quoted to you a while ago.

Fourthly, one of our best assets is our colonial empire. We have pacified and established our rule in vast countries, whose natural supplies are enormous, and whose populations are willing to work, and are loyal, as they have shown by giving us a total contribution of 918,000 men during the war, of which 680,000 were fighters, and 238,000 workmen in our war factories. With her possessions, France is actually the fourth of the great countries of the world as regards territory, the fifth as regards population. But we must develop these possessions. In order to perform that duty, we want ships. And again, our merchant fleet has fallen to almost nothing.

So, in order to fulfill her duties, France has two great objects to achieve: to rehabilitate her devastated regions, and to build ships. If her friends want to help her during peace as they have helped her during the war, they have two means of assisting her to regain rapidly, from an economic point of view, her place in the society of nations: helping her to rebuild what has been destroyed by the Germans, and helping her to construct, or to purchase, ships.

RECONSTRUCTION IN GREAT BRITAIN FOLLOWING THE WAR

By Sir H. BABINGTON SMITH, K.C.B.

ASSISTANT COMMISSIONER FOR GREAT BRITAIN IN THE UNITED STATES OF AMERICA

THE word "reconstruction" has a very wide application. Not only must the destructive processes of the last four years be reversed, but it is hardly too much to say that the whole framework of civilization is in need of reconstruction after the war. The word is used in several different senses which it will be convenient to distinguish.

1. Reconstruction, in its most limited sense, applies to the reparation of actual damage done by the war. This includes the rebuilding of houses, villages and towns which have been destroyed; the replacement of industrial plants and machinery which have been destroyed or carried off; the restoration of mines, railways, canals, roads, woods, orchards and so forth, and of the surface of the soil itself.

This problem is a large and urgent one, but its primary interest is for those nations on whose territory the land war has been waged. Except in one particular, with which I shall deal immediately, Great Britain is interested, not directly, as having suffered such damage, except in a minor degree; but indirectly, in seeing that all possible measures are taken to ensure that those allied countries which have been devastated shall be restored as completely and rapidly as possible, and in contributing, in such ways as may be possible, to the supply of materials or transport for that purpose.

It is in shipping especially that Great Britain has suffered losses, owing to the operation of German submarines without any restriction of law or humanity. The British losses of mercantile shipping from the beginning of the war up to October 31, 1918, from enemy action and marine risk amounted to 9,032,000 gross tons. The additions to British mercantile tonnage in the same period from new construction, from tonnage purchased abroad, and from enemy tonnage captured, amounted to 5,589,000 gross tons, leaving a net reduction in British tonnage of 3,443,000 tons, mainly due to hostile action.

The world's losses, excluding enemy countries, amounted to just over 15,000,000 tons. The new construction was 10,849,000 tons, and the enemy tonnage captured 2,393,000 tons, making together 13,242,000 tons, and leaving a net reduction of 1,811,000 tons. It will be seen that while British tonnage has lost 3,443,000 tons, the rest of the non-enemy world has actually gained on balance 1,632,000 tons.

There will undoubtedly be a claim upon all existing enemy tonnage to make good the marine losses of the Allies from illegal enemy action; but as the total German tonnage before the war was under 5,000,000 gross tons, and the tonnage possessed by other enemy countries was very much less than that, and, as a considerable part of this has already been captured or requisitioned by the Allies or America, it is obvious that only a part of the losses can be made good in this way.

British mercantile shipbuilding during the war has been heavily handicapped by the demands of naval shipbuilding, by the withdrawal of labor for military service, and by the great amount of repair work that was required both for the British and American Navies and the merchant marine. Out of 381,000 men, who were engaged shortly before the end of the war in shipbuilding, in marine engineering, and in repairs, only 116,000, or considerably less than one third, were engaged in new merchant-ship work. A considerable amount of repair and refitting will still be required after the war; but with the return of the men from the army, and with the cessation of the urgent needs for naval shipbuilding, it may be anticipated that the outturn of new ships will be rapidly increased. The tonnage completed in the year ending October 31, 1918, was 1,600,000 gross tons, and it is anticipated that, when peace conditions are reestablished, the annual output from British yards may reach 3,000,000 tons. It will, however, take some time before this rate is attained. Apart from any contribution from German shipping, it will probably be at least eighteen months, perhaps longer, before the destruction of war is made good; and it will, of course, be considerably longer before the normal increase which would have taken place in the last four and a half years, and the normal replacement of worn-out ships, will have been overtaken. During that time, the output of American yards, and of the yards of other countries will continue at a rapid rate; and, unless sane and long views are taken and suitable measures concerted, it is probable that in three or four years' time the world's shipping will be largely in excess of the world's needs, with disastrous results for shipowners and shipbuilders.

2. In its second meaning, the word "reconstruction" comprises the whole process of turning over from war to peace; the

process in fact of demobilization in its widest sense—military, naval, industrial and financial.

Military and naval demobilization can only be carried out partially while we are awaiting the final conclusion of peace. During the period of the armistice and of the peace conference, armies, and to some extent navies must remain upon a war footing; and, even after the final signature and ratification of the peace treaty, or treaties, it is possible that considerable forces may be required for the occupation of territories, pending the execution of the conditions of peace, and for purposes of international police.

Careful study has been given in Great Britain to the problems of demobilization. During the present period of partial demobilization, steps are being taken to release as many as possible of the men whose services are required in preparation for general demobilization. Such men are, in the first place, those described as *demobilizers*—that is to say, men whose services will be required for working the mechanism of demobilization—and secondly, *pivotal* men, that is men who are necessary for the reestablishment of industry on a peace basis, and for preparing the way for the reemployment and reabsorption of labor. Arrangements are also being made for regulating the priority of release, when the general demobilization starts. This priority will depend upon a number of factors. Men for whom a job is definitely waiting will be released first; priority being given at the same time to those trades—such as mining, ship-building, transport, building materials, agricultural machinery, etc.—for which there is a specially urgent demand, since their activity is a condition precedent to the full activity of other industries. Consideration will also be given to the claims of men with the longest service in the army, married men, and men, who, on the ground of special hardship, deserve early release. A furlough of twenty-eight days, with pay and ration allowance will be given to each man on his release.

A comprehensive scheme has also been drawn up for giving special intensive educational training to men who, owing to the interruption caused by military service, have lost touch with their particular professions and businesses, and measures have been taken for giving vocational training to men who have been maimed, or otherwise incapacitated for their former employment.

The demobilization of civilian workers, who have been employed on munitions work, will take place at an earlier date than the military demobilization, and will require equally careful organization. Arrangements were made to prevent, as far as possible, any immediate general discharge of munitions workers, upon the cessation of hostilities, and steps were taken to facilitate, by free transport and other measures, the return of munition workers to civilian employment. This task is aided by the fact that sixty per cent. of the persons employed in munitions industries were at work, for war purposes, upon industries in which they would, in the ordinary circumstances, be working for peace purposes; but a special difficulty arises from the large quantity of female labor which has entered industry, the munitions industry in particular, during the war in order to meet the deficiency of male labor.

However good the arrangements may be, it is certain that in many cases the individual soldier or civilian may have to pass through a period of unemployment before he is reabsorbed in peace industry. To provide for this, a special unemployment donation will be given for a maximum period of thirteen weeks in the case of the civilian worker, and twenty-six weeks in the case of the soldier. This donation is payable during any period of actual unemployment occurring in the first year after discharge in the case of the soldier, and in the first six months in the case of the civilian, provided that the claimant has endeavored to obtain employment through the labor exchanges.

Another process which forms part of demobilization, is the disposal of surplus property. There is a vast quantity of property, both raw materials and finished articles, in use or in reserve for military purposes. The value of such property is probably not less than two and a half billion dollars. In the interest of the tax payer it is necessary to guard against improvident selling; and it is also desirable to avoid the dislocation of trade which would result from too hasty a disposal of this property. It is possible, also, that organized schemes for the use of surplus property may be desirable; for instance, that the trucks and other automobiles which are no longer required for military purposes, should be used to set up schemes for rural transport for the benefit of agriculture. A special department in close relationship to the Ministry of Munitions has been set up to deal with this problem, and to dispose of all kinds of surplus property.

I have spoken of the industrial demobilization so far as it affects labor, but there is another side to it also—the question of the utilization of plants which have been created for the manufacture of munitions, or which have been specially modified for that purpose. In some cases the transition is easy. One factory, at least, which on November 11 was engaged on pure munition work, started on commercial work of a totally different kind on November 12. Textile factories, which have been making cloth for uniforms, or other materials for military use, can readily turn over to peace requirements. If the work has to be different in kind, the transition takes longer to effect. The nature of the changes in contemplation is shown by the following specimens from reports received by the Ministry of Munitions. Some manufacturers who have been producing aero-engines are going to make engines for motor cars, or for small launches. One firm, which has been manufacturing fuses, is turning over to the manufacture of electric fittings, another to motor accessories. In other cases, the change is more radical. An aeroplane factory will turn to household furniture and heavy toys. A firm at Newcastle-on-Tyne, which has been making guns will build locomotives and will employ 5,000 hands. Several munition firms are taking up the manufacture of hosiery needles and hosiery bearded needles, which in pre-war days were almost entirely imported from Germany. Other munition firms are preparing to make dairy utensils, boot machinery, fountain pens, typewriters and so forth.

On the whole, the problem is not so difficult as that which had to be faced in the early days of the war. The change from peace production to war production was a change from the known to the unknown. The return to peace again means going back in most cases to the known.

All these industries will require raw materials. The war has made it necessary for the government to assume control of stocks and supplies of almost all raw materials. It will not be possible to relax this control all at once, and the system of priority permits, and of export and import licenses may have to be continued for a time, in order to secure fairness in distribution, and in order that our obligations to the allied countries may be observed. The object will be to remove restrictions and regulations as soon as it is practicable to do so.

The problem of "financial reconstruction" may be divided into three branches, which are to some extent mutually interdependent, viz., national finance, currency and exchange.

The total expenditure of the United Kingdom from the beginning of the war to the present time amounts approximately to nine billion pounds (45 billion dollars), of which one quarter has been raised by revenue and three quarters by borrowing. Translating, for convenience, sterling into dollars, the national debt at the beginning of the war was three and a half billion dollars. It is now more than ten times that amount—thirty-six billion dollars. Against this, however, must be set various assets. We have advanced to the British Dominions more than one billion, to the Allies nearly seven and a half billions, making a total of eight and a half billions. A part, also, of the expenditure is recoverable; for instance, expenditure on food and raw materials which will be sold to the public, and the value of surplus stores, factories, etc. The ultimate value both of the advances and of the other assets is very difficult to estimate, but taking advances and realizable assets together, it is probably not less than ten billion dollars. This will make the net national liabilities at the end of the war, amount to something like 25 billion dollars. If six per cent. be allowed on this sum, in order to provide a substantial sinking fund as well as interest, the service of the debt will cost one and a half billion dollars per annum. The pre-war budget amounted to about 850 million dollars per annum, and to this must be added a large sum, perhaps half a billion, for pensions and other charges arising out of the war, and for necessary increases of expenditure. It may be guessed, therefore, that the annual post-war budget will be not less than two and three fourth billion dollars. There can be no doubt as to the ability of the United Kingdom to meet this charge when its energies are applied to peaceful production, but it will involve very heavy taxation, and one of the most difficult problems of reconstruction will be how to raise the necessary sum with justice to all portions of the community, and without placing burdens upon industry and commerce so heavy as to repress enterprise.

The various questions arising in connection with currency and the foreign exchanges during the period of reconstruction have recently been examined by a committee of experienced bankers and business men under the chairmanship of Lord Cunliffe, the late governor of the Bank of England. It appears from this Committee's report that the total issue of Bank of England notes and currency notes on July 10, 1918, was £343,000,000, of which £94,000,000 was covered by gold coin and bullion, and £249,000,000 represented the fiduciary issue. On June 30, 1914, the note issue amounted only to £57,000,000. There had thus been an increase of £256,000,000 in the note issue; but this increase has been accompanied by a reduction of £83,000,000 in the amount of gold coin in public circulation. It would occupy too much of your time if I were to reproduce the committee's analysis of the causes which have brought about this great expansion of legal tender currency. I may, however, briefly summarize their conclusions:

They consider it imperative that, after the war, the conditions necessary to the maintenance of an effective gold standard should be restored without delay. The first condition is that government borrowing should cease as soon as possible, and that an adequate sinking fund should be provided out of revenue so that there may be a regular annual reduction of capital liabilities. They recommend that the present currency notes should be gradually withdrawn and that the note issue should, in future, as in the past, be entirely in the hands of the Bank of England, subject to the existing rules of the Bank Charter Act, viz., that there should be a fixed fiduciary issue beyond which notes should only be issued in exchange for gold. They recommend that the gold reserves of the country should be held by the Bank of England, and that the amount to be aimed at should be in the first instance £150,000,000.

The committee would rely upon the operation of the Bank of England's discount rate for checking any outflow of gold, and for bringing, as in the past, the necessary regulating influence to bear on the foreign exchanges.

It must be borne in mind, however, that the maintenance of the foreign exchanges,—that is, of our ability to meet payments abroad,—depends primarily upon the balance of trade, and that the effect of a high discount rate in attracting floating balances is only a temporary remedy, except in so far as its indirect effects react upon the currents of trade. The position of the United Kingdom in respect of the trade balance has been materially altered for the worse by the war. Securities to a large amount have been sold in America in order to provide funds for purchases of munitions, food and raw materials, with the result that the interest on these securities, which contributed to the favorable balance between the United Kingdom and America, will no longer be remitted to London. Loans have been contracted in America and elsewhere, and the interest on these loans will have to be paid. The British Mercantile Marine has been depleted, and the amount receivable from other countries for freight will be proportionately diminished. It results from these causes that if an adverse balance of trade is to be averted, the United Kingdom must either export more, or import less, or both. In order to meet our obligations it will be necessary that every effort should be strained to increase production, both agricultural and industrial, and to diminish all unnecessary consumption.

If Britain is compelled to use every effort to increase to the utmost the industrial and agricultural production of the British Isles, and so render herself independent as far as possible of supplies from abroad, it must be remembered that one main object of this effort is the maintenance of our ability to pay our debts to other countries, and, in particular, to America. But the resumption even of normal production, and of the normal export trade from the United Kingdom must take time; and, in the interval purchases from the United States to the full amount required can only be made possible by the extension of credit in some form.

3. In the third and widest sense, "reconstruction" includes the solution of a large number of questions affecting the future welfare of the world to which the war has given special urgency and importance. Even to touch upon these would take me too far. International questions of this character form the greater part of the subject matter of the peace negotiations. Perhaps the most vital in the internal sphere is the great group of questions concerning the relations of labor and capital, employer and employed, industry and the state.

Other questions are those of rural development, including such matters as the replanting of forests, small holdings for ex-soldiers and others; housing; education; public health; railways and transportation; electrical supply on a large scale;—all these and many others are under discussion as parts of the great reconstruction which will occupy the world not for months only, but for years, perhaps for generations.

CHINA AFTER THE WAR

By CHAO-HSIN CHU

THE CONSUL-GENERAL OF CHINA AT SAN FRANCISCO

I TAKE great pleasure in presenting for your consideration a few thoughts as to the position of China after the war, and I much appreciate the opportunity so to do.

China is one of the oldest nations in history, but perhaps one of the slowest in scientific advancement, for I must admit that China has been backward in science. And yet, with it all, is it not true that some of the great inventions of the world had their start in China? Gunpowder, which has been used to such a great extent during these last four years of warfare, had its origin in China. Our trouble has been that our scientific inventions have not been effectively developed; in other words, what China needs, in the scientific line, in its after-the-war advancement, is scientific experts.

Thanks to your good government in its remitting of the Boxer indemnity funds, my country is now able to send large numbers of our young men to this country for education, and many of them are taking up scientific lines in your American colleges, with very satisfying results. With the help and under the guidance of your experts, these students will be able to do much for China. Take for example its mining conditions; there are in China a great many mines rich with various ores, which have been locked up, undeveloped, these thousands of years; with the opening of these mines, China would become a great factor in the world's ore market. And I confidently look forward to this happening in the not far distant future.

China is to-day in a more important position than ever by reason of the war. Her commerce has been increased to a great extent by reason of the war conditions. American merchants were forced to look to the Orient for many lines which they had heretofore got from Europe, and they also looked to the Orient for a market for many of their products which had heretofore been sent to Europe. Prior to the war, German trade in the Orient had been developed to a great extent. But to-day all German interests have gone, for we have driven the Huns out of business in China. You can therefore very readily see that this is the chance for Americans to expand your trade in the Far East for the replacement of the Huns. Truly, indeed, China, after the war, should experience a great business and scientific awakening if American business men and capitalists will but turn their attention to its resources. If your goods are being shipped there, it will then be but natural that you will give the country of China some thought and will begin to realize the possibilities contained within its boundaries.

China herself is in a position of being self-supporting, with which advantage she surely should build up all varieties of home industry. Yet she has not been able to show great achievement. Why? She needs expert guidance and assistance. She is looking for financial support and enterprising cooperation from her economic Allies, especially from the United States—a country that has such a splendid record for fair dealing with China in the past. We are not selfish nor do we desire to monopolize our home industrial activities. Our door is wide open. We are welcoming foreign bankers, capitalists, manufacturers and mechanical and scientific experts—especially those from America.

You will appreciate from what I have now said, that it is my belief that the future prosperity of China after the war depends to a great extent on the help she will receive from America. But I want to call your attention to this: The help she will receive will result in mutual benefit to both countries. The merchant in China will receive benefits, but equally, if not more so, will the merchant in America.

The next important consideration which will tend to make a great and prosperous nation out of China in its after-the-war development, is industrialism, and this I believe to be the salvation of China. Although China to-day still remains an agricultural country, she is fitted and suitable for manufacture. The reason is obvious. She possesses plenty of labor. The rate of wages in China is very low. The domestic goods now are generally hand-made, yet they are marketable in competition with foreign machine-made goods. Gentlemen, I wish to propose that American manufacturers extend their activities to the Chinese territory and obtain the advantage of utilizing the cheap labor there. Through this, the wage-earning class in China will also receive benefit, as well as the American manufacturers. China is very rich in natural resources; her raw materials are in unlimited supply. With the facilities of your machinery and the systematic management of your experts, cooperating with the benefits of our raw material, such manufacturing concerns so started in China, as I propose, no matter how large their scale may be, will be substantially conducted and turn out economic goods which will excel the world's market.

There are, at the present time, I must admit, many internal conditions which hamper China's progress. There has been for many years strife between factions of the north and factions of the south. But I am happy to say that steps are now being taken to bring this to an end, so that internal peace may reign in China. The currency and monetary questions in China have also been a hindrance to China's progress. These questions are now receiving the attention of the proper officials, who are endeavoring to map out a course which will solve this matter for China. With these internal troubles out of the way, and with your trade embargoes removed, as will no doubt come about in a short time, and with an increase in ocean tonnage which will without question come about after the military needs of the Allies are settled, I believe that China's future prospects for after-the-war development are exceedingly bright and that she can look forward to an era of prosperity. Her students are rapidly finishing their studies at your colleges and are returning to their home-land to take up the work there awaiting them—and there will be plenty for them to do. With trade properly developed, and her manufactures increased, China will then be ready to take her place among the nations of the world as a dominant factor.

In conclusion, let me invite you one and all to visit our country and see for yourselves what we have there. We will welcome you and endeavor to make you feel at home. Let industrial and mercantile commissions be sent from this country to report to the merchants, manufacturers and capitalists here what a grand opportunity awaits America for trade with China. We want your help in China; yes, but remember that in return we can give you large financial reward for such assistance. I sincerely hope that in your own after-the-war plans you will see the opportunities awaiting you in China and plan accordingly. Success and prosperity for China after the war would then be doubly assured.

THE FUTURE OF RUSSIA

By JEROME B. LANDFIELD

RUSSIAN ECONOMIC LEAGUE

THE future of Russia is a large topic. I shall be pardoned, I am sure, if I make the excuse that the time at my disposal is inadequate for a satisfactory treatment of it. But I will be frank and say that had I any amount of time I should not be willing to indulge in prophecy with any degree of confidence.

Nevertheless, it is possible to examine the materials at our disposal and trace some general lines of development in Russia that point to the probable course of events. To get a correct basis for our observations it is necessary to put aside certain prejudices and to throw into the discard a mass of misconceptions.

The prejudices are largely the result of ideas concerning Russia that were fostered in this country before the war through giving entirely too much credence to fugitive Russian revolutionists and to sensational journalists, and of our failure to realize the great part in the war played by Russia. It has been too easy for the average man to regard Russia as a traitor that went back on her allies, and forget that for two long years

Russia bore the brunt of the war and saved Europe at a cost of more than nine million casualties, and that she succumbed from utter economic exhaustion and German intrigue.

The Revolution was hailed in America as the dawn of a new day. As a matter of fact it was a violent disorganization of national life at a time when there were no constructive forces ready for the task of rebuilding the structure. The developments that took place were not unexpected to those who knew Russia.

In reality the revolution did not go very deep. The importance of its successive steps and currents has been greatly exaggerated by observers whose perspective has suffered from being too close to the stirring events in the large cities and from lack of experience in Russia in peaceful days. To the world at large Russia has appeared to be one vast chaos, aimless and hopeless.

To understand Russia you must visualize the people as being divided into two general classes: the minority dwelling in the cities and along the railroads; and the vast majority of agricultural peasants living away from these lines of communication, and therefore inarticulate. The former class includes both the "intelligentsia" and the industrial population. These are the people affected by the revolution, who participated in party struggles, who were demoralized by socialistic theory. These are the people whose voices we hear, whose ideas we interpret as the opinion of Russia.

The vast mass of the people, eighty per cent. or more, are silent. They do not know what the revolution is all about. They were disturbed, to be sure, by the land question and indulged in agrarian disorders, without however improving their situation or being brought into relationship with any of the political currents of the cities.

The character of a people, its ideals, its religion, its habits of thought, are not changed in a day or a year. Here we have a hundred and fifty million people, homogeneous, speaking the same language, having the same culture, professing the same religion. They have the conservatism of an agricultural population. Is it conceivable that they have suddenly undergone a complete transformation because little groups in the cities have been talking loudly about their various political programs?

This gives us a starting point for considering the probable course that events will take in Russia to-day. The people in the cities are starving; the peasants in their villages have food. Thanks to Kerensky and Lenin, industry is dead. The goods which the peasants need are not forthcoming. Economic life is at a standstill. The money which is being printed off at the rate of four bililons a month is valueless. The peasant hides his food and stands in fear of Red Guard requisitions. What is the result?

The peasant psychology is simple. He sees only two things: the old régime and the present anarchy. Under the old régime life was possible, he remembers its joys and forgets its hardships. In the present anarchy, life is unendurable. Such words as "democracy," "republic," "soviet" mean for him only tyranny and utter disorder. His whole tendency to-day, therefore, is toward reaction. It is most significant that for months the peasants in various parts of Russia have been sending delegations to the towns to seek out the landowners and beg them to return and take back the estates from which they had been forced to flee.

Now look at this tendency in its larger significance; in its bearing on the international situation. Russia is coming back —of this there can be no question. Nothing can prevent her people from again attaining a strong national existence. Leaders will be found, armies will be formed that will clean the canker out of Moscow and satisfy Russian national aspirations. Who the men will be, we do not know. But men will be found. It may take months or it may take years. Suppose then that the Allies and America continue their policy of inaction, merely standing by and waiting for Russia to work out her own destiny without assistance.

Almost inevitably there will result a military dictatorship, and then a powerful, reactionary autocracy. That autocracy will not only guide the destinies of all these millions of people, but it will dispose of an enormous area of undeveloped natural resources, comparable to the American continent of a century ago; wheat, cotton, iron, copper, gold, oil, coal and forests. The Russians will hate the Allies and America, for they will recall the sacrifices they made for the common cause and that, when they were in trouble, they called for help in vain. They will snap their fingers at any arrangements made for them at the Peace Conference, arrangements in which they had no hand, and neither Europe nor America will undertake a fresh war to coerce them.

Worse than this; it will be German brains that are employed in the tasks of reorganization. Your German engineer and business man will not wish to remain in Germany, where there will be a lack of opportunity and heavy taxation. He will find other lands closed to him. But the autocratic power in Russia, needing such ability in its work of reconstruction and in the development of resources, will turn to the German and open the wonderful field to him. Can you not picture the result?

Such is a view of the future of Russia if present tendencies are allowed to develop unguided, undirected. The situation is bad, but not hopeless. Quick, sagacious action may save it. The Russian situation is the key to the whole international situation, and upon its solution depends the durability of the peace to be made at Paris. Therefore it demands inter-Allied unity of plan no less than did the conduct of the war on the western front. The Allies must work through Russians; not through Russian politicians, but through the patriotic men who have been gathering together the forces of loyal soldiers to fight for the recovery of their land from the hands of the looters and plunderers. Quick support in money, arms, munitions and economic aid to these leaders will not only enable them to restore order and save Russia, but will also earn Russian gratitude and give us some voice and guidance in the formation of the government that is to come, and avoid the grave danger that would otherwise threaten the peace of Europe. This is no time for petty questions of non-interference or theoretical democracy; it is a matter of self-preservation for Europe and for ourselves. It is up to us to say whether we shall grasp the opportunity and do our duty, or whether we shall by inaction and academic haggling, take upon ourselves the full responsibility for another catastrophe.

GERMANY AFTER THE WAR[1]

By Dr. DAVID JAYNE HILL

LATELY AMBASSADOR TO GERMANY

IN accepting an invitation to speak of "Germany after the War," I feel constrained to say, that I should consider it adventurous for me, not being inspired with the gift of prophesy, to predict the condition of Germany when the war is really over; which, of course, will not be until a treaty of peace is signed.

The state of mind and the political situation in Germany when the conditions of peace have been imposed and must be executed, will perhaps be entirely different from what they are to-day. At present, Germany, virtually reduced to military impotence, is seeking to procure for herself the most favorable possible terms of peace. When the terms of settlement are finally made known to the government, they will probably appear to them far less advantageous than those which they have been inclined to expect.

The peace to which Germany was looking forward at the time the armistice was requested was expected to be arrived at by a process of bilateral debate on the meaning of the fourteen rubrics of discussion proposed last January by the President of the United States. Those rubrics, as then understood, were so broad in their scope and so indefinite in some of their applications, that it appeared possible to interpret them in such a manner as to procure for Germany a peace that would, in effect, be a greater victory than the German armies could ever hope to secure by war. The policy that was then adopted and is at this time dominant in the German mind is an effort to obtain an economic victory at the cost of a military surrender,—an economic victory which would completely justify an acknowledgment of military defeat if it could be secured by the acceptance of the German construction of the fourteen rubrics considered as the terms, and the only terms, of peace.

It is needless here to discuss the conflicting interpretations of which these rubrics seem to be susceptible. It is sufficient to note that they are held to provide for the following privileges which, after peace, Germany, equally with other nations, might be permitted to enjoy, under the protection of "mutual guarantees of political independence and territorial integrity" provided by "a general association of nations":

1. Absolute freedom of navigation upon the seas, alike in peace and in war.

2. The removal of all economic barriers, and the establishment of an equality of trade conditions.

3. Free and open-minded adjustment of all colonial claims, unprejudiced by the actual results of the war.

4. Entire national self-determination, which would logically include perfect freedom in choosing and maintaining a future form of government.

5. Admission on equal terms into a general league of nations.

A peace based upon these conditions, and involving only the surrender of what Germany had no claim to before the war, would render her not only a victor in all the substantial elements of victory, but would leave her in population the largest political unit on the continent of Europe, with a clear accession by union with Austria of more than eight million of the Teutonic race; and, after extruding some four million of her present subjects belonging to other races, would give her a net gain of some four or five million souls and a considerable amount of new territory. When the peace was signed, the zone of occupation evacuated, and the occupying troops demobilized, Germany, whether a republic or a monarchy, the choice being freely open to her, with untouched economic resources and organization, no matter what proportionate disarmament might be imposed, would be by far the strongest military state in Europe. She would possess racial unity, territorial enlargement, economic preeminence on the continent, and military security. Even though she had not been defeated in the field, that peace would be an advantageous one for Germany to make, a more satisfactory one indeed than she could ever hope to win by the victory of her armies on the field of battle.

How then has Germany hoped to secure such a peace?

The course of procedure was clearly marked out for her. Such a peace could never be made with the kaiser as the head of the empire. That had been plainly declared. What, above everything else, was demanded of Germany was that she should repudiate her Hohenzollern dynasty and take her place among the nations as a free, self-governing people; for a "people," it was assumed, when it takes government into its own hands, is always just, honorable and trustworthy; while rulers alone are untrustworthy and in reality not to be held responsible. Let the rulers and the military caste, therefore, be repudiated, and peace would be easily obtainable.

What nation, weary of a fruitless war, seeing its army, after a supreme effort to break through the enemy's reinforced lines, steadily and inevitably retreating, its territory about to be invaded, its cities bombarded and assaulted from the air,—what nation, I say, could be expected to miss such an opportunity to make a profitable peace?

Germany was too prudent to lose such a chance of advantage. The kaiser's own appointed imperial chancellor, accountable only to him, therefore, asked for an armistice, in order that such a peace might be negotiated.

"Who are you, who ask for an armistice, with a view to peace, and whom do you represent?" was demanded of the imperial chancellor. "Do you speak for the German people?"

The imperial chancellor is silent. How could he speak for the German people, with whom he had nothing to do, and to whom he is not responsible? The answer must be better staged.

It is a new officer, therefore, the representative of what poses as a new government, the secretary of state for foreign affairs, who responds to the question addressed to the imperial chancellor and writes for him a certificate of character.

"The present German Government," he declares, as if speaking by some new popular authority,—"the present German Government, which has undertaken the responsibility for this step toward peace, has been formed by conferences and in agreement with the great majority of the Reichstag. The chancellor, supported in all his actions by the will of this majority, speaks in the name of the German Government and of the German people."

Thus, at last, the long-silent "German people," the presumably just, honorable and trustworthy German people, who were assumed not to be responsible for the war, but rather the victims of a false and shameless autocracy too infamous to be dealt with, have, it is made to appear, really spoken! They have spoken, however, only through the voice of a "great majority of the Reichstag,"—a body which from the beginning had with unanimity supported the war and all its atrocious procedure; a body which only for a moment found a voice with which to speak the mind of the people, and having been for that one moment indistinctly vocal, has since subsided into the silence of the grave! If the German Reichstag really represents the German people, why is it not, in this great emergency, at its post of duty now?

Germany, in this fateful hour, seems to prefer to have no responsible government. Is it because it is more difficult to hold accountable, and on that ground to condemn and punish, a nation without a responsible government than a nation which can be on specific charges indicted and arraigned for its past misdeeds?

Say what we will of the kaiser's personal régime, it was at least one which, whether trustworthy or not, could be held accountable for its crimes. But the kaiser's government is alleged to be no longer in existence. In order that it might disappear, he was urged to abdicate. He professed to have done so, and went to Holland. Germany appeared satisfied, but the outside world demanded the evidence of his abdication; and it was not until nearly a month after his retreat that, in order to satisfy foreign demands, on the 29th of November, a document was finally signed by the alleged ex-kaiser.

The reason for his withdrawal from Germany William II. has himself frankly stated. "I go to Holland," he is reported to have declared, "in order to facilitate peace"; and no one has contradicted this statement of why he was going. The German people, it seems, when the kaiser's armies were beaten in the field, suddenly wished him gone, sent forth, as it were, like the "scapegoat" of ancient times, into the wilderness, not because his people hated him or considered him an arch-criminal, not because they themselves wished to destroy him—as they had, and still have, an opportunity to do—but because it appeared that he might be laden with their sins, and his going with this burden would "facilitate peace" by consigning responsibility to the wilderness of oblivion.

And why was it supposed that his going would facilitate peace? Was it because an irresponsible nation can demand easier terms than a responsible ruler?

The "people of Germany" seem to be pleading at the judgment bar of history, and preparing to say at the peace table: We demand peace because we are an innocent and a defenseless people. First of all, we are a "people," and how can you punish a whole people? Has it not been said that there is something sacred and sacrosanct in a "people"? You are trying "to make the world safe for democracy." We are now a democracy. See, we have dismissed the kaiser! We shall have no more of him. Have mercy upon us, kameraden! We accept all your glorious democratic principles. Now, undoubtedly, you are ready, since you would make the world safe for democracy, to make our democracy an asylum of safety for us!

Here is a change of plan, but is there any change of heart, behind these pretensions? Have all Germans, or most Germans, suddenly become social democrats, clamoring for a socialist republic? Where are all those millions of troops? Where are all those hundreds of thousands of officers, those Prussian generals who are said to have made the kaiser declare war? Have they gone to Holland? Only a few of them. The vast majority, armed, organized, waiting for a word of command, are in Germany; and they are silent, as silent as the Reichstag. Why are they silent? They are silent because silence is the order of the day, a token of irresponsibility and acquiescence in a new order of things. They are waiting to see if an economic victory can be won. If it is won, they will have their reward. If it is not won, they will have something to say in the future when the peace is concluded, and is yet to be executed, when the allied armies are demobilized, and when the rest of Europe has gone to sleep.

There was no revolution in Germany before the armistice. There has been hunger, there has been weariness, there has been joy at the cessation of battle, there has been a vision of peace, of comfort and tranquility. There has been also an emergence of bolshevism, the weapon which Germany skillfully forged and thrust into the vitals of Russia; but Germany expects to receive no serious wound from this weapon. There is, I think, no real revolution in Germany now, no movement beyond street fights and bread mobs, such as may occur in any city when the conditions of life are hard and when the passions of low-browed men are for a time let loose. The Councils of Workmen and Soldiers solemnly infest the Herrenhaus under the protection of a machine-gun; but the generals know that at any moment in Germany they could make short work of all this assemblage of the rags and tatters of bolshevism. But the time is not opportune. The disease of bolshevism, in so far as it is a social malady, may safely be permitted in Germany to run its course. It illustrates to the middle-class what the dangers of democracy may be. It shows to the world how wide the infection may become, if peace is not quickly made. It presents to the Allies the puzzling problem how to obtain redress from a people who disavow accountability and are too broken and disorganized to enforce the duties of a responsible state.

How real is a revolution when the domestic courts are in session, when the bureaucracy is administering affairs, and when life and property are not in great immediate peril? The Germans are an exceptionally orderly people. Their demonstrations are customarily innocuous. Their habits of life are prudent. Their burghers are not stricken with poverty, and their proprietors, accustomed to the use of arms, are able to guard, and are determined to defend, their own material interests. When a real revolution appears, if it does appear, they will unite their forces and rally to their own protection. What they wish at present to exhibit to their conquerors is a starving population incapable of bearing new burdens, an unsettled public order that may prove a contagion to their neighbors, an effort for democracy that will be an apology for the past, and above all a situation which will excite the sympathy of the credulous and the support of class interests of a revolutionary temper in the population of those countries which they would represent as their oppressors for capitalistic gain.

You wish the evidence of this? Then listen to the speech of Hindenburg to his army, on November 13 at the moment when he had decided that it was an economic rather than a military victory for which Germany was to look. Does he pretend that he or they had fought under autocratic orders? Does he confess that the course of Germany was wrong? Does he call for a change of heart, or merely for a change of policy? He says:

> Germany up to to-day has used her arms with honor. In hard fighting the soldiers have held the enemy away from the German frontier in order to save the Fatherland from the horrors of war. *In view of our enemies' increasing numbers and the collapse of our allies and of our economic difficulties*, our government was resolved to accept the hard terms of the armistice, but we leave the fight, in which for more than four years we have resisted a world of enemies, proudly and with heads erect.

If we turn to what calls itself a government of democracy, what do we hear from the alleged premier, Ebert, when he welcomes the troops coming home in Berlin? Does he repudiate the purpose of the war? Does he inform the returning soldiers that they have made useless sacrifices, or have been engaged in an unworthy cause, at the command of an autocracy in whose downfall they should rejoice? Tens of thousands of men march by, still bearing their arms, filing between other tens of thousands of people who are supposed to have made a revolution, who welcome them as joyful spectators, the troops laden with garlands, as they tramp on to the loud blare of bands of music intoning, "Deutschland, Deutschland über Alles."

> Your deeds and sacrifices are unexampled. No enemy overcame you. *Only when the preponderance of our opponents in men and material grew ever heavier did we abandon the struggle.*
>
> You endured indescribable sufferings, accomplished incomparable deeds, and gave, year after year, proofs of your unmistakable courage. You protected the homeland from invasions, sheltered your wives, children and parents from flames and slaughter and preserved the nation's workshops and fields from devastation.
>
> With deepest emotion the homeland thanks you. You can return with heads erect. Never have men done or suffered more than you.

Is this a proclamation of democracy? Is the world to be "made safe" by this adulation in a career of national crime? What can be said after this to the heroes who are told that in serving the kaiser they were nobly defending the fatherland, if for this glorious service they are asked to toil in the field and the workshops to pay for the damage they have done to Belgium, to France, to Poland, and to other lands which they have, without just cause, ruthlessly invaded and cruelly devastated? Can they be urged to make reparation? Or will they think it unjust that, having suffered so much in a cause so noble, they must be treated as if they were the perpetrators of outrages for which they, their children and their children's children must be held accountable?

Here is no note of penitence or contrition. It is the same Germany, speaking with the voice of Hindenburg and Ebert, which accepted the kaiser as its glorious war lord, that believed, or professed to believe, in the divine right of conquest, and threatened innocent nations with the extortion of enormous indemnities, covering not only the total cost of their exploits, but sufficient to enrich the nation and render it the most opulent in the world.

The attitude of Germany in accepting just conditions of peace will be the test of the character of the German people with whom in the future other nations must live and deal. The first necessity to a recognition of reformation is the disposition to repay, in so far as that is possible, at whatever sacrifice, the damage they have inflicted. If exemption from this obligation is claimed on the ground of irresponsibility, it will imply a degradation of character as deep as that evinced by the predatory enterprise in which all Germany was to profit by collecting the costs of the war from its innocent victims.

Without reparation for the injuries inflicted, there can be no real peace. The example of such an unpunished exploit would remain as an encouragement to future crime.

Will the German people, whose sense of justice, honor and moral obligation is soon to be put to a crucial test, voluntarily accept the burdens which a just peace will impose upon them? If not, what confidence can be placed in the proposal to make the world safe for democracy, and what will be the world's judgment upon the ethical standards of democracy itself? We shall soon learn from the conduct of Germany, now speaking only through a mask of democracy, whether or not we are to ascribe all the enormities of the war to the depravity and malevolence of her rulers, against whom, until the moment of defeat, the people offered no protest; and whether or not a people, left free to express its own character, will accept the burdens of an act of justice.

On account of the Great War, in which their duty rendered it necessary that they should participate, the people of the United States of America have not only freely offered to the cause of justice the lives of tens of thousands of their sons, but have paid, or will have paid probably over thirty billion dollars, which they have not yet demanded should be returned to them. The whole expenditure of the war, considered merely as a matter of monetary sacrifice, is said to exceed two hundred billion dollars; and yet this gigantic sum, which it will require generations to make good, is one of the least and one of the most easily repaid of the damages inflicted by this assault upon humanity.

In what light do the German people look upon their duty in this matter?

There is in Germany no more keen and frank exponent of the real purposes of Germany than that *enfant terrible* of journalism, Maximilian Harden. "No state," he says, "that was snatched along into this flood of the deluge can expect other indemnity than those which can be effected by thrift and savings," which, he points out, must be the effort of each people for itself. There are to be, then, no indemnities, paid by Germany. He says:

> Taxes and customs duties that would yield even the interest on the tens of billions of debt would necessarily paralyze trade and industry in competition with America, Australia and the Yellow World; would necessarily grind to bits the idea of private property. . . . What then shall happen? Something that has never happened before. . . . Let Europe's war debt become a treasure of atonement. Let the war loan certificates of all the European states that have participated in this war . . . serve as legal tender, guaranteed by all debtors; a form of money which in every land that is subject to the jurisdiction of the arbitration court must be accepted in payment in any transaction and by any creditor at its full face value!

Thus all the national war debts, Germany's included, it is proposed, should be pooled in one great "peace fund" and placed under a central control to prevent the outbreak of future war! "The court of the nations," so runs the scheme,—"serves as trustee of the treasure, and sets aside therefrom in equal parts out of the certificates of indebtedness of all the states what it needs for itself and its militia." It may punish disobedience of its judgments in the case of any individual state by means of a money penalty, declaring valueless all the circulating certificates of that state, calling them in, or destroying them, in the case of any state that breaks the peace without previously being itself bodily and vitally threatened. "Here," this writer continues, "is where a community of European citizenship beckons us. Thus the continent would be delivered from its money stringency; . . . thus it would gently be obliged to bury quickly and deeply the useless reminders of futile conflict."

It is time for Germany, if she would ever regain the respect of mankind, to dismiss such fantastic illusions as these, and to take up the burden of national responsibility in a serious sense. Let her, first of all, establish a government that will admit the responsibility of the nation for the past, and with which it is possible to deal. Then let that government assume and enforce those obligations which a just peace will certainly impose upon the German nation; not forgetting that the greatest possible calamity to mankind would be to write into the law of nations, by absolving the German people from complicity in a national crime, the ruinous principle that a people is not responsible for the government it supports, and that it may therefore exempt itself from merited punishment by merely changing its form of government.

Has Germany the character to stand this test. When she has proved her ability to do so, then, and only then, can there be a possibility, when years of fidelity have established her good faith, of admitting her to a place in a league of nations. If those who are gathering to conclude peace now cannot enforce that judgment, then it is more than futile to hope to do so in the future; for the contingencies of such a future would be simply appalling to contemplate.

SOME AGENCIES IN THE DEVELOPMENT OF CLOSER RELATIONS WITH THE COUNTRIES OF CENTRAL AND SOUTH AMERICA

By Dr. L. S. ROWE

ASSISTANT SECRETARY OF THE TREASURY AND SECRETARY-GENERAL OF THE INTERNATIONAL HIGH COMMISSION

IT had been my intention to speak to you to-day on the activities of one of the agencies with which I have been closely associated and which, during the last few years, has been contributing considerably towards the development of closer relations between the United States and the countries of Central and South America. The broad scientific character of the association which is here assembled in annual meeting, leads me to take up with you some of the broader aspects of the situation which presents itself to-day as result of the signing of the armistice. You have here represented the leaders of every branch of scientific endeavor and, as I look over this assembly, I am deeply impressed with the important part to be played by men of science in the elimination of causes of international misunderstanding and in the maintenance of close and amicable relations amongst the nations of the world.

The people of the United States have given but little thought to foreign affairs, and it is a significant fact that that thought is only stirred when we are at the brink of war. All the great national slogans relating to foreign affairs have been either war slogans or phrases shot through with belligerent intent.

The time has now come when public opinion must become a far more positive and constructive factor in guiding foreign policy. We are, I believe, all agreed that unless some form of effective international organization is agreed upon at the Peace Conference, the war will have been lost. In order, however, to make that international organization fully effective it is most important that the ties that bind nations together shall be moral and cultural as well as purely political. It is through organization such as this that these cultural ties can best be developed. I hope the time will come when every scientific organization in the United States will maintain close and cooperative relations with similar associations in the countries of Central and South America. Such relationship and such cooperation when once established will not only serve important scientific purposes, but will also be important factors in bringing about closer acquaintance between large groups of individuals in various countries. Acquaintance and cooperative action thus established exert a very real influence in removing international misunderstandings and prevent the irritation and distrust which have their root in a lack of mutual acquaintance. As an instance of the possibilities of such international cooperation, I wish to present the briefest outline of organization and results accomplished by the International High Commission.

The outbreak of the war threw into even higher relief than had previously been possible the extent to which the American republics are dependent upon one another and bound to each other. The community of interest called for a unity of policy, for frequent and the frankest consultation. The Secretary of the Treasury presided over a conference brought together by invitation of President Wilson, the avowed purpose of which was to devise means of absorbing the shock of the European War and settling the economic relations of the free countries of this hemisphere upon so firm a basis that no disturbance could later imperil them. That conference, held in the third week of May, 1915, considered the chief problems incidental to closer commercial and financial relations, such as transportation, banking facilities, the uniformity of commercial law and the substantial harmony of fiscal administrative regulations. With a view to enabling its recommendations to be carried out and to give permanency to its work, the financial conference recommended to the governments which had been represented in its sessions the establishment of a permanent international commission dedicated to the detailed working out of the questions with which the conference had dealt. A new principle was to be followed in this respect, inasmuch as the difficulties which had sprung from intermittent international meetings had made impossible any connecting and enduring international legislation. The proposal made and now successfully in operation was that there should be in each country a group of financiers and jurists under the chairmanship of the Minister of Finance, that these national sections should work for alterations and adjustments of their own respective law so as best to accommodate the needs of international commerce; that the sections or their representatives should confer in larger or smaller groups as occasion warranted; and that the work of the entire commission should be directed by a small cooperating and planning organization. This concept has been followed without any serious setback and at its first meeting in Buenos Aires in April, 1916, the commission adopted specific recommendations with reference to the major points upon its program and entrusted to a Central Executive Council, consisting of the officers of the United States Section of the Commission, the elaboration of projects, legislative or international conventions designed to give effect to these recommendations.

The commission is now successfully in operation, the chief emphasis being given to the simplification of fiscal methods and the essential harmony of the commercial law in force in the American nations. As the war has gone on, it has become more and more evident to how great an extent the peace and well-being of the future will depend upon technical legislation and economic agreement of the character aimed at by the commission. Time does not allow even an enumeration of the matters with which the commission has dealt either by way of suggestion as to alterations in national legislation or by way of international treaties. It is sufficient to say that the aspiration of the financial conference that a permanent body should be set on foot, empowered and enabled to carry out over a fairly long period a definite program of a non-political and non-diplomatic character, seems assured of fulfillment.

The International High Commission has been cited as a concrete example of the possibility of establishing close relations between national groups whose community of interest furnishes a firm basis for international cooperation. If such cooperative groups were indefinitely multiplied, it would be possible to develop international bonds so close that there would be little room for distrust, misapprehension or misunderstanding. We must recognize that the maintenance of a durable peace does not merely mean the maintenance of amicable relations between the constituted governmental authorities, but also an ever-increasing intertwining and interlocking of cultural and moral interests.

A LEAGUE OF NATIONS AS A TANGIBLE ORGANIZATION

By HERBERT S. HOUSTON, A.M., LL.D.

ON THE EXECUTIVE COMMITTEE OF THE LEAGUE TO ENFORCE PEACE

SOME thirty years ago a young Princeton bachelor of arts received from the Johns Hopkins University the degree of doctor of philosophy. Last week, in the old University of Paris this scholar, acclaimed as a world statesman of the first rank, received the highest degree of that ancient seat of learning, and, in acknowledging the academic honors he envisaged, in eloquent phrase, what has come to be the hope of the world—a league of nations. His conception of such a league, he said, was that it should operate as the organized moral force of the world. The subject that I have been asked to present to the American Association to-day is such a league, as a tangible organization. In responding to the request, let me say, at the outset, unless the League of Nations is a tangible organization, vigorous, effective, powerful, it will be but another foray in idealism, a filmy day dream in the land of mirage. As a distinguished jurist of the Netherlands, M. Asser, said in the Hague Conference of 1907, in speaking of the Permanent Court of Arbitration: "Instead of a Permanent Court the convention of 1899 gave only the phantom of a court, an impalpable specter." In the eleven years that have elapsed since 1907, four have been given to the most distructive of wars and the world is in a far less friendly mood to-day for phantoms and specters than it was in 1907.

There are those who express the fear that the President of the United States, the scholar honored by Princeton, Hopkins and the Sorbonne, is in favor of an academic ideal, rather than a practical one. But personally I am unable to share that view. It is not reasonable to suppose that the President has crossed the seas to urge the formation of a moral entente that shall satisfy itself with mere pious aspirations. He could not have traversed, this Christmas week, the devastated wilderness that was northern France; he could not have spoken to the victorious armies of the living or seen the silent camping ground of the great armies of the dead, and then ask the world to safeguard itself against the barbaric thrust of some future Germany with an armament of fine phrases and a league of nations held together by a rope of sand. That is not only unreasonable, but unthinkable. In seven of his fourteen points the President supports a league of nations with power to require covenants and to enforce guarantees. Ex-President Taft, who has heartily endorsed the President's attendance at the Peace Conference has recently done Mr. Wilson the further service of calling renewed attention to this fact.

In the second of the fourteen points, it is said that the high seas may be closed only "by international action for the endorsement of international covenants."

In the third point equality of trade conditions is to be required "among all nations consenting to the peace and associating themselves for its maintenance."

In the fourth guarantees are to be "given and taken that national armanents will be reduced to the lowest point consistent with domestic safety."

In the eleventh it is provided that "international guarantees of the political and economic independence and territorial integrity of the several Balkan States should be entered into."

By the twelfth it is enjoined that "the Dardanelles should be permanently opened as a free passage to the ships and commerce of all nations under international guarantees."

In the thirteenth it is required that Poland shall be secured "a free passage to the sea," and "political and economic independence and territorial integrity should be guaranteed by international covenants."

In the fourteenth it is said that a "general association of nations must be formed under specific covenants for the purpose of affording material guarantees of political independence and territorial integrity to great and small States alike."

Manifestly a league of nations able to perform such functions and to secure such results must be a tangible organization. A convention to establish such a league has been drafted by a group of able jurists and publicists, headed by a distinguished citizen of Batlimore. The Honorable Theodore Marburg. And a general plan for such a league has been adopted by the League to Enforce Peace within the past few weeks. As this plan is probably the most definite that has thus far been formed I shall undertake to describe briefly some of its most salient features. To begin with it proposes a league that shall have the organization requisite to safeguard the world's peace and to perform the work of the world that needs to be done internationally. It provides for legislative, executive, judicial and administrative agencies. These are to be parts of a tangible international roganization. It is proposed that these parts shall be operative continuously, making of the league a going concern to render service of such value that membership in it will be sought and prized. Consider for a moment the dozen new nations that are to be formed at the Peace Conference. Clearly they can not be left to shift for themselves, any more than Cuba could after the Spanish war. Their formation creates the responsibility of studying and guiding them and that is an international job that must be done internationally by a League of Nations. The plan of the League to Enforce Peace recommends:

> An administrative organization for the conduct of affairs of common interest for the protection and care of backward regions and internationalized places and such matters as have been jointly administered before and during the war. We hold that this object must be attained by methods and through machinery that will insure both stability and progress, preventing on the one hand any crystallization of the status quo that will defeat the force of healthy growth and change, and providing on the other hand a way by which progress may be secured and the necessary change affected without recourse to war.

And further recommendations in the plan, in addition to courts with the combined economic and military power of the league behind them, call for a representative congress to formulate and codify rules of international law and "an executive body, able to speak with authority and to act in case the peace of the world is endangered." Of course, this plan has not presumed to work out all of the details of these various international agencies for that is the task of the Peace Conference. But it does boldly propose and provide for a tangible organization that shall undertake to safeguard peace and do the international work the world has to do? Much of this work is a direct outcome of the war. It is an essential part of the victory of democracy.

If Jefferson was right in putting into the forefront of our Declaration that all peoples have "certain inalienable rights" such as "life, liberty and the pursuit of happiness"—and we believed that so stoutly that we sent two million men across the ocean to fight for it—then the peace to be established must make these rights secure for all nations, small and great. And it is manifest that among these rights are the fundamental commercial rights of access to the sea and access to food and to basic raw materials. Without these rights no nation can, for long, have life or liberty or happiness. If these rights, particularly for the new nations to be formed, are to be granted and guaranteed, a league of nations must have some clearly defined and adequately equipped agencies for these purposes. Happily these are already in existence—at least in part—in connection with the Supreme War Council at Versailles. The

International Shipping Board offers a good illustration. Then the urgent need arose for getting our army to France with the utmost speed, the Shipping Board saw to it that 60 per cent. of the vessels needed were obtained from the merchant marine of Great Britain. The important matter of getting food both to the armies and to the non-combatant among the Allies was taken care of by this International Shipping Board. Had it not been for the effective way in which the board used the available shipping facilities of the Allies, it is difficult to see how the war could have been won. Now some such International Shipping Board, as an agency of the League of Nations, could see to it that basic raw materials, which had been allocated among the nations by an International Raw Materials Board, were speedily and effectively distributed. Through these two boards, as adjuncts to the League of Nations, the administrative work of insuring nations access to the seas and to a proper proportion of raw materials could be provided for.

An International Clearing House has been proposed as an essential piece of machinery for the service of commerce in any world organization that would follow the war. An able Chicago banker, John J. Arnold, a man who is considered a master of international exchange, has long urged the desirability of such a clearing house. It could settle balances between nations just as our modern clearing houses now settle balances between banks in the cities in which they are located. When George B. Cortelyou was Secretary of the Treasury in President Roosevelt's Cabinet, he proposed that International Gold Certificates might be secured by gold deposits made by the various commercial nations and that these certificates could be used in settling trade balances, thus avoiding the delay and danger of transporting the actual gold. The Federal Reserve Banking System might serve as a model for an international banking system to accomplish the purpose which Secretary Cortelyou had in mind. If this took the form of an international clearing house, in which each nation should make deposits of gold, in direct proportion to the volume of its foreign trade, it is manifest that a piece of powerful international machinery would be established that could perform prompt and important service for the League of Nations. As an illustration, if a nation sought to make war in defiance of its pledge to seek adjudication of its differences before the courts of the league, it would as an automatic penalty, forfeit its gold deposited with the International Clearing House and also its trade rights and privileges as a member of the League of Nations. The procedure and penalty would be similar to the suspension and expulsion of a member from the Stock Exchange. Such a clearing house, therefore, would be an agency to aid in preventing war, and, what is of greater importance, it would be a powerful agency to aid in promoting peace; and that is true of all the other international commercial agencies that might develop in connection with the League of Nations. Their advantage would be so great—in fact so vital—to every nation that it is hard to believe they would be surrendered except as a final resort in a desperate situation.

An international food board—such as the one Mr. Hoover and the Food Controllers of the Allied Nations have virtually constituted, might be an essential part of the League of Nations. Its existence would be based on the broad humanitarian ground that the world must be fed. It appears that all the civilized parts of the world now believe that this is adequate ground for international action, and if it be once conceded that the duty of feeding the world rests upon the world as a whole, then it is clear that this duty can be discharged, much more fully and much less expensively, through a shipping board acting for the League of Nations than by the independent action of nations separately. Associated with the board could be the International Institute of Agriculture, which was formed at Rome some years ago by Mr. David Lubin and which had begun to render a service of the most far-reaching value to all countries, when its work was interrupted by the great war. And associated in this same field, although occupying more distinctly a field of charitable service, should be an International Red Cross. This organization under the Geneva Convention sprang from the impulse that the human service of succor in emergencies should pay no heed to national boundary lines. This has continued to be the fixed policy of the Red Cross, although for organization purposes it has established itself in many countries and limited itself to their geographical boundaries, but this international war has thrown into such high relief the international character of Red Cross service it would seem to be a natural and inevitable development that the organization should become avowedly and definitely international.

It is not improbable that an International Chamber of Commerce might become an essential factor in the League of Nations. In some countries the Chambers of Commerce have official status and connection with their respective governments. And whether they had such connection or not they could become a powerful agency for mobilizing good will among the nations, by the accepted give-and-take spirit of business, by the development of an established policy of fair dealing, under which trade discriminations would disappear, and by consciously weaving the bands of commerce into bands of peace.

Such an International Chamber of Commerce is already in existence, and it had a largely attended convention in Paris in the summer of 1914, shortly before the war broke out. The Chamber of Commerce of the United States has appointed a committee "To make a study of the question of the reconvening of the International Congress of Chambers of Commerce at the earliest time that it is judged expedient." Edward A. Filens, of Boston, who was a member of this committee not long ago expressed in this fashion what is doubtless the general view of American business: "It will not do to leave to traditional diplomacy and to ever-changing cabinets and governments alone the handling of those business difficulties which will menace the successful conduct of international trade and threaten the durable peace of the world." The Chamber of Commerce of the United States, representing the organized business of the nation, is squarely behind the proposal for a League of Nations and will unquestionably support the creation of international agencies that will make the league effective.

Of course the Postal Union is already an international organization. It would naturally be taken over by a league of nations. The controlling idea in the organization of the new world is interdependence and the essential factor in interdependence is communication. Following the post, by ship and coach and train, came the telegraph by land and sea, the telephone and then, as a capping achievement, the wireless. With these distributive means of communication the productive means also multiplied—the printing presses, typewriting machines and all manner of mechanical devices—and all these means of quick communication have geographical boundaries no more than have the winds of heaven. Their control must be international and the Postal Union is undoubtedly capable of important developments.

The cables in particular offer a field for international development of the most far-reaching character. Great Britain has demonstrated the incalculable service and value of using them for quick and cheap communication. Through her control of cables she has held her far-flung empire in the mighty mesh of friendly understanding—the most powerful bond of union the world has yet discovered. And a league of nations, made up of self-governing democracies, will surely find, as in the past, the cable and the wireless, agencies of tremendous power in weaving that fabric of common understanding that will be a sure basis of peace. This international power of quick communication might well be likened to the force of publicity the President had in mind at the Sorbonne, when he said:

> Just a little exposure will settle most questions. If the Central Powers had dared to discuss the purposes of this war for a single fortnight it never would have happened; and if, as should be, they were forced to discuss for a year the war would have been inconceivable.

One of the strongest arguments for these various international agencies, as I have pointed out, is that they are essential to enable the world to do the international work that must be done. But the very doing of this work, as part of an organized League of Nations, would lessen the danger of war and be preventive in the best sense, by removing the causes of war. That is only one of the essential purposes which the organization of these various international agencies would accomplish. Another great purpose would be the use of these agencies in developing and applying economic pressure as a sanction to place behind the world courts which a League of Nations would establish. If the members of the league realize that they would at once forfeit the incalculable service which these agencies would render them the moment they undertook to go to war rather than to courts for the adjudication of their differences, it is reasonable to believe that they would go with their differences to courts. If they failed to do so the economic pressure that could be at once applied would prove practically irresistible. This is not the ordinary trade boycott and must not be confused with it. Instead a nation would be bringing economic pressure upon itself by breaking its pledge to other nations and thus forfeiting its standing and membership in the league. Among other things it would forfeit its free use of the seas. Right here is a limitation in President Wilson's announced view in regard to the freedom of the seas that is often overlooked. In his oft-quoted statement of the war aims of the United States, made in an address to Congress, January 8, 1918, he declared that one of our aims was "absolute freedom of navigation upon the seas, outside territorial waters, alike in peace and war," and then he added this significant qualification "except as the seas may be closed in whole or in part by international action for the enforcement of international covenants." This exception offers a wide range for the effective employment of economic pressure. The seas are the great highways of commerce. In times of peace they are open to the commerce of the world, but a League of Nations, in spreading its control over the seas, could properly limit their use to the nations that observe the rules and regulations of the league. During the war the seas have been closed in whole to the commerce of Germany, through the international action of the Nations of the Entente; and this action was taken in order to enforce "international covenants" because of treaties broken and public laws spurned by Germany and her allies. The result was economic pressure of the most drastic character. The ocean-born commerce of the central nations was not merely reduced but destroyed. Their ships were interned in hostile ports throughout the world and these, of course, were all actions of war in time of war. Manifestly, should the freedom of the seas be abridged by the joint action of a League of Nations to enforce "international covenants" against the nation that had broken a covenant, the resulting economic pressure would be of overwhelming severity. No nation, however powerful, could withstand it for a long period; especially when many kinds of economic pressure were being applied at the same time through all the other international agencies that have been described.

It would appear therefore that the doctrine of the freedom of the seas is really merged in the larger proposal for the organization of a League of Nations and Earl Grey of Falloden, together with other English statesmen of authority, has made statements which indicate that this is their view; and assuredly it would seem that a League of Nations of which three such maritime powers as Great Britain, France and the United States were members—nations that have fought in a common cause to gain the victory over autocracy—might be entrusted with the international control of the seas.

The organization and control of the international work of the world by a League of Nations would make the league, from the beginning, an instrumentality of service which would gain for it respect and power. The inherent weakness of the Hague conventions, as all the world now agrees, was that they were not supported by any international organization having the power to give them effect. This weakness should not mark the league to be formed at the Peace Table. Instead it should be given the power to work surely and steadily toward peace, by lessening the causes of war. This, in the fulness of time, will result in a world accustomed to the orderly processes of peace and accustomed to the orderly processes of law, as developed in world courts. That is a great dream—but it has possessed the mind and heart of the free peoples of the world and they long to have it come true.

THE WORK OF THE DEPARTMENT OF LABOR OF THE UNITED STATES DURING THE WAR

By LOUIS F. POST

ASSISTANT SECRETARY OF LABOR

THE Department of Labor is the youngest of the ten executive departments of the federal government. It was carved out of the Department of Commerce and Labor by an act of Congress approved by President Taft on the 4th of March, 1913. President Wilson immediately appointed as the first Secretary of Labor, William B. Wilson, whose chairmanship of the Committee on Labor in the House of Representatives had just ended by expiration of his term as a Representative from Pennsylvania in the sixty-second Congress. The creation of the Department of Labor is for the purpose, as described in its organic act, of fostering, promoting and developing the welfare of wage-earners, improving their working conditions and advancing their opportunities for profitable employment. There is no discrimination in the act between organized and unorganized labor, although the department was created at the instance of organized labor through nearly half a century of agitation; and Secretary Wilson, himself a lifetime trade unionist, has established the policy of making the department serve all wage-earners alike, whether organized or not, and with full consideration for every other legitimate interest.

In the opening paragraph of his sixth annual report, the Secretary of Labor truly declared that if such a department had not existed at the beginning of the war, Congress would have been obliged to create one. This declaration is a necessary inference from the expansion of the department's functions. Until the entry of this country into the war in April, 1917, the department was equipped with four statutory bureaus—labor statistics, immigration, children, naturalization,—and with an administrative service for mediating labor disputes. It also administered a national system of labor exchanges known as the U. S. Employment Service, which had been developed by the Secretary of Labor for labor emergencies in peace time out of a division in the Bureau of Immigration. This modest departmental equipment had been so expanded before the armistice in November, 1918, as to comprise seven additional administrative services and two important boards—making a total of fifteen branches. An account of the activities of those branches during the war period and of the duties of departmental supervision which their activities required, would account for the work of the Department of Labor of the United States during the war except in two particulars. It would be necessary to add the invaluable work of the Secretary of Labor as chairman of the President's Mediation Commission which investigated and reported upon the gigantic industrial conflicts of the southwest mineral fields and the northwest timber regions, and to this again, his work as one of the six members of the President's Cabinet who were chosen from the ten Cabinet members to constitute the historic Council of National Defense.

A description of all the activities of the Department of Labor during the war, or of any of them in detail, would carry me far beyond my time, but a brief survey will doubtless answer the purposes of this occasion.

Hardly had our country's part in the war begun when the supreme need for wage-earning labor—for an industrial army at home to supplement our military army at the front—became evident in exciting fashion and with disturbing effect. Theretofore, whenever demand for wage-earning work had exceeded the supply of wage workers, and wages had consequently drifted below the level of decent living, the law of supply and demand was very learnedly invoked as the natural regulator of wages. But when the war came on and this law began operating in the opposite direction, employing interests were eager to discard it in favor of conscripting labor. One of the great services which the Secretary of Labor rendered at that crisis was his insistence that if conscription of labor became necessary, the corresponding opportunities for labor must be conscripted first, so that labor conscripts should work honorably for the government and the public good as soldiers do and not servilely for private employers and private profit. Nevertheless, much confusion arose out of the disposition among employing interests to regard wage-earners less as members of the community than as servants, less as fellow citizens than as items of "labor cost," and when checked by Secretary Wilson's effective resistance to conscription of labor, this disposition began to express itself in demands for some species or other of labor dictatorship.

We had a food dictator and a fuel dictator, "why not a labor dictator?" "Labor is as important and as scarce as food or fuel!" These were rather familiar formulas, in substance if not in literal terms, at one period of the war. Involving functions of several departments, they of course chiefly concerned the Department of Labor. Indeed its very existence in any vital way was clearly involved. To have placed a labor director and his staff of assistant directors over the Secretary of Labor, as was in fact seriously proposed, would have been revolutionary and not improbably disastrous. It would at any rate have been a menace to the department which had been set up in the interest of wage-earners.

In circumstances such as those the Department of Labor organized its war activities. They sprang out of a set of principles adopted by the Council of National Defense and approved by the President for regulating the relation of war industries to wage earning labor. These principles related to labor exchanges, the training of workers, priority of demands for labor, agencies for the dilution of skilled labor as needed, adjustment of labor disputes without stoppage of work, safeguarding of working conditions, collection of data necessary for effective executive action, and publicity for the clarification of public opinion. Upon his adoption of these principles the President assigned them to the Secretary of Labor for administration.

I have already referred to the administrative machinery which the Secretary of Labor adopted for that purpose. It consisted of the six preexisting branches of the department with the nine additional ones especially organized for war purposes under the authority of the President. The nine additional branches were a war labor policies board, a division of Negro economics, a woman-in-industry service, a labor investigation and inspection service, a shop training and dilution service, a service for public information and education with reference to labor, a bureau of industrial housing and transportation including a section on living conditions, a service on working conditions, and a war labor board for adjudicating industrial disputes.

The War Labor Policies Board is interdepartmental in character, being composed of representatives of all the executive branches of the government having to do with war problems involving relationships of employers and employees. Its chairman is a member of the staff of the Secretary of Labor and its responsibilities as a body are to his department. The Woman in Industry Service is responsible to the Secretary of Labor for those conditions which, ramifying most branches of industry, especially relate to women wage-earners. A somewhat analogous ramification of the interests of Negro wage workers is represented by the Director of Negro Economics. The Investigation and Inspection Service keeps all the other branches as well as the Secretary informed upon call of such available facts as they need to know for expeditious and intelligent action. The Training and Dilution Service was originally for the purpose in part of preventing industrial abuses of so called "dilution" of skilled labor under war pressure, and in part for improving methods of shop training in the interest of greater production by labor without prejudice to labor, but since the armistice, its "dilution" functions having been abandoned, its work is concentrated upon shop training. The Information and Education Service is for the purpose of informing and educating the public, both by print and speech, as to the work of the department and to those needs of the government with which the department is concerned. The Bureau of Housing and Transportation is charged with the welfare of wage-earners in so far as their welfare relates to living conditions in contradistinction to working conditions. The Working Conditions Service is charged with their welfare in so far as it relates to working conditions in contradistinction to living conditions. The War Labor Board has adjudicated numerous labor disputes on the basis of the right of wage-earners as well as employers to unionize in freedom, of the industrial wisdom of collective bargaining, of the justice of a living wage, and of equal pay for equal work when women are employed in place of men. These bases were adopted unanimously by a commission composed equally of representative employers and wage-earning representatives and presided over jointly by ex-President Taft and Frank T. Walsh.

The work of those new branches of the Department of Labor has been of extreme value, but the story does not end there. Through the Employment Service a national labor exchange has been furnished which has supplied factories with workmen and the wheat fields with harvesters. The Bureau of Labor Statistics has gathered information without which the government and the public could have been grossly misled; for instance, that when cost of living is considered the wages of vast numbers of wage-earners are not especially excessive. The Bureau of Immigration, cooperating with other governmental branches both within and outside the Department of Labor, has adjusted important problems of labor immigration to puzzling problems of labor supply. The Children's Bureau has conducted a nation-wide "drive" for the protection of the coming generation of men and women against the maleficent influences of war, upon children. The Bureau of Naturalization has made American citizens of thousands upon thousands of alien soldiers in the American armies in France as well as in the United States. The Secretary himself has laid the foundations for making the returning soldiers realize that the country they have fought for is measurably at least their own. And last, though by no means of least importance, the Mediation Service has amicably adjusted approximately 3,200 labor disputes, with satisfaction to all concerned, out of a total of about 3,800 entrusted to it during the war by the disputing parties.

The work of the Department of Labor as a whole is written at large in the sixth annual report of the Secretary of Labor, which brings the story down to the last days of the war.

THE LEGAL AND CONSTITUTIONAL ASPECTS OF THE PROPOSED PROHIBITION AMENDMENT TO THE FEDERAL CONSTITUTION

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THE proposed prohibition amendment is, outside of the merits of such a policy as a moral measure, so full of suggestions and questions that it becomes a citizen's duty to study its legal and constitutional aspects, its character and the results, if adopted, upon the system of our republican form of government; also the method of its submission by Congress to the states for ratification and the effect of the language wherein concurrent power to legislate is given to the federal and state governments.

The amendment reads as follows:

Section 1. After one year from the ratification of this article the manufacture, sale, or transportation of intoxicating liquors within, the importation thereof into, or the exportation thereof from, the United States and all territory subject to the jurisdiction thereof for beverage purposes is hereby prohibited.

Section 2. The Congress and the several states shall have concurrent power to enforce this article by appropriate legislation.

Section 3. This article shall be inoperative unless it shall have been ratified as an amendment to the Constitution by the legislatures of the several states, as provided in the Constitution, within seven years from the date of the submission hereof to the States by the Congress.

I

The fundamental objection to the amendment is that it proposes to put into the Constitution a matter of police regulation when that document ought to be, and so far has been, limited to a statement of the basic principles of a representative government. The Constitution deals only with such matters and as a great charter of rights and powers conferred by sovereign states upon a government, which forms a union of them all, more powerful than any one or indeed than all regarded separately, yet still their creature and serving each state, it has risen to a height never before attained by such an instrument.

The secret which pervades its majestic simplicity is that it has to do only with those subjects which lie at the root of government. All others are left to the local communities, the states, to decide. The immense territory covered by the nation, with its varying climates and the differing temperaments of its people—in fact, its myriad of local conditions, render it best that all matters not necessary for the union should be left in the control of the states.

A principle, no matter how good it may be, has no place in the Constitution of the United States if it does not fall within that class of matters with which the Constitution was intended to deal. If we should undertake to put a statement of everything that is regarded as good by the different peoples of our forty-eight states, we should soon find the Constitution stretched to and beyond its limit, subject to frequent change and regarded with contempt by a large number of good citizens. It is a matter of common knowledge that many statute laws are so regarded now. But those statute laws can be easily changed whenever public opinion in the several states, or in the United States, so desires, but when once those matters, which ought to be the subject of laws either statewise or national, become a part of the federal Constitution, they are elevated to a dignity which they do not deserve and they consequently lower the respect with which that document is held. This is indeed a most serious menace to our form of republican government. If we can put into our national Constitution a matter relating to police regulation, such as this proposed prohibition amendment is, no matter how wise it may be as a police measure, then others can be also inserted relating to other individual conduct, etc. The Constitution will thus be dealing with particulars of individual action, not related at all to the fundaments of a republic.

Personal matters should be left to local authorities, or if they are to go to the national government they should go as being subject to the laws of Congress rather than be put into the Constitution where they can only be changed by the slow and tedious method rightly provided by the Constitution for its amendment.

One of the principles upon which our form of government was founded was that personal liberty should be preserved so far as possible. To make absolute in the Constitution a principle relating to one subject invites making absolute other principles and thus the Constitution becomes an instrument of absolutism and defeats the very purpose for which it was established.

The liquor question would not be settled by adopting this proposed amendment to the federal Constitution. The laws in regard to it, if adopted, would be enforced in different degrees in the several states and the subject would be a never-ending force in both state and national elections. What amount of alcohol would make a liquor "intoxicating" and what constitutes "beverage purposes" would furnish large room for debate and inconsistent legislative action, which each state has the power under the proposed amendment to make.

It is well known that many of the advocates of this measure in the different states have been for years building up their political fences by endeavoring to pander to the prohibition vote without any regard to the effect upon our government. It would not much avail the *bona fide* prohibitionist to have prohibition at the expense of the republic, especially as he can have his desideratum otherwise without any injury to our form of government.

The Constitution should be limited to fundamental principles of government and should not contain police matters relating to personal conduct. If we begin with putting prohibition regulations in the Constitution we shall find other subjects, also not relating to the basic rules of a republic, crowded upon us for a place in that document. This course will bring the Constitution into disrepute and result in frequent changes and finally in its overthrow.

II

Another reason why the proposed prohibition amendment should not be ratified is that the amendment has never been passed on by the Senate and House of Representatives at Washington and submitted to the states in accordance with the provisions of the federal Constitution. The Constitution provides in article V. that "the Congress, whenever two thirds of both houses shall deem it necessary, shall propose amendments to this Constitution." Two thirds of both houses must concur in deeming it necessary. According to the certified statement of Mr. Trimble, the clerk of the National House of Representatives, there were 282 votes in favor of the proposed amendment, six less than two thirds of that house. In the Senate, according to a like statement of Mr. Baker, the secretary of the Senate, there were on the final vote only 47 in favor of the proposed amendment, 19 less than two thirds of the upper house, and not even a majority.

It is true that there have been rulings by speakers of the House and by presidents of the Senate to the effect that two thirds vote means two thirds of those present, or two thirds of a quorum. A quorum is a majority, that is, one half plus one. A quorum in the House would therefore be 217, two thirds of which is 145. A quorum in the Senate is 49, two thirds of which is 33. According to such rulings it would be possible for the National Congress to propose an amendment to the Constitution when 145 out of 432 members of the House and 33 out of 96 members of the Senate so voted. We believe that such is not the true intent and meaning of the Constitution. It was considered by the men who made that great bulwark of civil rights that it should not be easy to change it and they wisely provided that before an amendment could be submitted to the states for ratification it must be deemed necessary by two thirds of both houses. The Constitution does not say that the vote shall be by two thirds of a quorum or two thirds of the members present, as it would have done, we believe, if such had been the intention. When such a vote was sufficient it was so expressly stated, as in article I, section 3, which deals with the power of impeachment, where it is provided that "no persons shall be convicted without the concurrence of two thirds of the members present."

In article I., section 5, paragraph 1, it is declared that "each house shall be the judge of the elections, returns and qualifications of its own members, and a majority of each shall constitute a quorum to do business but a smaller number may adjourn from day to day," etc.

Paragraph 3 of same section: "Each house shall keep a journal . . . and the yeas and nays of the members of either house on any question shall, at the desire of one fifth of those present, be entered on the journal."

In article II., section 2, paragraph 2, it is provided that "He" (the president) "shall have power, by and with the advice and consent of the Senate, to make treaties provided two thirds of the Senators present concur."

This discriminating language gives confirmation to the construction of article V. that two thirds of both houses means two thirds of the full membership, rather than two thirds of the members present.

The Constitution was framed by men of the highest ability and character with an experience and surroundings such as could hardly again be expected. They had lived as colonists of Great Britain, were familiar with the principles underlying that great system for the protection of civil rights and liberties known as the common law, had gone through eight years of the Revolution, had seen and known the actual workings of the Articles of Confederation, which had been agreed upon during the Revolutionary War. They had realized that new states would come into the union. The Northwestern Territory was the main, if not the only thing, which kept the union from falling to pieces in 1786. This had been conquered by George Rogers Clark, in 1779, and which the careful and judicious part taken by our commissioners at the time of the treaty in 1782 had enabled us to hold. Virginia had apparent possession of it, but claims were also made by New York, Massachusetts and Connecticut. Maryland demanded that this immense territory ought not to be added to any one state or divided among two or three states, but that it should be the common property of the Union. She refused to ratify the Articles of Confederation until the four states named should relinquish their claims to the Northwestern Territory, which was done between 1780 and 1786. This action of Maryland was for many reasons a great contribution to the ultimate security and growth of the union. Congress spent much time in providing for the organization of this territory, culminating in the Ordinance of 1787, which was the beginnings of the great states of Ohio, Indiana, Illinois, Michigan and Wisconsin. Many disrupting forces were at work to destroy the union of the states but the problems arising in reference to the new territory tended to hold the union together. The construction of the Chesapeake and Ohio and Erie canals was the result of deliberations had in those early days for means of communication between the original thirteen states and this new territory. Commercial policies were discussed and a general convention of the states to decide upon a uniform system of regulations for commerce was called and held at Annapolis in September, 1786. Only eleven states sent representatives and the convention adjourned without transacting any other business than calling another convention to meet at Philadelphia on the second Monday of May, 1787, "to devise such further provisions as shall appear necessary to render the Constitution of the federal government adequate to the exigencies of the union."

The delegates to that convention were such men as Alexander Hamilton from New York, Robert Morris from Pennsylvania, George Washington and James Madison of Virginia, the Pinckneys from South Carolina, and Elbridge Gerry and Rufus King, of Massachusetts, and Oliver Ellsworth and Roger Sherman, of Connecticut. It has been stated by many eminent authorities that never again would it be possible to get together men of such intelligence, experience, training and sincerity in such an atmosphere as pervaded the deliberations of that convention. They had a clear vision of many new states. They knew the pitfalls in regard to the fundamentals of a republican form of government and the fact that the document, which they produced, has with slight changes stood the test for all these decades and now is regarded as a model for the world generally, is evidence of their great insight and wisdom.

After the instrument had been agreed upon, it was referred to a committee on style and it was written in the best and clearest of English. It is inconceivable that when it said "two thirds of both houses," one third only was intended; for 145, two thirds of a majority, or of a quorum, is substantially one third of 432, the total membership of the present National House of Representatives, and 33, two thirds of a quorum of the Senate, is one third of 96, the present membership of that body.

The atmosphere in which the Constitution was prepared should not be overlooked nor should it be forgotten that every article is founded on the presumption of a clashing of interests between the larger and the smaller states.

Notwithstanding any precedent which has been made in the House and Senate which allows so small a number of each house to be considered as two thirds, the states have never decided that such a construction of the Constitution was the proper one, although they have ratified amendments submitted by less than two thirds of both houses, about which there has been no disagreement and where the point was not raised before them. Failure to raise the question concerning an amendment in favor of which there was practically unanimity of opinion can not be held a waiver of the right to raise the objection nor an acquiescence in the precedent claimed to have been established. We believe that no state, deliberately and with its eyes open, would desire to put itself upon record as in favor of this method of changing the Constitution. If a sufficient number of states should ratify such a method of amendment the results would be fraught with grave consequence. This would be only the entering wedge.

The language of Mr. Justice Davis, in *ex parte* Milligan, 4 Wallace 125, is apropos:

> This nation, as experience has proved, can not always remain at peace, and has no right to expect that it will always have wise and humane rulers, sincerely attached to the principles of the Constitution. Wicked men, ambitious of power, with hatred of liberty and contempt of law, may fill the place once occupied by Washington and Lincoln; and if this right is conceded, and the calamities of war again befall us, the dangers to human liberty are frightful to contemplate. If our fathers had failed to provide for just such a contingency, they would have been false to the trust reposed in them. They knew—the history of the world told them—the nation they were founding, be its existence short or long, would be involved in war; how often or how long continued, human foresight could not tell; and that unlimited power, wherever lodged at such a time, was especially hazardous to freemen. For this, and other equally weighty reasons, they secured the inheritance they had fought to maintain, by incorporating in a written Constitution the safeguards which time had proved were essential to its preservation. Not one of these safeguards can the President, or Congress, or the Judiciary disturb, except the one concerning the writ of habeas corpus.

Article V of the Constituion also requires that three fourths of the states shall ratify any proposed amendment. It does not say three fourths of those that vote, but three fourths of the states. A state may refuse to vote upon the subject and if one state can refuse to vote, then 23 of them may so refuse, and three fourths of the other 25 may ratify the so called action of Congress; thus 25, being a majority or quorum of the 48, the proposed amendment would be a part of the Constitution by the ratification of only 19 states, if this method of amendment should prevail.

Those in favor of standing by the so-called precedents made by the speakers of the National House of Representatives and by the presidents of the Senate hold that the word "houses" means a session of the houses, capable of doing ordinary business; that is a majority or a quorum present in each house. But this matter of amendments to the Constitution is not the ordinary business of the legislative branch of the government. In the case of Hollingsworth *vs.* Virginia, 3 Dallas, 378, the United States Supreme Court held that the President's signature to a resolution proposing amendments to the Constitution was not required. Attorney General Lee, in his address to the court, said that "the case of amendments is evidently a substantive act unconnected with the ordinary business of legislation and not within the policy or terms of investing the president with a qualified negative on the acts and resolutions of Congress." He was about to continue further in his answer to the argument of counsel on the other side when he was interrupted by Mr. Justice Chase, who said, "There can surely be no necessity to answer that argument. The negative of the president applies only to the ordinary case of legislation; he has nothing to do with the proposition or adoption of amendments to the Constitution."

It is, therefore, evident that the framers of the Constitution considered the proposing of amendments an extraordinary power outside of the ordinary business of Congress. Any precedents made by the House and Senate in reference to overruling a veto of the president, where two thirds vote is required, are, we believe, not binding upon the states in their view with reference to this extraordinary exercise of constitutional power by Congress.

But this question, while partly legal and one which the courts can determine, has also a broader range and is one which in the immediate future is coming before our states for action. It has a political aspect, using that adjective in its best sense, and the responsibility should not be shirked by the Legislative Department and cast wholly upon the Judicial Department for decision. The state senators and representatives are sworn to support the Constitution of the United States as well as that of their own state and their sworn duty requires a rejection of any amendment which has not been submitted in accordance with that Constitution.

To show the lengths to which the speakers of the house have gone in defiance of the Constitution it might be stated that in February, 1902, the House was considering the joint resolution proposing an amendment to the Constitution in regard to the election of senators when Mr. Corliss, of Michigan, asked whether a roll call was necessary or would it be sufficient, if, in the judgment of the speaker, a two thirds vote was cast. The speaker answered that the presumption being that a quorum was present and the chair deciding that in his opinion there was a two thirds vote in favor of the measure, it was within the power of the House to test the vote but it was not necessary.

Thus if only ten members of either house were present and no want of a quorum was suggested, two thirds of the ten could pass a resolution submitting a constitutional amendment. Even when there is a quorum present, 145 members of the House and 33 members of the Senate would under such ruling be sufficient.

If 145 members of the House and 33 members of the Senate can propose an amendment to the Constitution and start it on its way for ratification by the states, that action permits 287 members or substantially two thirds of the lower house and 63 Senators, exactly two thirds of the Senate, to avoid the responsibility of deciding whether or not the amendment is necessary. It was the intention of the framers of the Constitution to require, and we believe the provision was a wise one, that the Senators and Representatives at Washington should take the responsibility of deciding, and that two thirds of them must agree that any proposed amendment to the Constitution is wise and necessary. The language of article V is mandatory and not merely permissive. Shifting of responsibility on so important a matter is full of evil consequences.

The states are interested in preserving the Constitution for their own protection and amendments ought to be jealously guarded.

The proposed prohibition amendment has never been properly passed by the National Senate and House of Representatives, and therefore it should not be ratified by the states.

III

Section 2 of the resolution proposing the prohibition amendment provides that "The Congress and the several states shall have concurrent power to enforce this article by appropriate legislation."

This provision is so clearly wrong that to make it a part of the Constitution would be a most unfortunate event. It would introduce an element of confusion in the enforcement of a great police power. No matter what views may be entertained by a person upon the subject of national prohibition, it is of the utmost importance that in respect to matters confided to the federal government that that government should have supreme power.

Constitutional authorities universally agree that the United States would never have risen to the dignity of a nation were it not for the provision that the Constitution and the laws of the United States made in accordance therewith and all treaties "shall be the supreme law of the land and the judges in every state shall be bound thereby, anything in the Constitution and law of any state to the contrary notwithstanding."

The prohibition amendment now under consideration specially confers upon the Congress and the several states concurrent power to enforce this article by appropriate legislation.

It has been held by good lawyers that the proposed amendment would extend the power of the several states over interstate and foreign commerce as it certainly extends the power of the United States over the manufacture and consumption within the several states.

If the amendment were adopted, it would doubtless lead to grave conflicts between the federal government and the states and would give rise to antagonistic legislation between the states themselves and between the states and the United States. If it means, as it says, that "the Congress and the several states shall have concurrent power to enforce this article by appropriate legislation," and as that necessarily implies that there must be concurrent action by all the states and the United States, all agreeing on the exact form of legislation, then it would be an absurdity, for it is too much to expect that all the states and the United States would exactly agree on subjects, about which the several states are in conflict and where there is so much diversity of opinion. The subjects under consideration would be what constitutes intoxicating liquors, that is, what percentage of alcohol makes a liquid intoxicating. The range of legislation would very probably be anywhere from a fraction of one per cent. to at least five per cent. of alcohol to make a liquid intoxicating. Another subject about which the Congress and the forty-eight states would not agree would be, what constitutes "beverage purposes." There may easily be forty-nine different laws on the subject and no person would know how he stood in respect thereto, for while acting entirely according to the laws of one state, he might be acting exactly contrary to the laws of other states, and perhaps contrary to the law of the United States.

Suppose the state of New York should pass a law that it was lawful to manufacture and sell all liquors containing less than three per cent. of alcohol and suppose Congress should pass a law which should make it unlawful to manufacture and sell any liquors that contained more than one half of one per cent. of alcohol. Which of these laws should prevail? There would be no concurrent action and both laws would fall to the ground.

For the first time in the history of the United States the ratification of this proposed prohibition amendment would introduce into the fundamental law of the United States a question of power, that is, cf concurrent power between the states and the nation in regard to a matter committed to the national government. It is going back to the false principles of the state rights leaders of Calhoun's time and a revivification of the old idea of condominium, which are sure to always cause trouble.

It will be noticed that concurrent power to legislate, not concurrent jurisdiction, is given to Congress and the several states.

Concurrent jurisdiction with sole power in the federal government to legislate would have been proper so far as this third point is concerned, for there would then be only one law to be enforced in either the jurisdiction of the federal courts or of the state courts.

The states already have the power to prohibit the transportation and dealing and use of liquor within themselves and the United States Congress has passed an act prohibiting the transportation of liquor into any state or through any state, where that is prohibited by the state government. The Supreme Court of the United States has approved and found the act constitutional. This law is known as the Webb-Kenyon act and by it and under it any state has full power to fully control the use, sale, transportation and manufacture of liquors, etc., within its own limits.

The very evident intent then of the proposed prohibition amendment is to force its provisions upon those states which do not want it. It is clear that in such states at least there would be endless conflict between the federal and state authorities, under this section 2 where "concurrent power" is given.

In the Thirteenth Amendment it was declared that neither slavery nor involuntary servitude, except as punishment for crime, etc., shall exist, and by Section 2, of that amendment, it was provided that "Congress shall have power to enforce this article by appropriate legislation." The same principle was applied and adopted in the Fourteenth and Fifteenth Amendments. In each the people declared the governing idea, whether positive or negative, and in each gave to the Congress in the same language just quoted, power to enforce the article by legislation. This is the simple, direct natural and clear way to draw such a provision. Why was it not followed in this case? Obviously it was not appreciated.

In cases in reference to boundary waters between different states it has been decided that where there is a concurrent power over those waters no regulation by either is effective unless consented to by the other.

In Houston *vs.* Moore (5 Wheat., 1 and 23), the judgment of the court was delivered by Mr. Justice Washington, who said that to subject citizens "to the operation of two laws upon the same subject, dictated by distinct wills, particularly in a case inflicting pains and penalties, is, to my apprehension, something very much like oppression, if not worse. In short, I am altogether incapable of comprehending how two distinct wills can, at the same time, be exercised in relation to the same subject, to be effectual, and at the same time compatible with each other.

If they correspond in every respect, then the latter is idle and inoperative; if they differ, they must, in the nature of things, oppose each other so far as they do differ. If the one imposes a certain punishment for a certain offense, the presumption is that this was deemed sufficient, and, under all the circumstances, the only proper one. If the other legislature impose a different punishment, in kind, or degree, I am at a loss to conceive how they can both exist harmoniously together."

Under the two state constitutions and the acts of Congress that admitted Oregon and Washington to the union they have "concurrent power" over the Columbia River. Both states passed laws by which they regulated the taking of salmon in the river. A man was convicted of violating a statute of Oregon, which differed from the statute of Washington in its provisions and in the punishment for its violation. In discharging the prisoner, the court said: "It is the act of concurrence between the two states in the exercise of legislative authority that validates the act and gives it the force of law, and unless there is a concurrence or assent by both states to the enactment, it cannot have that force."[2]

The section of the proposed prohibition amendment under consideration was introduced into the Senate at the very close of the debate on the principal question and it does not appear by the Congressional Record that there was any discussion upon it. It is evident that there was very little consideration paid to it.

Ex-United States Senator Sutherland, whose term expired March 4, 1917, said on this point:

> I happened to be a member of the Senate when the first draft of this proposed amendment was presented, and it was considered before the Judiciary Committee of the Senate, and at that time some of us called attention to the very objection that I am now calling attention to, and this objectionable language was stricken out, and the proposition was reported with a single provision that Congress should have power to enforce it. No vote was taken upon the proposition at that session. At the next session it was reintroduced, and it went through without any questions being raised about it by anybody and apparently without attention being called to it. This to my mind is so serious that I think lawyers who have any respect for a fundamental thing ought to put themselves on record as being against it.

IV

The seven year allowance for ratification, provided for in section 3 of the amendment, has been severely criticized, but discussion of this feature of the amendment is unnecessary except to call attention to the fact that the time within which the

[2] Ex. Parte Desjeiro, 152 Fed. 1004 (1907).

amendment may be ratified by the states does not expire until the year 1924. There is, therefore, abundant time for the states to give the matter most careful consideration.

In Conclusion

The method to be pursued by Congress in proposing an amendment to the Constitution is a mandatory, not a permissive one. Amendments to the organic law should not be submitted for adoption until that mandate has been complied with. Two thirds of both houses must deem it necessary and when that time arrives it is the duty of the Congress to submit proposed amendments and not before.

Outside of the amendments proposed by the first Congress no amendments to the federal Constitution were found necessary until after the close of the Civil War. Three amendments were then proposed and ratified. No further attempts were made until 1909 when the income tax amendment was adopted and then in 1913 came the amendment with regard to the election of the United States Senators by the people. Now in 1918 another amendment is before us for ratification. The tendency is dangerous. Where will the end be? A proper regard for the perpetuation of the union forbids a ratification of all unnecessary amendments and especially forbids a ratification of those not properly submitted.

On account first of its dangerous tendency; second, for the reason that it has never received a proper vote of Congress; third, because it gives rise to conflicting legislation, and finally, because it is inherently wrong as a part of the federal Constitution, the proposed amendment ought not to be ratified by the states.

THE RECENT WEBB-KENYON DECISION

Since this address was made the Supreme Court of the United States, in a case arising from Kansas, has decided that the Webb-Kenyon law which had previously been held to be constitutional was not affected by the fact that, on the vote in congress following the presidential veto, less than two thirds of the entire membership of both house and senate had passed the act over the veto.

In its consideration of the case the Supreme Court holds that the context of Article I., Section 7, Clause 2, leaves no doubt that the provision was dealing with the two houses as organized, and entitled to exert legislative powers.

The court then goes on to a discussion of the practice, which has prevailed in congress and which was alluded to in the address, to the effect that two thirds of both houses means two thirds of the members present, and bases its reasoning on the fact that the practice has been continued since the adoption of the first ten amendments to the Constitution up to the present time.

While the observations of the court in respect to the method of constitutional amendments are very largely, if not wholly, outside of the real subject for decision, it is very apparent from a careful reading of the opinion that its reasoning is not principally based upon any construction of Article V. of the Constitution, which that article itself would justify, but is mainly based on the fact of the congressional practice already alluded to.

Such a practice, followed by the ratification of the amendments, which have already been ratified in the past, and acquiescence therein, would constitute a waiver of any right on the part of any one now to claim that those amendments were not a part of the Constitution. So long an acquiescence would prevent such a claim.

There was substantially no question made about the advantage and necessity of each one of the amendments so far adopted, and no question was made at the time that they were not properly passed by congress.

We know that legislators, sometimes illustrious ones, do not always comply exactly with requirements and rules in dealing with subjects on which there is no disagreement and when the point of the violation of the requirement is not raised. But such action does not ordinarily establish an acquiescence or a waiver of the right of a party, be he a State or an individual, thereafter to stand on its or his rights in respect to a matter about which there is a disagreement, and where the objection is seasonably made.

It would be a very unfortunate situation if, as the speakers of the house and presidents of the senate have ruled, a senate and a house can propose constitutional amendments when a quorum has vanished from both chambers and the absence of a quorum is not suggested and the vote is passed by two thirds of those present; a situation justified by the opinion in question.

There is a vast difference between Article I., Section 7, relating to the two thirds vote required to pass a measure over the presidential veto and Article V. which relates to the amending of the Constitution.

In the former, Article I., the matter of a quorum is mentioned in Section 5, where it is stated that a majority of each house shall constitute a quorum to do business. Of course the presidential veto has to do only with the ordinary business of congress, where only a quorum is necessary and considerably less than a quorum frequently does do business when the absence of a quorum has not been suggested.

On the other hand, Article V. deals with an extraordinary matter, as is shown by the decision in the case of Hollingsworth *vs.* Virginia, 3 Dallas, 378, referred to in the address, and where the Constitution expressly provides that "the Congress, when two thirds of both houses shall deem it necessary, shall propose amendments," etc.

The decision in the Kansas case is limited to the number required to override a veto and is not conclusive of the construction to be given to the article relating to amendments, although in its opinion the court refers to that subject. Its decision as to the veto provision has a sound foundation without any reference to the amendment provision.

The opinion of the Supreme Court in connection with the Kansas case applies only to that part of the address which relates to the second point and does not in any way affect the fundamental objection to the proposed amendment in question, to wit: that it is not germane to the Federal Constitution and has nothing to do with the principles underlying our form of government, but is merely a police regulation and one of many, which might as well claim a place in that document.

The opinion of the Supreme Court also has no bearing upon that part of the address which relates to the objectionable feature contained in the proposed amendment, that the congress *and* the states shall have concurrent power to legislate, which is dealt with under part III. of the address.

THE REFERENDUM

At the present time two of the forty-eight states have refused to ratify the proposed amendment. Two others have not yet taken any action thereon. Thirty others have taken final legislative action ratifying the amendment. The remaining fourteen have taken preliminary action but the final legislative act is deferred until a referendum, provided for in their respective state constitutions, has been had.

The framers of the Federal Constitution, when it was passed in 1787, may not have had in mind the legislative referendum, which now exists in those fourteen states but the Constitution clearly intended that any proposed amendment must be legally ratified by the legislative action of three quarters of the states. It did not contemplate that any illegal or partial action on the part of the legislatures of the states would be sufficient.

Now it is perfectly competent for a state in its constitution to decrease or increase the number of its members or the number of its houses, either as they existed at the time the Federal Constitution was adopted or at any other time. It is entirely proper for a state to increase its house of representatives, for instance, to five hundred or a thousand, or even more, members if it sees fit. The effect of the referendum is a modification of the legislature as it previously existed. It practically increases the number of members of the legislature so far as the subject matter of the particular referendum is concerned, to the entire electorate of the state in question, and before any valid legislative action can be taken, in cases where the procedure is followed, a referendum must be had.

Of course no state, in its own constitution or laws, can change the Federal Constitution, but the action of a state in ratifying or not ratifying a proposed Federal amendment is a state action and the state has power to modify its legislative authority in any legal way and the referendum when properly sought is a legal modification of the legislative power. Until that has been had the legislative action of the state is not completed. The situation, in some respects, resembles the case where one branch of the legislature ratifies the proposed Federal amendment and the other branch does not act at all. There is thus incompleted action.

These subjects are new and have not yet been decided by our courts but because of their importance they merit the most serious consideration.

February 11, 1919

THE ECONOMIES OF SAFETY

By LEW R. PALMER

DIRECTOR SAFETY AND PERSONAL EQUITABLE LIFE ASSURANCE SOCIETY

IN order that I may direct my ammunition against the properly restricted sector of this elaborate program, I have consulted the usual authority, and am advised that "economy" comes from the Greek (οἰκονομία) "and implies management." We infer that the author means *good* management.

Safety, as treated in this paper, will deal with that vital factor in good management having to do with accident prevention, and must, of necessity, in the time allotted, be restricted to a very limited area of the entire field of activity.

While it can not be claimed that accident prevention has always been recognized as essential to good business, it can not be denied that to-day it is a generally accepted fact that *safety pays*.

A striking example of the effectiveness of a well-organized and active safety department is illustrated in a chart recently published by the United States Steel Corporation, which is submitted herewith. From it we learn that in the past twelve years there have been saved from death and serious injury within the plants of this organization, approximately, 23,000 workmen.

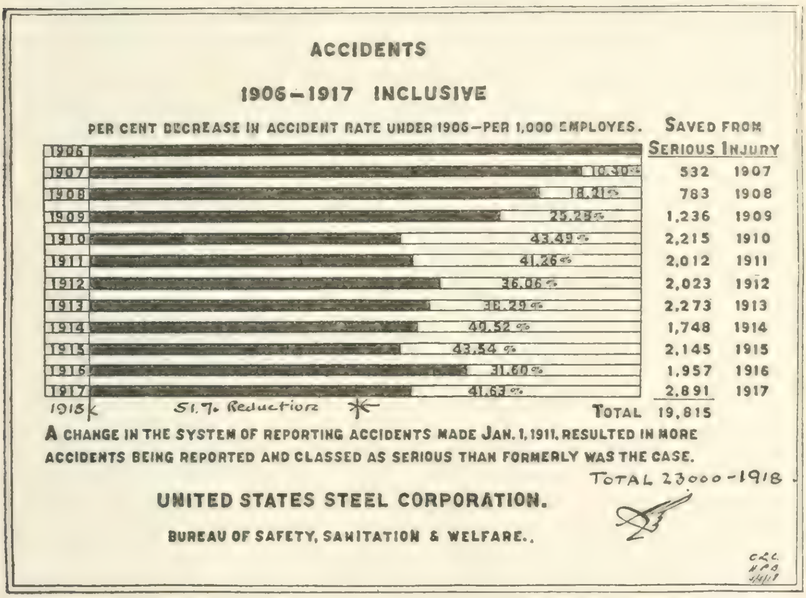


Fig. 1.

Surely, when you take account of the productive value of these workers thus saved to their task in the "trenches of labor," bearing in mind what that increased product has actually meant to our allied armies, fighting our fight for *universal safety* in the trenches "over there," all must agree that the money and effort expended in developing that safety organization had its return, and that many fold.

This highly specialized and important branch of plant management has not been the growth of a day; it has been a gradual evolution, with many elements involved, including the patient development of methods of education in order to combat that arch enmy of safety—carelessness—by opposing it with a united front, the man cooperating with the management.

Important as has been the installation of mechanical safeguards—many of which are monuments to some fallen pioneer —and the remodeling of plant arrangement and plant equipment, the human factor—the personal equation—still holds a bridgehead in the bloody arena of accident causation.

"*How to reach the man*" is a hard-fought problem of long standing, against which we have repeatedly directed our major offensives; on which we have trained our big guns, and, I fear, wasted not a few highbrow speeches.

However, when men of large caliber, vision and practical experience, direct the bombardment, entrenched carelessness and indifference must surrender to habits of caution.

These mass meetings, or safety rallies, to be of permanent value, should be reinforced with the rapid and continuous fire of education that comes from well-directed foremen's meetings, interspersed with the hand-to-hand personal contact of the workmen's committees. This should, in a large measure, insure that development of plant morale necessary to put safety "over the top."

In a recent bulletin published by the United States Bureau of Labor Statistics on "The Safety Movement in the Iron and Steel Industry," appears an interesting chart showing the variation in accident frequency as compared with the coincident variation of employment.

It will be noted that, following the period of minimum employment (at which time there was a parallel depression in the accident curve), with the introduction of new men came an increased accident frequency. This was to be expected, as it is in accordance with past experience.

However, the accident frequency was soon checked and the curve eventually brought down, even at a time of maximum employment, to a point as low as the best record at any period of minimum employment.

To those who have had experience in dealing with the new-man problem as related to accident frequency, this will appeal as a really remarkable achievement, and to my mind proves without a doubt that safety organization, even in the face of unprecedented stress of war work, has "made good."

It might be added that, when these figures have been brought up to date for the year 1918, they will indicate that there has been a further reduction as compared with the already good showing for 1917.

Many agencies have been active in the development of the safety movement to the point where we find it to-day. It was out in the Pittsburgh district where, according to tradition, "mules were once held of more value than mortals," that a group of engineers, in cooperation with some contemporary insurance officials, sowed the seed that brought to life the National Safety Council, which stands to-day as one of the foremost accident prevention organizations in existence.

FIG. 2.

Allied with the Safety Council, we have had the American Museum of Safety, a pioneer in promoting the "safety spirit" throughout the industries of this country, which, by holding exhibitions of safety and sanitation, distributing safety publications, and making special investigations on sanitary and safety conditions, has exerted an educational influence of marked value.

Focusing the industrial thought and purpose upon this special branch of plant management soon revealed the fact that, as we had been sadly negligent in conserving our minerals, forests and other natural resources, so had we been woefully wasteful of the lives and limbs of our industrial workers; and we were awakened to the realization that this annual toll of life and limb was not the sad necessity we had believed it to be, but that, by the proper application of organized effort—purpose plus money—amazing reductions in accident frequency could be effected.

From such records as were available ten years ago, we were shown that in the neighborhood of 35,000 fatal industrial accidents occurred each year, carrying with them approximately 2,000,000 disabling accidents for a like period.

In the light of the new day, with its avowed purpose to eliminate waste, the safety movement has played its part, and to-day it is estimated that the annual rate of fatal industrial accidents has been reduced to approximately 22,000, with a corresponding reduction in the disabling accidents.

To measure this enormous accumulative saving in our nation's man power by a money standard is quite beyond me, but I feel sure that none can deny it is of such unquestioned economic value that we can never again fail to take it into account.

For—is not
  An accident prevented—
    many dollars saved?
  An accident prevented—
    a productive life or limb conserved?
  An accident prevented—
    uninterrupted, therefore, increased production?
  An accident prevented—
    a father saved to his family?
    a family saved from charity?
  An accident prevented—
    a mine well ventilated?
    a thousand happy homes?
    a million dollars saved?
  An accident prevented—
    a high explosive plant properly located?
    a town still on the map?
  An accident prevented—
    a boiler filled with water?
    a plant still in operation?
  An accident prevented—
    an engineer educated to caution?
    "The Limited" at its destination?
    the passengers home in safety?
    the railroad's first duty fulfilled?
Is not accident prevention the *best* and *cheapest* compensation?
Is not the White Cross of Prevention an even greater national asset than the Red Cross of First Aid?

The good results accomplished in the field of accident prevention have encouraged the extension of the plan of obtaining mutual benefits through cooperative effort. In fact, safety has been the entering wedge whereby a better understanding can be developed between the employer and the employee. With it must come a frank discussion of one vital problem, the solution of which works for their mutual benefit.

Having found that the cooperative plan really works for the good of all in this one instance, does it not stand to reason that the circle of application will grow, become larger and larger until, through faith in each other, the contending forces will be led out of the wilderness of strife and misunderstanding into the promised land of industrial peace? Thus made a fact through a square deal for all.

Great as has been the achievements of the past, far greater is the promise of the future.

Though the most part of my ammunition has been directed toward the industrial sector, I feel it is not out of place to "drop a few" out there in the wider areas of the field of battle where the major offensives of the future will be staged and fought to a successful conclusion:

Why should the public be allowed to waste 60–75 yes and, unless checked, soon 100,000 lives annually?

Why not develop closer cooperation between all accident prevention agencies, and eliminate the waste of duplication?

Why not, through a further cooperation between the states and the casualty companies, prevent more, and compensate less?

Why should life insurance companies pay millions of dollars in untimely death claims when, by united effort, millions of lives can be extended?

Why not educate our children to live through carefulness rather than die by carelessness?

Why do tires still skid for the want of chains?

Why not reduce labor turnover and save lives as well as money?

Why reconstruct the war cripple and allow the industrial cripple to go to the bread line, or even further down?

Why, though "The lips of the righteous feed many," should "Fools (still) die for the want of wisdom"?

Why not! yes, *Why Not?* end *War* with a LEAGUE OF NATIONS?

For, does not *Universal Peace* go hand in hand with *Universal Safety?* Once that goal is attained, is it not truly worth safeguarding with the protecting power and cooperative support of such a *World League?* How else can we compensate for the appalling sacrifice already made? Who dares stay the hand that writes?

STOP! LOOK!! LISTEN!!!

And—"*These Sacred Dead Shall Not Have Died in Vain.*"

AN ENTOMOLOGICAL CROSS-SECTION OF THE UNITED STATES[1]

By Professor J. CHESTER BRADLEY

CORNELL UNIVERSITY

WELL that was an idea worth thinking about, any how. It had rather an appeal to it, which in its way was quite irresistible. So we did think about it and talked about it and dreamed about it, and assured each other that we were only dreaming, but then "quien sabe"? There was the Buick which one of us very much wanted to have in California with him the next fall and winter, and here were we, three greenhorns, almighty anxious to see the length and breadth of the land between, not swiftly from a car window, but leisurely, day by day, dallying here or there, investigating, collecting, prying into the secrets of the country.

So the idea grew. Our friends were interested, would like to go along. Certainly! We would merely add a Ford, then two, then three, then a trailer. Well! Well! the matter was growing serious, positively the party must not be larger. Then came the dark cloud of war, which left us uncertain whether to go at all, and took the pleasure out of planning. At last it was clear that since some must go to the coast any way, and some awaiting draft could spend the *interim en route,* and that the work of others would not be affected, our plans should "carry on" and so we started.

Who were we? Reader allow us to introduce ourselves. Dr. Albert H. Wright, assistant professor of vertebrate zoology in Cornell University and special agent of the U. S. Bureau of Fisheries. High-sounding titles don't make a zoologist, but no one would accuse him of needing them if they were to watch his dauntless enthusiasm in wading through mudholes after frogs and fish. Mrs. Wright, whose interests are largely botanical and photographic, always managed to chase the glooms away and laugh us all out of the grouches which threatened to settle on us when the Fords misbehaved themselves. Dr. Anne H. Morgan, head of the department of biology at Mt. Holyoke College and May-fly expert. Gracious! how the young

[1] I am indebted to the following persons for notes on the specimens collected during our trip: Dr. W. T. M. Forbes, all the determinations of Lepidoptera, Dr. Bequaert, Hymenoptera; Mr. Knight, Hemiptera; Mr. W. T. Davis, Cicadidæ; Dr. Wright, vertebrates. I am also under obligations to Dr. Munz, Messrs. Shannon and Ralph Wheeler, Mrs. Wright and Prof. E. O. Essig for photographs reproduced; and to Dr. and Mrs. Wright for assistance with the manuscript and proof.

Map of route of Cornell University Biological Expedition, May–Sept, 1917. Night camps are each numbered to correspond to the day of the month, as indicated in the accompanying table

ROUTE OF CORNELL UNIVERSITY BIOLOGICAL EXPEDITION, MAY–SEPT, 1917. NIGHT CAMPS ARE EACH NUMBERED ON THE MAP TO CORRESPOND TO THE DAY OF THE MONTH, AS INDICATED IN THE FOLLOWING LIST

Month	Day of Month	Day of Trip	Miles Travelled	Total Mileage	Town Nearest Night Camp	State
May	24	1	42	42	Owego	N. Y.
"	25	2	90	132	Scranton	Pa.
"	26	3	48	180	Bartonville	"
"	27	4	113	293	Collegeville	"
"	28	5	111	404	Baltimore	Md.
"	29	6	74	478	Alexandria	Va.
"	30	7	59	537	Fredericksburg	"
"	31	8	97	634	Petersburg	"
June	1	9	32	666	Dewitt	"
"	2	10	73	739	Soudan	"
"	3	11	99	838	Gibsonville	N. C.
"	4	12	169	1,007	Broad River	S. C.
"	5	13	101	1,108	Andersonville	"
"	6	14	88	1,196	Athens	Ga.
"	7	15	68	1,264	Stone Mountain	"
"	8	16	144	1,408	Auburn	Ala.
"	9	17	31	1,439	La Place	"
"	10	18	128	1,567	Flatwood	"
"	11	19	73	1,640	Leroy	"
"	12	20	78	1,718	Theodore	"
"	13	21	55	1,773	Biloxi	Miss.
"	14	22	53	1,826	Bay St. Louis	"
"	15	23	91	1,917	Covington	La.
"	16	24	117	2,034	Burnside	"
"	17	25	62	2,096	Schriever	"
"	18	26	52	2,148	Berwick	"
"	19	27	90	2,238	Near Cade	"
"	20	28	87	2,325	Sabine River	"
"	21	29	62	2,387	Devers	Texas
"	22	30	93	2,480	Richmond	"
"	23	31	35	2,515	Wharton	"
"	24	32	70	2,585	Victoria	"
"	25	33	73	2,638	Gilett	"
"	26–29	34–37	85	2,743	New Braunfels	"
"	30	38	54	2,797	Helotes	"
July	1	39	80	2,877	Sabinal	"
"	2	40	117	2,994	Devil's River	"
"	3	41	69	3,063	Juno	"
"	4	42	106	3,169	20 miles west of Sheffield	"
"	5	43	83	3,252	30 miles east of Alpine	"
"	6	44	77	3,329	Davis Mountains	"
"	7	45	60	3,389	Valentine	"
"	8	46	86	3,475	Sierra Blanca	"
"	9	47	63	3,538	Fabens	"
"	10	48	78	3,616	El Paso	"
"	11	49	24	3,640	Mesilla Park	N. M.
"	12	50	68	3,708	7 miles east of Deming	"
"	13	51	71	3,779	Lordsburg	"
"	14	52	56	3 855	Bowie	Ariz.
"	15–18	53–56	58	3,893	Ft. Grant	"
"	19, 20	57, 58	60	3,953	Texas Pass	"
"	21–23	59–61	54	4,123	Tucson	"
"	24	62	52	4,059	Oracle	"
"	25, 26	63, 64	27	4,086	Mt. Lemon	"
"	27	65	0	4,086	Congdon's Mine	"
"	28	66	84	4,170	Florence	"
"	29	67	50	4,220	Near Higley	"
"	30	68	93	4,313	Canon	"
"	31	69	87	4,400	Del Rio	"

Month	Day of Month	Day of Trip	Miles Travelled	Total Mileage	Town Nearest Night Camp	State
Aug.	1, 2	70, 71	171	4,571	Grand Cañon	Ariz.
"	3	72	94	4,665	Williams	"
"	4	73	61	4,726	Prescott	"
"	5	74	113	4,839	Beardsley	"
"	6	75	43	4,882	Avondale	"
"	7	76	61	4,943	Gila Bend Mts.	"
"	8	77	56	4,999	20 miles west of Palomas	"
"	9	78	28	5,027	Wellton	"
"	10	79	71	5,098	Sand Hills Colorado Desert	Cal.
"	11	80	61	5,159	Coyote Wells	"
"	12	81	19	5,178	Jacumba	"
"	13	82	28	5,206	Warren's Ranch	"
"	14	83	98	5,304	Torrey Pines	"
"	15, 16	84, 85	68	5,372	Laguna	"
"	17	86	62	5,434	Claremont	"
"	18	87	77	5,511	Saugus	"
"	19	88	115	5,626	Bakersfield	"
"	20	89	93	5,719	Lindsay	"
"	21	90	60	5,779	Giant Forest	"
"	22–26	91–95	0		Alta Meadow	"
"	27	96	0		Giant Forest	"
"	28	97	99	5,878	Fowler	"
"	29	98	118	5,993	Ripon	"
"	30	99	98	6,094	Berkeley	"

ladies at the college would have stared to have seen their revered professor after May flies, dressed in—but there, I must introduce Professor George B. Upton, of the engineering college, who was the chief of staff of our mechanical crew, and whose zoological interests ran to ornithology and shooting lizards. Mr. Harry H. Knight, hemipterist and especially keen

"Ezra Cornell" and the Trailer. On to the left running board of the Buick we had built a large metal box in which we carried articles likely to be needed during the day, and especially the noon-time lunch, thereby avoiding the necessity of unpacking the trailer en route. Forward of it, on the running board, is a five-gallon can for reserve gasoline, and a ten-gallon water can. After two experiences with broken springs, we carried the piece of scantling beneath the trailer to use in place of a broken spring if occasion arose.

"[illegible]." The plant presses strung across the radiators were a source of curiosity to those whom we met, but the plants dried splendidly in such a manner. Two of the cans carried water, one gasoline and one formaldehyde for preserving reptiles. The gasoline pressure lantern, when used at night, gave a very brilliant illumination for making bird-skins, pinning up specimens, etc.

for Capsidæ, was our second mechanician and Ford driver. Dr. Philip Munz, really a dragon-fly man, devoted his time almost entirely to collecting plants. We were all very glad to have a botanist along, as it gave us an opportunity to learn something of the flora that we should otherwise scarcely have had time for. Mr. R. N. Lobdell also collected plants, but spent most of his time with birds and mammals. Mr. Raymond Shannon, recently of the National Museum, was our specialist in Diptera, and many a fine catch he made. Dr. Joseph Bequaert, of the American Museum of Natural History, was also dipterist enough to fraternize with Shannon in gloating over their good finds, but Dr. Bequaert is more particularly an hymenopterist. He, with Dr. Wheeler and the writer made a trio of three Hymenoptera fiends, and how we did catch the ants and bees and wasps! Especially Dr. Bequaert, who it seemed was out and catching some rare specimen every time we stopped to read a road sign. Dr. William Morton Wheeler needs no introduction to entomological readers. It is our one regret that he and his son Ralph were not able to join us until we reached El Paso. Paul Needham collected dragon-flies and Neuroptera to send to his father, Dr. J. G. Needham, but his own interest was in butterflies.

It was our plan to camp out at all points, and this plan, I may say, was rigidly adhered to. But it increased our baggage difficulties. It was no easy matter to provide for carrying thirteen people with their personal baggage, camping outfit, garage supplies, collecting outfits and provisions in two Fords and a Buick even with a good big trailer to help out. We built large running board boxes and used every spare inch of space, shipped much goods ahead, and still were overloaded. The third day out we had an "elimination" party. We shipped back half a trailer-load of baggage, shipped a great deal forward, and still were overloaded. Little by little we eliminated the unessentials until gradually we had a reasonable load. Meanwhile we were gaining rapidly in experience and systematizing our camp life, our work and our packing.

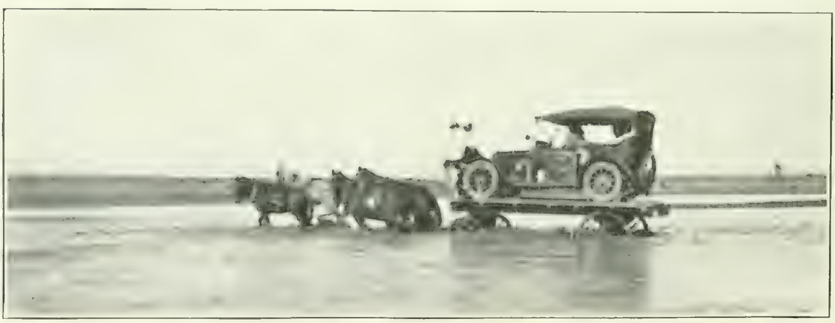
We left Ithaca on the twenty-fourth of May, headed south. The weather was still cold, raw and disagreeable. The first night camp was along the Susquehanna River near Owego. Crossing the Pocono Mountains and down through Allentown and Valley Forge, we arrived at West Chester, Pennsylvania, in a pouring rain. In Maryland we found the trees in full leaf and bade good-bye to bad weather with the last real hard rain that we were destined to see for a long time. Near Baltimore, Mr. Knight found many specimens of a tingid, *Corythuca ulmi* Osborn and Drake (ident. by Drake) on the leaves of *Ulmus fulvus*. At Washington we were joined for a day by Mr. Francis Harper, of the Biological Survey, who took us to a most delightful camping place near Alexandria. With the north behind us and good weather at hand, we felt that our trip had now really commenced, and for the first time were able to do

A Sandy Wash in the Yuma Desert near Wellton. The car is not, as might appear, taking a cross country jaunt, but is on the main New Orleans to San Diego auto road.

some real collecting. As we were seriously behind our schedule, however, we did not then, nor for a long time thereafter, feel free to linger where the country appealed to us, but were always under the necessity of hurrying on. It was from the start our plan to make a quick trip as far as New Orleans in order to have the more leisure beyond.

I had devised a trap lantern to work with the spot-light of the Buick car. It consisted of a cylinder of tin which fitted on to the spot-light, and the forward end of which was closed by a funnel of celluloid, with a two-inch opening through which the insects could pass into the chamber in front of the light. This chamber was connected with a very strong cyanide jar, made of a pint mason jar, which could be unscrewed from beneath the trap. I put this trap into operation first at Alexandria with very gratifying results. Thereafter I burned it nearly every night throughout the rest of the summer, reaping a harvest of the most astonishing abundance and variety, not only of Lepidoptera but also of Diptera and Coleoptera, and later of nocturnal Mutillidæ, which was what I was chiefly after. The Lepidoptera catch was so good and in such perfect condition, that I devoted to them all possible attention, spending often an hour or two of each morning in pinning them up, and am glad to say they reached the laboratory in fine shape. At present Dr. Forbes is engaged in studying them, and I have enthusiastic reports about them. Our first night's operation of the trap lantern, shining among the bushes on the edge of an open grove of young trees on a grassy knoll, yielded the very striking pink and yellow pyraustid, *Diasemia roseopennalis,* a far from common insect; the rare noctuid *Caradrina tarda* Guenée, and a good series of the recently described *Perimede particornella.*

Between Alexandria and Fredericksburg we passed through



Crossing the Gila River at Florence, Arizona.

A Muddy Road through the Chopawamsic Swamp in Virginia.

what proved to be, with one exception, the worst stretch of road between the Atlantic and Pacific. It was the notorious Chopawamsic Swamp near Occoquan, a stigma upon the fair name of Virginia. That such a mudhole should be tolerated within a day's ride of our national capital, blocking the main, almost the only, highway between north and south would be unbelievable if it were not so well known. While native harpies stood around eyeing us and chewing, ready with horses and tackle to pull us through for a goodly fee, we worked and sweated, pulling, pushing, shoveling, urging, broke a spring on the Buick, but finally got through and what is more, helped several others to get through, which made us quite unpopular with the natives. Females of *Vespa carolina* were common at the edge of the woods, searching for a nesting site. No workers were seen. At Fredericksburg Knight found *Corythuca arcuata* Say (identified by Drake) on oak. The trap lantern yielded, among other things, the uncommon noctuid *Ulolonche modesta* Morrison, the only eastern species of its genus.

The first of June found us in Petersburg. Amongst the trap lantern catch at this place appeared *Tetanolita mynesalis* Walker, and *T. floridana*, interesting noctuids of the subfamily Hypeninæ; *Ozarba æria* (a noctuid), the rare geometer *Priocycla decoloraria* Hulst, which was not represented in the National Museum collection at the time of publication of Dyar's list, the Crambid, *Diatræa zeacolella,* and the brilliant nolid, *Nigetia formosalis.*

Dr. Bequaert and I put in our best collecting these days at the noon stops for lunch, but the time available was little. On June 2, at South Hill, Virginia, were numerous bees in the flowers of *Senecio malli.* A shower near Gibsonville, North Carolina, on the following day was the last rain encountered until we reached western Texas. The country between had long been suffering severe drought, and nearly all garden truck was utterly ruined. This made difficult the purchase of fresh fruit and vegetables upon which we had been counting. A

The Colorado Desert at Coyote Wells, California. Looking southward into Mexico, from very near the International Boundary. The mountains are the Coast Range and form the western boundary of the desert.

like difficutly in obtaining milk was a source of continual amazement and disgust to those of us who were not used to southern ways. These members of our party were furnished a never-ending source of amusement in the open interest and undisguised curiosity in regard to our party manifested whenever we happened to stop. Although we were following the advertised lines of various auto "highways," nothing seemed to be more novel to the citizenry than transcontinental autoists. At each halt, especially in small towns, we were quickly surrounded by a curious but good-natured throng, who naïvely put to us whatever questions happened to occur to them, passed

CAMP IN THE DESERT NEAR SHEFFIELD, TEXAS. At night we would drive a short way from the road, and camp without further formality than to spread our blankets.

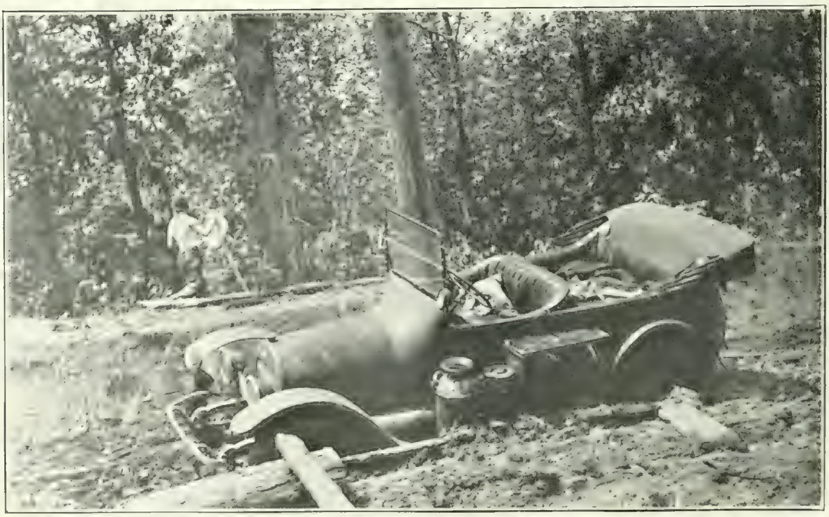
critical judgment upon our outfit and cars, and took keen delight in commenting to each other upon their probable sensations, if they were to take such a trip as ours. Net in hand, I was one day attentively regarding a bush along the road, when a lady passed, escorted by a gentleman. Her interest was all in what I was doing. I could hear her words, "My curiosity is getting the better of me, Jim! My curiosity *is* getting the better of me, Jim! My curiosity IS getting the *better* of me." But evidently she came off victorious, for strange to say they did not stop.

PHOTOGRAPHING A RATTLER AT BOWIE, ARIZONA, and the snake.

Our road led through Greensboro and Charlotte, North Carolina, Blacksburg and Spartansburg, South Carolina, into Georgia. *Raphiptera minimella*, a crambid, appeared in the trap lantern catch near Anderson, South Carolina. At Athens, Georgia, we were most hospitably entertained by Dr. J. M. Reade, professor of botany at the university, who accompanied us to Stone Mountain. Here the writer felt at

THE ENDLESS ROAD. Entering Musquiz Cañon in the Davis Mountains, Texas.

home, for it is to him an old and cherished collecting ground. On the bare rocks dwell a very interesting grasshopper, *Trimerotropis saxatilis* MacNeill, closely imitating the color of the rocks, even speckled with the green of the lichens with which the rocks are covered. The imposing spectacle of the north face of the mountain, like a huge Zeppelin at rest, a mass of bare granite, held a new interest, for workmen had started the heroic bas-relief figures of confederate heroes that are to cover it.



IN THE CATALINA MOUNTAINS NORTH OF TUCSON, ARIZONA, the autos yielded their load to slowly plodding burros. "Desert Canaries," the prospectors call them.

For night collecting, in addition to the trap light which I have described, we very generally made use of another device, the idea for which was derived from an article by H. S. Barber in the *Proceedings* of the Entomological Society of Washington (Vol. 13, pp. 72–73). It consisted of a tent of cheesecloth, four feet high, stretched over a pyramidal frame of eight wires, which could be taken apart and packed in a bundle. Four more wires formed an inner pyramid, two feet in height, which

CROSSING THE SABINE RIVER, with keen anticipation we set forth at last on the soil of Texas.

supported an acetylene burner, connected by a rubber hose with the prestolite tank of one of the Fords. The tent could be set up in a favorable situation, and never failed to draw a varied assortment of flies, moths, Hemiptera, Coleoptera, antlions, some grasshoppers, male ants, an occasional cicada, etc. Later on, in the west, it brought innumerable males of *Brachycistis* and *Chyphotes* (Myrmosidæ) and of *Photopsis* (Mutillidæ). It proved a very popular evening pastime to sit around this tent and pick off rarities. In the desert countries wind scorpions (Solpugida) were always to be found scurrying around it. Sometimes after an evening in which the insects were very numerous, we would turn the tent inside out and crowd it into a large cyanide can. Then after the catch was stilled what quantities of things were to be found! Of course the moths were largely ruined with that treatment. Some time I hope some *Lachnosterna* enthusiast may have the pleasure of rejoicing over his part of our nocturnal catches, and it will be no small share.

At Auburn, Alabama, we had a most delightful visit with Dr. J. W. Robbins, professor of botany in the Agricultural College. There was very good collecting on the flowers of *Ceanothus americanus* and of *Asclepias tuberosa*. In the trap lantern catch a prize appeared, a moth of a species which has subsequently been described by Barnes and McDunnough as *Lithacodia indeterminata;* also *Eois demissaria,* a good geometer.

South of Montgomery the road led through a wilderness that would delight one's heart. Perhaps the best of it was where we camped the night of June 11, two miles south of Leroy on a small stream flowing into the Tombigbee River. We had left the rolling red clay hills of the Piedmont Plateau behind us, and were in the sandy, piney woods of the coastal plain. A very sandy approach to an old negro church offered a good spot to pitch camp. To my great delight I soon found that this sand was the home of great quantities of Mutillidæ, which I spent all available time in collecting, males and females. *Calopteryx apicalis* lent a touch of tropical brilliancy to the foliage along the clear stream of black water, water the color of strong black tea. After supper we could not resist the lure of this stream with its sandy banks, and several of us had a fine swim; also washed our clothes. *Diachlorus femoratus,* the "yellow fly," was abundant and bloodthirsty, a perfect nuisance when bathing in the river. The spot was rich in horse flies: *Tabanus americanus* and *T. flavus,* the last-named species on the wooden walls of a house and in the tents in the morning. The trap lantern caught some fine crambids: *Raphiptera minimella* Robinson and *Iesta lisetta* Dyer. The previous night at Flatwood, we took *Diallagma lutea* Smith, representing a genus of Noctuidæ, hitherto unrepresented in the collection of Cornell University.

The Buick had now developed another broken spring, and was obliged to hobble along as far as New Orleans with one side propped up on timbers. Some day you may ask Mr. Shannon how it felt, riding over that wheel across the chuck holes of Mississippi. At Mobile we turned west along the Gulf, camping near Theodore. Here an interested lad of the region offered to guide some of us to "a fine swimming hole." *En route,* stimulated doubtless by the unusual features of our

Post Cañon in the Pinaleno Mountains. The charm of the forest-clad cañons and the upper slopes of these desert mountain ranges, so arid looking from below, is one of the desert's most charming surprises.

pursuits, he expounded upon philosophy in the following fatalistic words: "Live and larn, then die and fergit it all." But he was evidently less of a swimmer than philosopher, for the "swimmin' hole that us kids all goes in" was at most 15 inches deep and fifteen feet in diameter!

Across the road from our camp, some peculiar alligator-like grunts proved to be emanating from the southern bullfrog, *Rana grylio*. This species was described only about fifteen years ago. Its note is altogether different from that of our northern species.

Beyond Biloxi we camped on the beach, and wading out at dusk, kept going and going and going, and still the water was less than waist deep. We had gone out a quarter of a mile or more, when slowly, gracefully, between us and the shore, rose up and turned under, a great, huge fin! If the ichthyologist hadn't been along we might have said a shark, but he insists it was a porpoise, so in the interests of scientific accuracy we'll let it go at that. Here the trap lantern yielded *Hypenopsis macula*, a genus and species of Noctuidæ of uncertain relations, not represented in the university collections, a pyralid of the genus *Patissa*, subfamily Schœnobiinæ, that is probably undescribed and four specimens of a crambid with erratic venation and wing-form which Dr. Forbes believes represents a new genus. Another very interesting catch was *Diatræa evanescens*, described by Dr. Dyar as new to science at about the very time of our trip. This species we again caught at Schriever, Louisiana, and Richmond, Texas.

Crossing the Pearl River by ferry into the state of Louisiana, we lunched, June 15, near its west bank. Here is a typical bottom land, with cypress, black gum and other trees festooned by the great hanging llanos of bullace. Just the spot we thought for *Chlorippe*, so Paul Needham and I set off in search. We did not find any, but Paul did find our first *Thecla halesus*. Those who have seen this magnificent butterfly in the field will appreciate his abandoned delight. Surely we have in this country no more beautiful creature, with its brilliant azure wings and rapid darting flight. We also found on the cypress trees specimens of a beautiful new membracid, both here and again the following day at Colyell. Dr. Funkhouser has subsequently described them as *Stictolobus trilineatus*.

At Covington, Louisiana, we left the two Fords and the trailer to cross over some very wild country to Donaldsonville on the Mississippi River, while the Buick ferried across Lake

ONE OF THE FORDS. The streams of the desert rise with surprising swiftness after a rain, but drop again quite as suddenly.

Ponchartrain into New Orleans to have put in a new spring. This accomplished, we rejoined the Fords and started west from the river, June 17. The Fords had had some rough going, through dried-out cypress swamps, and the folks had had an interesting experience with moonshiners. Evidently the zoologists found good collecting, too, as it evidenced by the following passage from Paul Needham's diary:

> Ate dinner by a little stream, and it was here Dr. Wright went crazy. He drew a seine in it and caught everything he was after. He was chasing around, grabbing snakes, turtles, crayfish and frogs. In his great joy he heaved my net into the creek, and beat it away, yelling, after another snake. . . . Mrs. Wright had called dinner, but no dinner for him. He was giving orders, chasing snakes, catching frogs and so on. He ate his dinner on the way in the car.

That, multiplied by several, is not a bad picture of many of our noon-day stops. We always tried to pick out a favorable spot, and then after a hurried meal, devoted a specified amount of time to collecting. Invariably we made good and often exciting discoveries. Each man, working for his special group, would just be finding things of the greatest interest when honk-honk would go the horns and we would have to be off.

At Schriever, Louisiana, the trap lantern yielded some interesting species, among which may be mentioned two beautiful specimens of *Lophosis labeculata,* a crimson geometer with yellow border starred in Dyar's list as lacking in the U. S. National Museum; *Menopsimus caducus* Grote, probably our smallest noctuid, if indeed it is truly one at all, originally described from New Hampshire and here rather out of its known range; the female of a new species representing a new genus of herminiid deltoid (Noctuidæ) of which we were to take the male a few nights later; the species looks like a geometer. We also took *Chloropteryx tepperaria* Hulst, a fine geometer of neotropical affinities, the only species of its genus and previously represented in the university collection by a mere fragment; moreover, Dyar's list indicates that it was not represented at all in the National Museum. *Ampelopsis arborea* yielded good returns of Hymenoptera.

At Berwick we watched a shrimp catcher at his work, but found a backyard full of mink far more interesting. The owner took us in and they certainly were fascinating to watch. They crawled about over everything, and were particularly fond of climbing along the roof of an old shed, peering over the edge and watching one with their tiny black eyes. Here we caught the only North American endotrichid, *Neodavisia singularis* B. and McD. recently described from Florida.

UPS AND DOWNS NORTH OF PHŒNIX, ARIZONA.

From New Iberia we drove out to Avery Island, a bird sanctuary owned by Mr. McIlhenny. Here a heronry, tenanted by thousands of birds of several species, was a most interesting sight. There were numerous nests with young of various stages, upon which Mr. Shannon was very anxious to discover some Hippoboscidæ, but he had no success.

Much of Louisiana we found quite different from other communities. The French villages and planters, the great sugar plantations and the rice fields were novel to our experience. The never ending road took on new turns and twists, and especially endless right angle jogs through the interminable cane fields. In the villages, as main-and-only-street, it became the playground of swarms of children and domestic or semi-domestic animals and along it daily at four in the afternoon commenced the promenade of multitudinous hens. I suppose all autoists have noticed this habit of our domestic fowls to swarm forth on to the road for a sociable time as the afternoon begins to wane. In this particular region the custom seemed to have become established as chief social event of the chickenry and was even participated in by the hogs and the dogs.

Our night's camp was in a pasture hidden by a massive hedge. It contained many patches of the most beautiful cherokee roses. Mine host, who came down to bid us welcome, was a Frenchman, and a very serious-minded fellow. He discoursed with Mr. Lobdell at length upon the ethics of hospitality, offering it as his opinion that it was one's Christian duty to make the traveller welcome.

The following night our camp was quite without a parallel. Approaching the Sabine River the road was built up for several miles across the most splendid cat-tail marsh. We had several close-up views of some Florida gallinules, and also saw an alligator. A dozen rods before we came to the river at the ferry was a tiny elevated spot with a few trees around it, to one side of the road. Here we camped, while the mosquitoes made merry. Next morning, before starting, Dr. Bequaert and myself found excellent collecting on several kinds of flowers in the swamp and along the road. These were being visited by several kinds of bees. One fine large black species, *Emphor bombiformis*, was nesting in the black level clay of the road; the entrances to the galleries were protected by short, vertical chimneys of clay; the bees were visiting flowers of *Hibiscus oculiroseus*. During the night the trap lantern had been accumulating a catch of unusual interest. Among many others may especially be mentioned the following: *Celama sorghiella*, a nolid moth not represented in the Cornell University collection; the male of the undescribed genus and species of

TEXAS PASS.

Texas Pass, Dragoon Mts., Arizona. In this spot, suggestive of the Garden of the Gods in its fantastic rocks, we found many interesting species, some of the most notable being *Amblychila baroni,* and a large series of *Crioprosopus magnificus.*

noctuid of which we had taken a female at Schriever; a tineid near *Opogona* probably undescribed, and without close relatives in this country; a female of the enormous Pyralid, *Schœnobius maximellus,* and a series of the somewhat smaller, *S. sordidellus; Eoreuma densellus* Zeller, a crambid; *Ozarba æria;* three noctuids, *Arzama densa, Cobubatha luxuriosa* Sm. and *Tetanolita floridana.* This last is listed as occurring in Florida and Texas. We took it at localities all the way from Virginia to here, but not farther west.

Crossing the Sabine River, we entered Texas June 21, twelve days behind the schedule which we had outlined for the trip. We were all very enthusiastic, for from now on the collecting might be expected to yield the most interesting possible results. Ahead lay the deserts and arid waste lands. The car drivers looked forward to new experiences in driving over roads which must be very different from those of their previous experience and all were impatient for the transition from the humid country to the arid.

At Devers where we spent the night, the trap lantern collected our first specimens of a not uncommon Texan lithosiid: *Comacla simplex* Walker, which however represented a genus and species new to the university collections. We subsequently took the species at several localities.

We lunched on the twenty-second along the San Jacinto River. There is a fine growth of heavy woodland along the stream. The beautiful clear water and white clean sand bars proved an irresistible attraction for a swim. The bars were swarming with Cicindelas of two species, of which we caught many. The camp that night on an embankment overlooking the Brazos River, opposite the town of Richmond was, entomologically, an unusually fine one. Dr. Bequaert and myself had been long impatient to find the first male nocturnal Mutillas. This group of Mutillidæ is very abundant in the southwest, but with the exception of two species, is unknown from east of Texas. The two more easterly forms have been taken very rarely (both by the writer) in Georgia and one in Alabama. We were not so fortunate as to take either of these species this trip, but here, almost our very first night in Texas, we took one of the western forms and also males of a large species of *Eciton,* one of the legionary ants. *Comacla simplex* and *Diatræa evanescens* were also in the catch again. The next morning, along the river, collecting was very good, especially for Mutillidæ and aculeate Hymenoptera. Butterflies of several interesting species were also abundant. Within a few feet of our tents we caught two copperheads, and in knocking a log to pieces to get one of them, found any quantity of a fine steel blue pentatomid, *Proxys punctulatus* (P. B.).

Opposite Wharton on the Colorado River we had a real sensation. We were encamped in an open grove overlooking the river, very busy collecting, amongst other things, the Mutillidæ which were especially abundant here, when lo and behold! a herd of zebus came slowly toward us, stopping to graze and apparently not at all surprised or interested in *us,* though you may imagine that we certainly were in them. What magnificent creatures they are, when at large. It seems that we were encamped in the pasture land of a very progressive stock farm, the owner of which, not content with the more ordinary kinds of cattle, had imported these Indian beasts.

Of the several species of *Mutilla* found here, *orcus* was the most conspicuous, a truly western species. *Comacla simplex,* the lithosiid, was again in the trap lantern, as was *Cobubatha quadrifera.* Knight found the following Cicadidæ: *Tibicen pruinosa, marginalis, superba, viridifascia.* At Victoria we collected *Eresia texana,* not previously in the university collections. There the trap lantern again did good work. Notable among the captures were: *Eubolina impartialis* Harvey, a Texan noctuid not represented in the university collection, nor even its genus; a crambid of the genus *Thaumatopsis; Tamarrha delliella* Fernald, *Macrotheca flexilinealis* Dyar, a recently described species representing a subfamily of Pyralidæ erected by Barnes and McDunnough, related to Galleriinæ. We took this at New Braunfels and had taken it previously at Wharton. The same is true of *Cobubatha quadrifera* which was also in the catch. A horned toad, the common *Phrynosoma cornutum,* the first that we had seen, was a decided reminder that we were close upon the truly arid regions.

From Victoria northwestward, we travelled along the dividing line, as drawn by Bailey, between the austroriparian and sonoran life zones, that is to say, between the humid and arid divisions of the lower austral. We continually passed extensive undergrowths of mesquite, often miniature forests. Sometimes when this was in flower, it attracted numbers of *Pepsis* and other Hymenoptera. Camping in one of these thickets we were delighted to find a cactus wren building near at hand. Interesting sounds from the mesquite led us to a still hunt for Orthoptera after dark with flashlights, but the singers were exceedingly wary and we had little success. During the night the trap lantern caught: *Yrias crudelis* Grote, a genus and species of Noctuidæ new to the University collection; *Eublemma obliqualis,* a species of noctuid not recognized from the United States when Dyar's list was issued; and *Illice unifascia. Ozonadia tenuifascia,* specimens of which we collected the preceding night at Victoria, was until recently supposed to be a variety of this pretty little lithosiid.

Here for the first time we captured one of the whip-tailed lizards, characteristic species of the open desert, and of which we subsequently found many specimens of four species. The one here was *Cnemidophorus gularis.* Here as at Victoria were many Cicadidæ of a species ordinarily identified as *Pacarina signifera* Walker; another species, *Tibicen marginalis,* also occurred at Victoria and *T. superba* at Sutherland Springs near here. At the last-mentioned locality we also found the little erycinid butterfly, *Calephelis perditalis,* which at the time we collected was still new to science, and the large longicorn *Stenaspis solitaria.*

(*To be continued*)

Portrait by Ralph Clarkson

THOMAS CHROWDER CHAMBERLIN

THE PROGRESS OF SCIENCE

PRESENTATION OF THE PORTRAIT OF PROFESSOR CHAMBERLIN

THROUGH the initiative of Professor J. Paul Goode, the colleagues and students of Professor T. C. Chamberlin have presented to the University of Chicago his portrait painted by Mr. Ralph Clarkson. In the course of his presentation address, Professor Bailey Willis said: "Thomas Chrowder Chamberlin is one of the great minds of science and his heart is as great as his mind. Large of stature as he is large of brain, he is a man whose manhood has been proved in every sphere of activity, which called for energy, endurance, and vitality. He carries on to-day vigorously, after seventy-four years of unsparing demand upon his physical powers, and we have every reason to hope that our cherished wish that he may carry on for many years to come will be fulfilled. Chamberlin's purpose has always been constructive. The impulse of the builder has ever been conspicuous in his mental work. It appears at every point of his career, from the time of his young manhood, when he built up the geological survey of Wisconsin, throughout his presidency of Beloit and of the University of Wisconsin, to the constructive period of the University of Chicago, and throughout his activity on innumerable committees of the communities in which he has lived. The constructive purpose stands out as characteristic of the man's nature. In science also his activity has been that of a great builder, although, as fate would have it, he was first obliged to destroy old structures because they stood in the way of the nobler structures which must be built. Chamberlin combines the mentality of the explorer with that of the poet. He possesses in a high degree the power of imagination which distinguishes them both. But he is greater than the explorers of strange lands, even as Columbus was greater than Cortes, in that in him love of adventure is dominated by love of truth; and Chamberlin outsoars the poet in that his imagination rises into realms of truth beyond those reached by a Tennyson or a Browning, yet remains ever conscious of the dominance of eternal law."

In accepting the portrait President Judson spoke of Professor Chamberlin as "one of the founders of the University of Chicago, one of the founders of modern geological thought, one of the founders of the highest schools of intellectual and scientific integrity." On being called upon, Professor Chamberlin spoke of the cooperation of his students and colleagues and said: "The view that stability in the past and great endurance in the future are prime attributes of our planet—that part of creation in which we are participants—is the one tenet about which my affections cling more strongly than any other. It is to me supremely satisfactory that a prolonged study of the earth yields steadily accumulating evidence of fundamental conditions that give a generous outlook for our race. This gives an enlarged value to what we ourselves may do; it is lasting in kind. It is gratifying to feel that adequate time is likely to be given for truth to work out its good influences in spite of the adverse effects of untruth. If the earth is to pass away in a few thousand years—at least as a habitable globe—the good and bad seem so nearly balanced in this initial stage of our evolution that their equated value is relatively small and the creation of the earth seems scarcely to have been worth while; but if adequate time is to be granted so that the truth may grow and may fully prove itself, and the good triumph over the bad because it is good, the outlook for the future becomes inspiring to the last degree."

THE FOREIGN-BORN POPULATION OF THE UNITED STATES

PROBLEMS of war and reconstruction call special attention at the present time to the foreign born population of the country. It may consequently be desirable to reproduce the diagrams and descriptions published by the Bureau of the Census.

Fig. 1 indicates, by the length of the bars, the number of natives returned at the census of 1910, from each of the foreign countries that were tabulated separately, the countries being arranged in the order of the total number returned. There were 2,501,333 natives of Germany, over three quarters of a million more than was returned from Russia, which stood second. The smallest number returned was 1,736, from Central America.

FIG. 1. FOREIGN-BORN POPULATION BY COUNTRY OF BIRTH, 1910.

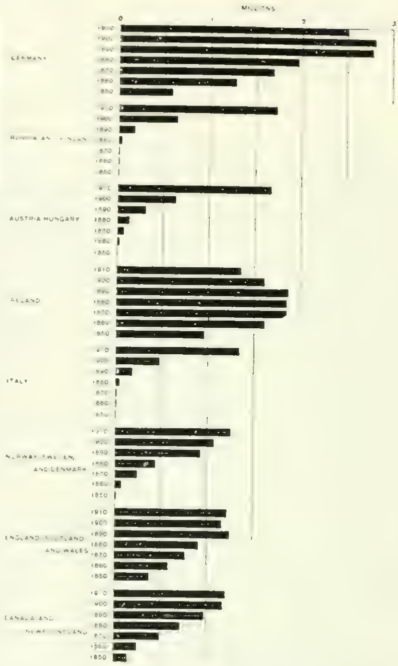


FIG. 2. FOREIGN-BORN POPULATION BY PRINCIPAL COUNTRIES OF BIRTH, 1850–1910.

Fig. 2 shows, by the length of the bars, the number of natives of each of the principal foreign countries that were returned at each census, from 1850 to 1910, the countries being ranked according to the number returned in 1910. The natives of Germany increased in numbers from 1850 to 1900, but in 1910 there was a falling off. There was a comparatively small number of natives of Russia and Austria-Hungary returned at the censuses prior

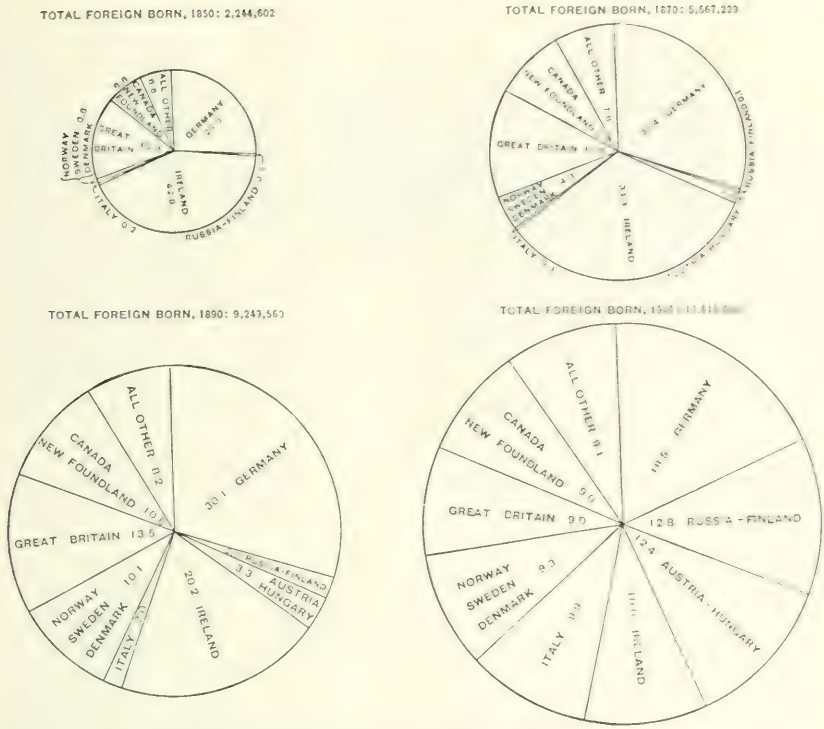


Fig. 3. Per cent. Distribution of the Foreign-born Population by Principal Countries of Birth, 1850, 1870, 1890, and 1910.

to 1900. Increasing numbers of Irish are found at each census from 1850 to 1890, when the highest mark was reached; since then the number has steadily decreased. The natives of Italy, like those of Austria-Hungary, came in great numbers to this country between 1890 and 1900, and especially between 1900 1910. Norway, Sweden and Denmark combined have had a constant increase at each census since 1850. Natives of England, Scotland, and Wales increased from 1850 to and including 1890; 1900 showed a slight decrease from the previous enumeration, but in 1910 an increase over the 1900 census was reported. The natives of Canada and Newfoundland increased at each enumeration from 1850 to 1910, although the increase from 1900 to 1910 was small.

In Fig. 3 the four circles are proportionate in size to the total foreign-born population returned at the censuses of 1850, 1870, 1900 and 1910. The divisions of each circle present the percentage of distribution of the foreign-born population by principal countries of birth. In 1850 the natives of Ireland (42.8 per cent.), Germany (26 per cent.) and Great Britain (16.9 per cent.) formed 85.7 per cent. of the foreign-born population. In 1870 the same countries furnished 77.5 per cent. Germany increased its proportion and was nearly equal to the Irish, the percentage being 33.3 for Ireland against 30.4 for Germany. In 1890 the Germans outnumbered the Irish at the rate of 30.1 to 20.2. In 1810 Germany was again the country furnishing a larger proportion than any other, with 18.5;

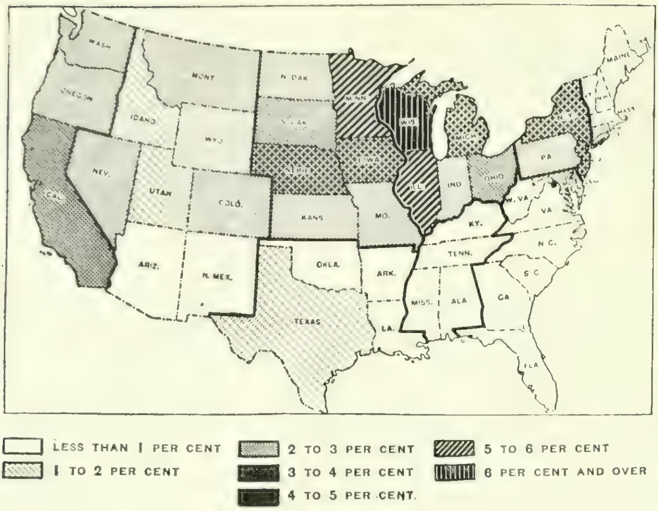


FIG. 4. PER CENT. OF GERMAN-BORN POPULATION IN EACH STATE; 1910.

Russia and Finland, with 12.8 per cent., and Austria-Hungary, with 12.4 per cent., were second and third, respectively, Ireland having fallen to the fourth place, with 10 per cent., and being about equal to Italy with 9.9 per cent.

Fig. 4 shows the percentage of the population of each state, at the census of 1910, born in Germany. The Germans form a larger proportion of the total population of Wisconsin (10 per cent.) and Illinois (5.7 per cent.) than of any other state.

The figures so far given refer only to the foreign born, but we are also concerned with natives of foreign parentage, and the natives of mixed parentage—that is, one parent foreign born and one parent native. Fig. 5 presents the foreign white stock by principal countries of origin, for 1910, in these three classes. The largest number was from Germany, the bar being shaded to indicate first the number born in Germany; second, the number born in this country, both parents born in Germany; and third, the native with one parent born in Germany and the other in

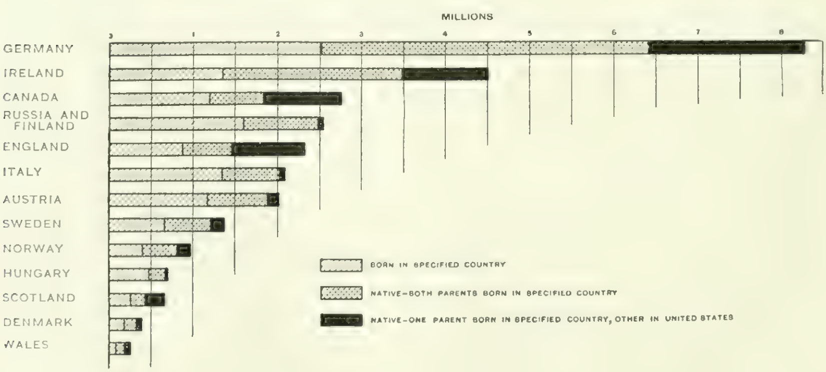


FIG. 5. FOREIGN STOCK BY PRINCIPAL COUNTRIES OF ORIGIN, 1910.

the United States. The same designations are carried out through all the bars. One peculiarity will be noticed in the bars for the countries which have only recently begun to send large numbers of their natives to the United States. Of Germany, Ireland, Canada and England, the foreign white stock includes a large number of one parent born in the specified country and one in the United States. The bar for Russia and Finland, as well as those for Italy, Austria and Hungary, have a very small proportion in this class.

THE USE OF HELIUM FOR AIRSHIPS

AN article in *Nature* states that shortly after the commencement of the war it became evident that if helium were available in sufficient quantities to replace hydrogen in naval and military airships, the losses in life and equipment arising from the use of hydrogen would be enormously lessened. Helium, as is known, is most suitable as a filling for airship envelopes, in that it is non-inflammable and non-explosive, and, if desired, the engines may be placed within the envelope. By its use it is also possible to secure additional buoyancy by heating the gas (electrically or otherwise), and this fact might possibly lead to considerable modifications in the technique of airship maneuvers and navigation. The loss of gas from diffusion through the envelope is also less with helium than with hydrogen, but, on the other hand, the lifting power of helium is about 10 per cent. less than that of hydrogen.

Proposals had been frequently put forward by men of science regarding the development of supplies of helium for airship purposes, but the first attempt to give practical effect to these proposals was initiated by Sir Richard Threlfall, who received support from the Admirality through the Board of Invention and Research.

It was known that supplies of natural gas containing helium in varying amounts existed in America, and it became evident from the preliminary investigations as to cost of production, transportation, etc., that there was substantial ground for believing that helium could be obtained in large quantities at a cost which would not be prohibitive. In the course of the investigations, which were carried out with the cooperation of L'Air Liquide Co., it was found that large supplies of helium were available in Canada, which could be produced at a cost of about one shilling per cubic foot.

In the summer of 1917, when the United States of America had entered the war, and after the investigations referred to above were well under way, proposals were made to the Navy and Army and to the National Research Council of the U. S. A. to cooperate by developing the supplies of helium available in the United States. These were made, on behalf of the Admiralty, through the Board of Invention and Research by Sir Ernest Rutherford and a special Commission consisting of Commander Bridge, R.N., Lieutenant-Colonel Lowcock, and Professor John Satterly.

The authorities cited agreed to cooperate with vigor in supporting these proposals, and large orders were at once placed by them with the Air Reduction Co. and the Lynde Co. for plant, equipment, cylinders, etc. The Bureau of Mines also cooperated in developing a new type of rectifying and purifying machine. By July, 1918, the production of helium in moderate quantities was accomplished, and from that time onward the possibility of securing large supplies of helium was assured.

Concurrently, all practical details of the production of helium-borne airships and of the navigation of this type of craft were developed by the airship production section of the Navy. At the same time, under the direction of Professor McLennan, plans were prepared and steps taken to erect and equip a station for purifying the helium which might become contaminated in service. Experimental investigations were also initiated with the object of developing the possible technical and scientific uses of helium. In particular, balance and spectroscopic methods for testing the purity of the gas were worked out, studies on the relative permeability of balloon fabrics to hydrogen and helium were commenced, and experiments were begun to exploit the use of helium in gas-filled incandescent lamps, gas-filled arc lamps, and thermionic valves. The equipment provided for the purification of contaminated helium in large quantities supplied the major portion of the apparatus required to liquefy helium, and arrangements were therefore made to produce this gas in a liquid form.

The advances already made by the time the armistice commenced warrants the opinion that at the end of another year large supplies of helium would have been produced within the empire at a low cost, helium-filled aircraft would have been in service, and great progress would have been made in exploiting the technical and scientific uses of this gas.

SCIENTIFIC ITEMS

We record with regret the death of Charles Leander Doolittle, Flower professor of astronomy, emeritus, at the University of Pennsylvania and director of the Flower Obervatory; of John Wallace Baird, professor of experimental psychology in Clark University; of Captain Theodore de Booy, the archeologist and explorer; of G. Carey Foster, formerly principal of University College, London, and previously professor of physics there, and of R. A. E. Blanchard, professor of parasitology in the faculty of medicine, University of Paris.

Dr. William Williams Keen, the distinguished surgeon, had conferred on him the honorary degree of Doctor of Laws by the University of Pennsylvania on University Day. Dr. Keen is the only commissioned officer in the present war who was a commissioned officer during the Civil War.—Dr. Livingston Farrand has resigned the presidency of the University of Colorado to become the executive head of the American Red Cross. Dr. Farrand was formerly professor of anthropology at Columbia University.

The work on volcanology at Kilauea has been placed under the U. S. Weather Bureau. The transfer was effective on February 15 and the appointment of the Director Professor T. A. Jaggar has been approved. An appropriation of $10,000 for the year is made by the government for continuing the work heretofore maintained by the Volcano Research Association.

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BIOMETRIC STANDARDS FOR ENERGY REQUIREMENTS IN HUMAN NUTRITION

By Dr. J. ARTHUR HARRIS and Dr. FRANCIS G. BENEDICT

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ONE of the primary requisites in all of the exact sciences is the establishment of standard bases of comparison. For a decade the Nutrition Laboratory of the Carnegie Institution of Washington has been engaged in the precise investigations which must underlie the establishment of such standards in human nutrition.

This is an undertaking of the greatest practical importance. In times of peace, industrial efficiency and the physical well-being of the population demand exact knowledge of the amount and proportion of the different kinds of food which should be taken by the individual. If communities or nations are to be stringently rationed during periods of emergency, it is also necessary to know the minimum amounts of food required to maintain health and efficiency.

The problem is also one of great complexity. Aside from all questions concerning the chemical composition, digestibility and other physiological properties of the various foods, there are a large number of problems concerning the characteristics of human individuals which must be taken into account.

For example, it is obvious that those who are engaged in severe muscular work must consume larger quantities of food supplying energy than those who are less active. It might seem reasonable to suppose that larger individuals would require more food to carry on their normal activities than those who are physically smaller. It is a matter of common observation that older men and women demand smaller rations than those in the earlier stages of life.

All these questions require precise investigation before one is justified in drawing conclusions concerning them. If such investigations are to be used as a basis of recommendation concerning diet in peace or of regulation of diet in war, it is essential that the laws of energy transformation be expressed in a quantitative form.

Nutritional physiologists agree that, as far as energy is concerned, the food requirements of the living organism shall be expressed in calories per unit of time. Thus a physical standard is taken over from the quantitative sciences of physics and chemistry. Theoretically, then, the metabolism must be determined by placing the subject in a calorimeter and directly measuring the number of calories produced. This has been done in a large number of cases.

Since, however, the setting free of energy in the human body is merely a process of combustion, the measurement of the amount of oxygen consumed and the quantity of carbon dioxide excreted from the lungs should furnish a good index of heat production. Thus the nutritional physiologist may avail himself of the method of *indirect calorimetry* as well as of *direct calorimetry*. Heat production, in short, may be determined in a calorimeter or it may be computed from the gaseous exchange as measured in a respiration chamber.

The development of apparatus by which the heat production of the living organism may be directly measured in the calorimeter or by which the gaseous exchange may be precisely determined in the respiration chamber has occupied the attention of a large number of ingenious experimenters, among whom may be mentioned Lavoisier, Rubner, Zuntz, Atwater, Rosa, Lusk and Du Bois. The labors of these and others have brought the apparatus for the measurement of both heat production and gaseous exchange to such a high degree of refinement that the manipulative phases of nutritional physiology may be regarded as among the most exact techniques of biological experimentation. Extensive comparative studies have shown that, in the case of human subjects, it is much simpler and essentially as accurate to calculate the heat production indirectly from the gaseous exchange than to measure it in the calorimeter.

The problem is not, however, solely one of physical and chemical measurement. A number of biological factors must be taken into account. Muscular activity and the stimulatory action of recently ingested food are of chief importance. The apparatus with which students of human nutrition now work has been brought to such a stage of perfection as to measure the energy transformation accompanying such slight muscular activity as that required in the raising of the hand from the side to the mouth. The cost in calories of masticating food may be directly measured. For example, recent studies at the Nutrition Laboratory by Carpenter and Benedict have shown that the muscular work in chewing gum may increase heat production approximately 17 per cent. The difference between the heat production of a new-born infant asleep in its basket and crying can be precisely measured. Thus Talbot and Benedict found that the metabolism of the new-born infant is increased on the average by 65 per cent. in crying with its attendant muscular activity. Students of animal nutrition have long realized that the demands for energy of an animal standing are far higher than that of the same beast lying down. This fact must be taken into account in computing the maintenance requirements of cattle and other domestic animals.

Heat production is greatly increased after eating, and the amount of the increase is closely dependent on the nature of the food consumed. For example, the metabolism of a subject may be increased by 25 per cent. after a meal consisting chiefly of carbohydrates, but by as much as 45 per cent. after a heavy protein meal.

It is necessary, therefore, to eliminate all such factors in determining the standards which shall serve as bases of comparison in applied nutritional physiology.

Since the outbreak of the war, and particularly since our own participation in the conflict, the Nutrition Laboratory has, in addition to extensive investigations on the influence of subnormal rationing upon health and efficiency, pushed forward as rapidly as possible its work on the establishment of nutritional standards. One phase of this program has been the statistical investigation of the so-called basal metabolism of the human individual.[1]

Physiologists have gradually come to a general agreement that the heat production at complete muscular repose and in the post-absorptive state—*i. e.*, about twelve hours after the last meal—shall be called the basal metabolism and shall be used as a standard of comparison in the investigation of all the special problems of human nutrition.

[1] The detailed measurements and the statistical constants, with full discussions of pertinent literature, are about to appear in Publication 279 of the Carnegie Institution of Washington. We shall not, therefore, burden this brief outline with references to literature or statistical detail. Two of the diagrams used here are redrawn from this publication.

For several years the Nutrition Laboratory has been engaged in the measurement of basal metabolism in normal human individuals of both sexes and of widely different ages. These have been made with all the modern refinements of method and manipulation. The subjects were in presumably good health. All those with febrile temperature were rejected. All were in the post-absorptive condition. Perfect muscular repose during the short periods required for indirect calorimetry was assured by instruments providing an automatic record of all movements, even those imperceptible to trained observers.

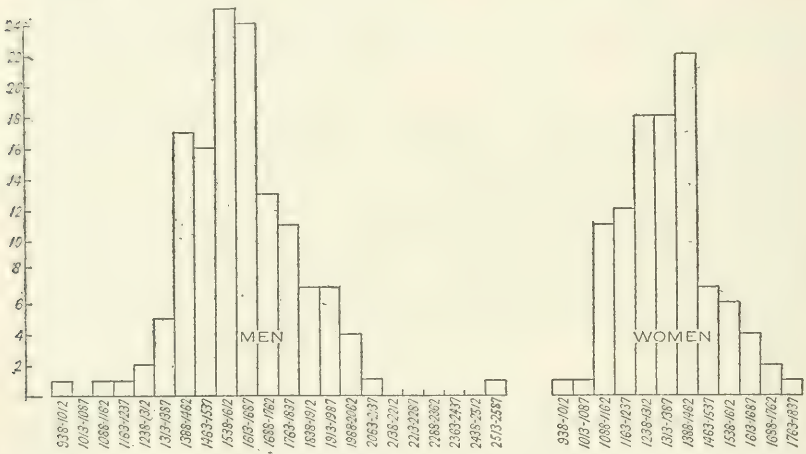

FIG. 1. FREQUENCIES OF MEN AND WOMEN PRODUCING VARIOUS NUMBERS OF CALORIES PER TWENTY-FOUR HOURS.

In carrying out a biometric analysis of the measurements which have been made on 136 men, 103 women, and 94 newborn infants, we have proceeded on the conviction that the widest possible usefulness of laboratory investigations of normal human metabolism will result from basing measurements upon those in presumably good health but otherwise typical of human beings in general. It is only when the subjects used for experimentation are representative of the population at large in type, variability and correlation that the results of laboratory research upon limited series may be safely generalized for rationing or for other practical social applications. An explanation of the statistical tests which have been applied to determine the suitability of the series used in the present investigation would lead us into too great detail for this discussion.

The average basal metabolism per twenty-four hours is as follows:

For 136 men	1631.74 calories.
For 103 women	1349.19 calories.
For 51 male infants	144.55 calories.
For 43 female infants	140.37 calories.

Thus it appears that the basal energy requirements of the American men are a little less than one half of the number of calories (3,300) established by the Inter-Allied Scientific Food Commission as necessary for rationing in the case of men doing average work eight hours per day. They are a little less than half the 3,200 to 3,600 calories used by a group of men at the Springfield Y. M. C. A. college before they were subjected to rationing tests by the Nutrition Laboratory. The average for new-born infants is somewhat less than ten per cent. of that of women.

Human beings differ in their basal metabolism just as they do in stature, weight, pulse-rate and other measurable characters. For example, the 136 men and 103 women showed the daily caloric output represented by Fig. 1. In these polygons the ordinates represent the frequencies of total heat production in calories per twenty-four hours.

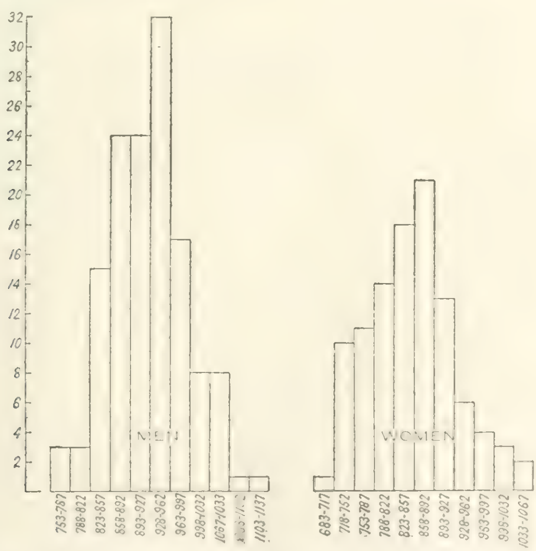

FIG. 2. FREQUENCIES OF MEN AND WOMEN PRODUCING VARIOUS NUMBERS OF CALORIES PER SQUARE METER OF BODY SURFACE PER TWENTY-FOUR HOURS.

The distribution of daily heat production in men and women is represented by monomodal, more or less symmetrical frequency polygons. This result is of considerable interest since it shows that the distribution of the magnitude of human basal metabolism exhibits the same orderliness that biometric work has shown to prevail in the variation of other biological measurements. When data are somewhat more numerous, it will be profitable to carry the analysis further by fitting theoretical frequency curves to these frequency distributions.

Measured statistically, the variability of these subjects may be expressed by standard deviations of 204.66 calories in men and of 155.18 calories per twenty-four hours in women, or by coefficients of variation, *i. e.*, of standard deviations expressed as percentages of the means, of 12.54 per cent. in men and of 11.50 per cent. in women.

The statement that variation in the total daily heat production of adults is measured by a coefficient of 11.5 to 12.5 per cent. will mean very little to the non-statistical reader until he can compare these with coefficients for characters with which he is more familiar. In our series stature shows a coefficient of variation of 4.39 in men and 3.20 in women, body weight a coefficient of variation of 16.06 in men and 20.35 in women, pulse rate at complete rest a coefficient of variation of 10.99 in men and 12.01 in women. Thus basal metabolism shows a variability far greater than stature but less than body weight and of roughly the same order of magnitude as pulse rate.

Basal metabolism is, therefore, rather highly variable. The reader will have noted, however, that the foregoing polygons and constants are based upon the total daily heat productions of adults in presumably good health but of various body weights, statures and ages. It has already been suggested that basal metabolism is related to these physical characters.

We must now inquire whether the observed variability in heat production is due in part to differences in bodily dimensions. This influence has been considered so great that some physiologists have asserted that heat production per square meter of body surface is a constant.

That heat production expressed in calories per square meter of body surface is not a constant in any exact sense is shown by Fig. 2, in which the ordinates represent the frequencies of total heat production per square meter of body surface as estimated by the Du Bois height-weight chart.

These diagrams show clearly that heat production per square meter, like total daily heat production, is a variable function. In both cases the frequencies decrease as the magnitudes of the constants diverge more widely, in both the plus and the minus direction, from the average for the whole series.

The fact that a large variability in daily heat production remains when it is reduced to calories per square meter of body surface does not, however, warrant the conclusion that metabolism is independent of bodily dimensions.

To investigate this problem we have merely to group all individuals according to some physical character and to determine whether metabolism changes with variation in the magnitude of the selected physical dimension. For example, Fig. 3 is made by representing the stature and the heat production

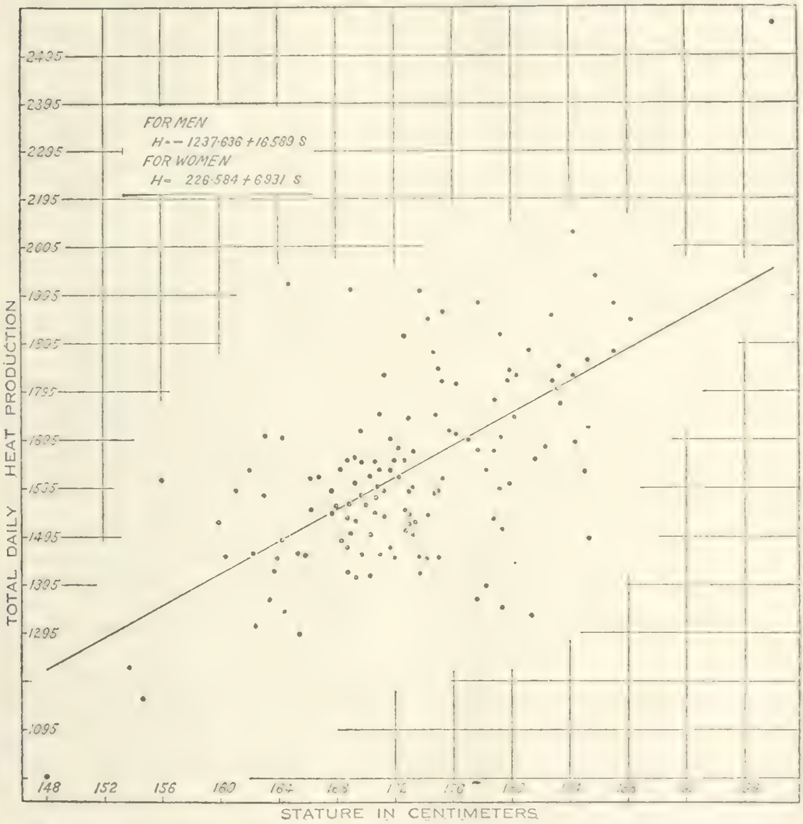

FIG. 3. RELATIONSHIP BETWEEN STATURE AND TOTAL DAILY HEAT PRODUCTION IN 136 MEN.

of each individual on the horizontal and the vertical scales by a dot. It will be seen at a glance that the metabolism of men of any stature is highly variable. Nevertheless there is an orderly trend in the swarm; there is a marked tendency for taller men to show greater daily heat production.

Such relationships may be represented in a different way. Take another physical character for purposes of illustration. One may determine the average daily heat production of individuals of different body weights, represent these averages by a series of points and smooth them with a straight line. Thus Fig. 4 shows quite clearly that the daily heat production of individuals tends to increase in a sensibly linear manner with their mass.

For exact comparison we must have recourse to some precise method of expressing the degree of relationship between physical characters and basal metabolism. This may be done by the use of the coefficient of correlation which measures the degree of interdependence of two variables on a universally

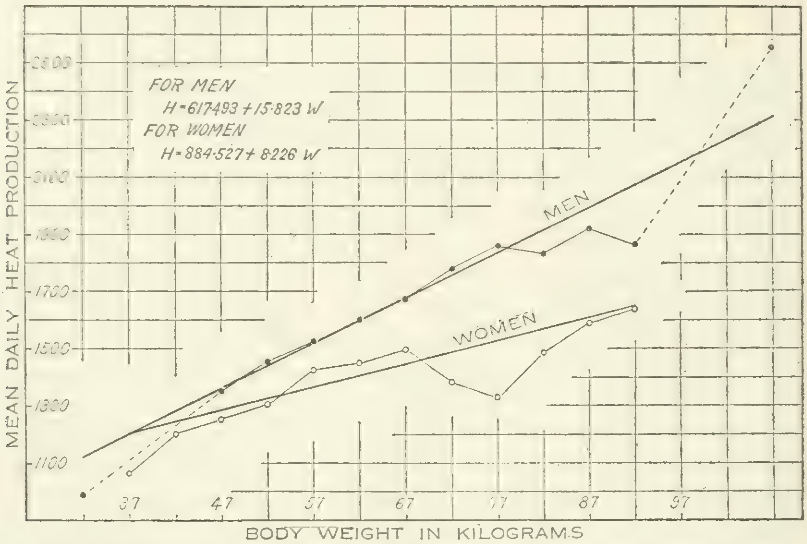

FIG. 4. RELATIONSHIP BETWEEN BODY WEIGHT AND DAILY HEAT PRODUCTION. Actual averages and fitted straight lines.

comparable scale of unity. We find the values for the correlations between stature, body weight and body surface on the one hand, and total daily heat production on the other given in the accompanying table.

Series	Stature and Total Heat-production	Body-weight and Total Heat-production	Body-surface and Total Heat-production
Men (136)	+ 0.615 ± 0.036	+ 0.796 ± 0.021	+ 0.820 ± 0.019
Women (103)	+ 0.232 ± 0.063	+ 0.609 ± 0.042	+ 0.611 ± 0.042
Male infants (51)	+ 0.619 ± 0.058	+ 0.752 ± 0.041	+ 0.749 ± 0.042
Female infants (43)	+ 0.743 ± 0.046	+ 0.808 ± 0.036	+ 0.809 ± 0.036

The coefficients measuring the relationship between body weight and metabolism are in all cases higher than those between stature and metabolism. Body mass is, therefore, a more important factor in determining (in the proximate but not necessarily in the causal sense) the basal daily heat production of the individual than is a linear bodily dimension such as stature. The correlations between body weight and metabolism and between body surface and metabolism are of approximately the same magnitude. The two characters have, therefore, the same value in indicating the basal metabolism of the subject.

We have just noted that metabolism is correlated with both stature and body weight. Heavier and taller individuals have a larger daily food requirement. But body weight and stature are correlated characters. The interesting question, therefore, naturally arises whether the greater heat production of tall individuals may not be merely the resultant of the relationships between stature and weight on the one hand and weight and metabolism on the other.

This question may be solved by the use of appropriate partial correlation formulæ. We have to determine whether there is a correlation between body weight and daily heat production when correction has been made for the influence of stature, and conversely, to determine whether there is a correlation between stature and daily heat production when correction is made for the influence of body weight. The results are given in the accompanying table.

Series	Correlation Between Weight and Total Heat-production			Correlation Between Stature and Total Heat-production		
	Gross Correlation	Corrected for Stature	Difference	Gross Correlation	Corrected for Weight	Difference
Men (136)	+0.796 ± 0.021	+0.687 ± 0.031	+0.109	+0.615 ± 0.036	+0.321 ± 0.052	+0.294
Women (103)..	+0.609 ± 0.042	+0.580 ± 0.044	+0.029	+0.232 ± 0.063	+0.045 ± 0.066	+0.187
Male infants (51)...	+0.752 ± 0.041	+0.549 ± 0.066	+0.203	+0.619 ± 0.058	+0.095 ± 0.094	+0.524
Female infants (43)...	+0.808 ± 0.036	+0.494 ± 0.078	+0.314	+0.743 ± 0.046	+0.149 ± 0.101	+0.594

Since the partial correlation coefficients have sensible positive values, it is evident that both stature and body weight have independent significance in indicating daily heat production. This is a result of great importance, since it underlies the determination of the best formulæ for the prediction of the basal metabolism of the individual.

Let us now consider the relationship between metabolism and age.

The change in the food requirements of the human individual with age is not merely a question of material importance to the clinician, but of great interest to the biologist in its bearing upon the general problem of senescence.

The decrease in basal metabolism with age during the period of adult life has been shown to be well represented by the linear equations.

For men ($N = 136$),

$h = 1823.80 - 7.15\,a$, $h_k = 28.703 - 0.112\,a$, $h = 1022.17 - 3.60\,a$.

For women ($N = 103$),

$h = 1420.47 - 2.29\,a$, $h_k = 28.308 - 0.124\,a$, $h = 924.25 - 2.96\,a$.

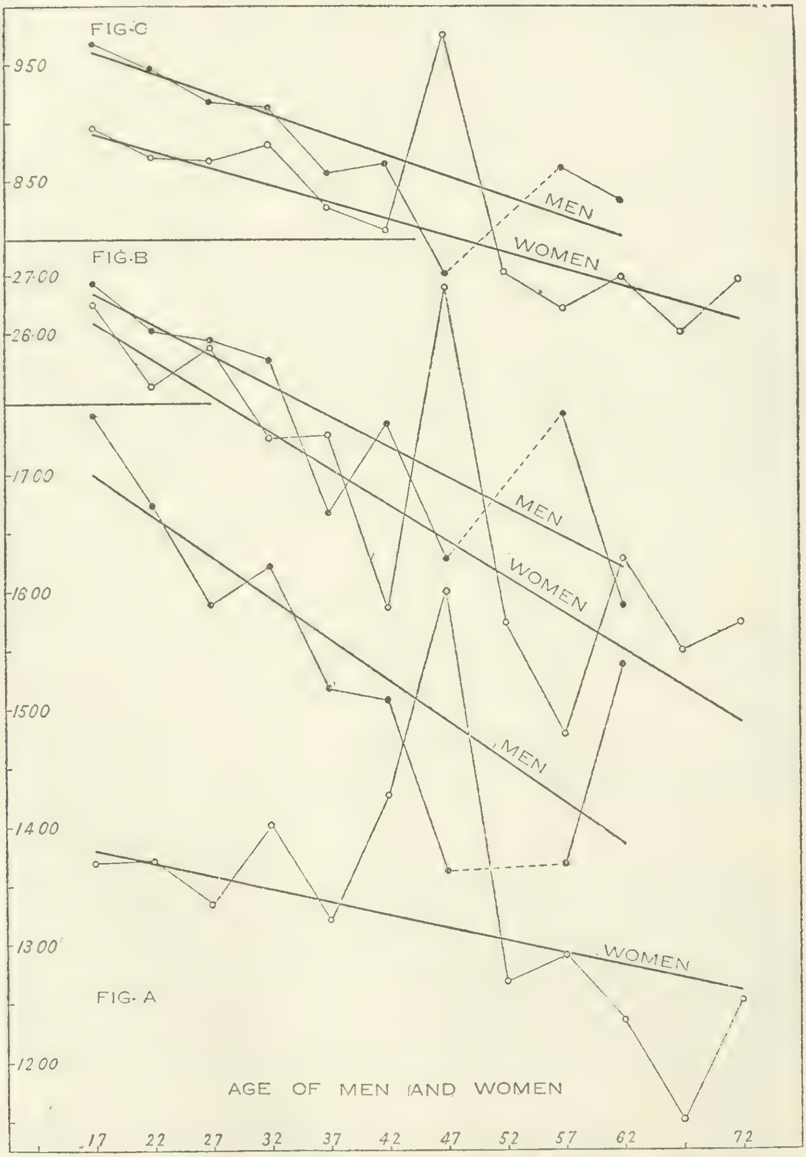

FIG. 5. DECREASE IN METABOLISM WITH AGE IN MEN AND WOMEN. Fig. *A* shows the decrease in total daily heat production, *B*, the decrease in calories per kilogram of body weight and *C*, the decrease in calories per square meter of body surface. The straight lines are due to the equations given in the text.

where h = total heat production in calories per twenty-four hours, h_k = calories per kilogram of body weight, h^D = calories per square meter of body surface, as estimated by the Du Bois height-weight chart. These lines are represented in the three diagrams of Fig. 5. While the actual mean heat productions are distributed about these lines with very great irregularity because of the small number of individuals (considered from the statistical, not from the physiological, side) it is doubtful whether equations other than those for straight lines could be advantageously employed.

These equations show that in men the daily heat production decreases about 7.15, while in women it decreases about 2.29 calories per year. Women are smaller than men and have a lower heat production. When the decrease in metabolism with age is expressed in calories per kilogram of body weight or in calories per square meter of body surface, the results for the two sexes are more nearly identical. The linear nature of the change in metabolism with age during the period of adult life fully substantiates the conclusions of biological writers concerning the greater continuity of senescence in the vertebrates as compared with lower organisms. It also shows that during adult life senescent changes take place at a sensibly uniform rate.

Throughout the entire history of the investigation of the metabolism of the warm-blooded animals, the question of the relationship between the body surface area of the organism and its heat production has been a center of interest. Even before the development of adequate experimental methods of investigating the energy transformation which takes place in the body of the vertebrate organism, the possible relationship of body surface area to heat production was a subject of speculation. Physiologists recognized that a whale or an auk in the arctic exposes relatively far less surface for the loss of heat than a flying fish or a humming bird in the tropics. Attempts were consequently made to explain the relatively higher food requirements of small as compared with large animals by the relatively larger surface exposed for heat loss in small organisms.

Newton's law of cooling made a strong appeal to the imagination of earlier physiological writers. It is not surprising that, impressed as they were by the relative constancy of body temperature in the warm-blooded animals, they conceived of heat production as proportional to heat loss as a means of maintaining constant body temperature, and came to look upon heat loss as determined by body surface area, and to consider heat loss as determining in its turn heat production.

This is not the place to trace the history of the so-called body surface law, according to which heat production per square meter of body surface is a constant. It has been widely maintained since the days of the speculative writings of Bergmann, the comparative studies of Rameaux, and the experimental investigations of Müntz, Rubner and Richet. Of recent years this so-called law has assumed practical importance in that writers have maintained that the closest approximation to the basal metabolism of a subject is given by

$$h = \bar{h}_s \, s,$$

where h is the required daily heat production, $\bar{h}_s$ the average heat production per square meter of body surface in a standard series and s the body surface of the subject under consideration.

The reader may be inclined to inquire why such a formula is of practical significance. The answer should be evident on a moment's reflection. Suppose the clinician wishes to investigate the influence of some disease, for example diabetes, on the metabolism. A subject is selected from the hospital ward, placed in the respiration chamber, and his daily heat production determined. This is merely a technical matter. The interpretation of the result presents a much more serious problem. The caloric output of the subject in a pathological state has no significance as indicating the influence of disease upon metabolism until it can be compared with a normal value. With what normal constant shall it be compared? Naturally, with that which would be expected for the same individual in good health. Thus the *theoretical* metabolism of the subject in health must be taken as a basis of comparison for his actually measured metabolism in disease before one can draw any conclusions whatever concerning the influence of the disease.

Again, suppose that stringent rationing is under consideration. What ration shall be allotted to individuals of various sizes? Clearly, both the most just and the most advantageous procedure would be to allow them food proportional to their physical needs.

Now one of the crucial tests of the validity of a law is its capacity for predicting the unknown. If the "body surface law," expressed by the above formula, serves to predict the heat production of a subject more precisely than any other formula, it must certainly take its place as one of the most important empirical laws in nutritional physiology.

This problem has been investigated in great detail in the extensive data collected at the Nutrition Laboratory during the past decade. These are now so numerous that it is possible to use one fraction of the records as a basis of prediction equations, and to test the validity of these equations by considering the metabolism of other actually measured individuals as unknown, calculating their caloric output by the various methods, and determining which formula gives the closest prediction. That formula which estimates the metabolism most exactly from measurable physical characters must be looked upon as the most valuable empirical law.

It must be admitted that the "body surface law" has given excellent results. If, however, there be no purely physiological basis for assuming a causal relation between body surface and heat production it would seem desirable, if possible, to replace this formula by a more rational one.

The foregoing analysis has shown that weight, stature and age all have independent significance for predicting the metabolism of the individual. Availing ourselves of the constants showing the independent relationship between these easily ascertainable characters and metabolism, we deduce the following multiple prediction equations:

For men $h = 66.473 + 13.752\,w + 5.003\,s - 6.755\,a.$
For women $h = 665.096 + 9.563\,w + 1.850\,s - 4.676\,a.$

where w = body weight in kilograms, s = stature in centimeters, and a = age in years.

These equations make possible the closest prediction of the daily caloric output of an unknown subject. They are particularly well adapted to practical work. To calculate the most probable metabolism of any subject it is only necessary to substitute the actual values of weight, stature and age in the equation; for example, A. S. F. is a man 21 years old, weighing 69.3 kilograms, and 169 centimeters in height. His most probable daily heat production will therefore be given by

$$h = 66.973 + (13.752 \times 69.3) + (5.003 \times 169) - (6.755 \times 21) = 1723 \text{ calories.}$$

His actually measured heat production was 1,733 calories, or there was an error of only 10 calories per twenty-four hours or of 0.6 per cent. in predicting his metabolism from two physical characters and age.

The result is unusually good. K. G. M. is 32 years old, weighs 68.8 kilograms and is 171 centimeters tall. His daily heat production should, therefore, be given by

$$h = 66.473 + (13.752 \times 68.8) + (5.003 \times 171) - (6.755 \times 32).$$

The equation gives 1,652 calories as compared with 1,889 calories actually measured. This is an error in prediction of 237 calories, or of 14.3 per cent., and is next to the worst result secured by the use of our formula in a series of thirty-one tests on subjects measured subsequent to its development. For only five of the thirty-one individuals was the error of prediction over ten per cent. The average computed heat production of the 31 subjects was 1,661.03 calories per day, whereas the average measured heat production was 1,653.35 calories, or 7.68 calories per day less. If the individual differences between the observed and the measured heat productions be considered without reference to sign, *i. e.*, without regard to the fact that some are too low, whereas others are somewhat too high, we find that there is an average difference of ± 87.87 calories. Thus by the use of this biometric equation we have been able to predict the heat production of a series of subjects from two physical characters and age alone with an average plus or minus error of only 5.30 per cent.

We may illustrate the practical application of such multiple prediction equations[2] in clinical calorimetry by the values of

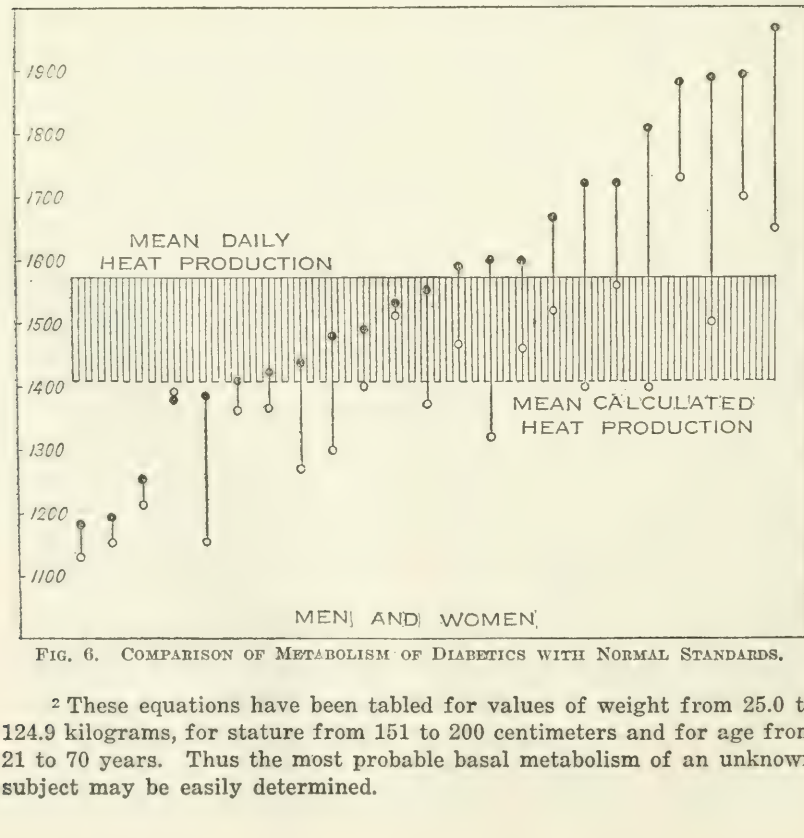

FIG. 6. COMPARISON OF METABOLISM OF DIABETICS WITH NORMAL STANDARDS.

[2] These equations have been tabled for values of weight from 25.0 to 124.9 kilograms, for stature from 151 to 200 centimeters and for age from 21 to 70 years. Thus the most probable basal metabolism of an unknown subject may be easily determined.

the daily heat production of a series of 23 diabetic subjects investigated by Joslin and Benedict. These are represented on the scale at the left by the position of the solid dots in Fig. 6. The patients are arranged in order according to the magnitude of their daily heat production. The values given by the equations are represented by the position of the circles. In every case but one the metabolism of the diabetic is greater than that which would be expected for a healthy subject of like physique and age. The solid and the broken lines show the averages of the actual and the control heat productions. The average of the actually determined values is about 1,572.2 calories, or 11.55 per cent. higher than the average of the standard controls which is 1,409.4 calories. The influence of diabetes on the basal metabolism is clearly demonstrated.

As another illustration of the usefulness of these equations we may take the data for a series of twenty-two vegetarians, eleven men and eleven women, studied by Roth and Benedict. The question at issue is: Does, or does not, a vegetarian diet modify the basal metabolism?

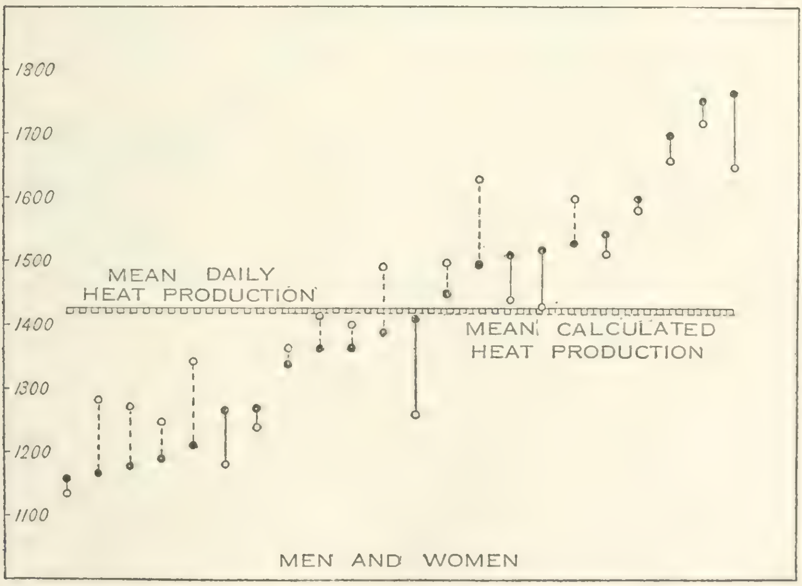

FIG. 7. COMPARISON OF THE METABOLISM OF VEGETARIANS WITH NORMAL STANDARDS.

Fig. 7 shows the actual heat productions (solid dots) and the computed heat productions (circles) of the men and women. Since the equations used in computing the predicted values are for men and women respectively the two sexes may be treated together. In eleven cases the actual heat productions are higher, while in eleven cases they are lower than the values computed from the equations. The means of the actual and computed heat productions are practically identical. These results show clearly that there is no appreciable influence of vegetarian diet on the basal metabolism.

Other illustrations might be given. Perhaps the most interesting is the use of the equations in investigating the difference in the metabolism of men and women. This problem, which has attracted the interest of a number of investigators in the past, has been reconsidered from all sides on the larger series of data now available. The results show that the average daily (twenty-four hours) basal heat production of the 136 men investigated is 1,632 calories, whereas that of the 103 women studied is 1,349 calories. Thus the daily heat production of women is about 300 calories less than that of men. But women are smaller than men. If correction for body size be made by expressing heat production in calories per kilogram of body weight, it is 25.7 calories in the men as compared with 24.5 calories, or 1.2 calories per kilogram less, in the women. The men show an average daily heat production per square meter of body surface of 925 calories as compared with 850 calories, or 75 calories less, in the women.

The most critical test of the existence of a difference in the metabolism of men and women is that furnished by comparing the actually measured metabolism of women with that calculated from biometric equations on the assumption that they are men of like stature, weight, body surface, age or combinations of these characters. The diagrams in Fig. 8 show the differences between the actual metabolism of women (circles and lower lines) and the heat production calculated on the assumption that they were men of comparable physical characters and age (solid dots and upper lines). Diagrams *A–C* represent the results given by three different equations. The shaded zone shows a deficiency in the actual heat production of the women, who are classified according to body weight, throughout.

These and further statistical tests which can not be discussed in detail show conclusively that the metabolism of American women is lower than that of men. Our results show that the differentiation of the sexes is not evident in infancy. They do not confirm the conclusion of Sondén and Tigerstedt that the difference between men and women tends to disappear with age. Instead we find the difference in the metabolism of men and women well marked throughout the period of adult life.

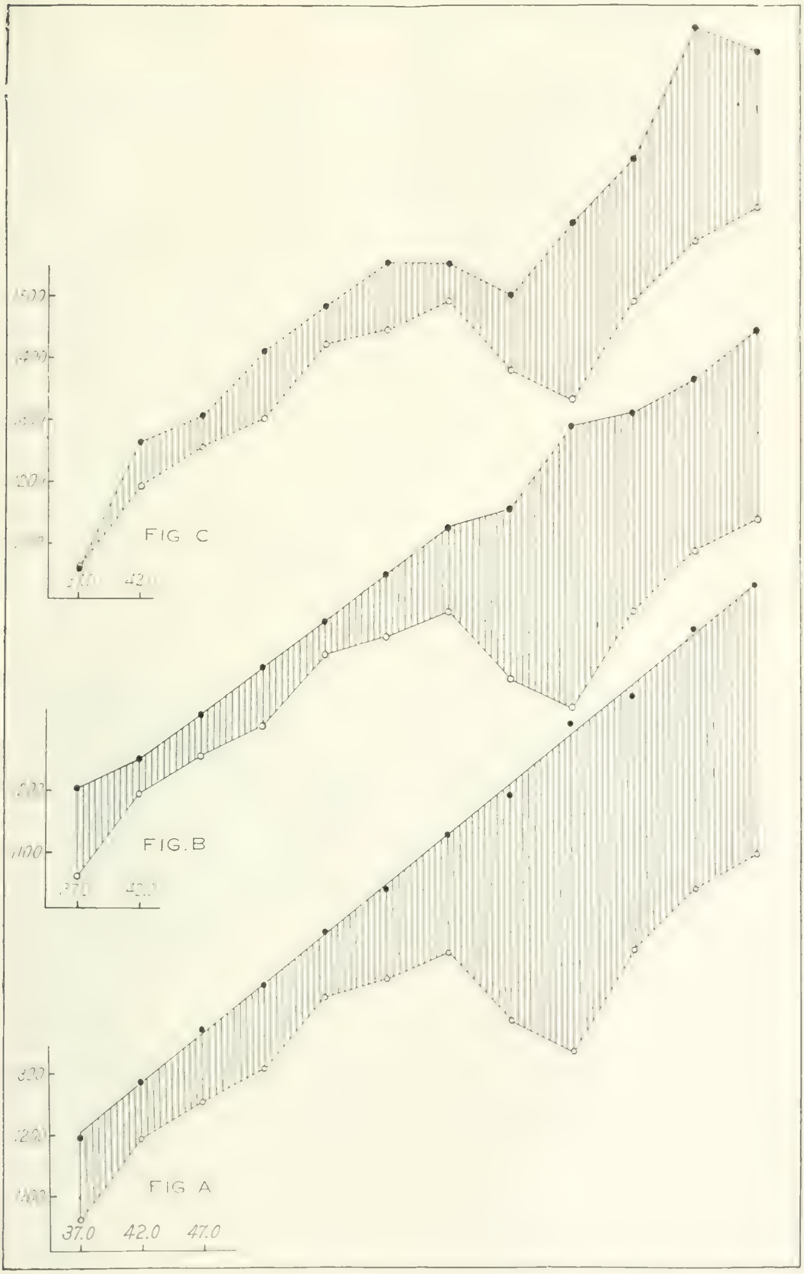

FIG. 8. COMPARISON OF METABOLISM OF MEN AND WOMEN.

This brief outline may serve as an introduction to some of the problems which require consideration in the establishment of normal standards for work in human nutrition.

It would be quite unfair to leave the reader with the impression that the basal metabolism is a fixed and unchangeable physiological constant. While extremely valuable as a basis of comparison, the basal metabolism is subject, not only to great variation from individual to individual, but to modification in response to profound experimentally induced changes in the level of nutrition of the subject. Thus a man who underwent a 31-day fast at the Nutrition Laboratory, during which he took no food whatever and only about 900 cubic centimeters of distilled water per day showed a decrease of 28 per cent. in his basal metabolism.

A more recent investigation of the influence of severely limited diet, undertaken by the Nutrition Laboratory on squads of men who volunteered for this purpose at the International Y. M. C. A. College at Springfield, Mass., in response to the need for more exact information concerning the influence of war-time diet on health and efficiency, has shown a striking influence of reduced diet accompanied by rapid alteration of body weight on the basal metabolism. One squad was kept for a period of four months on a restricted diet with an energy content of one half to two thirds of the requirements prior to the fast, when the normal demand of the men ranged from 3,200 to 3,600 net calories. After a reduction of only 12 per cent. in weight, 1,950 calories only were required to maintain this weight.

Notwithstanding this fact, and the wide variability in basal metabolism in whatever units it may be expressed, the basal metabolism when measured on large numbers of individuals in good health and living under normal conditions, and described in terms of the proper biometric constants and equations, furnishes a valuable, and as yet the only available, standard of comparison in the investigation of all the special problems of energy requirements in human nutrition.

AN ENTOMOLOGICAL CROSS-SECTION OF THE UNITED STATES. II.

By Professor J. CHESTER BRADLEY
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If one were to draw a curved line from Austin, Texas, through San Marcos, San Antonio and Uvalde to Del Rio, he would be tracing the south and southeastern escarpments of an elevated limestone region, known as the Edwards Plateau. In this area many rivers of clear water take their origin, and as is the way in limestone countries, flow underground until the escarpment is reached. About 30 miles north of San Antonio at the old German community of New Braunfels, what is perhaps the finest of these rivers comes pouring out of the cliffs in a series of magnificent springs. It is the Comal River and with all haste it empties its beautiful waters, after a very

GUADALOUPE RIVER AT VICTORIA, TEXAS. The river is approximately the border between the humid and arid regions of Texas. Its clear blue waters were no more resistible to us than to a party of negro boys and girls, who *sans* everything in the way of clothing, enjoyed themselves noisily above our camp.

short course, into the Guadalupe. Calladia grow wild along the bank, and quite a jungle of semi-tropical plants, while its course is lined beneath with the most beautiful profusion of aquatic plants that I have ever seen. At these Comal springs we took our first real rest from the road and tarried several days. Dr. Wheeler has described the spot in his paper on the fungus-growing ants of North America. Here some years ago he found a very interesting association of ants, including species hitherto known only from more tropical regions.

While at New Braunfels we drove one day to a sanctuary up in the hills, known as Anhalt. The kindly Father who greeted us, when he discovered that we were entomologists, presented us with a small, but interesting, collection of the beetles of the neighborhood, which unfortunately was in an advanced state of destruction by *Dermestes*. We climbed up to a small chapel on the summit on a knoll and there, clinging to the sides of an old well, observed great masses of harvestmen and smaller groups of *Ceuthophilus*. We lowered Needham into the well by a rope and he secured many. When the harvestmen were slightly disturbed they seemed to teeter up and down in a rhythmic sway, but perhaps the rhythm was fanciful. Meanwhile Shannon was attracted by a shrill elusive buzzing, which he finally discovered emanated from a fly poised in front of a live oak. Others were located, but always they darted away with great swiftness as soon as observed. When at last one was caught it proved to be *Hirmoneura flavipes* Williston, a nemestrinid, one of the rarest of flies. Dr. Bequaert and I joined in the chase, and after we learned how to catch them, we obtained among the three of us quite a goodly series, of both sexes. Always they were poised in the air in front of a tree, emitting a peculiar shrill humming. However, I discovered one female crawling about over dead twigs as though hunting a place to oviposit, but I could not observe that she did this. Dr. Bequaert saw some *in copula*, the pair hovering in the same way. Another capture at Anhalt was *Eburia stigmatica*, a longicorn and also the magnificent green *Callichroma plicatum*.

During our stay at New Braunfels we collected in the trap-lantern a fine series of *Fernaldella fimetaria* G. & R., a geometer, common in Texas, but interesting as representing the only genus of its subfamily; it was unrepresented in our university collections. There also were nine specimens of a striking little aquatic Pyralid of the subfamily Nymphulinæ, representing a genus new to science, or at least to North America. Accord-

SOURCE OF THE COMAL RIVER IN ENORMOUS SPRINGS AT NEW BRAUNFELS, TEXAS. Here Dr. Wheeler has found ants of a distinctly tropical affinity. The banks stand thick with calladia, and the limpid waters flow over a bottom hidden by aquatic vegetation of astonishing luxuriance. Photograph by P. A. Munz.

ing to Dr. Forbes it is related to Elophila in structure and marks, with reduced venation and long porrect palpi. Here we caught also *Cobubatha flavofasciata* Grote, an interesting noctuid, the commoner *C. quadrifera,* and for the first time *C. luxuriosa,* which we were destined to take on two or three later occasions, westward as far as the Dragoon Mountains of Arizona.

Our visit to New Braunfels was made both more pleasant and more profitable by the kind hospitality of some old friends of Dr. Wheeler's, the Dittlingers, who showed us many courtesies, piloting us around to the most favorable collecting grounds.

"ANHALT," in the hills near New Braunfels, Texas.

CHURCH AT YSLETA, TEXAS. One of the oldest churches on the continent. Photograph by R. C. Shannon.

On the night of June 30 we camped in a most charming park of small conifers near Helotes, Texas, close to a dry stream. This is eighteen miles from San Antonio, in the hills, and a most attractive locality. In the early morning, upon arising, we observed and captured several specimens of a smaller nemestrinid, *Hirmoneura texana* Ckll. These were also hovering in the air before the conifers and were difficult to catch. Here we also caught some noteworthy butterflies, the semitropical *Kricogonia lyside,* in both sexes, the male typical, but the female belonging to the variety *unicolor* G. and S., more of the then undescribed *Callephelis perditalis* B. & McD., which we had previously taken at Sutherland Springs; a typical *Anosia strigosa,* an arid region form, which here must have been at the eastern limit of its range; and *Melittæa calina,* a much confused species, really belonging to *Phyciodes,* sometimes known as *ubrica* Stk. Mr. Knight found some unusually fine Hemiptera at the light-trap here, among them a new genus and species of the very rare family Isometopidæ, since described by E. H. Gibson from specimens from Brownsville as *Lidopus heidemanni,* a new species of the typical genus Isometopus of the same family, and a mirid of the South American genus *Zoshippus.* Tingitidæ that he found on *Malvaviscus drummondii* have since been described by C. J. Drake as *Calotingis knighti.* There were more strange Hemiptera here than at any other place.

Early we were on our way westward, along the general course of the Southern Pacific Railway. Our first night camp was at Sabinal, on the Sabinal River. Alongside of the road, as we stopped, was awaiting a gopher turtle, *Gopherus berlandieri,* the only one that we observed. Here we found a splendid colony of *Atta septentrionalis,* the Texan leaf cutter ant, working on the leaves of the small native walnut (*Juglans rupestris*). Their well marked paths extended from the nest in diverse directions, well paved with walnut leaves. These were the first leaf cutter ants I had ever seen at work and were of absorbing interest to me personally. In the morning at 6:30 of the clock, *Hirmoneura texana* appeared again.

The west fork of the Nueces River proved an enticing spot for lunch and good collecting. There were several striking species of flowers along the bank, and clear, swift-running water in the stream. Among birds we noted: blue grosbeaks, Mexican goldfinches, and the little Texan kingfisher. On desert willow (*Bignonia*), which was blooming lustily, we collected *Tibicen delicata* Osborn. By night, we reached the Devil's

River and camped along the bank of this most remarkable of streams. Imagine the effect of coming suddenly from the hot and parched desert upon the wall of a cañon or huge barranca, and to find upon descending to its bottom no sandy wash, or standing pools or trickling stream, but a river of large dimensions and volume, swiftly flowing, clear, blue and cool. After

Crossing the Pearl River from Mississippi into Louisiana. Photographed by Anna A. Wright. The trip through Louisiana is described in the earlier part of the article.[1]

dark I searched a sand bank with a flashlight for females of *Photopsis*. The males of this genus of Mutillidæ are nocturnal and come commonly to light, but the females are but very rarely collected, and little is known of their habits. I was rewarded by finding two running busily about over the sand. Near here, Knight collected a single male each of *Tibicen montezuma* Distant and *Cacama valvata* Uhler, the latter a species of cicada not taken elsewhere on the trip. In the trap-lantern

[1] By mistake the names of the photographers were omitted from the legends under the illustrations in the first part of this article. The photographs taken by others than the author were: By Ralph Wheeler, "Ezra Cornell," "The John Harvard," "Sandy Wash in Yuma Desert," "Crossing the Gila River," "One of the Fords," "Ups and Downs North of Phœnix"; by P. A. Munz, "A Muddy Road through the Chopawampsic Swamp," "In the Catalina Mts." (The titles under these two pictures are incorrect, and should read, respectively: "Cypress Swamp, Louisiana," and "A Muddy Road through the Chopawampsic Swamp in Virginia"), "Photographing a Rattler"; R. C. Shannon, "Post Cañon"; Mrs. A. H. Wright, "The Endless Road," "Texas Pass."

COVINGTON, LOUISIANA. Some lumbermen are floating a log raft down the stream. Photograph by Anna A. Wright.

catch appeared *Aleptina inca,* described by Dr. Dyar from Arizona in 1902 and the only species of the genus. It was new to the university collection. In this western Texas region scissor-tailed flycatchers are common, and we saw an occasional *Pyrrhnoloxia texana,* one of the most beautiful birds seen on the trip, an ally of the cardinal.

Following north along the general course of the river we

AVERY ISLAND, the bird sanctuary near New Iberia, Louisiana. Photograph by P. A. Munz.

Cypress along the Pearl River, Louisiana. Photograph by P. A. Munz.

camped near Juno. Again we found a most attractive spot, and although it was a true desert region there were most beautiful ferns of several species. A sweet-scented flowering tree attracted numerous butterflies as well as *Pepsis* and other wasps. We caught two specimens of a magnificent metallic green longicorn, *Callichroma plicatum*, looking as though it were a stray creature from the tropics, with its gorgeous livery. A most amusing incident occurred here. So far we had not seen a rattlesnake. Within a few feet of camp at dusk, Dr. Bequaert, stooping to examine a supposed curious cactus, was greeted with the sharp buzz of a rattle's warning. His exclamation drew the entire camp, and the specimen was duly dispatched and admired. After the excitement had subsided the doctor thought he would have a little joke upon the others and purely in jest, pointed suddenly toward the ground, exclaiming "Look out, there's another!" Suddenly from exactly where he pointed, another rattle sounded. I should like to have had a yardstick to have measured how far *he* jumped to find his jest come true! Both specimens (*Crotalus atrox* and *confluentus*) are now in the collection of Cornell University. It is interesting that they should have belonged to different species.

We celebrated the fourth of July by crossing the Pecos. Trans-Pecos, Texas! What scenes these words conjure to the naturalist. At that time the country had been so long suffering from drought that the cattle were dying by the thousands, their carcasses everywhere in most pitiful evidence. From New Braunfels we had shipped our tents home, preferring to sleep thereafter in the open. They had given us protection from mosquitoes which were not to be expected in the desert, while as to rain—well we had had none since leaving Virginia, and the summer showers of the desert, if we met with any, we thought would be no inconvenience. Poor greenhorns that we were! From now on we were seemingly continually playing tag with thunderstorms, and sleeping in *swarms* of mosquitoes! Reader, have you ever seen a desert thunderstorm? I will describe one, calmly. It rains *pretty hard* where you are, but not before you nor behind you. Or it rains a little harder before you or behind you, but not where you are. These storms are very particular about *where* they rain—they would not think about trespassing on one another's territory. They go wandering about over the desert, three or four of them sometimes at once, avoiding each other and looking like huge columns of smoke. But where they do rain they *rain*. They

"Simon Henry" in action in the Chopowompsic Swamp in Virginia. Photograph by P. A. Munz.

dump the water out—well as I said before right hard, anything to get rid of it, and that quickly. And where they rain nothing travels for a while. Mud has its qualities and desert dobe is genuine. The vacillating streams, having neglected to provide for themselves a course while the weather is dry and they have time to think it over, are called upon when it rains to decide in a hurry. That is the hour of their glory. They laugh at the lordly desert and cut across it at will, carrying rocks, boulders,—half a mountain side. Now *they* rule by the power of might, and the rest of creation must sit and await their pleasure. Well, one would not have chosen otherwise, for the rains brought leaves out on the desert plants, flowers everywhere, and with them insects. Fortunate were we, that when we could not travel we could collect.

This was a fine region for interesting Cicadidæ. Along the Pecos River were *Tibicen delicata* and *Proarna venosa.* The latter was abundant from this region westward into New Mexico. At Ft. Stockton and from there also westward into New Mexico *Tibicen eugraphes* Davis were abundant on mesquite, screw bean, etc. At the bridge over the Pecos Dr. Bequaert caught a remarkable tabanid, *Silvius pollinosus* Williston. We camped on the desert some twenty miles from Sheffield. Again we found two rattlesnakes (*Crotalus atrox*) after dark, close to the camp. We came upon them while hunting with flashlights for Mutillidæ and Orthoptera. On the fifth of July we ate lunch at a little stream, where attractive looking dragonflies were abundant. We camped at Chancellor within sight of the Comanche Mountains, and well on toward the Ft. Davis range. Cicadas were very abundant, singing on the mesa after sundown in a long continued chorus, like the shrill rattle of a rattlesnake. Tarantula hawks (*Pepsis*) were also very abundant.

In the Fort Davis Mountains we had our first brief glimpse of the fauna and flora of a desert mountain range. According to Mr. Rehn the affinities of these mountains are strongly with the more northern Rockies and divergent from the Chisos Mountains to the south, which we should have visited had time permitted. In Musquiz Cañon near Ft. Davis we collected in a creek during a thunderstorm. Parnidæ (*Dryops*) and other aquatic Coleoptera and Hemiptera were very abundant. The scenery here was suggestive in its strange rock formations of the Garden of the Gods or of Texas Pass in Arizona which we were to see later. We spent a day well up Limpia Cañon, but owing to the excessive drought it was not very fruitful.

We had hoped for *Plusotus* but were disappointed. Enormous *Allorhina mutabilis* kept buzzing around the oaks. In the trap lantern was an interesting crambid, *Eufernaldia cadarella* Druce [*argenteonervella* Hulst]. The tree *Uta* (*U. ornata*), a scaly lizard related to our eastern swifts, we found in these mountains, and subsequently at two stations in Arizona.

The night of July 7 we camped on grazing land some miles northeast of Valentine, close beside a wash filled with bushes, several of which were in bloom. In the morning Dr. Bequaert and I found admirable collecting for Hymenoptera in this wash. There was a very populous colony of a small *Stizus*. One small tree attracted great numbers of flies. From time to time, resting upon its leaves and evidently attracted by the flies, came specimens of a *Mellinus*—always a rare wasp. Some fine bees were visiting the flowers. Finally, on the bank, several cacti infested with borers yielded a number of specimens of the tenebrionid-like longicorn *Monilema.*

At Sierra Blanca, in the road at night I observed a very populous colony of a pale yellow nocturnal honey ant, *Myrmecocystus mexicanus.* In a flooded creek Dr. Wright found several interesting amphibia; two species of spade foot toads, *Scarpiophorus couchi* and *S. hammondii,* were breeding, and there were three species of *Bufo* (*cognatus, compactilis,* and *woodhousei*), of which one was breeding. During the following morning we observed, growing along the roadside, a small white flower, *Lepidium eastwoodiæ*, which was attracting great numbers of small aculeate Hymenoptera. Dr. Bequaert and myself also collected two magnificent species of large bees of the genus *Hemisia* (*H. rhodophus* Cockerell and *morsei* Cockerell) on the large heads of *Centaurea americana.* This was done while waiting for a freight to get out of our way, and the others were doubtless vexed at the delay! In this region and westward flowers of the allthorn (*Koeberlinia spinosa*) afforded a wealth of Hymenoptera, but especially Philanthidæ and *Pepsis.* At night the pepsids would sleep among them, but during the day the bushes became the scene of an incessantly active,—extremely active, host of wasps. To catch them in their quick and nervous flight here, there and away amongst the innumerable unyielding thorns which alone compose the allthorn bush was no easy task.

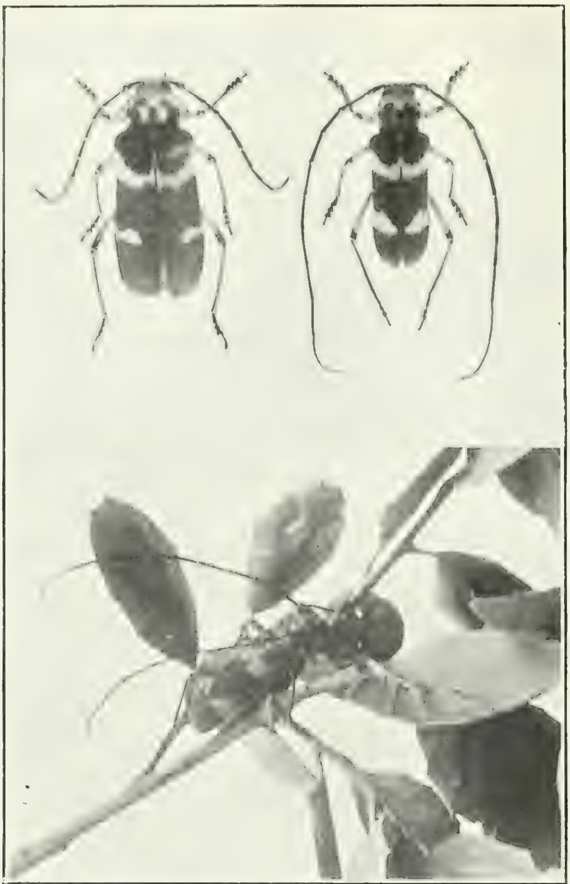
At Fabens, in the irrigated country east of El Paso along the Rio Grande, Dr. Bequaert was so fortunate as to make one of the really noteworthy captures of the trip—a small nocturnal bee, at night. It is probably a new species which the doctor will publish in due course—a tiny species of the straw-yellow color which is characteristic of nocturnal Hymenoptera and with great ocelli. At one point along the road hundreds of winged harvester ants, *Pogonomyrmex* sp., were observed clinging together in great masses, attached to branches of a mesquite tree.

While the Buick was having a spring reset at El Paso, Dr. Bequaert had opportunity to collect in the irrigated fields along the Rio Grande ten miles north of the smelter, and obtained among other fine wasps, a single male of the very rare scoliid wasp, *Engycistus rufiventris* Cresson, described from lower California and the only known representative of its anomalous genus, unless, as has recently been stated, it really belongs to the South American *Pterombus*.

On the eleventh we camped near Mesilla Park. Dr. Wheeler discovered a *Trachymyrmex*, one of the small leaf-cutting ants. Each individual was transporting a fragment of a stem or dried leaf. Their motions were slow and hesitant. With some difficulty we found the entrance of their colony, merely a tiny orifice in the earth. Close at hand, we collected a number of specimens of a very large *Trox* from the carcass of a coyote. In the trap-lantern were: *Heteranassa mima,* a genus and species of Noctuidæ new to the university collection; *Conochares interruptus,* probably a variety of *C. arizonæ,* which we took later in swarms in western Arizona, but representing another noctuid genus not in the university collections; *Trichocosmia inornata* Grote, a third noctuid.

The next morning we crossed the Rio Grande and ascended over the high mesa, traversing a highly volcanic region. At Aden *Proarna venosa,* a small cicada, was abundant on a desert grass; we collected a fine series. Whip-tailed lizards were in numbers at Aden, as at many other desert localities, they being very abundant and characteristic features of the desert life. We obtained two species here, *Cnemidophorus perplexus* and *C. melanostethus,* and a third species, *C. tessellatus,* at Deming, just beyond. They are mostly of dark color with bluish mottlings or lines, and are known by their exceedingly long tails. At our night camp near here ant-lions were numerous, attracted by the lights of the machine or flying to our tent lure. The males of *Brachycistis*, a genus of nocturnal Myrmosidæ also came to the light here in numbers, as they did nearly every night westward. The capture of these was personally one of my chief aims in undertaking the trip, and the

GIANT CACTUS OR SUAHELO, one of the most characteristic features of the landscape of southern Arizona. Photograph by Ralph Wheeler.



Crioprosopus magnificus Lec. Photographs by Prof. E. O. Essig.

lure as well as the lantern swarmed not only with these but many other interesting insects. Among them may be mentioned *Saluria ostreella* Hulst, looking deceptively like *Eufernaldia caderella,* but in reality an anerastiid, and a geometer which has since been described by Barnes and McDunnough under the name of *Eucestia marcata.*

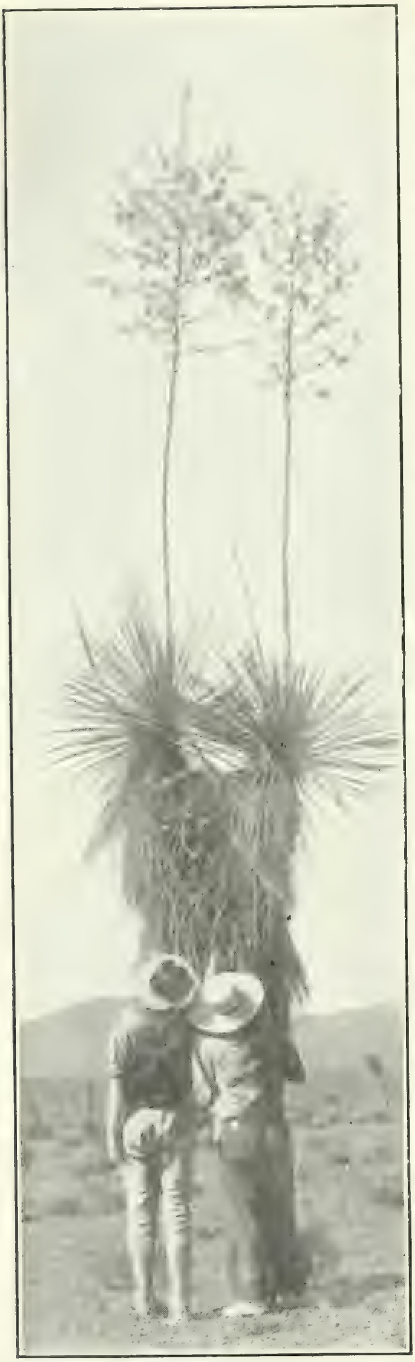
We crossed New Mexico in a little over two days and left it on the morning of the fourteenth, after passing through the town of Steins, which will long linger in our memories as a synonym for squalor and dreariness. Piles upon piles of empty tin cans bore mute witness to the pitiful gastronomic debauchery of the residents. The road led into a backyard and stopped and we drove around, lost amid goats, sodden children and innumerable cans, seeking an outlet. Finally we discovered that the transcontinental highway turned out through an alley on to the front side of a row of buildings, from which we were apathetically, if not hostilely, surveyed by the leisure class from the stoops. The insects were better, for, near here, the pods of *Acacia greggii* secreted a nectar which attracted many Hymenoptera. The previous day, at Deming, Needham captured a large moth of a desirable species, *Gloveria arizonensis.*

On the afternoon of the fifteenth we made camp for a

FOREST IN THE CATALINA MOUNTAINS. Photograph by P. A. Munz.

MARTIN HOUSES MADE FROM GOURDS SUSPENDED TO THE CROSSBARS ON THE POLE. These are seen in many parts of Alabama and Georgia on the coastal plain.

several days' stay near the mouth of Post Creek, close back of the States Reform School at Fort Grant at the base of the Pinaleno Mountains. Culminating in Mt. Graham with an altitude of 10,510 feet, these are the highest and most extensive ranges of southern Arizona. In their higher slopes they are heavily timbered. As low as our camp the creek was still a splendid flowing stream, well bordered by oaks or other trees, while in the cañon further up the vegetation became denser and more humid in character. We



YUCCA. These stately plants grace and beautify the desert ranges. Far above out of reach their waxen flowers draw honey-gathering wasps, bees and butterflies.
Photograph by P. A. Munz.

followed up to where it became of a distinctly transition type.

Never in my life have I beheld a glory equal to that of some of the storms and ensuing sunsets that marked the close of the days. Across the distant lying plain of the Arivaypa the storms would sweep, now involving the Galiuro range on the other side, now skirting the mountains on which we stood, until the sun, setting, lit both rain clouds and the distant gray curtains of falling rain themselves in one vast crimson purple and the whole sky involved seemed flaming fire, then dying faded out to sudden night. It is impossible to justify by description, it would be impossible for artist to paint the glory of those sunsets.

The dipterists found the nemestrinid *Hirmoneura texana* Ckll. again and also a blood-sucking leptid (*Symphoromyia*) and some fine Syrphidæ and others of interest. Dr. Bequaert and Mr. Knight collected specimens of *Tibicen castanea* Davis and of a variety of *T. cinctifera* Uhler. Amongst moths we found *Ptychoglene phrada* rather abundant, flying by day and visiting flowers. It closely resembles the lampyrid, *Lycus fernandezii* Duges, from the same zone, a specimen of which we found later at Texas Pass. Dr. Wheeler, with the help of the rest of us, listed forty-three species of ants, representing twenty-four genera. Perhaps the most notable was *Polyergus lucidus*, the shining slave maker, well out of its known range. Several of the party witnessed a raid of this species upon a species of *Formica*. *Mutilla orcus* was common, and the collecting for wasps on the various flowers in the cañon as well as lower down was excellent. The erycinid *Apodemia nais* was abundant in the cañon, and we obtained quite a series; other interesting butterflies were: *Basilarchia arizonensis, Limenitis bredowi, Neonympha rubricata, Thorybes epigona, Kricogonia lysida* and *Terias mexicana*. Among the beetles may be mentioned the cactus longicorn, *Monilema appressum*, a female *Prionus heroicus, Sphænothecas suturalis, Discodon bipunctatum* Schaeffer and the large odd *Erotylus boisduvali*. Some of the tarantula hawks had elegant violaceous wings with white tips, standing in marked contrast to the ordinary red-winged type; these belong to Lucas's species *oblikuerugosa*.

It may be of interest to mention some of the reptiles of this locality. *Sceloporus jarrovii*, an uncommon swift, was associated with the larger, more bristly and much more common *S. clarkii*. Up in the cañon, more or less into the Canadian zone, lives *Gerrhonotus nobilis*, a clumsy creature sometimes called an alligator lizard, contrasting strongly in his slow motions with the swift scurrying lizards of the desert. The common horned toad of the lower slopes is *P. cornutum*, but upon a ridge Needham and the writer found the red head, *P. hernondesi*, which we also found well up in the Catalina Mountains; also up on the mountain Dr. Murry and Ralph Wheeler caught a dog-faced rattler, *Crotalus molossus*. The whip tailed lizard, *Cuemidophorus gularis*, and *Uta ornata* were other lizards observed. One of the most beautiful birds was *Phainopepla nitens*, suggestive of a cedar waxwing in appearance, but not color. A pierid butterfly, probably *P. monuste*, was very abundant near the school.

On leaving the Pinaleno Mountains we stopped awhile at Bonita; found many fine bees sleeping in the flowers of *Cucurbita fœtidissima;* among them males of *Xenoglossa patricia* Ckll. (identified by Dr. Lutz). This bee has very large ocelli and is probably nocturnal or crepuscular.[2]

Dr. Wheeler, who had collected previously in the Huachuca Mountains, came to the conclusion that the forms of the lower slopes of these two ranges are very much alike. I should advise any one wishing to collect at higher levels in these mountains to enter them from Thatcher or Safford on the eastern

[2] Note by Dr. Bequaert.

side. I am informed that pack outfits may be obtained there and that there are two summer camps up in the pines.

West of Willcox we saw some fine mirages, and crossing extensive alkali flats came upon great numbers of several beautiful species of *Cicindela*. That night we camped in Texas Pass in the Dragoon Mountains and reckon our day's stay there as entomologically the best of our entire trip. The scenery is notable for the grotesque rock formations, strongly suggestive of the Garden of the Gods. To start collecting off well Mr. Shannon captured by the cook stove an *Amblychila baroni*, Dr. Wheeler another amongst the rocks, and Dr. Bequaert a third. Determined to be as fortunate I hunted everywhere but without success. Flying about the live oaks we observed males of a magnificent large black and orange cerambycid, *Crioprosopus magnificus* Le Conte, an extremely rare beetle. The whole party turned in and collected them, with the intention of marketing the catch, a nice series, to defray a bit of the expenses of our trip, which were mounting high. Dr. Wheeler called our attention to a foray of *Eciton* (the legionary ant of the tropics). On *Zizia*, or some similar very spiny shrub, innumerable aculeate Hymenoptera of many fine species, incessantly active, held Dr. Bequaert's attention, and mine. On these same bushes a beautiful yellow lampyrid, *Lycostoma loripes*, was inordinately abundant; other lampyrids that we caught were: *L. fulvellus, Lycus fernandezi; Cenopœus palmeri*, a fine large longicorn, also was found, and a portion of the tarantula hawks were of the magnificent violet-winged species *Pepsis obliquerugosa*. At the tent light-trap, amongst other things were two speices of the capsid genus *Sericophanes*, one new to science and since described by Mr. Knight as *S. triangularis*, the other being *S. tarnsversus*. Both species Mr. Knight had also caught on previous nights, the new one at Lordsburg, Bowie and Deming, the other east as far as Gillette. The vertebrate zoologists found *Cnemidophorus gularis*, a whip-tailed lizard, for the last time.

(*To be continued.*)

PSYCHO-PHYSICAL TESTS OF AVIATORS

By Professor GEORGE M. STRATTON

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THE application of psychology to the problem of discovering special aptitude for flying is one of the interesting developments of the war. All such work in this country has had the benefit of that done by the French. Nepper, the most distinguished of them in this field, is primarily a physiologist, but he is aware that the attention to the physical fitness of the man to be trained as a pilot leaves out of account many important things. His idea has been that a thorough clinical examination gives assurance of excellent sense organs, but it leaves quite undecided whether the future aviator will be able to make proper use of the impressions which these sense organs bring to him. He might have added that such an examination gives assurance that the future aviator will have normal muscles, but gives no assurance that he will be able to make use of these muscles with unusual skill.

Nepper laid stress upon two qualifications which he regarded as central and essential for aviation; namely, coolness and the power to make rapid decisions. The power to make rapid decisions he felt could be tested by means of the standard laboratory experiments in "personal equation," or what is more commonly known among us as reaction time; that is, the time which it takes a person to respond by a movement—perhaps of the finger—to some signal. Such signals Nepper gave in the regions of sight, of hearing and of touch, measuring the time of the person's response by electric keys connected with a delicate chronoscope. Having taken a number of such measurements in each of these three senses, he counted it against the man if his reaction time either was too slow or was too irregular. And the person was too slow for him if the average time of his reaction for sight was more than .01 of a second slower than the average time which he found among those he examined, such average time being for sight, .193 sec., for hearing .144 sec., and for touch .142 sec. He also set a narrow limit of irregularity which he permitted in the man's reactions, and if the person was more irregular than this, he regarded it as an indication that the man was unsuitable for training as a flyer.

Coolness Nepper tested by delicate apparatus familiar to all psychologists and physiologists, which gives a written record of one's breathing, of the changes of volume of blood in his finger, and of the steadiness with which it is possible for him to hold his hand, these records being obtained from the aviator in the first place under comparatively normal conditions, which were in due time suddenly changed by giving some violent form of surprise, either by a flash of light, or by cold water, or by a blank shot from a pistol near the man. On the basis of these two forms of experiment he classified his candidates into good and poor, and rejected those whom he regarded as unsuited for the work of aviation.

The Italians also during the great war have used psycho-physical methods in the selection of aviators, the two men whose names have come most prominently in this work to us being Gemelli and Gradenigo. They too made use of the reaction-time experiment and of the test of emotional steadiness, much after the French fashion, and yet with modifications. An interesting enlargement of procedure on their part was by means of what is known as a "Carlinga," which reproduced in some respects the cockpit of an airplane and could be moved in various directions. The candidate blindfolded was required to indicate the vertical after he had been tilted from the vertical; and again, without being blindfolded, was required to respond quickly by means of his "joy stick" to some sudden tilt of the machine. His value as a future aviator was estimated in part by the character of his responses under these conditions.

The work in America, as was said, has had the benefit of this work on foreign soil. With us, the research, beginning among civilian scientists, was in due season taken over by the Air Service of the Army and more particularly in the later months of the war by the Medical Research Laboratory of the Air Service at Mineola. In order to understand more fully the conditions under which the work was planned, it may be of interest to tell briefly the character of the examination of aviators before any psycho-physical features were introduced.

The candidate appeared before some one of the many Aviation Examining Boards established throughout the country, and his examination by the board took two interestingly different directions. The candidate was given in the first place a most careful physical and medical examination by medical officers in the army and he was also given what was designated as a professional and mental examination by one or more officers who were not in the Medical Corps. This latter examination was based upon the candidate's carefully written answers to several pages of questions that were put to him with regard to his family history, his education, his business experience, his athletic interest and training, the character of the responsibilities placed upon him in civil life, the organizations to which he belonged, and his military experience. He had also to furnish letters testimonial from persons who knew him well, and credentials of his schooling. Of particular importance was the personal interview, when the applicant faced his military examiners and was required to clarify or supplement the facts given in the ways just described. Thus by a direct personal judgment assisted by various means, it was decided whether the man should go into training or should be courteously and with due appreciation told "No."

The method is on the whole an excellent one, though any one who has had experience as an officer upon such a board knows how fallible a judgment often issues from the professional and mental side of the board's examination. It is unquestionably true that many an applicant gives far better promise than his later performances fulfill, and, on the other hand, men are thrown out by such a method who would have made successful aviators.

The purpose of proposing psycho-physical tests in the Air Service was not to do away with any part of the several examinations here described, but rather to supplement these examinations and reduce the probability of error in them. And in particular the research with which this paper is concerned aimed to discover whether certain and particular tests that might be proposed would actually assist appreciably the examinations already established in the Aviation Examining Boards. The method was not to adopt tests out of hand on the assumption that they must of necessity distinguish promising from unpromising candidates. Rather the investigation aimed to put the tests to trial and to find out whether they actually gave evidence of worth. Until they could give scientific evidence of their value, that value was regarded as wholly problematic.

The tests which were subjected to investigation were in part similar to those used by Nepper and Gradenigo; but, for the sake of wider exploration, many other tests were brought to trial. Every investigator is in debt to many others, and especially is this true in the present case. Professor Brown and his assistants at the University of California, Professor Thorndike, of Columbia University, Professor Henmon, of the

University of Wisconsin, and Doctor Burtt, of Harvard University, made possible by their scientific judgment the research here reported. Nor within the Army itself was the work possible save by a hearty personal cooperation of a great number of officers and men, in Washington, in Mineola, and at San Diego. Everywhere in the army such work as this found something that could not be had by force of mere authority and orders.

Besides reaction time and emotional stability, aviators were tested as to their power rapidly to learn to form several complicated and untried combinations of muscular movements not unlike those which an aviator has to learn, the idea being that in this way the least skillful persons might be eliminated. Other tests were concerned with a careful recording and measuring of the success with which a person could stand motionless with eyes open and with eyes closed, indicating general and constant control over the muscles of his body as a whole. He also had to show evidence of the fineness with which he could perceive gradual departures of his entire body from the perpendicular brought about by a mechanism of screws and levers, the test being aimed at his sensitivity, his power to perceive, rather than to control, since it might well be asked whether a nicety of perception of the position of the body is an important factor in guiding the aviator as he restores his airplane to its proper balance in the air. And, since the landing of the airplane is one of the difficult parts of the aviator's early task and requires judgment as well as careful response and control as he approaches the ground swiftly with his ship, he was tested as to his power to continue in imagination certain fragmentary curves that were given him; for his skill in landing might well require him to anticipate where his present course at any moment would, if continued, carry him and how he must needs alter it to make it suitable in angle, speed and place. A simple test of dexterity was also used; the candidate was required to balance one of a graded series of rods vertically upon his finger for a stated time to see how short a rod he could balance; and his success or failure in this was accurately measured.

Even after findings from such tests had been obtained, they still were regarded as subject to check and suspicion. The tests were repeated with different groups of aviators at the same field, and under the direction of different officer-scientists at different fields, in order to reduce the danger that the particular findings might be the result of chance or of some special interest or error or suggestion of those in charge of the experiments. And as an essential element in determining the value of any test, it was necessary to have the best judgment of the army officers who were actually in charge of the aviators' training in flying. For the psychologist did not assume that he could as yet estimate by his tests the fitness of any person for flying. He simply wished to discover whether, as a matter of fact, there was any parallel between the degree of success with which a person could pass a given psycho-physical test and that person's peculiar skill as an aviator; and this skill must be judged not by a psychologist, but by one practically versed in flying, himself a flyer and a trainer of flyers. A possible parallel between success in aviation and success in passing the psycho-physical tests would constitute what is known technically as a "correlation," to be indicated by a mathematical expression known as the "coefficient of correlation."

The outcome of the experiments was that, as a matter of fact, these tests all showed a relatively low correlation with flying ability, and yet, in some of the tests, there actually was invariably a correlation of respectable amount. And this made it clear that the test itself might, with proper precautions and supplementing, be used with some degree of reliability to assist in the work of selection.

The tests which under this stern trial proved to be of value were those on the perception of gradual tilt, on the power to stand steadily, as judged by the record which a man makes when a writing point attached to his head moves over a smoked surface, on his power quickly to discriminate between a sudden jerk of his body to the right or to the left, particularly when this is combined with his reaction time to a visual signal and to an auditory signal, and on the steadiness of his hand when a pistol shot is fired behind his back. The tests which did not scientifically justify themselves were those upon a person's power to learn certain complicated combinations of movement of hand and foot, on the power to continue in imagination a fragment of a curve presented to him in model, and on dexterity. This latter test was disapproved not so much because it arrived at nothing which could be connected statistically with flying ability, as that it could so largely be influenced by practise, and practise would be invited if the test were introduced as a regular part of a board's examination, when the candidates would soon know beforehand that they would be tested on this feat of dexterity.

The research may therefore be regarded as having had its measure of success. Tests were actually found by which it was possible to give a more assured judgment than was possible by credentials or by personal interview that the candidate could learn to use with skill the sound and normal body which the medical examination gave assurance that he possessed. But it will perhaps not be needless to repeat that in the writer's judgment such tests are not, nor do they promise to become, a substitute, but only an assistance to the other and standard means of estimating a candidate's ability.

The experiments bring home to one the exceeding complexity of the flyer's ability. His power to attain success in his hazardous and delicate work evidently is not due to any one factor in his psycho-physical constitution, nor to any small group of factors, but rather to a happy constellation of many factors, of which each counts only in a limited way.

A French aviator who examined with some care and moderate approval the apparatus which has been described, expressed appreciation of the work, but expressed also his conviction that such tests did not touch the central fitness of the aviator, the "heart" of the man, meaning, no doubt, the courage, the temperament, the spirit which he would show only in the midst of danger or of crushing fatigue. Such a reservation in judgment the writer feels is not to be despised even by those enthusiastic over instrumental means of discovering special ability. Such doubts, however, should not discredit the laboratory means, but rather should keep them in their place. In so difficult a matter as that of determining special ability to fly, all agencies and aids are needed. Any one means is fallible; but when all good means are joined, there is prospect of far greater success, of far less error and failure. Especially would it be unwise to say that we have already exhausted the possibilities which lie in psycho-physical tests. Judging by the past, it seems likely that a research of this kind has merely come to the threshold of its opportunity and that it will with time and intelligence and ardor enter a region of fruitful work of which we have now but a faint idea.

DELUSION, MASS SUGGESTION, AND THE WAR: A DREAM AND THE AWAKENING

By Professor JOSEPH JASTROW

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THE classification of delusions as innocent and dangerous does not commend itself to the scientific student; to a practical-minded society, exposed to the contagion of error, the distinction is supreme. Circle-squarers, discoverers of perpetual motion, solvers of the riddle of the universe are nuisances only to the patent-office, to philanthropists, and to professors. But couple the same order of mental twist with a grudge, give it a setting in political conflict, and you have the motive that made martyrs of three Presidents. The erratic masses have the same complexion as the erratic individual; but the collective menace is indefinitely more formidable. Yet popular delusions may be fairly innocent. When the stolid Dutch burghers of the seventeenth century spent half a fortune for a rare tulip-bulb, or the staid investors of France and England in the eighteenth century fought for the privilege of subscribing to the "Mississippi Scheme" and other speculative "bubbles," or the corresponding classes of New York and Boston fell for the "Perkin's tractors" (see Oliver Wendell Holmes), or put blue glass in their windows to absorb the health radiations before the days of absent treatment, the fad had no more serious aspect than the loss of money, of energy, and the momentary depreciation of the currency of sanity. When a powerful nation loses its reason on the subject of war, the world is aflame; and the allied fire-departments of the sane nations are summoned to extinguish the conflagration.

The stages of the made-in-Germany war may be traced psychologically in terms of delusion and mass-suggestion. The mental munitions were as essential as those for rifles and shells. Like the material preparedness, the campaign of delusion was inaugurated decades ago. An early form of the delusion was that of encirclement. The German people were encouraged to believe that they were surrounded by envious and increasingly aggressive nations. The French motive was revenge; the English greed; Russia stood for the Slavic peril. Gradually the suggestion took hold that war was inevitable; the "*Tag*" was on the calendar. Once endured, the notion was cherished, then embraced. The delusion was incorporated in desire, enhanced by ambition, and justified by a flattered self-esteem. The finger of destiny pointed to the German Empire; the German was the superior race; German Kultur alone could redeem mankind. Every delusion, every subterfuge, every evasion is motivated by desire—as no one has more subtly demonstrated than the keen Austrian alienist, Dr. Freud—but in its expression meets with resistances. These must be overcome. The moral resistance goes out against an offensive war; defense is sanctioned, becomes a patriotic virtue. Hence the further elaboration of the delusion—the fiction of a preventive war. The transfer of guilt to others is essential to the self-esteem of delusion. Since the enemy is preparing to attack, he can be met only by an anticipating offensive. Hence the war, however it came, was "the war that is thrust upon us." That phrase is the nub of the aberration, repeated to nauseating insincerity, but clung to to the last. It remained set as the keystone of the delusion; with that loosened or detached, the arch must crumble.

War is a complex enterprise; the system of delusion that supports it is equally so. The soil in which delusion is to grow must be well prepared. The cultivating process is at once positive and negative. The mind must be made docile and submissive; it must see and see intensely what it is directed to see, and nothing else. The blinders must not be worn on the outside where they might be removed; they must be grafted on the seeing organ itself, and induce a mental blindness. Obedience to orders must be made a national habit, and *Verboten* signs plentifully distributed and rigidly heeded. Habits of thought must be censored; the press is to print only what the Minister of Delusion issues. The people must be fed on figments in generous rations, and substitutes for truth circulated at all hazards. To within three days of the final smash, all enemy attacks were uniformly repulsed in the German reports, all retirements were voluntary and to carefully prepared positions. The Marne was an unknown river in Germany; victories were heralded in megaphonic tones, and promises were accepted when victories failed.

The technique of denial and that of justification were carried on side by side; the deluded mind is not sensitive to inconsistency. Belgian civilians were snipers; the stories of Hun cruelties were fabricated in London. The German army remained the finest school of morality anywhere in session; German Kultur could not be guilty of the reported violations; and whatever Germans did was right, as the State could do no wrong. The more tender-minded German citizens, retaining reserves of moral resistance, were narcotized by the denial; the tough-minded who had abandoned them (and in the sacrifice, if such it was, could be comforted by the authority of Nietzsche) were stiffened by the official sanctification. So vast a delusion must reach and enthrall all sorts and conditions of men. The *Massensuggestion*—which is the German term for the mote in their neighbor's eye and is not applied to the beam in their own —was as huge and as highly organized as the German army itself; recruits of delusion can not be conscripted, but they enlist in equal numbers by the contagion of suggestion. The machinery of delusion must be kept running, and all the reserves of the psychological armament drawn upon. There was the campaign of hate, as well as the campaign of superiority, and the campaign of Pan-German ambition, the whole culminating in a gigantic, relentless megalomania. Follow the trail of the hate, and it leads to the bitterest disappointment. France was expected to resist; that England should shatter the glorious plan at the outset by keeping her pledge to Belgium made all Englishmen hypocrites, and the German's daily prayer: "*Gott strafe England*!" For that is the way of delusions among the insane in asylums as in nations at large, fixing the object of suspicion or wrath upon the frustrator of desire.

It is true to the psychology of delusion that it should aspire to the intensive force of great emotional exaltation by which the heroic deeds of individuals and the collective enthusiasms of masses have reached the high moments of human endeavor. A mystic, a religious fervor attaches to them, retaining in the one instance and losing in the other the fine distinction that divides the sublime from the ridiculous. Exaggeration and self-absorption inhere in both. The partnership of the Kaiser and Gott—now apparently dissolved—is more a symptom than a pose. The imperial exaltation and autocratic omnipotence of a sacrosanct emblem of power is a popular asset to the spread of a dazzling cause. The same self-deluded and self-exalted mood of prerogative extends to the lesser stars of the constellation; and the wretched Zabern affair thrilled far more generally than it outraged the German sense of propriety.

Out of it all grew the national habit of delusion, the refusal on the part of those directing, the inability in those who succumbed to the delusion to see things as they are. Figments, fictions, vain imaginings, blind denials, perverted excuses, crude suspicion, unreason rampant, all sanity forsaken in a psychic saturnalia of abandonment: such is the picture of *Mania Teutonica!* Such is its contribution to the history of mass-suggestion; such is the world war considered not as a military conflict of nations, but as the direst mental epidemic, the most devastating trench-fever that has ever swept over the minds of men to their undoing.

All delusions reflect the expressions and the circumstances of their time. In older days deluded patients heard divine voices in the air; now the inspired messages come through an invisible telephone. Formerly the victims writhed under the torture of the minions of Satan; now they suffer through "malicious animal magnetism" and mental vibrations. The political aspect of the great German delusion that precipitated the world-war and maintained it for four years in all its terror, all its running amuck among the shrines and sanctuaries of civilization, wears the garb of the twentieth century. Since liberty is the political concept of the generation, the Germans maintained the delusion that they were free. They accepted the strait-jacket as the uniform of patriotic discipline, and the padded cell as a token of solicitous paternalism. They accepted the tether of their permitted excursions as the limit of wise desire, and the goose-step as an improvement in human locomotion. German *Freiheit,* like German *Treue,* was an ancient quality; its venerability ensured its permanence, let the facts be what they may. The license of other lands inhabited by a degenerate and mercenary folk was an unenviable example; the invincible German army was the triumphant reward of discipline, and the industrial conquests—the only real structure in their astigmatic *Realpolitik*—a comfortable second prize for the dull days of peace. Through the network of delusion runs the double strand of concern for the values regarded by the rest of mankind, and the camouflaged thread that loosens every mesh. Germany professes peace while she plots war; Germany is indignant that neutrals should have opinions denouncing Teutonic ways, and places its arch-spies in the embassies of countries too generous to be unduly suspicious.

Somewhere in the moving German theater of war hangs the curtain that separates the performers on the stage from the audience: the responsible actors initiated into the plot and the deluded people who accept the drama as real. Unmistakable is the responsibility of the intellectuals, and pitiable the treason to their trust. *Lehrfreiheit und Lernfreiheit!* another slogan of delusion! Again the two camps of denial and of justification.

The ninety-three professors, thirty-five of them men of science, professing loyalty to the principles of proof, yet protesting seven times over: "*It is not true that*" of violations in Belgium of which they could not have the slightest knowledge, and which have been proved seven times worse than first reported; quite as many of the learned guild justifying by shameful jugglery the crassest fallacies and grossest idols of the mob. Can one fail to suspect that they owe the high positions which they occupy to the truculent qualities revealed under the stress of a war-delusion? The military and political leaders may have heavier sins to bear, but they have not added prostitution to their crimes. What wonder that with such perversity among respected leaders, the baneful suggestion could spread without check among the well-drilled masses! For the overwhelming fact, once we have partially recovered from the super-Satanic enormity of the plot, is the eager acceptance of such a devastating, demoralizing, dementalizing delusion by a supposedly enlightened people. It is as true of nations as of offending individuals, that those whom the gods would destroy, they first make mad.

Yet the interest of the psychologist is not in judgment as denunciation, but as understanding. Now that we can see in close retrospect the movement of events steadily and see them whole, we turn with admiration to those whose insight was prompter and truer than ours. Our lack of preparedness to meet the military situation testified to our creditable incredulity that such things could be; our lack of understanding of the stages of revelation requires to be more charitably interpreted to be so regarded. Of all the readers of the handwriting on the wall—now that Babylon has fallen—none is more deserving of the honor that is denied to prophets in their own lands and beyond them, than Professor Otfried Nippold of the University of Berne. A specialist in international law, a supporter of the Hague Conferences, the son of a German professor, a close student of German tendencies, his warning issued in 1913 in his "German Chauvinism" remained largely unheeded, despite the fact that the volume contains Germany's own evidence of hope and intention, of confident defiance and overweening self-assertion. It is to Professor Nippold's credit that for five years he has interpreted the German situation as a vain dream, and has consistently predicted the awakening and the *Katzenjammer* of many a day after. He has ever had confidence in the existence of another mind in Germany, a minority, small but not insignificant, the true *Realpolitiker*, ready to see things as they are—as other sane people see them. Deeply disappointed in the renegade performances of the Social-Democratic leaders, he yet hoped against hope that the saving remnant in Sodom would appear. As a Swiss neutral, he protested against the right of a formal neutrality to deprive him of free speech. He warned the German Swiss of the treachery of the propaganda of Berlin, and, like President Wilson, he held it to be the duty of all true friends of Germany to save the German people from their arch enemies, the German autocratic government. And yet, in February, 1918, bowing to the despairing truth as he saw it, he wrote:

> The people has no voice, and indeed it has no desire to make its voice seriously heard; it is content if it can but shout "Hurrah!" with Hindenburg. The German Revolution is still remote. The German people has not yet awakened. And the German Reichstag is the personification of modesty; it believes everything that the Government considers it desirable that it should believe.

With a stronger faith in the psychological uniformity of human emotion, he would have anticipated that the violence of the reaction would be proportional to the intensity of the disillusionment. The vain dream of Teutonic mania, the terrible nightmare of the rest of the world is over; the awakening has come. The road to recovery is long and difficult, but it is the clearly charted road of sanity. The lesson of the war is not alone the triumph of right, but the supremacy of sanity, the enthronement of right thinking as the safeguard of right action. The lesson of Germany, as the fallen assailant of right thinking and right action, is a demonstration on a national scale of the psychology of delusion. Delusion and deception, the one inward, the other outward in its operation, hold the psychological key to the frightful drama that was played on the political stage. The technique of the self-delusion with its sense of superiority, disdain of others, blindness of mind toward the obvious and the real, calls to its aid the technique of the deception of others by treachery, intrigue and plot. The common ground is the domain of lying, and the brutal products of cruelty, hatred and the abandonment of restraint. It is the war as a psychological phenomenon that is enlightening, the costly demonstration that the minds of men are the arbiters of their fate. The delusion that begins as a mockery ends as a snare.

TROPICAL VERSUS ARCTIC EXPLORATION

By the late THEODORE DE BOOY[1]
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WE wonder if the average reader has ever realized that tropical exploration spells something else besides sitting on a hotel veranda, surrounded by dusky servitors whose sole object in life is the carrying of iced drinks which are usually said to be provided with the proverbial "stick" and sometimes even with the "big stick"? Compared to what the general ideas are about trips to the polar regions, it must be admitted that one feels more favorably inclined towards a visit to the tropics than towards a voyage to the arctic seas. Let us see how the two journeys compare.

One leaves New York, let us say, for a voyage to the arctic regions. Knowing full well that one will find but little in the way of food after leaving the last Eskimo outpost, a stock of edibles is laid in that embraces the products of the Seven Seas. True, most of this stock is in canned form and not comparable to the delicacy of one's daily menu. But one has the means of transporting the stuff, first on the vessel that is used for the exploration and afterwards on the dog sleds that are certain to be employed on the venture. The glamor that goes with all arctic voyages does not fail to attach itself to the undertaking. In consequence, one is heralded by the newspapers, fêted by the scientific societies and farewelled by one's friends. This incident publicity also means that but little trouble is experienced, in normal times, to secure the necessary funds for the expedition.

The reverse of the above is true for the outfitting of a tropical undertaking. Funds are hard to secure. Does not the jungle provide all that is necessary towards a happy existence? Else why the breadfruit and the banana? And does not the coco palm provide the material for the building of houses, the making of hats, the manufacturing of mats and clothing and at the same time provide food in varied form? The tropical explorer asks for funds only in order to spend more time on the hotel veranda and, once in the bush, needs naught beyond the abundant resources of nature! As a result, with but few exceptions, the tropical expedition is all too scantily furnished with funds. Why trouble with clothing? The natives dispense

[1] The author of this article, distinguished for his explorations in tropical countries, died from influenza while it was passing through the press.—EDITOR.

with it. Why carry instruments or medicines? The tropical climate makes the latter unnecessary and, as for the instruments, why trouble to take observations when *per se* the tropical explorer is discredited before even leaving his native shores?

And now, let us see what happens when the field of exploration is actually reached. I am not qualified to speak of arctic conditions from personal experience, but any reader of arctic literature will agree with me that the situation as I shall show it is more or less in accord with general experiences. As a parallel, I shall show what the tropical equivalents are and leave the reader to decide upon the verdict.

The arctic explorer leaves his base. He is generally accompanied by a goodly party which makes traveling all the jollier. The provisions, be they ample or be they scant, are packed on sleds, drawn by trusty dogs. Generally the trusty dogs are too trusting, as they not infrequently wind up their useful career as nourishment for the explorers. Progress over the ice is fairly rapid and at times easy, especially when the explorers are riding on the sleds. One can see in all directions. There are no hostile inhabitants to contest the right to visit the region. It is cold, but the special clothes that are worn go far towards alleviating this hardship. Camp is made at night, after covering perhaps as much as twenty or more miles, a satisfactory day's progress. No time is lost in setting up the small tents and in preparing the food with liquid fuel. Outside of the cold, one is quite content.

The tropical explorer leaves his base. He usually travels alone or at the best with but one companion. No matter who the chief of the party is, he will usually quarrel with his associates before the expedition has progressed very far. This is due not to a mean streak in his make-up, but to the irritating effect of the climate and the mosquitoes. Naught but two saints —and these are scarce upon the earth—would travel a hundred miles through the tropical bush without having at least one violent quarrel. On leaving the base, certain provisions have to be taken along. The tropical forest is not nearly so generous with its gifts as one hears mentioned. The provisions that are taken weigh a great deal and have to be transported on the backs of the carriers. One is lucky to obtain sufficient carriers. Generally, the demand is far greater than the supply, so that, in the end, the amount of food that goes with the explorers is pitifully small. However, the tropical explorer is by nature optimistic and generally risks the chance of being unable to obtain game during his stay in the jungle. Of the food carried, at least fifty per cent. will spoil on the trip. This is mostly due to the intense humidity that is experienced. The daily progress made depends entirely upon the nature of the country. Sometimes it is as much as ten miles per day and often it is as little as four miles per day. Under the most unfavorable circumstances it means a slow, laborious cutting through the dense underbrush which is fatiguing and trying on the nerves. The thorns, with which so many bushes are plentifully endowed, do not fail to exact a bloody toll from the explorer. The thousand and one insect varieties lose no time to apply for their quota of the traveler's blood. Again, hostile Indians may be met with, and these may carry out what the insects tried to do, and put a final stop to progress in the desired direction. It is at last decided to make camp at night. Some leaves are cut and a temporary shelter is hastily erected. The more hastily this is done, the surer it is to rain that very night. By dusk, one begins to consider cooking a meal. Despite all the fallen giants of the forest, there is nothing harder to find than dry firewood in the tropics. At last a smouldering fire, with much smoke, has been created. Just about then, the mosquito outposts have spread the news to their far-off brethren that a newcomer is in the forest.

The arctic explorer travels on. One day's progress is not much different from another. Sometimes it snows and sometimes it is clear. Always he can see the road ahead. His provisions get low after a while, but he is still able to press on with comparatively little fatigue. At last the goal is fairly near. If it is reached and he returns in safety, a new discovery is hailed by press and public. If he fails, the return voyage provides him with ample leisure to explain, ingenuously, wherein the failure lay and how it was caused. The return of the arctic explorer is hailed with joy and he has even less difficulty than before in obtaining funds for a new expedition. Should failure mean death, his widow is fêted, honored and made to publish reminiscences of her husband. As for the lonely corpse upon the ice floe, it is generally discovered in later years. Death in the arctic means death from cold and starvation. I can not believe that such a death is hard.

The tropical explorer travels on. There is a startling variety in the experiences of each day. Sometimes he travels through the dense underbrush, combating with nature at every step, cutting down the very effective barriers of jungle which seem to defy his attempts at exploring the mysteries that lie beyond. Again, the trail leads over forbidding mountains. On the summits of these a cold is experienced that eclipses any cold suffered in the arctic. The explorer lacks all means to protect himself against these climatic changes. After a while he strikes a swampy region where the dreaded miasma covers the landscape with a mantle of death. Wild animals, wild Indians and wilder insects conspire against the traveler's happiness and peace of mind. Provisions get low. The tortured explorer, racked by fever, covered with insect bites and sores, enfeebled from lack of food, continues only because he knows that he is nearer to his goal than to his base. And if he reaches his goal? The few that hear of his success must needs consult a map to learn of his achievement. His friends regard his claims to recognition with scant concern and are too much inclined to dwell upon the delights of the tropics to take the narrative of his hardships seriously. The explorer is forgotten before he was ever remembered. He is forced to return to his tropics where nature at least does not belittle his attempts at solving the mysteries of the Beyond, but appears to feel that the great obstacles she places in his way serve but to heighten his achievement. And if the explorer fails to reach his goal? It would not be well to dwell upon the nature of his death. May be some kindly Indian arrow made it short. May be he lingered long, deserted by his carriers, tortured by insects, with fever visions that accentuated his agony, helpless to proceed, helpless even to do more than wish for a speedy ending. So have the tropics taken toll, year after year, century after century.

And now for the results. The arctic, practically all explored, and we have arrived at the realization that, while the scientific results of the expeditions are beyond price, the practical results have yet to be demonstrated. The tropics, partially explored, and the world has been enriched with new lands, new minerals, new drugs and a wider outlook. The pioneer, the explorer, has been forgotten, but the settled areas that resulted directly from his labors and his sufferings are monuments more impressive than those an ungrateful public failed to erect.

It must not be thought that these lines are in any way intended to slight the pretensions of arctic explorers. The work done by these intrepid travelers is beyond all praise. But so is the work that is carried out by the tropical explorer and this fact appears to be so seldom recognized, more is the pity! For the first, the medals, the glamor and the glory; for the second, the obscure position in the scheme of things in general, or, at the best, the self-knowledge of a task well done. And at the worst—the bleaching bones under the noon-day sun, seen only by the jaguars and the parrots, a warning, and at the same time, an attraction, to others who have the same longing for the tropical mysteries.

THE OLD INTERNATIONALISM AND THE NEW LEAGUE OF NATIONS

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IN drawing up the provisional draft of the Covenant of the League of Nations the commission has recommended that all international institutions existing before 1914 be utilized in the prospective international state.

> Article XXII. The high contracting parties agree to place under the control of the league all international bureaus already established by general treaties if the parties to such treaties consent. Fundamentally they agree that all such international bureaus to be constituted in future shall be placed under the control of the league.

It is the purpose of this article to give an account of the various bureaus and organizations that may be taken over by the league.

Before the World War broke there was a surprising amount of international activity carried on by various groups of states. There were sixty odd official organizations cooperating to facilitate and improve methods of communication, to promote commerce, to carry on international police and sanitation work, to secure and disseminate scientific data, and to perform various social, economic and political matters of common interest. Some of these activities were carried on by permanent bureaus, commissions and institutes, and it is these standing organizations that are to be taken over by the league of nations provided the signatory powers in each case agree to such a transfer.

Foremost among international organizations, though very quiet in its workings, is the Universal Postal Union, in existence since 1874. All the nations of the world are members; periodical congresses and conferences are held to draw up regulations for the handling of the mail of the world. The Union established a bureau in Berne for the purpose of collecting and publishing information and statistics concerning the work of the Union and to investigate and make known the needs of the Union. The expenses of this bureau are borne by the various powers in accordance with a certain scheme, each nation contributing its share in proportion to its size and the amount of service it gets from the Postal Union. This system has evidently worked well, for in article five of the Covenant of the League of Nations it is provided that "The expenses of the international secretariat shall be borne by the states . . . in accordance with the apportionment of the expenses of the international bureau of the Universal Postal Union." The arrangement is this: The countries of the Union are divided into seven classes, each contributing in proportion to a certain number of units. The first class contributes 25 units, the second 20, the third 15, the fourth 10, the fifth 5, the sixth 3, the seventh 1 unit. The states of the first class contribute twenty-five times as much as the states in the seventh class; the states of the second class twenty times as much and so on.[1] The budget of the Union has been surprisingly small. In 1874 it was fixed at $15,000; in 1878 it was increased to $20,000; in 1891 it was raised to $25,000, though the expenditures have always been less than this last amount.

There are three other organizations with permanent bureaus to take charge of various aspects of means of communication. Since 1865 there has been an International Telegraph Bureau supported by all the European states and some countries in South America, Asia and Africa. Since 1908 this bureau has a special division that issues regulations and information concerning wireless telegraphy. Eleven of the continental coun-

[1] The countries of the Union are classified as follows:

First class: Germany, Austria, United States of America, France, Great Britain, Hungary, British India, Commonwealth of Australia, Canada, the British Colonies and Protectorates of South Africa, and the whole of the other British Colonies and Protectorates, Italy, Japan, Russia, Turkey.

Second class: Spain.

Third class: Belgium, Brazil, Egypt, Netherlands, Roumania, Sweden, Switzerland, Algeria, French Colonies and Protectorates in Indo-China, and the whole of the other French Colonies, the whole of the insular possessions of the United States of America, Dutch East Indies.

Fourth class: Denmark, Norway, Portugal, Portuguese Colonies in Africa, the whole of the other Portuguese Colonies.

Fifth class: Argentine Republic, Bosnia-Herzegovina, Bulgaria, Chile, Colombia, Greece, Mexico, Peru, Servia, Tunis.

Sixth class: Bolivia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Hayti, Republic of Honduras, Luxemburg, Republic of Nicaragua, Republic of Panama, Paraguay, Persia, Republic of Salvador, Kingdom of Siam, Uruguay, Venezuela, German Protectorates in Africa, German Protectorates in Africa, German Protectorates in Asia and Australasia, Danish Colonies, Colony of Curaçao (or Dutch West Indies), Colony of Surinam (or Dutch Guiana).

Seventh class: Congo Free State, Corea, Crete, Spanish establishments in the Gulf of Guinea, the whole of the Italian Colonies, Liberia, Montenegro.

"United States Statutes at Large," Vol. 35, Part II., 60th congress, 1907–1909, pp. 1730–1732. Universal Postal Union, Universal Postal Convention, signed at Rome, May 26, 1906.

tries of Europe have since 1893 maintained a bureau that oversees the execution of various agreements concerning international freight service. Through this organization it is possible to send freight from one country to another without unloading at national frontiers, and the publication of railroad tariffs enables shippers to ascertain freight rates and the changes made in those rates from time to time. One of the most successful phases of international cooperation has been the work of the International Danube Commission, created by the Congress of Paris in 1856 at the close of the Crimean War. This commission is composed of representatives of England, France, Germany, Austria, Russia, Italy, Turkey, Serbia and Roumania; it has made the lower end of the Danube navigable by dredging channels and keeping them open; the expenses incidental to these activities have been met by the collection of tolls.

There have been three bureaus to handle various international commercial matters. Since 1890 all European states except Switzerland, Luxemburg and Montenegro have maintained a bureau at Brussels for the publication of tariff rates. Through these publications the merchants and manufacturers of these countries are kept constantly informed concerning the import and export duties of the countries of the union. In 1902 all of the states of Europe that raise sugar signed a treaty regulating the production of sugar in each country so there would be no oversupply or unnecessary competition between the countries. A permanent bureau, stationed at Brussels, is composed of the representatives of each of these European states and Peru; the bureau sees to it that the existing agreements are executed and also collects data that must be considered by the conventions that are held periodically to formulate new regulations. Most of the states of Europe, the United States and some Latin American states maintain the international bureau of metric weights and measures at Sèvres, France. This bureau has charge of the original metric weights and measures, such as the meter, the gram, the liter; it is here that can be found the original platinum rod or stick that is one meter long at the temperature of melting ice. It is also the purpose of this union to perfect the metric system and to secure its universal adoption in the interest of science and commerce.

On three occasions the European powers have created international commissions to administer the financial affairs of debtor nations, in order to ensure that an adequate part of the revenue would go towards paying the interest on the public debt. In 1878 was created the international commission for the administration of the Ottoman debt; in 1880 the powers organized the international commission for the supervision of the financial administration of Egypt. After Greece was defeated in her war with Turkey in 1897 she had to pay Turkey an indemnity of $20,000,000; to see that this was paid the powers established the international financial commission at Athens. It is not at all unlikely that some form of commission will be created by the Peace Congress to administer the finances of Germany so she may meet the financial obligations imposed by the indemnity that is sure to be exacted from her.

For the international administration of justice a number of permanent organizations have been created. Best known of all these, of course, is the Hague Tribunal, established in 1899 by the first Hague Conference, and given an enlargement of powers by the second Hague Conference in 1907. This tribunal or permanent court of international arbitration is composed of four representatives of each of the contracting nations, and in case of disputes being submitted, the disputants select whom they please from these members of the court. Since its organization this court has adjudicated fifteen international disputes. There is a permanent administrative council that looks after the affairs of the court; it is composed of the accredited diplomatic representatives of the contracting powers at the Hague. An administrative bureau exists also; its duty is to keep the records and do the secretarial work of the tribunal. It is not clear that the Hague Court will be taken over by the league of nations. Article XV. of the Covenant states: "The executive council shall formulate plans for the establishment of a permanent court of international justice, and this court shall, when established, be competent to hear and determine any matter which parties recognize as suitable for submission to it for arbitration under the foregoing article." There is no good reason for not taking over the Hague Court and modifying it as necessary. Of course the Hague Court as constituted before 1914 was made up of representatives of forty-four nations, and thus far only fourteen nations are participating in the discussions of the league of nations. Much will depend on the number of the nations entering the league and on whether Germany and her allies will seek and be granted admission to the league.

In 1907 was formed the Central American Arbitration Union, with a court at Cartago in Costa Rica. This court has settled three disputes. If the Monroe Doctrine and Pan-American interests are recognized by the Peace Congress, as will presumably be the case, the continued existence of the Arbitration Union of the American Republics will be assured. This organization has been in existence since 1892 and settles all disputes arising out of money matters. It includes all American republics except Venezuela, Brazil and Panama.

Before 1914 there existed three international organizations for the purpose of protecting intellectual and literary property. Since 1885 the European nations, the United States and other countries have maintained an organization at Berne to protect the owners of patent rights, copyrights, trademarks, trade names, and to prevent the false labeling of goods as to their origin. There has been a European organization with its bureau at Berne to protect artists, authors and composers against pirating and the violation of international copyright laws. The Pan-American Union has a similar organization with two bureaus, at Havana and Rio de Janeiro.

Various groups of powers have maintained organizations and bureaus for police and sanitation purposes such as the following: To prevent illegal trade in alcoholic liquors in the North Sea, to prevent the sale of alcoholic liquors to African natives, to prevent the spread of cholera and other contagious diseases, to suppress the African slave trade, to suppress the white slave trade.

Most of the European nations and some others have cooperated in scientific investigations. There are bureaus for carrying on geodetic surveys, for studying the causes of earthquakes and making seismological observations at stations in all parts of the world, and for taking deep sea measurements. The International Institute of Agriculture at Rome has existed since 1905 for the purpose of compiling statistics concerning agriculture in all countries. The bureau of the American Republics collects and publishes information concerning the political and economic conditions in all countries in the Pan-American Union.

The foregoing shows that before the Great War there were many international organizations and much cooperation among nations. It is gratifying to see that the Covenant of the League of Nations provides for the assumption of all of these activities wherever that can be arranged by the League. It is to be hoped that all or most of these activities will be taken over by the league and that the international life that existed before 1914 will be merged into a larger and deeper world organization that will prove far better than anything else that the terrible sacrifices of the last four years have not been in vain. May it be true that not only have we made impossible a recurrence of unprincipled aggression, but that we have also laid the basis for the permanent cooperation of the nations of the world for the benefit of all.

THE PSYCHOLOGY OF DEMOCRACY IN PUBLIC EDUCATION

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BUILDINGS, farms, laboratories, machinery, railroads, banks, ships, guns, armies, are necessary although vanishing implements and products of society. The essential and permanent basis of democratic society is that psychic thing called an *ideal.* No present or future exigency should be permitted to separate permanently the idealistic and the practical in an educational system supported by the people—whether the "practical" be of the manual or of the intellectual types of training. This is a good principle to set down at the outset of a discussion of any form of education supported by and for the public. It is peculiarly applicable in the consideration of phases of education called vocational, *i. e.*, education considered as preparation for and participation in occupations of social value. The absolute necessity of conscious ends to be attained by the race, of ideals standardized by altruism, can be appreciated better after a brief consideration of the development and results of knowledge, of power, and of human standards and ideals, from the psychological view point.

Emerging from primitive life, mankind with the slow accumulation of knowledge and skill gained power. With skill and dexterity came dominion over fire, light, the forest, the sea and wild beasts. With the accumulation of fact and knowledge, disease and pestilences were also overcome, pain was diminished by anesthesia, and duration of life prolonged. Especially has trained consciousness vanquished superstitions and fear. However, knowledge and skill brought evils to mankind along with good. There are several kinds of evils and unhappiness that come to the race and to the individual with the evolution of knowledge.[1] *E. g.*: The man of thought foresees the inevitable course of nature in decay and death—and this realization may bring unhappiness in hours of leisure. "La prévoyance, la prévoyance," complains Rousseau, "voilà la veritable source de toutes nos misères." Possibly art and music had one primitive beginning in the reaction from this unhappiness, as well as in the expression of excess, or playful energies. Formal expressions of religion also may have had

[1] Ebbinghaus, "Psychology" (tr. Meyer), 1908, p. 184.

one beginning in the reactions following man's depressing consciousness of his relative minuteness and helplessness in the universe. Still another persistent unhappiness resulting from knowledge, and for which society also has evolved a corresponding antidote, is the misuse of accrued knowledge and skill and power by the more fortunate individuals and groups of men, for the exploitation and even enslavement of their fellows. Thence came slavery, caste, robbery, wars of aggrandizement —with their attendant long trains of evils, such as cruelty, ignorance, poverty, disease, weakness and degeneration. The misuse of knowledge, skill and power through centuries of costly experience has taught mankind that the majority must agree and unite in suppressing evil-doing. Ideals of conduct must be defined and maintained, as well as skill and knowledge. Some of these universalized agreements of society are written visibly in constitutions, statutes, and laws. Other consensuses regarding right conduct are invisible yet potent forces existing in the form of customs, traditions, sentiments and aims and ideals—the last being definite products of creative imagination.

To us in America the word *democracy* is the symbol for all that is best in common agreement, sentiment and determination of a collective people—whether the determination be expressed in book or in conscience. This solidarity of understanding and approval and feeling constitutes the psychic basis of democracy—and is the most real and durable element of the whole structure of democracy. The essential fact stands out clearly that neither knowledge nor skill, or both combined, are sufficient for human welfare, especially in democracy where the good of the people is cherished. Ability to make and enforce law, imagination to create aims and good ideals, and sentiments and emotions that react habitually to the true, beautiful and good—these are quite as essential as accumulation of fact, or of specialized accuracy and speed in coordinated brain, eye and hand. Thus there is a psychological and ethical basis for the development of a true vocational education inculcating a combination of knowledge, of skill and of ideals—an indispensable basis indicated emphatically in the hard experiences of the race. The unimaginable suffering of the World War is a result that accrued where knowledge and skill were unleashed upon the world without controlling aims and ideals truly democratic. The ideals and emotions of the cave man have been linked by Prussian autocracy to modern technic, art and science.

The average man upon occasion is proud, and if necessary is pugnaciously assertive, of his Americanism. Nevertheless it may be difficult for him to define what Americanism means. Elsewhere we have sketched as follows the possible mental content of the average thinking citizen with regard to the matter of those democratic ideals which are the basis of our social life in the United States. Habituated in his every-day thinking there are aspirations, principles and fixed attitudes such as these:

> In the life of the individual there will be liberty compatible with the welfare of the majority of the inhabitants; freedom of personal development and expression will be maintained, but standards of conduct will be established and maintained for the betterment of society. The zealous protection of women and children will always enlist unremitting efforts toward progressive legislation to meet changing social and economic conditions. There is cherished a survival of the nobler sentiments of chivalry as concerns women and children. Equality of opportunity is a right and cooperation of civic responsibility is a duty, in American democracy. Life in its fullness, true liberty and the pursuit of happiness based on health, knowledge and achievement, are as yet found nowhere on this globe, but all these, he knows, surely are nearest of realization in the United States and in Canada, blessed of all countries of a world returned temporarily to fierce struggle for elemental things. In the social consciousness of the seasoned American we can also discern, aside from mawkish sentimentality, a collective, emotional reaction in which are mingled sentiments of admiration for our soil, our mountains, our lakes, our mines and forest—for the very land itself and for the pioneer-conquerors of it, along with convictions held in common concerning the essentials of government and of union, convictions and sentiments that make for determined solidarity and brotherhood—a true patriotism for both peace and war.

If the essence of American democracy is that these habitual sentiments and convictions are nourished in common by the increasing millions of our population, who nevertheless are more and more remote in time from the aggressive spirits who established these principles in this land, then measures can be undertaken by us who now live, for the deliberate strengthening of such habits of mind until they become increasingly permanent. The perpetuity of the elements of our democracy will be uncertain, unless there be effective preparation to train each new generation, and all newcomers, for social participation in the best phases of modern life in America, as well as for industrial efficiency. The best instrument for this undertaking is, we believe, the public educational system, in its manifold aspects from kindergarten through university.

Better realization of the possibilities of democracy in assuring life, liberty, and the pursuit of happiness, and more money for the public schools, might result from general deliberation upon the basal reasons for the support of education by every unit of our organized people, be it federal, state, county, township, municipality, or other contributory agencies. These reasons may be indicated here by suggesting respectively six principles: (1) Each child is a potential citizen and therefore should be made an intelligent, good man; (2) it is necessary to conserve and increase human power through the acquisition of knowledge and technical skill; (3) the state must supply the child with his biological birthright—a suitable environment for development; (4) the power and money of the whole people are alone adequate for the stupendous task; (5) the years of school life are important aspects or chapters in the book of democracy—rather than mere preparation for its enjoyment. It may be opportune in this connection also to bring in rapid review before the people certain basal facts about the nature of education, its instruments, the difficulties, and the present status of this our greatest American undertaking. One could compile a small volume to include attempts at defining education. We may agree to indicate by the term the "attempt to modify human beings in accordance with chosen ideals and aims." The broadening relations of education emphasize the truth that many elements or factors other than the teacher and the school are operative in modifying the human organism. It is necessary only to hint at the possible effects upon individuals, groups or races, of climate, heat, cold, moisture, dryness, proximity or remoteness from the sea, disease, occupation, the family, the crowd, the church, the press, the theater, peace, war.

So impressive is the magnitude of modern educational machinery that the incessant operation of these other agencies of change in innumerable forms may be overlooked, if we neglect the fundamental characteristics of formal education as an undertaking to modify, alter, to develop, or to suppress, the original inheritances of man's nature. It is true that we may not be able directly to cause or to prevent desired changes in the young generation dwelling daily for some years within the schoolhouse. It is convenient, however, when we define education as a formal process, to say that it is an effort to cause or to prevent modifications in human beings in accordance with a chosen aim or ideal. At best, we can only manipulate stimuli and environment in a manner conducive to the desired changes in the human organism. Education is not properly a daily task for a sleepy pedagogue, a pedant or a mere wage-earner. There are profound problems in physics, chemistry, zoology, physiology, psychology, hygiene, as well as in ethics, economics, industry and occupations, before the professional educator of to-morrow.

Public education as a deliberate attempt upon the part of the state to mold human beings can have no narrow aim, restricted ideals, or be an exclusive privilege of caste, of sect, of wealth, or of poverty. The process touches all ages of men, both sexes, all races, and is to be articulated with all socially desirable occupations within agriculture, forestry, animal husbandry; industries for the extraction of minerals; the manufacturing and mechanical industries of the factory, building or hand-trades; commerce; public service; professional service; domestic and personal activities; and the merely clerical occupations. Universal education will include eventually in its scope appropriate training in skill, or in knowledge, or in both, of those human beings who exhibit extreme individual variation from their kind, whether the variation be destructive or abnormal, or one of unusual mental capacity, *i. e.*, the supernormal, and also the defective—such as the feeble-minded, the confirmed delinquent; and the blind, and the deaf, and the crippled, whether they be victims of birth, of industrial accident, or of war.

There are to-day kindergartens, primary grades, grammar grades, intermediate schools, junior high schools, classical high schools, commercial high schools, technical high schools, industrial, trade, continuation, part-time and evening schools. Scores of differentiations in school work intended to adapt better the school to individual and community need are familiar to us, *e. g.*, open-air classes, oral teaching of the deaf, classes for epileptics, schools utilizing the preventive mode of attack upon vice and crime. And in addition, utilized by a fractional percentage of our population (less than one per cent.) there are the colleges, the professional schools and the universities. The passage of the Smith-Sears Act of Congress, for the rehabilitation of disabled, returned soldiers, largely through the processes of occupational therapy and of vocational education, is a significant extension in the application of universal education. Whatever may be one's verbal definition of universal education, a glimpse of the above list of typical kinds of educational machinery at work in our country reveals the presence of multitudinous, formal instruments of education which, if well coordinated for the higher purposes of democracy conceived as organized humanism, would constitute a near-realization of universal education in practise.

Classification of Human Types

- A. As to genesis.......
  - *a.* Chromatic race.......
    - I. White.
    - II. Yellow.
    - III. Red.
    - IV. Brown.
    - V. Black.
  - *b.* Sex.........
    - I. Male.
    - II. Female.
  - *c.* Nativity ....
    - I. Native-born
      - 1. Native parentage.
      - 2. Foreign parentage.
    - II. Foreign-born.
- B. As to personality . .
  - *a.* Age.........
    - I. Minority ...
      - 1. Infancy.
      - 2. Childhood.
      - 3. Youth.
    - II. Maturity.
    - III. Senescence.
  - *b.* Vitality .....
    - I. Physically normal ...
      - 1. High type.
      - 2. Medium type.
      - 3. Low type.
    - II. Physically defective .
      - 1. Blind.
      - 2. Deaf.
      - 3. Crippled.
      - 4. Anemic.
      - 5. Tuberculous.
    - Border line types ....
      - 1. Retarded.
      - 2. Epileptic.
      - 3. Speech defective.
  - *c.* Mentality ...
    - I. Mentally normal ...
      - 1. High type.
      - 2. Medium type.
      - 3. Low type.
    - II. Mentally defective. .
      - 1. Feeble-minded
        - 1. Moron.
        - 2. Imbecile.
        - 3. Idiot.
      - 2. Insane.
  - *d.* Morality and sociality...
    - I. The moral (and social)
      - 1. High type.
      - 2. Ordinary type.
    - II. The immoral (and unsocial) .....
      - 1. Untrustworthy.
      - 2. Incorrigible.
      - 3. Delinquent.
      - 4. Confirmed criminal.
- C. As to environment
  - *a.* Home conditions......
    - I. Normal ....
      - 1. High type.
      - 2. Medium type.
      - 3. Low Type.
    - II. Subnormal. .
      - 1. Neglected.
      - 2. Deserted or homeless.
      - 3. Ill-treated.
      - 4. Orphan or half-orphan.
  - *b.* Literacy ....
    - I. Literate.
    - II. Illiterate.
  - *c.* Vocational background
    - I. Professional.
    - II. Artisan.
    - III. Unskilled.
    - IV. Idle.
  - *d.* Economic background
    - I. Wealthy.
    - II. Middle class.
    - III. Poor.......
      - 1. Insolvent.
      - 2. Dependent.
  - *e.* Political background.
  - *f.* Religious background.

Naming solely in general terms the kinds of schools which we have developed in varied forms to meet different needs, is not sufficient to indicate fully the complexity and the magnitude of the task. Within each school, and class, there are differentiated types of groups and of individuals. The skillful adjustment of instruction to individual differences is ever a problem conscious to the intelligent teacher. Even pupils of the same chronological age differ in anatomical and physiological maturity, in mental growth, capacity and interests. Various attempts have been made to exhibit in convenient form an inclusive classification of all the manifold types of human beings which universal education must touch. On p. 448 is one such classification arranged by McDonald[2] upon the threefold bases of genesis, personality and environment of the population groups.

Both the common striving for universal education and also the vigorous expression of individualism are witnessed in the contemporary forms of educational machinery. The present status is not without danger, lest conflict, waste and chaos result from the failure to coordinate into practical administration the whole school machinery of the nation, through the power of broadly democratic and educational ideals, clarified and made controlling in the thinking, customs and laws of our swelling population. Educators have wasted much time in debates about words. The difficulties of some teachers in mental reconstruction, in surrendering prejudices, or, at least, in keeping in proper relation those educational aims or ends which are only immediate or proximate in nature, apart or distinct from those ends, aims and ideals which are consummate or ultimate in nature—are two persistent obstructions to better realization of universal education. Each of the numerous traditional notions defining the "ultimate" aims in education, *e. g., formal or mental discipline, culture, development, perfection, utility, knowledge*, etc., has still its place, and, clarified, doubtless will continue, but they will all be subordinated to a high ultimate aim for public education, an education intended to produce men and women who live in health, in economic productivity, in civic intelligence, and in observance of standards of conduct, and in the happiness of brotherhood, whatever be the occupation or status of the individual. Neither crass materialism, on the one hand, nor obsolete asceticism, on the other, will suffice in place of this unifying conception of the mission of public education.

An individualism bringing personal or national isolation—

[2] McDonald, R. H. F., "Adjustment of School Organization to Various Population Groups," New York, 1915, 145 pp.

in essence selfishness and fear, is as incompatible with American democracy as a radical socialism and collectivism which knows not the individual. In the struggle to define and maintain the sane and righteous balance between the demands of the individual and the demands of the group, comes the trial of democracy. A severe critic of the democracies so labeled in history thinks that popular governments imply a breaking up of political power into morsels, and the giving to each person an infinitesimally small portion. "They (democracies) rest upon universal suffrage, which is the natural basis of tyrany; they are unfavorable to intellectual progress and the advance of scientific truth; they lack stability; and they are governments by the ignorant and unintelligent." Further, declares Maine, "By a wise constitution democracy may be made as calm as the water in a great artificial reservoir; but if there is a weak point anywhere in its structure, the mighty force which it controls will burst through it and spread destruction far and near." Maine's fear of democracy seems based upon the assumption that prejudice and ignorance render the masses more dangerous than the controlling few, because the masses will run counter to scientific conclusions.[3] The agonies of Russia seem to support the theory. This expressed principle, however, only illustrates first, the necessity of universal, public education including inculcation of sentiments of liberty, equality, fraternity, loyalty—the prejudices of democracy, and, secondly, we are reminded that they who control, be they representatives or monarchs, must be animated by democratic ideals in order safely to guide the uses of science at their disposal. The public education we have achieved in America, and the success of our democracy now adequately tested, demonstrates that we are learning how to upbuild and to perpetuate democracy through the instruments of public education, and of ideals made conscious and potent in high places. We have referred to American democracy as symbolizing all that is best in common agreement, sentiment and determination of a collective people who have tested the worth of democracy through the storms of more than a century. This experience, and contemporary world events, increase our confidence in the system and now awaken forethought to safeguard and perpetuate American democracy. First, there has been the matter of overcoming vicious idealism, autocracy, Prussian militarism, which has brought cataclysms. Secondly, there exists also

[3] Garner, J. W., "Introduction to Political Science," New York, 1910, pp. 224, 318–321.

amongst us at home some anarchism, and a pestilential propaganda called socialism. Thirdly, there is the matter of methods and means to be adopted in safeguarding and perpetuating the best of American habits, convictions, sentiments, attitudes and ideals, in the mind of the present and future public.

These mental conditions constitute the foundation rock of our democracy. Our valiant Army and Navy, supported by industry and by our people, united in manifold efforts to "seek the reign of law, based upon the consent of the governed and sustained by the organized opinion of mankind," are the designated agencies to deal directly with the matter of defense and of offense as concerns Prussian autocracy. The public schools are an agency to be relied upon in the matter of perpetuating American ideals. The schools are a tremendous engine for effecting changes in human nature in times both of war and of peace. An idea inculcated firmly in the minds of the Prussian children of twenty or thirty years ago ("With God, for King and Fatherland") and viciously developed to delusions about Kultur finds atrocious expression to-day. In America we are reaping the rich mental and social fruitage of the convictions concerning "Liberty, Equality, Fraternity" inculcated in the minds of our own children born thirty years ago, and of their fathers. Who can calculate, therefore, the glorious results for humanity, in the lives of the unnumbered millions yet to be born, if the schools of to-day effectually inculcate in the creative imagination of children the purest ideals of democracy, ideals refined in the fires of the century and a half of our national existence and in the recent experiences of the world war?

Opportunity exists for those who are expert in the actual technique of instruction to discover and to evaluate for us all available methods of inculcating democratic ideals as consciously selected and followed goals in individual life. It is a phase of the complex problem of moral education, but the undertaking concerns in detail every thing done in the school. Expertness in the technique of teaching, efficient methods, are more urgently needed for this purpose than even in reading, writing and arithmetic—the pedagogue's favorite field for experimentation. Given the content for instruction in ideals of democracy, the problem is to devise methods for making these ideals both conscious and permanently controlling in human lives.

Great has been the demand for technique in imparting elementary knowledge, and the contemporary emphasis upon the vocational aspects of education also calls imperatively upon the teaching body for economical and effective methods of imparting skills in mechanical occupations. The present national emergency magnifies the two demands for better methods in the acquisition of knowledge and in the acquisition of mechanical skill. An important aspect of each of these two problems—the acquisition of elementary knowledge and of technical skill, is the further introduction of ethical idealism into all teaching, whether it be for knowledge or for skill. It is not our purpose to enter into the detail of this question, "how to teach ideals," the answer to which is being sought ably by such teachers as Bagley, Thorndike, Dewey and Charters. The problem is becoming more difficult now that stress upon vocational education lower than college grade is growing by leaps since the passage of the Smith-Hughes Act. It is recognized that we must have general intelligence, and citizenship, along with technical skill. For example, it is often said that we need sorely the development of industrial intelligence as well as industrial skill. A broad interpretation of *industrial intelligence* reads into this expression (*a*) an *ethical idealism,* as well as (*b*) *information* about industries of economic value to accompany (*c*) *specialized skill* in the sense of manual dexterity and training, coordination of brain, eye and hand. We venture to lay down tentatively the following outline of ten means whereby democracy, including industrial intelligence, may be sought in our schools. In practical contact with individual and with social and occupational groups the wise superintendent and professional educator utilizes many different channels to move forward ethical idealism. A distinction of course fundamental is that between the *lay* (legislative) and the *professional* (executive, supervisory) functions in school administration. The first function belongs to school boards, hence first we speak of the matter of control:

1. *Ultimate, Single Control.*—Systems of public education, whether organized into federal, state, municipal, county or smaller units, should avoid rival boards of control. There should be ultimate, unitary control in order to enforce but one kind of ideals—the ideals of democracy. Our constitution and practises provide safeguards to prevent perversion of unitary control to permanent autocracy. Dual systems of education supported by public funds, whether set up by irreconcilable educational factions, by religious denominations, or by partisan politics, are essentially wasteful, promotive of caste and have not proved satisfactory upon trial. Adherence to *single control,* however, does not negate the value of temporary boards, commissions, or other bodies for educational control,

organized to establish and regulate neglected phases of education in the face of obstructive academic opposition, and constituted with representatives of the schools, of labor, and of capital, and with carefully restricted and defined powers. An approximate example of this type of board, or commission, is the Federal Board for Vocational Education, organized to cooperate vitally with State Boards and with the United States Bureau of Education and other federal bureaus and departments. Both the spirit and the letter of the Smith-Hughes Act make possible a cooperation and unity of effort, rather than rivalry or dualism; ultimate control inheres in appeal to Congress as well as in the legislatures of the States. If the work of the Federal Board later should be absorbed by a national Department of Education, there should be secured a safeguarding of oneness of aim and administration compatible with democracy.

A good type of unitary state control is where the code and the statutes of a state authorize: (1) A small, appointive, or elective-at-large board of education composed of intelligent laymen; (2) these laymen appoint an expert educator to discharge executive and professional functions as head of the state department of education; (3) this executive (commissioner of education) nominates other trained persons to be executives of various divisions of his department—as, division of elementary education, division of high schools, division of vocational education, division of health, division of educational research, etc. The whole school system of the State thus may be coordinated for teaching consistent with democracy. Universities and other special institutions may be included in the scope of such a plan, with necessary boards affiliated with the state board. Municipal and county boards advantageously could be modeled in similar but simpler form.

2. *Didactic Assertion, Simple Teaching of Truths by Word of Mouth and by Printed Page has its Place.*—Reaction from the Socratic doctrine that "virtue can be taught" need not lead us to utter abandonment of the principle that information, understanding, facts, are conducive to steady action. When one considers the universality of imitation in the human mind, and the power of normal suggestion in modifying conduct of individuals and of groups—he is likely to magnify the utility of oral or written words in the inculcation of effective ideals. The "winged word" is the most powerful of all instruments. The difficulty is that our words meant to convey deepest truths often lack the masterly utterance and timeliness of the great teachers—Jesus, Confucius, Socrates, Plato.

3. *Curriculum Changes.*—Educational research has uncovered wasteful practises in tread-mill repetition and inconsistent courses of study in our elementary and secondary schools. Encouraging progress is being made toward economies of time and effort, which will give better opportunity for emphasis upon the civic and ethical bearings of every subject in the curriculum and by every teacher.

4. *Expression or Practice.*—Vivid and incessant oral and visual portrayal of ideals is not enough. There must be expression if the ideals are to be ingrained in individual life. Opportunities for development of expression inhere in the school, in the shop, in play, in social organizations, in participation of pupils in the multiplying activities of the war, such as thrift campaigns, gardening, the Boy Scout movement. The day is past when the teacher of language, or mathematics, or manual training, or science, or history, or civics, or hygiene, etc., may consider safely his subject as of value in itself, and to be taught to receptive or merely absorptive students regardless of any bearings that the subject may have upon active or community life. Every teacher may consciously indoctrinate and make active the principles of democracy as revealed in his subject—be they properly related principles of culture, discipline, utility, knowledge or skill. Only teachers who can do this thing are fully qualified for public education. There are abundant potential avenues in the schools for putting into practise the choicest ideals of equality, fraternity, liberty, fair play, team spirit, manly competition, sympathy, love of our country.

5. *Consciously Developed Attitudes.*—The development of educational psychology has brought forward some facts and methods from general psychology of value to educational practise—as witness the psychology of instincts, of habit, of interest, of attention, of formal discipline, of the learning process, etc., the psychology of the elementary and high-school subjects, and the tendency toward experimentation or trial rather than toward dependence upon debate and oratory in educational advancement. Some new light also has been thrown upon the psychology of prejudices, set convictions, emotional attitudes. Attitudes may be in large measure the product of controllable factors or situations. It would seem that in the matter of inculcating ideals, and those mental complexes called attitudes, which embody both ideas and emotional factors—good opportunity appears for practitioners of applied psychology to tell us more definitely how to develop consciously those desirable attitudes and prejudices toward the good, which may be util-

ized in the development of individual character and for the stability of our democratic society.

6. *Emotionalism.*—Aims and ideals in order to live in daily conduct must be rooted in the impulses, feelings, emotion and sentiments that motivate most lives more deeply than perceptions or reasoning. Cold-blooded analysis of fact, verbal portrayals of truth in immaculate rhetoric, but somewhat totally lacking the qualities of appeal, are not sufficient in teaching ethical and national ideas to pupils. Music, poetry, the drama, real oratory, personal appeal, the Flag, each has a vital function not to be neglected and not to be relied upon as exclusively sufficient.

7. *Specific Education for Patriotism.*—The sentiment of patriotism is a subtle form of emotion. Abiding patriotism as a mental characteristic in the individual includes definite ideas developed by the people of a nation as concerns the common good, equality, liberty and the principles for which our fathers fought. It includes also the affective glow of pleasant feeling which, combined with the ideas about principles, pioneers, country, constitute, altogether, the sentiment of patriotism—a subtle sentiment to analyze, but a real, stupendously powerful, social energy. The point is, there are definite ideas and facts to be nourished in engendering patriotism, ideas found in the Declaration of Independence, in the Constitution, in the non-sectional history of our country, and in the expressions of choice thoughts by our great men.

Teachers who nourish in their hearts true loyalty to American ideals, and who know enough of history, tradition and literature, to supply the indispensable basis of unbiased fact, are the ones qualified to instil patriotism—and no others are. Whether the teacher's subject of instruction be German or science, Latin or gymnastics, English or machine work, the building trades, or home economics—the indispensable qualifications for seasoned loyalty and patriotism are essential in our democracy.

8. *Health.*—"While some gifted persons may possess strong wills in spite of weak bodies, for most people physical and moral vigor are connected intimately," remarks Neuman. Samuel Johnson's remark that the sick man is a scoundrel is given some credence by the numerous instances where vice, intemperance, gross indolence, harmful fears, obsessions, fanaticism and crazed radicalism may be traced to bad health cr physical weakness. One of the other functions of public education, in addition to the establishment of standards of individual capacity to share in social life, is to provide the best

conditions for the conservation of physical strength, the prevention of disease and of accident. New significance therefore will attach to the administration of all valid health and safety measures in our effort to conduct a public education conducive to the upbuilding of true democracy. In our pragmatic emphasis upon the spiritual, and upon ethical idealism—we can not afford to ignore the other, the physical aspect of the human organism, whatever may be our metaphysical theory of the nature of the mind-body relation.

9. *Attendance, and Cure of Elimination.*— Our public schools will never serve completely all the people until we achieve: (1) Compulsory and regular attendance during an adequate school-year, and (2) until the present evil of premature elimination is overcome. Schools which in upper grades and in the high schools educate only a small, fortunate fraction of the population are contributing to a caste and aristocratic tendency. That less than a seventh of the pupils who enter the first elementary grade ever graduate at the average American high school is due to various factors in the pupil, in society and in the school, worthy of serious study and determined remedial effort in each community.

10. *Conserve Existing Schools.*—The schools of the past quarter century have succeeded marvelously in preserving the ideals of democracy. Otherwise, how came this unanimity of action, this oneness of purpose and whole-hearted effort of our people working and fighting to preserve the best of civilization and to make the world "safe for democracy"?

An educational pessimist can easily tabulate a score of serious defects in characteristic American public schools—although he might admit relative progress. One weak point revealed by the war has been our industrial unpreparedness, and inability to furnish trained men for and from those industries utilizing skilled labor. At enormous costs these deficits in skill have been met by strenuous emergency measures for training. The world will never be the same again. A twofold problem before us in public education is, first, to supply adequate opportunity for elementary, for liberal and for vocational education in behalf of that ninety-nine and one half per cent. of our population which never enrolls in a college, university or professional school. Secondly, in our effort to reorganize the public educational system thus for democracy, it is essential to conserve and not merely to destroy. Our public school system, with all of its defects, has delivered for world service millions of young men—most of them healthy, efficient, clean-minded, and imbued with the ardor and ideals of democracy.

NERVOUS AND OTHER FORMS OF PROTOPLASMIC TRANSMISSION. I

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IT is an old story that living protoplasm is "irritable." This is one of the many and undeniably important truths of which—as Dr. Johnson used to say—men need to be reminded rather than informed. The whole living cell or tissue, and in many cases the whole organism, *responds* (as we say) to an environmental change by some characteristic change in its own activity. Such inciting changes or *stimuli* may be of the most varied kind; mechanical influences, changes of temperature, light, chemical substances, the electric current may all call forth in an irritable tissue or organism an active response. The precise nature of this response is determined by the special constitution of the living system, and is largely independent of the character of the stimulus; in whatever way it is stimulated a muscle always contracts, a gland secretes, a protozoon carries out a motor reaction. All this is familiar enough. But what is not always clearly recognized, although evident when we stop to consider, is that when a cell, or a whole organism, responds in this way to a single localized stimulus there is always a *transmission* of physiological influence from the point of stimulation to other regions not immediately affected by the stimulating agent. It is because of the ability to transmit such influence that the living system is enabled to react in a unified manner, *i. e.*, as a *whole*. The active state resulting from the local disturbance seems possessed of an innate tendency to spread and to involve the entire cell, and often to extend to other cells. If we reflect we shall see that this is no merely incidental or occasional vital property, specially developed in certain cells or tissues such as nerve, but that any vital response tends to involve a larger area than the area directly receiving the stimulus; that in fact we are dealing here with one of the most general and distinctive peculiarities of living matter. The continued existence of a living cell, and in a larger sense of each living organism, depends upon its acting as a single self-regulating system, the various separate activities of which mutually influence and control one another and are so coordinated as to secure a definite unity of action in the whole. It is by means of such unified and effectively directed action of the *whole* living system upon its environment that its own survival is made possible; and it is plain that any such unification demands prompt and ready transmission of physiological influence from one region to another.

This may be made clearer by a few examples. In animals we usually find that antagonistic pairs of motor processes, which would interfere with each other if they took place at the same time, are so interconnected functionally that their simultaneous occurrence is impossible. Thus flexor and extensor muscle groups can not normally be innervated simultaneously; activity in the one group of controlling motor neurones automatically prevents or decreases activity in the other; *i. e.*, an inhibitory influence is transmitted between the two regions of the central nervous system which innervate the respective muscle-groups. This reciprocal influence is by no means confined to the nervous system. It is shown, for example, in the passage of peristaltic waves along the intestine, in the locomotor movements of worms, and even in amoeboid movement, and apparently forms an essential factor in all motor coordination. Even the more fundamental physiological processes like growth and metabolism are subject to a similar kind of control; in both animals and plants the growth of one part often inhibits the growth of an adjoining part, and it can be shown that the attainment of the normal form and structure in a developing organism depends largely upon such transmitted influences. What is most remarkable is that they control the rate and character of formative and other processes in spatially separate regions of the organism in a manner which often seems independent of any transfer of material substance between the regions concerned; control by material transfer (hormone influence), which is also widespread, is an entirely different type of phenomenon (apparently sometimes confused with the first). Now coordination of activity, functional, metabolic, and formative, is perhaps the most fundamental characteristic of life-processes in general; it is inherent in all vital organization, which, as I need scarcely remind the reader, includes organization of physiological activity as well as of structure. And since this coordination implies that physiological processes in different regions of the cell or organism mutually influence one another, in a constant and dependable manner, it is evident that transmission is a necessary element in any kind of definite response to stimulation. We can not, after the fashion once prevailing in physiology, speak of "irritability" and "conductivity" as if they were two separate and independent properties of protoplasm. Both are always present. When a cell or a nerve-fiber *responds*, it at the same time *conducts*. If it fails to conduct no response is possible. Accordingly we must conclude that the ability to transmit physiological influence from one region to another is common to all forms of living protoplasm. The readiness, completeness and rapidity of this transmission and its precise functional manifestations vary in different cells and in different organisms, but without it normal vital activity is inconceivable. Conduction, in this general physiological sense, is a universal property of living protoplasm.

The problem of the physico-chemical nature of protoplasmic conduction or transmission is thus one of the most fundamental in biology. It includes such problems as that of the nature of the nerve impulse—one often treated in too special and limited a manner by physiologists—and many other special problems of coordination and integration. It is therefore largely a problem for comparative physiology. What kind of influence is it which is thus transmitted? Since living organisms are systems which operate by means of chemical energy freed by oxidation or other chemical changes in cell-constituents, it is obvious that any influence modifying functional activity must first of all be an influence modifying the rate or character of the chemical processes which underlie and determine the function in question. These chemical processes are collectively termed "metabolism." In any form of protoplasmic transmission, therefore, we have an instance of transmission of metabolic influence to a distance; metabolic processes are primarily affected, and along with these the dependent functional activities of the living system. Our general problem accordingly resolves itself into the problem of the means by which chemical or metabolic influence is transmitted from one region of the living system to another more or less distant region. Such transmission is universal in living protoplasm. The main difficulties of the problem arise from the fact that the process may take place independently of the transfer of material between influenced and influencing regions, and often at a very considerable velocity. These peculiarities are well illustrated by the case of nerve-conduction, which may be regarded as the type-phenomenon of the class. What is the essential physico-chemical basis of this type of transmission?

Now that the fundamental problem has been defined, the situation may perhaps be made clearer by a concrete application. Most of us are familiar with the behavior of a typical protozoon like *Paramœcium* and will remember what happens when this organism is locally stimulated, for example at its anterior end. A definite sequence of locomotor processes follows, constituting what Jennings has called a "motor reaction." First of all the ciliary stroke is reversed over the whole surface of the body and the animal backs; then the cilia change their direction of stroke in certain regions, causing a turning movement toward the aboral side; and finally the original ciliary stroke is resumed and the animal again swims forward in a different direction. The slight local stimulus sets up some kind of transmitted influence which modifies in a definite and orderly sequence the activity of the motile surface-structures or cilia in different parts of the body. The resulting changes of movement, which unify and coordinate the behavior of the whole organism in a manner which often appears intelligent or consciously adaptive to our eyes, depends upon the transmission of this influence from the original point of stimulation. The transmitted influence follows a definite path, occupies a definite time in its passage, and calls forth a correspondingly definite succession of physiological events. Since the normal physiological sequence is a constant one, we are justified in inferring the existence of some fixed or stable structural and physiological "organization" in the protoplasm, determining the rate, direction and character of the transmitted influence. At least certain definite conduction-paths must be assumed, forming part of the inherited organization and furnishing a ready-formed basis for the constant sequence of motor activities. Transmitted influences of some kind, coordinated both in space and time, evidently control the whole behavior of the animal, and hence determine the possibility of its continued existence as an organic species. And what is true of a single organism like *Paramœcium* is true of countless others and probably of all. There is infinite diversity of detail in different organisms, in correspondence with the diversity in modes of behavior, but in all cases the characteristic sequences of physiological activity and behavior, on which continued normal life depends, are determined by the definite and regulated transmission of physiological influence between different regions of the organism. In higher animals the chief conducting paths are clearly defined anatomically and constitute the central and peripheral nervous system; but even in the individual cells it is probable that equally definite and delicately coordinated pathways of protoplasmic transmission exist, controlling the local differences of metabolism and functional activity. The case of protozoa shows that there may be such pathways within the limits of single cells.

Many single cells of higher animals exhibit certain simple types of transmission following local injury, which have only recently been studied in detail and deserve particular attention, since they seem to throw light upon the more complex processes of normal protoplasmic conduction. I refer to the transmission of the effects of local mechanical injury in isolated cells like blood-corpuscles and germ-cells, as shown in the recent experimental work of Kite, Chambers and Oliver, using the methods of microdissection.[1] Any cut or puncture of the cell-surface, if sufficiently extensive, or even in some cases a simple contact of the needle, may result in a progressive and often rapid disintegration of the whole cell. Thus a red corpuscle pricked at one point immediately begins to lose hæmoglobin over its entire surface; a leucocyte similarly treated soon disintegrates. Evidently a change in the protoplasmic surface-film, involving loss of semi-permeability, is transmitted from the point of injury over the whole cell. The cell-surface appears to be so constituted that a rapid local alteration of this kind induces automatically a similar change in adjoining areas. Hence the effect *spreads*. There is an essential resemblance between this kind of transmission and the transmission of the excitation-state in irritable elements. In both cases there is evidence of a transmitted alteration in the osmotic properties of the surface-layer;[2] in the typical irritable element, however, this surface-change is rapidly reversed and the original or "resting" condition is restored, while in the blood-corpuscle the destruction of the surface-layer is permanent and the cell breaks down. It is important to recognize that the transmission of the effects of local alteration is not confined to those specialized cells or cell-structures which we agree to call "irritable"; it is only that in the latter case the transmitted effect is more readily produced, is locally evanescent or reversible, is propagated more rapidly, and calls forth more definite and conspicuous effects than in

[1] Cf. *Science*, 1914, N. S., Vol. 40, pp. 625, 824; Vol. 41, p. 290.

[2] *I. e.*, a temporary increase of surface-permeability appears to be very generally if not universally associated with stimulation in irritable living cells. This change does not remain localized at the point of stimulation, but spreads rapidly and involves the whole irritable element. It will be seen below that a similar kind of self-propagating surface-change takes place under certain conditions in the surface-film formed at the interface between certain metals and the solutions with which they react (*e. g.*, passive iron in nitric acid, mercury in hydrogen peroxide solution, etc.).

other types of cell. In such cases we are accustomed to regard this property as a special physiological function, and call it "conduction." In nerve it is especially highly developed, and for this and other reasons the transmission of the nerve-impulse has often been regarded as constituting a special problem in itself. Nervous conduction, however, is only one special instance of the more general phenomenon of protoplasmic transmission. Yet because of its many striking characteristics, and also because in this tissue the conduction-process is apparently uncomplicated by other processes, most of the special studies of protoplasmic conduction have been made on nerve. I shall therefore refer largely to the results of such studies in considering, as I shall now attempt to do, the physico-chemical nature of the transmitted influence.

What, then, is the essential nature of this influence? It can not depend upon the bodily transport of material between excited and unexcited areas; its rate is far too rapid for that. In man a stimulating influence is transmitted from the central nervous system to the muscles along the motor nerve-axones (each with a sectional area of perhaps 50 to 100 square microns) at a velocity of 120 meters per second; while the most rapidly diffusing dissolved material particles, the hydrogen ions, move at the rate of only a few centimeters per hour, even under the influence of steep electrical gradients. Nor is the influence mechanical in nature, like (for example) the transmission of signals by the old-fashioned wire bell-pulls, for there is no visible mechanical deformation in a nerve or in a *Paramœcium* during transmission. Change of temperature is also ruled out as a possible factor; in a nerve during the passage of a single nerve-impulse the rise of temperature is estimated by Hill as not more than a hundred millionth of a degree; this fact disposes of the analogy to an explosion-wave, a process which is propagated by local rise of temperature associated with increase of pressure. There is also no resemblance to the transmission of physico-chemical germ-effects, as, *e. g.*, in crystallization; in a tube filled with a supersaturated solution of Na_2SO_4 the introduction of a crystal of the salt at one end causes separation of crystals throughout the whole solution, the effect being propagated rapidly from end to end. But in this case a mechanical and optical change and a rise of temperature accompany the process, and neither of these is perceptible in a conducting nerve. Moreover the crystallization process is not spontaneously reversible, and the rapid reversal of the local change is perhaps the most striking feature of normal nervous conduction. On reviewing the various known modes of transmission in inorganic processes we find none corresponding even remotely to the protoplasmic process, with the possible exception of some form of electrical influence.

But a comparison with the electric current does not seem at first sight to offer any escape from our difficulties. It is true that we have here a case where rapid transmission of chemical influence to any required distance is possible. We may connect a battery by wires to an electrolytic cell at an indefinite distance; when the circuit is closed chemical processes start simultaneously in both battery and cell; and any change in the rate of the chemical process in either system at once causes corresponding changes in the other. This is a simple consequence of Faraday's law of electrolysis. There are, however, at least two essential differences between chemical transmission of this type and nervous transmission. In the electrical circuit the transmission of chemical influence takes place instantaneously, *i. e.*, at the speed of the electric current (3×10^{10} cm. per second), and the intensity of the chemical effect at the terminals decreases as the length of the conducting path increases, because of the inevitable increase in electrical resistance. Further, in such an arrangement there is always a *circuit*, *i. e.*, two spatially separated metallic paths by which the current respectively leaves and returns to the battery; while in the case of a nerve-axone there is only a single slender fiber of high electrical resistance, which conducts chemical influence with apparently undiminishing intensity along its whole length. This last peculiarity should especially be noted; there is no evidence that the nerve-impulse decreases in its intensity as it passes along the normal nerve; on the contrary there is definite and, I think, conclusive evidence that it maintains its local intensity unaltered.

And yet there are many indications that electrical processes play an essential part in protoplasmic conduction; that in fact the transmission of activity from the excited to the adjoining unexcited areas is directly due to electrical influences. The comparison of the nervous impulse to an electric current through a wire is plainly a false one. Nevertheless, the possibility remains that the transmission is the result of electrical effects of a quite different kind. We know that the activity of a living cell, *e. g.*, a muscle cell, is associated with the production of an electric current, the so-called action-current, and that this current is able to stimulate other muscle-cells. Is it not possible that in a similar manner the electrical disturbance accompanying activity in one region of a muscle-cell or nerve-fiber may arouse activity in the adjacent still unexcited regions of the same cell or fiber? These regions, on thus secondarily becoming active, would influence similarly the adjoining regions beyond, and in this manner the state of excitation might be transmitted as a wave along the irritable element—each successive region activating the one next beyond by means of the action-current at the boundary between resting and active regions. Such an hypothesis would be free from the objections just cited, and in fact it has been suggested from time to time (although usually in a vague and experimentally unsubstantiated form) by various physiologists from Du Bois-Reymond on.

This general hypothesis, that the bioelectric variation itself constitutes the normal exciting condition in the transmission of local activity from place to place in living cells or nerve-fibers, renders intelligible one of the most remarkable and significant general peculiarities of living organisms, namely, their sensitivity to electrical influences. This sensitivity is so great that in Galvani's early electrical investigations the nerves and muscles of frogs were used as delicate electroscopes in studying the effects of friction and similar treatment upon the electrical condition of bodies.[3] And, as all know, the discovery of current-electricity followed from observation of the effects of simultaneous contact of dissimilar metals upon these living tissues. So long as the electric current was regarded as an exclusively artificial or "laboratory" product this highly developed electrical sensitivity of living matter was difficult to understand on teleological or other grounds. It seemed to be a purely incidental peculiarity, probably unconnected with normal function. But we now know that electrical currents are associated with the most various physiological functions, and there is every reason to believe that they are a constant accompaniment of all cell-activities. If this is the case, such currents must constitute a normal feature of the environment of most living cells, at least in multicellular organisms; and that a sensitivity to such currents should exist is no longer surprising. It now seems probable that the bioelectric currents play a general co-ordinating rôle of the widest possible application in living organisms, and that they form the chief, though not the only, means by which physiological and metabolic influence is transmitted from cell to cell and between different regions of the

[3] A striking instance of extreme sensitivity to weak electric currents has recently been discovered by Parker in the catfish. The simple dipping of a metallic rod into the aquarium produces through local action sufficient current to excit the fish. Cf. *Amer. Journ. Physiol.*, 1917, Vol. 44, p. 405.

same cell. Such a view would regard the phenomena of transmission in cells and nerve-fibers as essentially an expression or consequence of electrical effects resulting from local activity. Let us now inquire if the general peculiarities of the bioelectric variations in such a tissue as nerve—which is the best for illustration because it is primarily conducting in function—are in fact consistent with such an hypothesis.

The transmission of the excitation-state in living tissues must have at least this in common with the other innumerable instances of transmission of physical changes in nature—that the change taking place at one region of the transmitting medium or system in some manner produces or determines a similar change at adjoining regions. By a repetition of this effect the state of activity, whatever its special nature may be, is propagated from region to region. Our present problem is: what is the essential physico-chemical nature of the process which takes place at the excited region of a conducting element (like a nerve-fiber) and causes excitation in adjoining resting regions? We have seen that the electrical variation accompanying activity is the only observable change (in nerve at least) which is known to be capable of stimulating a resting part of the same tissue. We are thus led to form the hypothesis that the bioelectric variation at the active region is the direct cause of stimulation at the adjoining resting region. If this can be shown to be the case, transmission is accounted for, since all portions of the tissue are equally sensitive to electrical stimulation. In his Croonian Lecture, delivered in 1912, Keith Lucas formulates the problem with his customary clearness and exactitude. He reviews the various facts indicating that the bioelectric variation is an inseparable feature of the "propagated disturbance," *i. e.*, of the excitation-wave or nerve-impulse, and proceeds as follows:

> Up to the present the available evidence does not contradict the proposition that the electric response is a constant concomitant of the propagated disturbance. But for the purpose of any hypothesis as to the physico-chemical nature of the latter the mere stringent proof of this proposition would not be enough. The important point for any such hypothesis is whether they are identical, *i. e.*, whether the disturbance of electric potential at one point in a nerve is the actual and direct cause of the same phenomenon in a neighboring part. Any hypothesis must be prepared to state whether the electric phenomena play the essential part in propagation or are to be relegated to the position of a mere by-product.[4]

Evidently this distinction is an important one to bear in mind, for it might well be that the electrical variation accompanying

[4] *Proc. Roy. Soc.*, 1912, Vol. 85, B, p. 507.

the excitation-wave is merely a sign or index of some other underlying process (which determines both the local change and the transmission), and is in itself of no functional importance.

It is necessary first to inquire under what conditions an electric current led into the tissue from outside causes stimulation, and then to inquire whether the current produced by the tissue in its own activity has those characteristics—of intensity, duration, rate of variation, and direction—which will enable it to stimulate the adjoining resting portions of the same tissue. If this is found to be the case, the view that the normal transmission is due to this current will be substantiated; for if the bioelectric current can thus excite the inactive areas, and especially if the rate of this excitation is sufficient to account for the observed velocity of the excitation-wave, there is no reason to seek other causes for the transmission.

In order that an electric current passed through a nerve or other irritable tissue shall cause stimulation, it must have a certain minimal intensity and duration, it must reach that intensity with sufficient rapidity, and it must have a certain direction relatively to the surface of the irritable elements. Too weak a current will not stimulate, nor will one which lasts for too short a time or which rises from zero to its full intensity gradually instead of suddenly. We know, however, from simple observation that in these last respects the current produced by an active muscle or nerve is adequate to stimulate the resting tissue; this is shown by the experiment with the rheoscopic muscle or nerve, in which, *e. g.*, the action current of one muscle is made to stimulate another muscle. The question of the direction of the current relatively to the cell-surface at the region of excitation is more important. In general, electrical stimulation is a *polar* phenomenon; the current stimulates only at the region where the positive stream *leaves* the cell or nerve-fiber; where it enters the cell it causes the reverse effect of inhibition. This is the so-called "law of polar stimulation," which is of very wide if not of universal application in irritable tissues. If the current is led into a nerve by non-polarizable electrodes it can be shown that the excitation-wave arises at the negative electrode or cathode; if the positive electrode is interposed between the cathode and the muscle the excitation-wave may fail to reach the latter because of the inhibitory or "blocking" influence at the anodal region of the nerve. Similar facts apply to muscle; here also where the positive stream leaves the tissue it excites, and where it enters it inhibits. The physiological effects produced by breaking the current illustrate the same law, since in this case the reverse polarization-current is to be regarded as the cause of stimulation.

Now when we study the peculiarities of the bioelectric current produced by the conducting tissue in its own activity we are at once struck with the fact that this current has all of those characteristics of intensity, duration, rate of change and direction which would be required if the current were actually *designed* to stimulate the tissue at the adjacent resting regions and bring it again to rest at the active region. All of the conditions required for the automatic transmission of the excitation-state from active to resting regions are in fact present. This may be seen from a consideration of the diagram (Fig. 1).

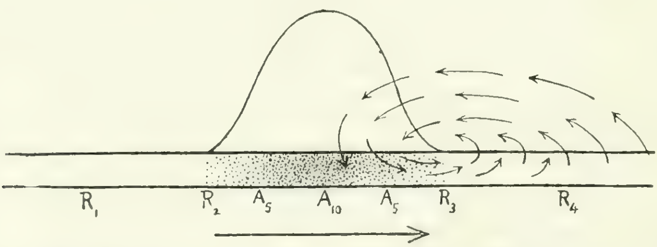

FIG. 1. Diagram of the momentary conditions in a frog's motor nerve at 20°. The shaded region marked A, between R_2 and R_3, is occupied at the instant under consideration by the excitation-wave, which is regarded as advancing in the direction of the large arrow at the rate of 30 meters per second. Its length, assuming the total duration of the local process (as indicated by the duration of the local bioelectric variation) to be .002 second, is 6 cm. The excitation-process is just beginning at R_3, has reached its maximum at A_{10}, and has just subsided at R_2. The curve represents the variation from the resting potential at different points in the active region; the maximum P.D., at A_{10}, is ca. 40 millivolts. The regions marked R are in the resting state. The small arrows indicate the direction of the bioelectric current (positive stream) in a portion of the active-resting circuit. Between R_3 and R_4 its intensity is sufficient to excite the nerve; excitation is thus always being initiated at a distance 3 cm. in advance of the wave-front (*i. e.*, up to R_4). For a somewhat similar distance R_1R_2 in the wake of the excitation-wave the nerve is refractory to stimulation.

The region which is in a state of activity is electrically negative to the regions which are in a state of rest; *i. e.*, there is a circuit in which the positive stream flows in the external medium from inactive to active regions; the current enters the cell-surface at the active region and leaves it at the inactive regions. An external current from a battery having this direction would tend to excite the tissue at R and tend to inhibit an already existing excitation at A (see Fig. 2). There is no apparent reason why a self-generated current should have different physiological effects from one which reaches the tissue from an outside source. Hence we are forced to conclude that the local bioelectric current, as soon as it originates, tends to excite or activate the resting regions immediately adjoining the active area, and to cut short or inhibit activity in the active area itself. We may compare the active and the adjacent inactive areas with a pair of electrodes applied to the surface of the tissue, with the obvious difference that these areas are continually changing position, keeping pace with the excitation-wave as it advances. The consequence of this is that as each successive

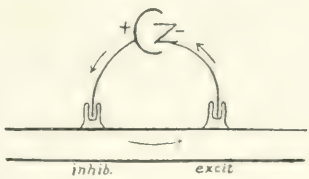

FIG. 2 (inserted for comparison) indicates the effects of passing an external current through a nerve from a battery by non-polarisable electrodes. At the entrance of the current (region corresponding to *A* in Fig. 1) the effect is inhibitory; at its exit (corresponding to *B*) excitatory.

region becomes active, excitation is automatically induced at adjoining regions, and automatically cut short at the active region itself. What we actually observe, quite apart from hypothesis, is that a wave of activity, accompanied by a local electrical circuit, travels in either direction from the original point of excitation. Since this electrical circuit is an essential component of the activation-wave, it is not surprising that the latter produces the characteristic physiological effects of an electric current—excitation at one pole, inhibition at the other—at every region which it traverses in its course. Both the self-propagating and the self-limiting character of the local excitation-process may thus be understood. It should again be noted that excitation at one region, in constant association with simultaneous inhibition at another, is a frequent phenomenon in living organisms, not only in the central nervous system, where it is well-known under Sherrington's term of reciprocal inhibition, but also in locally controlled muscular movements like peristalsis (myenteric law), and even in growth processes and amœboid movement. The condition observed during the passage of the excitation-wave along a nerve-fiber, where the region *in advance* of the wave-front and that immediately *behind* are oppositely affected, being respectively stimulated and inhibited, is thus in no sense unique or unexampled. A fundamental property of protoplasm, that of being influenced in a polar manner by the electrical current, is apparently the essential factor in all of these phenomena.

Why the excitation-wave continues its progress in the one direction, and does not strike back, so to speak, may seem to require explanation. Why should not any region of the tissue, when it has once returned to rest, be again excited by the active area which is receding from it, just as it was previously excited by the active area advancing toward it? This effect, however, is rendered impossible by the fact that the tissue always becomes temporarily inexcitable for a brief period (the so-called refractory period) immediately following excitation. The excitation-wave thus leaves behind itself a trail or wake of inexcitable tissue, and by the time any single local region has recovered its normal excitability the region of activity is already at too great a distance in advance to exert any stimulating influence at the recovered region.

It would thus seem that when we take into consideration the fact of an electrical circuit between active and inactive areas, and apply the law of polar stimulation, the wave-like transmission of the active state along the nerve-fiber may be accounted for, if we assume that the intensity of the bioelectric current traversing the resting region at a certain distance in advance of the active region is sufficient for stimulation, and that its duration and time of development at that point meet the chronological requirements of the tissue. It can, however, be shown that this is almost certainly the case. The potential-difference between excited and unexcited areas can be measured, and in a frog's nerve has a value of 30 or 40 millivolts; two platinum electrodes with the same P.D., placed 3 or 4 centimeters part in contact with the nerve, will give a current sufficiently intense for excitation. The normal bioelectric current passing between an active region and an inactive region at a similar distance apart (say 3 cm.) should have the same stimulating efficacy as that between the platinum electrodes, since the P.D. and the conditions of resistance are similar in the two circuits; and there are other facts indicating that the current of the local bioelectric circuit has a sufficient intensity at a distance of two or three centimeters from the active area to stimulate the resting tissue. We know too the duration of the local current and its rate of development; these may be ascertained by measuring the time-relations of the bioelectric variation with the string galvanometer. By this means the local variation of potential at the excited area is shown to occupy a certain time which in a given tissue is definite and characteristic,—*e. g.*, in frog's motor nerve, ca. .002 sec. at 20°, according to Garten's observations;[5] *i. e.*, the variation rises from zero to its maximum and

[5] *Cf. Garten*, Winterstein's "Handbuch der vergleichenden Physiologie," 1910, Vol. 3, Part 2, pp. 135 seq.

subsides at a definite and rapid rate. Lucas and Lapicque have shown for a large variety of tissues from different animals that the normal duration of the bioelectric current and its normal rate of change are closely similar to the duration and rate of change required in the minimal electric current which excites the tissue on being led into it from outside. The tissue is *timed*, as it were, to be excited by a current of a definite duration and rate of change which are essentially the same as those of the current produced by the tissue itself in its own activity. Speaking teleologically, we might say that each tissue is *adapted* to respond to its own action current. It is evident that the rate and degree of the change of potential at the active area will determine the rate of variation and the intensity of the current traversing the unexcited region of the tissue at any fixed distance from that area (see diagram, Fig. 1). The intensity of the portion of current which thus traverses the surface of the nerve-axone at any point will of course depend upon the P.D. and the total electrical resistance of the circuit which includes that point (Ohm's law), and hence will be greater in the immediate neighborhood of the active area than farther away. This implies, however, that there will be a certain minimal distance from the active region at and beyond which the current traversing the resting tissue will be too weak to excite. At all points nearer than this critical distance (R_4 in the diagram) there will be excitation. In frog's nerve, as already pointed out, this distance is probably about three centimeters under normal conditions, but it is no doubt subject to considerable variation. The more sensitive the tissue is to weak electric currents the greater this distance will be, and hence the more rapid the rate of transmission. This is probably the chief reason why, in general, highly sensitive tissues conduct rapidly.

We may thus form the following picture of the transmission-process in such a tissue as nerve. At a certain time-interval after the local stimulation the resulting local bioelectric current will cause excitation in the adjoining resting regions of the tissue at all points up to a certain maximal distance beyond the original site of stimulation. These regions on becoming active will at once repeat this effect on regions beyond, and if the excitation-process does not lose in its intensity as it advances along the tissue it is clear that by continued repetition of the same process transmission to any distance is possible. Under such conditions there would be no possibility of the excitation-wave dying out before it reached the end of the tissue, any more than in the case of an ignition-wave in a train of gunpowder. In both of these instances the energy required for both the local process and the transmission is furnished by the local chemical change; as the wave of chemical activity passes from point to point there is no necessary decrease in the energy available for the local process,—*i. e.*, nothing comparable to the inertia of a moving body, tending to bring the process eventually to a rest. We have, in fact, direct evidence that just such conditions exist in the normal nerve-fiber. The work of Gotch, Lucas and Adrian, and others has shown that in a normal nerve the least stimulus capable of causing excitation produces a response of full intensity; in other words, that the "all-or-none" principle applies to the nerve-fiber as well as to the normal unfatigued voluntary muscle-cell or to cardiac muscle.[6] Hence at the point R_4 in the diagram, *i. e.*, at the maximal distance in advance of the excitation-wave where the intensity of the local bioelectric current is sufficient for excitation, a full response is elicited; and by continual repetition of this effect the wave travels uninterruptedly along the tissue independently of its distance from the original point of stimulation.

The above account of the conditions of protoplasmic transmission is not so much hypothesis as it is reconstruction of the whole process on the basis of well-established single facts of observation and experiment. But can this conception account for the varying speed at which the excitation-wave travels in different tissues, and especially for the high velocity (120 meters per second) which it attains in the motor nerves of mammals? We can answer this question by considering the rate at which the local excitation-process develops. We have a measure of this rate in the time occupied by the bioelectric variation. It is clear from the diagram that if the local change of potential at any region is quick and prompt the transmission to adjoining regions will be correspondingly rapid, while if it is slow the transmission will also be slow. This is inevitable if the local excitation is directly due to the local current formed between active and inactive regions. A quick rise of this current from zero to its maximum will thus mean quick transmission. And in fact comparative observations show that a close relation exists between the rate at which the local change of potential rises to its maximum and the rate at which the excitation-wave is propagated. In frog's nerve at 18° the upstroke of the action-current curve occupies ca. .001 second; to this corresponds a propagation-velocity of ca. 30 meters per second;

[6] Cf. Keith Lucas, "Conduction of the Nervous Impulse," London, 1917, for data and references.

at 32° the corresponding time is approximately halved, ca. .0005 second, and the rate of transmission is doubled. Now if we assume that the current of the bioelectric circuit, as soon as it attains its full intensity, stimulates the resting region at all points up to a distance three centimeters in advance of the region which is already active, we see that at .001 second (at 20°) after excitation has begun at one point it is initiated at a point 3 centimeters in advance of that point.[6a] This means a transmission-velocity of 30 meters per second. And at a temperature 20° higher, with a temperature-coefficient (Q_{10}) of 2, the rate would be 120 meters per second. Lucas has shown in experiments on the sartorius muscle of the frog that rise of temperature increases the rate of the local variation of potential in almost exactly the same proportion as it increases the rate of transmission.[7] And in those numerous tissues where the bioelectric variation is slow, the propagation-rate is also slow, as in the non-medullated nerves or the heart-muscle of vertebrates, or the nerves and muscles of many invertebrates. There seems to be no question that the speed of the local variation of potential is the chief factor determining the speed of propagation. It must be understood, however, that other factors play a part and that the proportionality may not be exact, although in the same tissue, as Lucas' work has shown, the parallelism is very close.[8]

Some curious consequences follow from this correlation between the time-relations of the local electric change and the speed of propagation. Since the stimulation of any resting region by the active region adjoining is due to the electric circuit between the two regions, it is essential that the time-factors of excitation should be similar in the two. This is of course normally the case in any single conducting tissue like a nerve, since all regions of the tissue have similar properties. We should expect that the same rule would also apply in the transmission of excitation from one tissue to another, if this kind of transmission is similarly determined; and as a matter of fact comparative observations show that rapidly responding muscles are always innervated by rapidly responding nerves, and vice versa.

[6a] It must be remembered that the transmission of electric influence from region to region in a circuit is instantaneous (*i. e.*, 3×10^{10} cm./sec.) whether the conductor is metallic or electrolytic.

[7] K. Lucas, "On the Relation between the Electric Disturbance in Muscle and the Propagation of the Excited State," *Journal of Physiology*, 1909, Vol. 39, p. 207.

[8] In *Amer. Journ. Physiol.*, 1914, Vol. 34, pp. 417–420, I have given a table showing the relation between the local rate of development of the bioelectric variation and the speed of propagation of the excitation-wave.

Lapicque has shown that there is a general correspondence between the rate of the bioelectric variation in a nerve and that in the muscle which it innervates.[9] A muscle with a rapid time-factor of excitation—which means a rapid electric variation—contracts rapidly, *i. e.*, has a short single twitch; and a nerve with a rapid time-factor conducts rapidly. Hence quickly contracting muscles are always found to be innervated by quickly conducting nerves,—a relation which Carlson observed years ago,[10] but which has become intelligible only with the development of our modern views of excitation. This relation is simply an incidental consequence of the fact that the electric variation, if it is to stimulate a tissue, must vary at a certain minimal rate which is determined by the nature of the tissue. As Lapicque puts it, the muscle and its innervating nerve are "isochronous," *i. e.*, have similar time-factors of excitation; if this isochrony is disturbed, as, *e. g.*, in poisoning by curare which slows the excitation-process in muscle, transmission is no longer possible. Accordingly it appears that for transmission from one irritable element to another the time-factors of their respective excitation-processes must coincide, or at least not diverge too widely. Certain other peculiarities of conduction from element to element, such as the irreciprocality of conduction between the neurones in the central nervous system, may perhaps also be explained on the basis of this general principle.[11]

Another consequence of the present theory of protoplasmic transmission is that under otherwise similar conditions the rate of transmission will be a direct function of the electrical conductivity of the medium. The bioelectric circuit through tissue and medium has naturally a certain ohmic resistance, which is mainly determined (apart from structural conditions) by the nature and concentration of the electrolytes present, since all living tissues are electrolytic conductors. The intensity of the current in the bioelectric circuit at any point (*e. g.*, R_4) a certain distance in advance of the active region will thus be determined by the electrical conductivity of the portion of the circuit which includes that point. Hence a decrease in electrical conductivity should decrease the maximal distance between active and responding regions, *i. e.*, should decrease the rate

[9] Cf. Lapicque, *Comptes Rendus Soc. Biol.*, 1907, Vol. 13, p. 787, and 1908, Vol. 15, p. 733.

[10] A. J. Carlson, *Amer. Journ. Physiol.*, 1904, Vol. 10, p. 401, and 1906, Vol. 15, p. 136.

[11] Cf. my paper cited above, p. 424; also *Science*, N. S., 1918, Vol. 48, p. 58.

of the transmission along the conducting element. In the recent work of Mayer on the propagation-velocity of the nerve-impulse of the medusa *Cassiopea* in sea-water of varying dilutions, a remarkably close parallelism between the electrical conductivity of the medium and the speed of the impulse has in fact been found.[12] If, for example, the electrical conductivity is decreased by a third the rate of transmission is found to be lowered to about the same degree. And in work which Mr. Pond has recently carried out in the Clark laboratory, on the transmission of the contraction-wave in strips of heart-muscle, it was found that dilution of Ringer's solution with isotonic sugar solution causes a definite decrease in the speed of the wave, and that the original speed tends to return if the tissue is replaced in the undiluted salt solution. The relation between electrical conductivity and rate of transmission is not so direct in this case as in Mayer's experiments with *Cassiopea*, but this is hardly to be expected in view of the nature of the tissue and the number of variables involved. It must be remembered that changing the nature of the medium inevitably affects the physiological state of the tissue itself. Mayer finds that it is only if the sea-water is diluted with distilled water, within a certain limited range of dilutions, that electrical conductivity and propagation-velocity vary in a parallel manner. If these limits are exceeded, or if the medium is concentrated instead of diluted, the parallelism fails. If the sea-water is diluted with isotonic $MgCl_2$ solution instead of water, the speed is reduced to about the same degree as if water is used, although electrical conductivity is little changed. In this case the specific depressant influence of magnesium enters as a factor. And change of temperature has a much greater influence on the velocity of propagation than on electrical conductivity. But it is probable that such facts simply obscure without altering the essential dependence of the transmission-rate on electrical conductivity. The latter is only one out of a great variety of factors, some of which are metabolic in nature. If, while keeping temperature constant, we could change the electrical conductivity of the tissue-medium without essentially altering the normal properties of the tissue, the propagation-rate, according to the present theory, should exhibit a close dependence on electrical conductivity. These conditions seem to be approximated in *Cassiopea* when the sea-water is diluted within moderate limits. It is probably because of the remarkable resistance of the *Cassiopea*

[12] A. G. Mayer, *Amer. Journ. Physiol.*, 1917, Vol. 42, p. 469, and 1917, Vol. 44, p. 591.

tissue to injurious influences, including changes in the osmotic pressure of the medium, that the curve of propagation-rate in dilute sea-water follows so closely the curve of electrical conductivity. These results throw an interesting light upon the general physiological significance of the salts always present in living tissues and their surrounding media. Both protoplasm and medium must possess a certain electrical conductivity if the transmission of physiological influence by bioelectric circuits is to be possible. And the inorganic salts of protoplasm may be important largely because they impart this necessary conductivity. We need not assume that this is the only or even the chief rôle of the salts, but it is undoubtedly an essential one.[13]

We have now briefly reviewed the chief characteristics of the conduction-process in living tissues and have come to the conclusion that its physico-chemical basis is essentially a simple one, depending upon the formation of local electrical circuits between the active and the adjoining inactive areas of the tissue. With elements which are sensitive to electrical excitation, and also give rise to electric currents in their own activity, such transmission of excitation is inevitable. If, however, the essential conditions are actually as simple as this, we ought to be able to produce phenomena of the same kind in non-living inorganic systems. There is no apparent reason why this type of transmission-process should be confined to living matter. General evolutionary considerations naturally lead us to this conclusion, since the living has developed from the non-living. We are thus led to inquire if there are in fact any known inorganic processes where transmission of chemical influence takes place under conditions similar to those which we have just described.

(*To be concluded*)

[13] The fact that stretching a nerve (within moderate limits, so as not to injure the tissue) leaves its rate of conductivity essentially unaltered is in harmony with the present theory. Evidently some condition which varies directly with *distance, as such*, determines the rate of transmission. This experiment indicates that the interval traversed by the excitation-wave in unit time is not that between two *structurally* defined points of the nerve, but is determined by the length of the column of fluid (*i. e.*, electrolytic solution) between the active and the responding areas (corresponding to the interval between R_3 and R_4 in the diagram). The observed electrical conductivity of any solution is directly proportional to the distance between the electrodes. Cf. Carlson, "Evidence of the Fluidity of the Conducting Substance in Nerve," *Amer. Journ. Physiol.*, 1905, Vol. 13, p. 351, and *ibid.*, 1911, Vol. 27, p. 323; also McClendon, *Proc. Nat. Acad. Sci.*, 1917, Vol. 3, p. 703.

THE PROGRESS OF SCIENCE

EDUCATION FOR AMERICAN SOLDIERS IN FRANCE

THE University at Beaune, twenty miles south Dijon, is now in full operation, according to letters received by Secretary Stokes of Yale University, chairman of the committee which during the past year has represented the Army Educational Commission in this country. Over six thousand students from the army were registered by the middle of March, these being divided into the following colleges—Colleges of agriculture, arts, business, education, engineering, industry and trades, journalism, law, letters, medical sciences, music and science The teaching faculty includes over 500 men drawn from the army and from the experts—several hundred in number—sent over by the Young Men's Christian Association for developing the plans of the Army Educational Commission.

The organization of the university includes a superintendent, Colonel Reeves, formerly president of Norwich University, Vermont; an educational director, Professor Erskine of Columbia University, chairman of the Army Educational Commission; the directors of the various schools; the faculty, etc. Each term is for three months, the first term being March, April and May; the second, June, July and August. Each student carries as a minimum three lectures or recitation hours daily during five days of the week, and four and a half hours daily in study periods.

In addition to the University at Beaune, the army educational commission has arranged for students to attend British and French universities. A recent cable from London reports the enrollment of American soldiers on detached service in British universities as follows: Oxford 200, Cambridge 205, London 725, Edinburgh 215, Glasgow 265, Sheffield 20, Bristol 21, Birmingham 75, Manchester 75. In France there are 2,000 students at the Sorbonne in Paris alone. Of these 400 are in law, 650 in letters, 798 in science and 150 in medicine. The number at the Sorbonne is so great that it has been necessary to appoint a special American reference librarian, Captain A. Law Vogue, of the Engineering Corps, former reference librarian of the Mechanics Institute in San Francisco. About 2,000 American students are at the other French universities including a large number at Bordeaux, Toulouse and Grenoble. At each of these universities there is an American army officer in charge and a representative of the army educational commission as a dean of students. No student is detailed to a French university unless he has had at least two years' work at an American college, and agrees to remain to complete the three months term. The officers and professors of the French universities have done everything in their power to facilitate the studies of American students.

Special emphasis is being placed on agricultural education, an army farm school having been opened at Allerey in April. It is under the supervision of President Butterfield, of the Massachusetts Agricultural College, a member of the army educational commission. It takes care of students who are not sufficiently advanced to pursue agricultural courses at the university in Beaune. Over 1,000 are in attendance and about 350 acres of land are available for farm demonstration work.

Design for the Eastern Facade of the American Museum of Natural History.

In addition to these facilities, agricultural "institutes" covering three days are being held at various places.

Another development is that of the correspondence college. The subjects in which students may take correspondence work are as follows: Civics and citizenship, salesmanship and personal development, gasoline and automobile, farm management, arithmetic, geometry, history of the United States, shorthand, algebra, trigonometry, shop arithmetic, advanced shop mathematics, steam boilers, heat and steam engines.

In addition to these opportunities, there is, as already announced, a system of post schools in the army which has been developed by Mr. Frank Spaulding, superintendent of public schools of Cleveland, Ohio, who with Professor Erskine and President Butterfield make up the army educational commission sent over by the Young Men's Christian Association. These give instruction in common school subjects and lead up to divisional high schools where the instruction is midway in grade between that of the post schools and of the university.

Running through the whole educational plan abroad is the emphasis on citizenship. Not only is instruction in this subject emphasized at the various schools, but "institutes" are held at various places for intensive instruction. The first of these began in Verdun on March 26. The troops were brought in by their commanding officers in groups from 200 to 500; speakers presented problems of public health, community betterment, economic relations, etc. Exhibits and motion pictures were used to enforce the lessons. Emphasis is also being placed on vocational guidance. A group of experts is stationed at Le Mans, where most of the troops are quartered for several weeks before sailing home. Here everything possible is done to supply soldiers with information regarding the industrial situation in America, and to give the men personal advice as to trades and occupations.

THE AMERICAN MUSEUM OF NATURAL HISTORY IN 1918

The American Museum of Natural History in New York City completes this year its semi-centenary, but the celebration of the anniversary has been postponed owing to war conditions. During this period the city has contributed $5,318,820 for building purposes and somewhat over four million dollars for maintenance, while the trustees have presented to the city collections and endowments valued at nearly fifteen million dollars. It is now twelve years since any addition has been made to the buildings. The museum has an ample site for extension, and as shown in the accompanying illustration plans have been drawn for a facade facing Central Park. It is, however, to be feared that under existing conditions the city is not likely to make appropriations for new buildings, desirable as it would be to celebrate in this way the fiftieth anniversary of the foundation of the museum.

For the current year, in fact, the city has decreased its appropriation for maintenance by $25,000, the decrease being in effect $50,000 because of mandatory increases in the wages of employees who have been earning $1,800 and under per year. In 1918, the trustees contributed the sum of $88,348 for the payment of salaries and other maintenance expenses for which the city budget had not made sufficient provision. This year, with living expenses no lower, and a maintenance fund smaller, it has not only been found impossible to make deserved salary increases, but a number of employees have been dismissed. Further plans for retrenchment include

Sir William Crookes.

The eminent chemist and physicist, whose death at the age of eighty-six years, removes one of the last survivors of the great group of scientific men who gave the Victorian Era its distinction in science.

closing one half the exhibition halls, keeping the museum open only during daylight hours, cancelling all evening lectures, discontinuing circulation of teaching nature study collections to the public schools of the city, except in the Borough of Manhattan, reducing from twenty-four to ten the number of lectures given at the museum to public school children, and discontinuing all lectures given in the schools.

The museum, during 1918, turned its greatest effort to war work, and, owing to the number and variety of specialists in its many departments, was able to render a very real and valuable service to the United States and to the allied nations. The various preparedness and food utilization and conservation exhibits drew crowds of people eager to see how they could safeguard and improve their health, and how to obtain the most nourishing and attractive food at the lowest cost.

In exploration and field work during the past year but little activity has been possible. Practically no new work has been undertaken, the museum limiting itself to carrying on in so far as possible projects which were already under way. The second Asiatic zoological expedition, under the direction of Mr. Roy C. Andrews, has been able to secure a number of large game animals from China. The third Asiatic zoological expedition, conducted by Mr. Paul J. Rainey, assisted by Mr. Edmund Heller, collected in adjoining regions. This work was financed entirely by Mr. Rainey. Work in South American archeology and ornithology has been done by Dr. Herbert J. Spinden, Mr. George K. Cherrie and Dr. Frank M. Chapman, who has combined the advancement of museum interests with Red Cross activities. The collecting of fossil vertebrates, long under way, has been continued during the past year by Mr. Barnum Brown, in Cuba, Mr. Walter Granger, in Colorado, and Mr. Albert Thomson, in Nebraska. Investigations into American Indian life and archeology were continued by Dr. Clark Wissler in Ohio, Messrs. Earl H. Morris and B. T. B. Hyde in New Mexico and Mr. Leslie Spier in Arizona. Mr. Roy W. Miner has carried on his researches in invertebrate zoology at Woods Hole, Mass.

It has been possible during 1918 to complete a number of new habitat groups, many of which were already under way in 1917. These include the Florida Group—the largest and finest the museum has so far produced. It represents a typical Florida cypress swamp teeming with various forms of life, and presenting much information to even the most casual observer. Another fine group in the 1918 series is the Nahant Tide Pool Group, which reproduces the "Agassiz cave" of Nahant. The other groups, which are less elaborate, are the Blue Shark, Lemur and Migratory Butterfly Groups. A special exhibit of teeth, illustrating the kind, method of growth and replacement, etc., of the various types of mammal teeth, was also installed. Two notable single specimens were prepared and placed on exhibition—a mounted specimen of an okapi—a rare and shy animal of the African interior—and a model of a giant magnolia (*Magnolia macrophylla*), which is so life-like that visitors invariably mistake it for the actual flower, wonderfully preserved. The year also saw the practical completion of the rearrangement of the hall of primates.

EXPLORATION IN THE AMERICAN ARCTIC REGIONS

UNTIL recently only the larger features of the northern part of the American Arctic region have been known. The coast of this region has now been explored for more than

500 miles westward from Herschel Island to Point Barrow, and in all this distance, except at these two places, practically no permanent human habitation can be found. The sea is visited only by an occasional whaler or by a United States revenue cutter, and the land back from the shore tempts few to its wastes except geographers or geologists, who will not be content until they have explored and mapped all parts of the world. The results of long-continued travel and study in this far-off land by one of these explorers, Ernest deK. Leffingwell, have recently been published by the United States Geological Survey, Department of the Interior, in a report entitled "The Canning River Region, Northern Alaska."

Mr. Leffingwell spent nine summers and six winters on the Arctic Coast, made thirty-one trips, covering about 4,500 miles, by sled and small boat, and traversed the coast ten times by ship. Nearly all other parties that have made explorations in Alaska have been large enough to permit a division of the scientific observations and the physical labor incident to travel among several men, but during most of the time he devoted to these explorations Mr. Leffingwell had only one white man to help him—a man who could take no part in the scientific observations. In many of his journeys he had only one or two Eskimo companions, and in some he traveled entirely alone. He chose his own field and made explorations at his own initiative and expense, and the results he sets forth in the report just published are therefore in every sense of the word entirely his own contribution to science and to a better understanding of Arctic Alaska.

The Canning River region, which is the principal subject of the report, lies one third of the distance between the international boundary and Point Barrow. It is about midway between the area explored in 1911 and 1912 by the International Boundary Survey party, to which A. G. Maddren, of the United States Geological Survey, was attached as geologist, and the Colville River region, which was mapped both topographically and geologically in 1901 by a party sent out by the United States Geological Survey in charge of W. J. Peters and F. C. Schrader.

The southern part of the Canning River region lies in the Endicott Mountains, whose high, rugged, snow-clad peaks rise to elevations of 9,000 feet. Many large streams head in these mountains and flow northward, transverse to the trend of lower ridges, which extend east and west. At a distance of fifteen to fifty miles south of the coast these ridges disappear and the country has a gently sloping, almost unbroken, surface. This shoreward region is simply a flat tundra plain dotted with shallow ponds and lakes. Many of the larger rivers flow through this plain in cuts so shallow that their existence might not be suspected at a distance of half a mile.

SCIENTIFIC ITEMS

We record with regret the death of Frederick Du Cane Godman, the distinguished English naturalist, and of J. J. T. Schloesing, professor of agricultural chemistry at Paris, who has died at the age of ninety-four years.

The British Association for the Advancement of Science will resume its series of annual meetings this year at Bournemouth from September 9 to 13, under the presidency of the Hon. Sir Charles Parsons.—The annual meeting of the National Academy of Sciences was held at the Smithsonian Institution in Washington at the end of April. The William Ellery Hale Lecture was given by James Henry Breasted, professor of Egyptology and oriental history, University of Chicago, on "The Origin of Civilization."

THE SCIENTIFIC MONTHLY

JUNE, 1919

THE PLACE OF MODERN LANGUAGES IN RESEARCH, PARTICULARLY GEOLOGICAL RESEARCH

By the late Professor JOSEPH BARRELL[1]

YALE UNIVERSITY

TRAINING for scientific research is given in courses of instruction which lead up to the degree of doctor of philosophy. The rules of almost every graduate school require that a reading knowledge of French and German must be attained by every candidate for this degree, irrespective of his department of study. Since these languages are specified and the student's time is limited, it means practically that the study of other languages is discouraged. The modern language requirements for advanced scientific study are thus run into a single stereotyped mold. It is true that a department may require at its option any number of additional languages and that substitution of some other language for French or German is possible by special vote of a faculty, but the very purpose of a general rule is to discourage exceptions. Inflexible rules, however, do not make for progress and adaptation to new conditions. The conclusion reached in this article is that the present almost universal rule set by the *graduate schools* of our universities requiring all candidates for the doctor's degree to possess "a reading knowledge of *French* and *German*" should be modified to "a reading knowledge of *two modern languages other than English* to be selected in view of the student's field of research with the approval of the *department of principal work* and the dean." This is the rule already in force at the University of Chicago.

It is to be presumed that at least four students out of five would still be advised by their departments to offer French and

[1] Professor Barrell, one of the most distinguished American geologists, died on May 4. We hope to print next month an obituary appreciation.—Editor.

German, but if the fifth student submitted French and some other language there would be fostered in this country a more cosmopolitan knowledge of the learning of the world. The question of greater liberty in the choice of modern languages should turn upon the standing of German scholarship in each field of learning rather than upon prejudices based on their ruthless conduct of a war of murderous aggression. But if it can be shown that in some lines of research a knowledge of some other language is comparable in importance to German, then the present distaste for things Teutonic may reasonably be taken into account.

The following article has been written from the standpoint of a geologist, but it touches on matters common to many sciences, and it seems time for consideration of this problem in these other sciences as well. The need for a good knowledge of modern languages is as great, if not greater, now than ever before, but other languages besides the traditional German and French seem destined to come forward in the future for worthy consideration. In so far as original work is concerned, the writer has believed for some years that German science has been over-rated, and that in geology at least the average quality of German writing is distinctly below the standard in English. For the study of volcanoes and earthquakes Italian is more important than German. To economic geology the Germans have in recent years contributed little of importance in comparison with that published in English and French.

If the quantity of scientific literature is made a test of the question it is clear that English and German are the two most important languages. But the quantity and quality of scientific work in German in the different fields of science is very uneven. Germany has been preeminently the land of reviews and compendiums, which, as Doctors E. B. Wilson and P. G. Nutting have recently pointed out, call for industry rather than fertility in real research. If the English-speaking nations should see that henceforth such publications are fostered in their own tongue, a considerable part of the need for German would be obviated. The Smithsonian Institution has for its fundamental purpose "the increase and diffusion of knowledge." The Congressional Library is the central repository of printed matter for the United States. From the standpoint of national interest it would be eminently appropriate and wise for Congress to provide that the United States, the wealthiest of the English-speaking nations, should publish under its auspices digests in English of the scientific literature of the world. Nothing else would so soon shake us free from the insidious scientific control of Germany. Such work would be equally valuable from another standpoint, as it would make known the literatures of Russia, Japan, Brazil, and such other nations as are now closed to nearly all American scientists for the double reason that the publications are not accessible and could not be read if they were accessible.

The International Scientific Catalogue already lists and classifies all titles. An editorial board should in addition give digests which should range from a single sentence for unimportant articles to translations of an entire work where in the judgment of editors the exceptional value warrants such a course. Such annual digests should be sold on a cost basis to the general public, but presumably should be donated to a certain number of the larger libraries designated as public repositories. Under such a system the government would be called upon to supply the organization and just enough capital to assure the success of the enterprise.

In view of the ever-increasing quantity of scientific and technical contributions it is a question if it would not be also to national self interest to have in census years a census taken of the increase of knowledge in the previous decade in the form of a series of volumes, drawn from the literature of the entire world. Such a plan might well be placed in the hands of the National Research Council or the Smithsonian Institution. The ablest men in their respective fields should be sought as authors of such work in order that the results should be authoritative. If such a plan had been in vogue for 1900 and 1910 this nation might not have been handicapped to such a degree in chemical industry as was the case at the opening of the great war.

There is large need for the government to foster research on the consequences of research. If such a body as the National Research Council had existed before the war there might have emanated from it investigations on the possible effects of the American inventions of the submarine and the aeroplane. Because of the blindness of the people those great inventions were permitted to become a menace to the democracy which gave them birth and cost through their destructiveness in ruthless warfare billions of dollars before their antidotes were discovered and applied. Here is a striking illustration of the need of parallel research to control the misuse of research. The need for such controls could have been predicted long before their immediate solution became a matter of life and death. In such a far-seeing policy of research upon the consequences of research, an initial step would be to make the conclusions from all important scientific literature immediately available in the

English language. As a second step, a more comprehensive survey on subjects of vast national importance, but on subjects which, because they affect the future welfare of mankind, are beyond the vision of the politician or the means of the individual scientist, could be undertaken with value in the form of a census of knowledge as suggested, supervised by committees of leading scientists at the opening of each decade.

Even if such a plan should be adopted there would be nearly as much need as previously for modern languages in the training of scientific research to enable the investigator to do intensive work in his particular field, but such intensive work would less exclusively require the use of German than is now the case. Italian, Spanish, Russian or other languages would have more opportunity for consideration. In the course of the next decade it is probable that the quantity of German science will notably decrease. It was an inflated product containing, however, much of real value. In the lean years which lie ahead for Germany the inflation is likely to diminish and, more regrettably, the good work as well. Scientific research is largely a product of prosperity as well as of ability.

But the foregoing deals only with the value of modern languages as means of library research. This is a fundamental side, but an even more fundamental side to research is first-hand contact with the subject matter in museum or laboratory. What would be thought of an institution that should give a doctor's degree in chemistry to a student who, no matter how conversant with chemical literature in English, French and German, could make only limited use of a laboratory? It would seem that in sciences which involve travel for their prosecution, the idea that only French and German are acceptable languages for the doctor's degree is based on a narrow view. The world is a great laboratory, even more a series of great museums as wide as nationalities. The neophyte in research should be provided with French and German as keys to libraries, but he needs keys at least as much to the laboratory or museum from which he must gather at first hand his facts. In geology, geography or anthropology, if his work should take him beyond the bounds of the English-speaking countries, a good knowledge of the language of the land would be as valuable a key for research as an equal knowledge of German.

Of course, the ideal plan would be for the student to acquire French, German and the language of the country in which his work is to be carried forward. But many good scientists are rather poor linguists, art is long and time is fleeting, and the practical question is—if only two modern languages are required, what two will be of most value for original research. A traveler can pick up in a few weeks or months a sufficient knowledge of a langauge to enable him to travel in a strange country, but such a half knowledge is very different from an ability to search out local literature, to read freely, to speak idiomatically, and to establish intelligent cordial working relations with provincial inhabitants.

To test the value of modern languages in geological research the writer sent a questionnaire to all those members of the Geological Society of America who had been elected to membership from 1903 to 1910, both years inclusive. This society maintains high professional standards for admission. Before being eligible to election candidates must have several publications to their credit and be active in research. The group of members chosen includes as a class men whose training was obtained at a time after good graduate departments in geology had been built up in American universities and who have been working geologists long enough for them to have tested the values, both for their work and their general education, of the subjects studied in the graduate schools.

Answers were received from thirty men who held the degree of Doctor of Philosophy. Excluding one who stated that he had long since forgotten his modern languages, the answers are tabulated as follows:

VALUE OF MODERN LANGUAGES IN GEOLOGICAL RESEARCH

Answers by 29 men holding the degree of Doctor of Philosophy, elected to the Geological Society of America in the years from 1903 to 1910, both inclusive

Degrees received from the following universities

California	1	George Washington	1	Toronto	1
Chicago	5	Germany	2	Wisconsin	3
Columbia	2	Harvard	3	Yale	5
Cornell	1	Johns Hopkins	5		

Chief fields of geologic work, most men having worked in two principal fields

University teaching and research	23	Museums	6
Governmental surveys	18	Private economic work	5

Special division of geologic research, most men having worked in two divisions

Areal	6	Stratigraphic	8
Glacial	7	Paleontologic	10
Physiographic	7	Economic	9
Petrographic	4		

Reading knowledge required for their doctor's degree

French .... yes 24, no 3 German .... yes 25, no 1

Rough estimate of foreign literature actually read in post-graduate study for doctor's degree

(Over 500 pages = much; 500–100 pages = some; 100–1 pages = little)

French	much 5,	some 11,	little 7,	none 3
German	much 7,	some 13,	little 7,	none 1

Opinions as to whether the information was important and inaccessible in English

French .... yes 13, no 9 German .... yes 14, no 10

Value of modern languages in later geologic research

French	necessary 15,	advantageous 12,	little use 1
German	necessary 17,	advantageous 10,	little use 2
Spanish	necessary 6,	advantageous 2,	little use 6

Chief use of language in order of importance

French	articles, reviews, manuals, travel, correspondence
German	articles, reviews, manuals, travel, correspondence
Spanish	travel, articles, correspondence

Number of foreign languages which should be required for a Ph.D. in geology

In favor of two languages......................	22
In favor of one language	5

Opinions as to whether a language should be required or optional

French	required 19,	optional 7
German	required 17,	optional 8
Spanish	required 3,	optional 12

Other languages (Italian, Russian, etc.), optional, several.

Should a student be permitted to offer any language of his choosing as a second required language?

Yes .... 11 No 12

The contributors to this questionnaire are all productive scientists. Their answers give testimony to the value of modern languages for geological research. If some graduate students should question the amount of time asked of them for the study of modern languages, an inspection of this tabulation should convince them of the desirability of modern languages in research of the highest grade. In certain fields of work and for considerable periods of time a knowledge of foreign languages may not be needed. Then suddenly they may become for some topic vitally essential, and the scientist to whom they are unavailable may realize that doors to knowledge are closed to him which are open to his competitors.

A considerable number of letters were received supplementing the answers to the questionnaire. A few writers consider the present time inopportune for discussion of this question, the majority, however, consider that this is a very appropriate time for its consideration. Most of the contributors discuss the use of languages wholly from the library standpoint, some, however, lay stress also upon languages as a medium of obtaining information in the field. Still others consider that the subject is hardly worth discussion because German and French are so clearly the necessary languages. The majority of the writers, however, are of the opinion that some degree of freedom of choice is desirable, the final decision to rest with the department of study and not with the student. Limitations of space prevent the publication of all of these communications, but several quotations have been selected, the writers having kindly given consent to the use of their names.

Whether the Germans are our friends or our enemies, there is no denying that their contributions to science are enormous. To-day, in my opinion, the absolute scientific value of the world's various languages puts them in approximately the following rank: (1) English, (2) German, (3) French, (4) Italian, (5) Russian, (6) Japanese, (7) Spanish. If all the Scandinavian languages are combined they perhaps rank above Japanese.

Moreover, the Japanese may be publishing more original material than I realize, but I have an idea that their publications are largely taken from those of other countries. Of course the estimate here attempted is very rough, but the method has a real value and would have much more if one had time to use it as the basis of an actual statistical study.

E. Huntington,
Captain, Military Intelligence Branch
War Department, Washington, D. C.

Am glad you are bringing up the matter for discussion. The Germans have plainly abused the deference which has previously been paid to their language. To my mind, for a considerable number of years prior to the war, they had attained such a self-sufficiency that they paid practically no attention to what the outside world was doing in science—except to make frequent raids and incorporate advances that had been made by others in such a manner as to make them appear their own. Moreover, I have already been placed in a position where I should have known Spanish. In vulcanology, it is wise to know Italian and with the opening up of Russia and Siberia, some serious students should have the opportunity of tackling the Russian language.

J. Austen Bancroft,
Department of Geology,
McGill University.

In this connection perhaps I ought to state a little more explicitly my general point of view. The Ph.D. degree, while ordinarily the end of formal graduate work, is of course only a preliminary to the larger field of scientific research. For that reason a student should get while in college the linguistic equipment necessary not merely for his three or four years of graduate study, but for his subsequent career as a scientific investigator. To illustrate, I can well imagine that one of our students could go through our graduate school, write an admirable thesis, and get his doctorate without knowing any language but English; but as a rule, I should think it very unwise for a man to attempt to become a geologic scientist unless he could read two or more of the most important foreign languages. At almost any stage in an investigation he may find that indispensable material is contained in French or German publications, or sometimes even in Italian and Russian.

Undoubtedly five or six languages would be an advantage to the average geologist, but it seems unreasonable to require so many. Probably two is not an unreasonably large number, and for those two it seems to me French and German are by far the most important for geology.

Eliot Blackwelder,
Department of Geology,
University of Illinois.

I venture to supplement this questionnaire with a few comments, expressing my position more exactly.

1. French I regard as the most essential foreign language, not merely because of its important scientific literature, but because of the training which it affords in clear thinking, exact reasoning and especially in concise and luminous presentation of ideas. As the amount of literature increases we need to place more and more emphasis on these features.

2. The relative utility of German has changed considerably since I was at college. English and American scientific literature has advanced along practical and progressive lines, while German literature, although huge in bulk, has, I think, deteriorated in quality, especially in critical judgment and "intellectual honesty." Nevertheless, German remains essential for the reviews and summaries of literature in the various sciences, and for similar compilation works which have no equal in English or French. Moreover, some of the best scientific work past and present is in German and untranslated. A large part of Dutch, Swiss and Scandinavian geology and paleontology is written in German. A knowledge of German and English also makes Dutch, Danish-Norwegian and Swedish easy to acquire if necessary.

3. Spanish I have found necessary, and regard it as likely to become more important with the development of South and Middle America. It is one of the four world-languages, and it might almost be regarded as necessary rather than optional. It is well to remember that a passable acquaintance with Latin is not only of great value in understanding French, and considerable in English, but enables one to pick up Spanish, Italian and Portuguese with very little difficulty. I do not say that Latin should be necessary, but I do think it should be encouraged and made one of the optional languages.

4. It is difficult to foresee what may be the development of the Slavic group of languages in the immediate future. At present they have little scientific importance, but Bohemian and Russian may expand in the near future, possibly others of this group may come up with the spread of popular free governments and education of the masses. The present trend toward the development of nationalities is very likely to involve the growth of vernacular scientific literatures to such an extent as to afford a very grave problem. There will be too many languages for any one to have

command of all that are of any importance to his scientific work. We shall have to devise some international system of translations and abstracts. This last I regard as the most important matter that scientific societies have immediately before them.

I wish I could see it as possible to do without German science. It is a perpetual irritation to me to have to wade through the obscure, clumsy, muddy bulk of it. And I have always thought that in geology and paleontology at least, German science was much overrated, and in the last twenty years much of it was astonishingly silly—there is no other word for it. But you can not master your subject without going through the summaries and abstracts of what has been done, and more careful reading of the contributions of the five or ten righteous men who redeem that particular linguistic Gomorrah from destruction and oblivion.

W. D. Matthews,
American Museum of Natural History.

For appointment to the United States Geological Survey only one foreign language is required, either French or German, the test consisting in the translation of scientific matter into English. The modern language counts as ten per cent. of the total examination for the lowest grade. This appears to be a very proper rating of the minimum requirement. Promotion may be made to all grades without further language examination. This is no argument, however, against the value of a larger knowledge of languages. For special work, special requirements may be set, and under date of January 16, 1919, Dr. G. O. Smith, Director of the Survey writes as follows:

In connection with the subject of language requirements you may be interested to know that the Survey has asked the Civil Service Commission to hold an examination for persons qualified to undertake certain special investigations regarding mineral deposits. For this examination the Geological Survey has a language requirement specifying that the candidate must make translation of certain scientific material in two of the following five languages: French, German, Spanish, Russian and Portuguese.

In regard to the value of Spanish, the correspondence shows a wide range of opinion. One economic geologist writes:

Spanish is merely a means of obtaining a fee. In Spanish-speaking countries one needs the language: also one needs a raincoat. From the standpoint of literature, to the economic geologist the Scandinavian and Russian languages are much more important.

The rejoinder is that if one is traveling simply for a fee in Spanish-speaking countries the language is merely the means of obtaining the fee, but if one is traveling for scientific research the language, by bringing the investigator in contact with the field, is an important means of obtaining scientific knowledge. Another economic geologist who is a university professor expresses a very different opinion. He writes:

I feel that it is necessary that the men whom I train specially in oil geology should have Spanish. Spanish is the most valuable field language for them and the second most valuable reading language, there being more literature of moment to them in Spanish than in French.

A number of writers, although favoring the modern language requirement, emphasize what they believe to be an unnecessary waste of time spent at a late stage in the student's education in learning to read modern languages by means of plays and poems. One contributor expresses himself very vigorously in regard to a system of education which provides no opportunity for learning languages until the years of early youth are past and the boy or girl has lost that keenness for memory work which language requires, then forces languages on him when the memory faculty has become subordinated to a more or less highly developed analytical and reasoning faculty. He says:

I base these views on my own mental development. I recall that I found it a pleasure around the years of ten to twelve to learn history *verbatim*. A little later of course I learned that this was a highly unsatisfactory way to learn history. If my teachers at that time had been working under an intelligent system I could have acquired then with relative ease and pleasure two or more foreign languages before I ever entered college. When I reached college I had lost the ability and taste for pure memory work. Result,—I wasted years in getting a very mediocre knowledge of Latin and German and came to hate both worse than the Teuton hates righteousness. You men who teach ought to get clearly into your heads the fact that a boy's mental angles change as rapidly and completely as do the angles of an ammonite's suture line as it approaches maturity. If a boy needs one or five foreign languages why not install the machinery in the schools for giving him those languages while he is still at an age which makes it easy for him to take either whooping cough or French? The coming of the adolescent period will most certainly greatly reduce his chances of taking either. Can't the teaching profession learn anything from such people as the French Canadians who teach English at an age which gives the average French Canadian a fair command of English notwithstanding the very few years which he is able to spend in school?

I insist that for the average youth consideration of his language problem is postponed too long by ten years. It should be taken up in the primary grades, not in the university. It may to-day be impossible in the village and rural schools to teach foreign language at the proper age, but it can easily be done in the cities. With the passing of America's former policy of splendid isolation should naturally come a reconsideration of the entire language-teaching problem and you are selecting a propitious time to discuss it. But I hope you will see the importance of taking up language while the boy is still in the language stage of his ontogeny. I am an example of a man who had to take up this subject after that stage was passed and, although I spent years on two foreign languages, can claim a mastery of no language other than English in spite of my answers to your questions.

A great deal is assumed regarding the scientific productivity of this or that nation, but measurements are seldom attempted. The quantity may be measured by means of the International Scientific Catalogue, but quality, consisting in origination of new ideas, or elaboration of old ones, is less easily evaluated. The International Scientific Catalogue is an impartial measure for those nations which contribute to it, since the data are supplied by each nation and each is supposed to see that its own material is complete. It is not complete for the whole world, however. For example, no Latin American country contributes, with the result that the Spanish language is barely represented in the catalogues of the geological sciences. The publications in Spanish and Portuguese are mostly of a descriptive rather than of a critical nature, but there is much of a grade which would find its way into the catalogue if it had been published in English, French or German.

To test the quantity of scientific work in mineralogy, geology and paleontology in English, French, German and Italian the year 1908 was selected as previous to the great war and the one in which a new classification first became effective in geology. The results are tabulated as follows, the data being supplied by Miss Withington of the Yale library:

MINERALOGY, 1908[1]

	Number of Titles	Classification				
		General	Mineralogy	Petrology	Crystal	Sum
English	812	41	1336	266	97	1740
French	175	16	428	95	64	603
German	733	46	947	215	284	1492
Italian	147	2	271	73	23	369
Others	202	4	7	1		12

GEOLOGY, 1908

	Number of Titles	Classification								
		General	Dynam. Geology	Petrography	Tectonic Geology	Metamorphism	Experimental Geology	Stratigraphical	Topographical	Sum
English	613	86	283	41	54	9	10	278	110	871
French	506	70	132	11	74	9	1	313	73	683
German	782	104	422	52	105	6	3	425	146	1263
Italian	410	74	248	17	12		2	72	46	471
Others	234	21	79	5	20			117	41	283

[1] Under Mineralogy all titles in Russian, Japanese, etc., are listed under their translations with no indication of the language of the text. They are included for the most part in the French and German titles, but a few are in English.

PALEONTOLOGY, 1908

	Number of Titles
English	371
French	180
German	316
Italian	91
Others	75

RELATIVE QUANTITY OF ENGLISH AND GERMAN WORK, 1908

	Mineralogy			Geology			Paleontology		
	Number of Titles	Average Length in Pages	Total Pages	Number of Titles	Average Length in Pages	Total Pages	Number of Titles	Average Length in Pages	Total Pages
English	812	30	24,360	613	39	23,910	371	50	18,550
German	733	13	9,530	782	45	35,190	316	38	12,010

The total number of pages is obtained by multiplying the number of titles by the average length. The latter was obtained by taking sample pages of the Catalogue and may be in error as much as five per cent.

The ratio of German work in geology in 1908 to that in English seems to have been above the average. For 1912, the last volume published before the outbreak of the war, the titles are distributed as follows:

GEOLOGY, SEPTEMBER, 1911, TO SEPTEMBER, 1912

	Number of Titles
English	1,277
French	310
German	1,100
Italian	551
Others	363

To properly appraise these tables it should be noted that the German catalogues show a padding which tends to give them an undue importance. It has been stated that under mineralogy a considerable part of the articles in Russian, Japanese, etc., have had their titles translated with no other indication of the language of publication than the name of the author and source of publication. German appears to have gained the most by this system.

The same article is often listed under two or three of the subjects mineralogy, geology and paleontology. It is probable that the German list has been expanded in this way in geology somewhat more than the English list.

Many minor articles in English, such as reviews, summaries, etc., have been omitted from the English list. It is difficult to compare the English and German catalogues in this respect, but the writer's impression of a large part of German scientific literature is that it does not consist of original work so much as of reviews and compilations. It seems as though writing in Germany had become a profession, promotion of young men being determined largely by the quantity of writing. Mediocre minds short in ideas but long in industry could turn out hack work and find mediums for its publication.

It is to be anticipated that during the coming generation there will be less of this grade of writing in Germany, as the breaking up of the empire will probably tend to reduce the number of unessential government positions, for university professorships are there government jobs. The energies of mediocre young men and the governmental income will no doubt be largely consumed in paying to the allies the cost of the German joy of war. Furthermore, a considerable quantity of writing in German has been the product of foreign students who have studied in Germany, or of scientists who have preferred that language for publication instead of their native tongue. It is to be presumed that there will be a marked diminution in these voluntary contributions.

A considerable number of years should in reality be compared to gain an accurate measure of the relative contributions of the different languages. This is partly because the manuscript for these volumes of the International Catalogue was received by the editors at irregular times and the content is not restricted to a single calendar year. Actual productivity also shows considerable fluctuation. The result is that the number of titles in geology for 1912 shows a great expansion in both English and German over 1908. Of this quantity of geological publications perhaps two thirds of that in English in 1912 is to be credited to North America.

The measurement of bibliographies tests the quantity of scientific literature but not its quality. Some measure of quality and importance to American students may be obtained in another way, by noting the relative number of citations to works in the several languages which are given in treatises of comprehensive scope by authors who have made a special study of the literature. A great range may be observed in this matter, owing to the fact that illustrations may often be selected from one language as well as another. The analysis of the following list of standard works is illustrative.

To discuss these examples in order. English-speaking geologists are greatly indebted to F. W. Clarke. Such a work as his data of geochemistry renders them largely independent of

Germany in that field, as it is seldom necessary to go back of the volume to the original source. In this field of chemical geology the Germans show at their best, as it consists largely of a compilation of chemical data developed in the laboratory.

PERCENTAGES OF REFERENCES TO WORKS IN ENGLISH, FRENCH, GERMAN, AND OTHER LANGUAGES

	English	French	German	Other
Clarke, "Data of Geochemistry:"				
Chap. IV. The Ocean	60	17	16	7
Chap. XII. Decomposition of Rocks	50	10	36	4
Harker, "Natural History of Igneous Rocks"	47	14	37[2]	2
Daly, "Igneous Rocks and Their Origin"	70	10	15	5
Grabau, "Principles of Stratigraphy"	71	4	25	0
Lindgren, "Mineral Deposits"	86	6	7	1
Leith and Mead, "Metamorphic Geology"	92	0	8	0

A prominent field of German geological work is in the petrography of igneous rocks. A. Harker, as shown in the table, gives 37 per cent. of his references to writings in German, but, as noted above, two fifths of these are to Brögger and Vogt, two Scandinavian geologists. The remainder of the German references are to a very few writers.

Daly, Grabau and Lindgren, geologists of the widest training, have all studied in Germany as well as in other countries. Their works listed in this table were published in 1913 and 1914, before the self-revelation of the Germans began to change the good will of the English-speaking world.

Daly's work lies in the same field as Harker's, but is fuller in its bibliography and makes much larger use of North American literature.

Grabau's work of 1,185 pages on the "Principles of Stratigraphy" is really much broader in scope than its title indicates, but its central thesis is the interpretation of the sedimentary rocks. It is dedicated to Walther, a German professor who has done much in this field, under whom Grabau has studied, and a considerable part of the value of the treatise is owing to the fact that more than any other recent work it brings into English the best of German geology. The bibliographies are full and excellent, yet notwithstanding the special search of German literature, only 25 per cent. of the citations are to works in that language.

Lindgren's volume on mineral deposits is devoted to the discussion of principles illustrated by examples. Notwithstanding his familiarity with a considerable number of European languages, between eight and nine tenths of his work is traceable

[2] Forty per cent. of the references in German are to Brögger and Vogt, two Scandinavian geologists.

to sources in the English language, but no doubt where equally good examples were available those from American sources have been preferred.

In "Metamorphic Geology" by Leith and Mead, the sources of chemical analyses as well as references to literature were counted to ascertain the relative proportion of source materials. The eight per cent. of references to German origin are mostly to analyses and to about three German writers.

From this study of quantity and quality we may conclude that although German geological literature is roughly equal in quantity to that in English it is not by any means as important in the advancement of knowledge of the earth. When the geographic factor is included and the relative value estimated for American investigators it may be stated that for works of comprehensive scope, dealing with principles rather than descriptions of examples, the literature in German is about one tenth as important as that in English. For studies in North American regional geology rather than on the principles of geology German may almost be ignored.

In geologic writings perhaps on the average half of the references are to illustrations rather than to principles or to original sources of ideas. Such illustrations could be selected from other regions and other languages without intellectual dishonesty. In view of the self-sufficiency and lack of courtesy which characterized much of German writing for many years before the advent of the world war it would seem to be within the limits of good taste to avoid mere courtesy references to German literature.

In conclusion, it should be borne in mind that the field of literature in every subject has become so vast that the student can cover only a portion. The same principles may be found developed in manuals in several languages. It seems time to emphasize the value of languages other than German for regional studies of literature and for field research. Although, in general, students in geology should be advised to study German as the most important member of the Teutonic group of languages and French as the most important living Latin tongue, yet the arguments are strong in favor of permitting students in certain branches of geology, if they find distaste or difficulty in the study of German, to substitute Spanish, Italian or some other language of importance to their work. Such substitution, furthermore, should be by permission of those in direct charge of the work and not require the setting in motion of machinery necessary for the breaking of a rule of a graduate school.

THE BIOCLIMATIC LAW AS APPLIED TO ENTOMOLOGICAL RESEARCH AND FARM PRACTISE

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IN CHARGE OF BRANCH OF FOREST ENTOMOLOGY, BUREAU OF ENTOMOLOGY

THE best success in entomological research, carried on with the view of advancing scientific knowledge and determining facts of practical value to agricultural pursuits, is founded on fundamental laws and principles which govern the seasonal activities and geographical distribution of the species of insects studied. Success in farm practise may be and is attained without any recognized knowledge on the part of the farmer of the laws that govern the results of a given farm practise, but at the same time there are many failures which certainly could be prevented through his recognition of some of the fundamental as well as general features of such laws.

It is, therefore, one of the missions of scientific research to reveal and explain the natural laws that govern certain human activities and to point out how success may be attained and failure avoided through a proper interpretation and application of the information thus acquired and disseminated.

We have in the so-called bioclimatic law of latitude, longitude and altitude[1] an example of a natural law which represents the general laws of climate as affecting the seasonal activities and geographical distribution of land-inhabiting species of plants and animals, periodical practise in agriculture, and the adaptation of farm crops to the requirements of climatic conditions. The law is founded on the determined country-wide average rate of variation in the time at which periodical events occur in the seasonal development and habits of plants and animals at different geographical positions within the range of their distribution. Other things being equal, this variation is at the rate of four days for each degree of latitude, five degrees of longitude and 400 feet of altitude. Therefore, from any given place, as related to extensive regions, an entire country, or a continent, the variation in a given periodical event is (at the rate stated) later northward, eastward and upward in the spring and early summer and the reverse in the late summer and during autumn.

[1] Supplement 9, *Monthly Weather Review*, 1918.

For example, if the date of an event in the spring is March 15 at a given place, the same event should occur, under average conditions at the same altitude, four days later (March 19) at a place one degree north, five degrees east, or 400 feet higher. In the opposite directions it should have occurred four days earlier (March 11) at a place one degree south, five degrees west, or 400 feet lower, while at a place one degree south, five degrees west, and 400 feet lower, the date should have occurred four days earlier for latitude, four days earlier for longitude and four days earlier for altitude or a total of twelve days earlier (March 3).

In like manner, if the date of an autumn event is September 15, the corresponding date for the same event, at a place one degree north, five degrees east, or 400 feet higher, should have been September 11, or four days earlier. In the opposite directions it would be four days later (September 19), while at a place one degree south, five degrees west, and 400 feet lower, it would be twelve days later (September 27). In a like manner the rate of variation in time is the same with any given combination of latitude, longitude and altitude, provided other conditions are equal. We know, however, that conditions as to topography, exposure, prevailing winds, sunshine, rain, etc., are rarely, if ever, equal in two or more regions and, even at different places within a restricted locality, the topography, character of soil, air drainage and other minor influences on life activities may be quite different. We must expect, therefore, to find, and do find, a greater or less departure of the actual from the computed date of a periodical event for a given place.

The amount of the departure of the actual from the computed date is found to be in direct proportion to the intensity of the controlling influences. Therefore the date, as computed from the time coordinates of the law, serves as a constant by which the intensity of the influences which cause the departure can be measured in terms of days or the equivalent in degrees of latitude or feet of altitude.[2]

Thus a date in the spring, four days earlier than the computed constant, represents, as a rule, an accelerating influence equal to four days' advance of the season or the conditions to be found one degree south or at 400 feet lower altitude; on the other hand, a date in the spring four days later than the computed constant would represent a retarding influence equal to four days' retardation of the season or the conditions that occur

[2] Four days of time equal, according to the law, one degree of latitude or 400 feet of altitude.

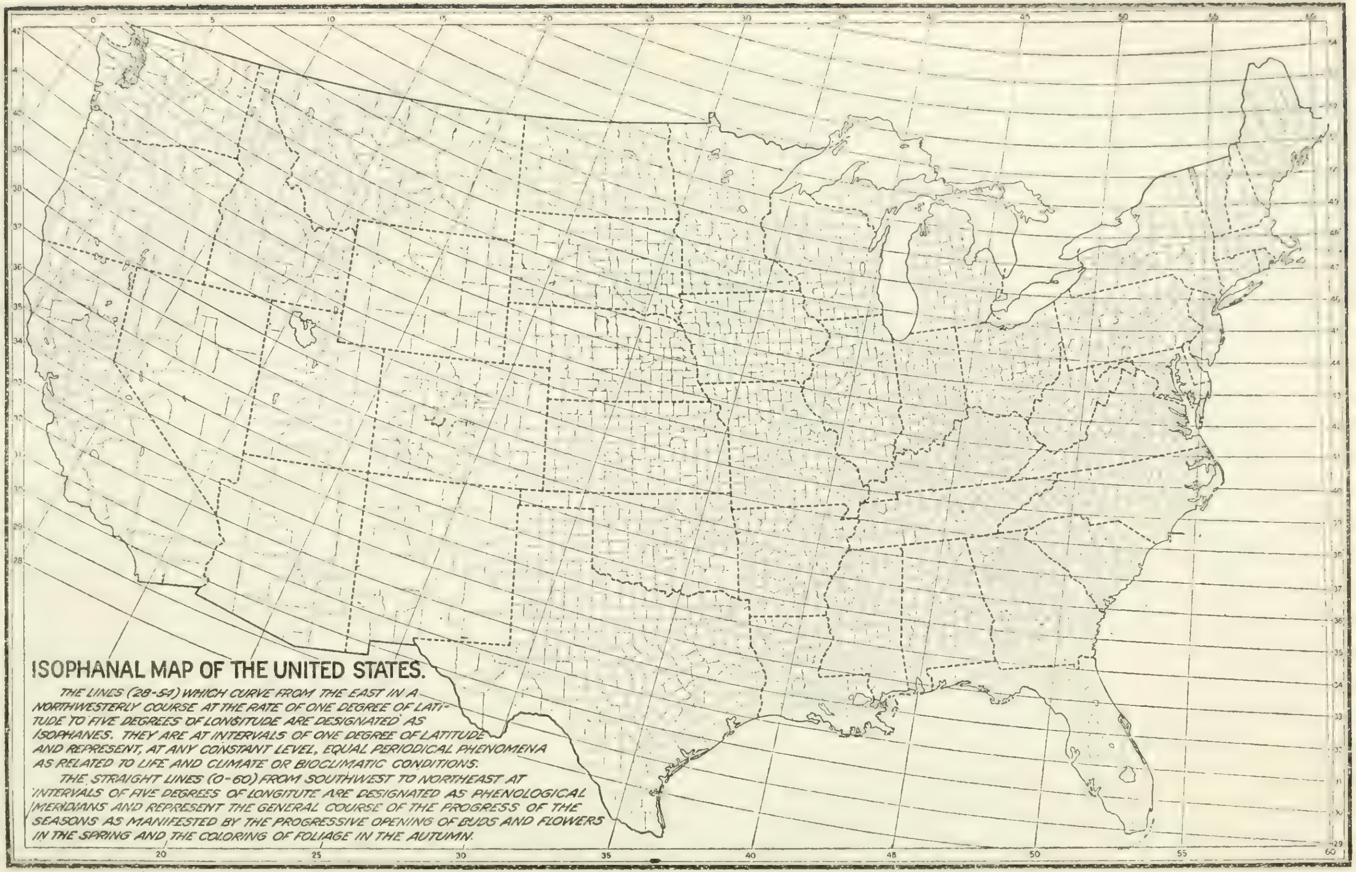

FIG. 1. ISOPHANAL MAP OF THE UNITED STATES IN 1 DEGREE ISOPHANES and 1 × 5 degree quadrangles to illustrate method of expressing the geographical constants of the Law.

one degree farther north or at an altitude 400 feet greater. In the autumn an earlier date would represent an influence equal to that which would cause four days' advance in autumn conditions, whereas a later date would represent an influence equal to that which would cause four days' delay and, in a like manner, the intensity of the influences would be measured in days of time or their equivalent in latitude or altitude. See Fig. 2 for estimated spring and autumn departures for phenological quadrangles.

It will be seen from the foregoing that from the date of a periodical event or practise at an established base[3] in any given season we can, by means of the time constants of the law and their equivalents in latitude, longitude and altitude, compute a corresponding date constant of the same event for any other place within the range of the species or periodical practise involved. Or, having determined for any section of the country the upper or northern limit in the geographical distribution of a native or introduced species or variety of animal or plant, the corresponding limit constants for altitude or latitude can be computed for any other section; and having determined also the lower or southern limit, the altitude and latitude constants can be worked out for the possible geographical range in which the species or variety, under its other environmental requirements, would survive and thrive.

With the time, altitude and latitude constants determined in this manner and the rates of departure determined from recorded facts and prevailing evidences at enough representative localities to establish the general intensity of the influences which cause and maintain the departures, and with this intensity measured in terms of time, altitude or latitude as required, the constants can be corrected by adding to or subtracting from them the amount of the departure, thus closely approximating the actual.

The methods of procedure and the results attained in a study of the wheat-harvest and wheat-seeding data, as described in Supplement 9 of the Monthly Weather Review, serve to illustrate the practical application of the law to any line of biological research or farm practise which involves a consideration of geographical relations and seasonal periodicity.

[3] A phenological base is a geographical position represented by a named place or locality where a sufficient number of observations have been made to establish corrections for local and regional influences, so that the date of any seasonal event recorded there may serve as a reliable basis for the computation of corresponding dates for the same event at any other geographical position within the same or different regions of a country or continent.

FIG. 2. ISOPHANAL MAP OF THE UNITED STATES IN 5 DEGREE ISOPHANES and 5×5 degree quadrangles to illustrate method of designating phenological areas for the study of influences which contribute to time, altitude or latitude departures from the geographical constants. The estimated minus (earlier) and plus (later) departures in days from the computed time constant for spring and autumn events, as given for each quadrangle, are based on a study of more than 40,000 reports on the date wheat harvest begins and on other statistics of planting and harvest dates for wheat, potatoes, etc., and represent averages for the entire quadrangle.

Isophanal maps (Fig. 1) are prepared to serve as an aid in the computation of the time, altitude and latitude constants and to facilitate the location of places, regions, etc., in connection with studies of applications of the law. (See explanation of isophanes and phenological meridians on the map.) The intervals between the isophanes in Fig. 1 represent one degree of latitude and the isophanes are numbered to correspond with the numerical designation of the parallels of latitude intersected by them on the one hundredth meridian of longitude. The course of the isophanes across the map at the rate of one degree of latitude to five degrees of longitude provides for the variation in the longitude factor of the law, so that the only factors to be considered in the computations of the constants are latitude as represented by the isophanes and the altitude as determined for any given place. Since the isophane represents the same constant or average date of a periodical phenomenon for any given level throughout its length, any variation in level will involve a variation in the time constant at the rate of one day for each 100 feet. Thus, if the date of a spring event at one place on or near isophane 40, at an altitude of 400 feet, is March 15, it should be the same date at the same altitude, four days later at 800 feet or four days earlier at sea level, at any other place on or near this isophane. Following this method, calendars of date constants are worked out from a given base date to apply to a range of altitudes along any or all of the isophanes of a map of the state, region, country or continent for which the calendar is prepared, as in Fig. 3.

To find the calendar date for any given locality on the map, determine the geographical position of the place with reference to the nearest isophane to the south of it, then determine the average altitude of the place and find the date in the calendar on the horizontal line bearing the same number as the isophane and in the altitude column giving the altitude nearest to that of the place.

Application of the Bioclimatic Law to Entomological Research

The investigations begun by the writer in 1895 which resulted in the development of facts and evidence on which the bioclimatic law is based were with the object of solving problems in forest entomology. Some of these problems were:

(*a*) The relation of the geographical distribution of forest insects to the life zones proposed by Merriam (1890 to 1894).

(*b*) The relation of variations in the seasonal or life history of forest insects to variations in geographical positions.

(*c*) The relations of critical events in the seasonal history of destructive forest insects to certain periodical events in plants, including the trees they infest, with special reference to the discovery of reliable guides in the plant events to the best time to conduct control operations against the insects at any altitude or latitude within their range.

ALTITUDE IN FEET ABOVE SEA LEVEL

a	200	600	1000	1400	1800	2200	2600	3000	3400	3800	4200	4600	5000	5400	5800	6200	6600	7000	7400	7800	8200	8600	9000	9400
53	25	21	17	13	9	5	1	28	24															
52	29	25	21	17	13	9	5	1	28	24														
51	2	29	25	21	17	13	9	5	1	28	24													
50	6	2	29	25	21	17	13	9	5	1	28	24												
49	10	6	2	29	25	21	17	13	9	5	1	29	24											
48	14	10	6	2	29	25	21	17	13	9	5	1	28	24										
47	18	14	10	6	2	29	25	21	17	13	9	5	1	28	24									
46	22	18	14	10	6	2	29	25	21	17	13	9	5	1	28	24								
45	26	22	18	14	10	6	2	29	25	21	17	13	9	5	1	28	24							
44	30	26	22	18	14	10	6	2	29	25	21	17	13	9	5	1	28	24						
43	4	30	26	22	18	14	10	6	2	29	25	21	17	13	9	5	1	28	24					
42	8	4	30	26	22	18	14	10	6	2	29	25	21	17	13	9	5	1	28	24				
41	12	8	4	30	26	22	18	14	10		2	29	25	21	17	13	9	5	1	28	24			
40	16	12	8	4	30	26	22	18	14	10		2	29	25	21	17	13	9	5	1	28	24		
39	20	16	12	8	4	30	26	22	18	14	10	6	2	29	25	21	17	13	9	5	1	28	24	
38	24	20	16	12	8	4	30	26	22	18	14	10	6	2	29	25	21	17	13	9	5	1	28	24
37	28	24	20	16	12	8	4	30	26	22	18	14	10	6	2	29	25	21	17	13	9	5	1	28
36	1	28	24	20	16	12	8	4	30	26	22	18	14	10	6	2	29	25	21	17	13	9	5	1
35	5	1	28	24	20	16	12	8	4	30	26	22	18	14	10	6	2	29	25	21	17	13	9	5
34	9	5	1	28	24	20	16	12	8	4	30	26	22	18	14	10	6	2	29	25	21	17	13	9
33		9	5	1	28	24	20	16	12	8	4	30	26	22	18	14	10	6	2	29	25	21	17	13
32	17	13	9	5	1	28	24	20	16	12	8	4	30	26	22	18	14	10	6	2	29	25	21	17
31	21	17	13	9	5	1	28	24	20	16	12	8	4	30	26	22	18	14	10	6	2	29	25	21
30	25	22	17	13	9	5	1	28	24	20	16	12	8	4	30	26	22	18	14	10	6	2	29	25

JULY · AUGUST · SEPTEMBER · OCTOBER · NOVEMBER · HIGHEST LIMIT · OPTIMUM → · LOWEST LIMIT

FIG. 3. Calendar of wheat seeding date constants for Isophanal Map Fig. 1. *a*, Isophanes. The dates in this calendar are the computed constants for the given altitudes to be corrected for the 5 × 5 quadrangles of Fig. 2, by adding the + and subtracting the — autumn date which will give the general average date for the average altitude and average season.

(*d*) The devising of systems of maps and calendars by means of which the date, period, altitude or latitude constants could be shown or found for any geographical position within the range of the insect or subject involved.

(*e*) Problems *a* to *d* as related to farm, garden and fruit insects.

(*f*) The time to sow winter wheat at any given geographical position within the range of winter wheat culture to avoid serious damage by the Hessian fly.

Progress Towards the Solving of Entomological Problems

With regard to certain forest insects and the Hessian fly, considerable progress has been made towards solving some of the fundamental features of the problems mentioned.

The Southern Pine Beetle

The southern pine beetle (*Dendroctonus frontalis* Zimm.) is by far the most destructive enemy of southern pine timber. It is safe to say from observations and records that during the past thirty years it has killed, and otherwise been the primary cause of the destruction of, more merchantable-sized timber in the states south of Pennsylvania than all other natural agencies combined, including forest fires.

Distribution.—The normal distribution of this beetle is represented by that of the long-leaf and loblolly pines and the greater part of the range of the short-leaf or eastern yellow pine, south of Virginia and West Virginia. Its abnormal range extends through the pine areas into the spruce areas, or Canadian zone of North Carolina, West Virginia and the pine areas of southern Pennsylvania, where, under a series of years of favorable climatic conditions, it may become temporarily established, as it did during a few years preceding 1893, and become exceedingly destructive to the pine and spruce timber.

Number of Generations.—In the northern and highest limits of distribution there are not more than two complete generations of the beetle annually, but in its southern range there are five or more generations with a most complex overlapping of the broods of several generations during the late spring, summer and early fall months.

Control.—The essential requirements of control relate to a period beginning with the last active flight of the beetles in the fall and ending before flight begins in the spring.

Between the northern or highest range of distribution and near sea level along the Gulf of Mexico, the ending of the critical period for control work will vary, with latitude and altitude, from early in February along the gulf coast to the middle of May at the northern or the highest limit. In like manner the autumn period will begin in the north and at the higher altitudes in September and farther south toward sea level in December.

It is necessary to have some reliable guide as to the time for ending control operations in the spring and for beginning them again in the fall at any given place intermediate between the northern or highest and southern or lowest limits. This guide is provided through the application of the bioclimatic law in the computation of time constants and the preparation of a map calendar of control dates, so that, knowing the location of an infested area, the dates for the beginning and ending of control operations can be recommended without preliminary investigation.

The Western Pine Beetle

The western pine beetle (*Dendroctonus brevicomis* Lec.) is closely related in specific characters and habits to the southern pine beetle and is equally destructive in its attack on the western yellow pine (*Pinus ponderosa*) of the Pacific Slope and northern Rocky Mountains.

Distribution.—The distribution of this beetle is represented by the latitude and altitude range of its host tree throughout the Pacific Slope and the drainage area of the Columbia River, eastward to central Montana and Wyoming, southward into Utah and Nevada, and northward into British Columbia.

Number of Generations.—Towards the highest altitude limits there is one complete generation annually and the beginning of a second, while at lower altitudes there may be two generations annually.

Control.—The essential requirement in the control of this beetle, like that of the southern pine beetle, is to begin control operations in the fall after flight ceases and end them before general flight begins in the spring.

Owing to the zonal limits of the western yellow pine, determined as it is largely by altitude, there is not the wide range with latitude in the spring ending and fall beginning of the critical period of control that is found in the case of the southern pine beetle. This is because the lower altitude limit of the western yellow pine rises southward at the general average rate of about 400 feet to each degree of latitude; thus the influence of latitude is balanced by the influence of altitude. The variation in the time for the beginning or ending of the critical period between the lowest and highest altitude limits in any latitude is thirty to forty days or more, so that the application of the law to the determination of the time constants for different localities relates almost entirely to the variation in altitude.

In this particular species of insect we have to deal with an exceptionally wide range of departure from the time constant owing to its extreme sensitiveness to local influences affecting the temperature. Repeated observations at the forest-insect station at Ashland, Oregon, show that towards the higher altitude of the Siskiyou Mountains there is a marked retardation from the constant owing to the particular regional influences and the consequent slow melting of deep snows of some winters and, on the other hand, a remarkable acceleration in development and emergence on the south side of a tree as compared with the north side. In connection with observations on the seasonal phenomena of insects and plants at phenological stations located at intervals of approximately 500 feet, from the lowest elevation at 2,700 feet to the highest altitude at 5,700 feet, sections of bark infested with broods of the western pine beetle were taken from one tree near the lowest station and placed on the north side of a tree at each of the other stations. The results were exceedingly interesting and instructive as to the relation of altitude and exposure to the retardation and acceleration of the development and emergence of the insect.

Table I. shows the departures from the computed constant (*c*) in the average time of the three events in the developments of the broods in the bark placed on the north side of the trees as represented by first pupæ, first adults and first emergence.

TABLE I

Variation in the Dates of Events in the Development of Broods of the Western Pine Beetle at Different Altitudes

Station No. (*a*)	Altitude (*b*)	Departure from Base Station 16		
		Computed Constants (*c*)	Actual (*d*)	Actual from Constant (*e*)
	Feet	*Days*	*Days*	*Days*
21	5,700	+25	+53	+28
20	5,200	+20	+36	+16
19	4,600	+14	+26	+12
18	4,200	+10	+19	+ 9
17	3,700	+ 5	+ 3	− 2
16	3,200	0	0	
15	2,700	− 5	−17	−12

Explanation.—*a*, station numbers; *b*, altitudes of stations; *c*, computed departures in days from the base; (+) = later, (—) = earlier than base date; *d*, averages of the departures in days from the average of the recorded base dates of first pupæ (February 20), first adults (April 20), and first emergence (May 16); *e*, departure of the actual from the computed.

This table shows (in column *e*) that there was an increasing intensity in the retarding influences from station 18 to 21 and that at station 17 there was a slight accelerating intensity of two days, while at station 15 there was an accelerating intensity of twelve days.

The observations were made in the spring of 1915 under the supervision of Mr. J. M. Miller, in charge of the forest insect station. Deep snow prevailed from stations 18 to 21 which was slow in melting, and this, as suggested by Mr. Miller, plainly accounts for the retarding influence. The accelerating influence at station 15 may be explained by the absence of snow and the fact that on the slopes of a mountain above a valley there is nearly always a warm or transition zone between the valley and the higher levels; the valley being cooler on account of the element of air drainage and inverted temperature, while the lower temperature of the higher levels above the warm zone is due to altitude. The results as shown in this table serve as a striking example of departures from the constant caused by local influences, what the influences are, and how the intensity is measured in terms of time as expressed in days.

In connection with the same series of experiments carried out in 1916 a large section of bark containing larvæ of the beetle was divided, one piece being placed on the north side of a tree and the other on the south side of the same tree. The records show that the development of the broods on the south side were in advance of those on the north side by 20 days for first pupæ and 35 days for first adults and first emergence, thus showing a remarkable accelerating influence on the south side as compared with the north side of the same tree. This represents an extreme case of divergence at the same place where the influences, except exposure, were identical. It also shows how exceedingly sensitive one species of insect may be to accelerating and retarding influences of temperature. This fact, therefore, must be taken into consideration in connection with the study of departures from the computed constant in the seasonal events of this species.

The Mountain Pine Beetle

The mountain pine beetle (*Dendroctonus monticolæ* Hopk.) is exceedingly destructive to the mountain or western white pine, the lodgepole pine, the sugar pine and less so to the western yellow pine. Whole forests of mountain pine, and especially lodgepole pine many square miles in extent, have been killed by it and a very large number of the finest sugar-pine trees of the Pacific Slope have been lost as a result of its destructive work.

Distribution.—The geographical distribution of the mountain pine beetle is not governed by that of a single host, as in the case of the western pine beetle, but by that of at least four species of pine. Thus its range extends throughout the pine zones of the Pacific Slope and into Wyoming, Montana and British Columbia, with a range of altitude from near sea level on the shores of Puget Sound to near timber line in the northern Rocky Mountains, and Cascades, to 10,000 feet or more in the southern Sierra Nevadas.

Number of Generations.—Normally there is only one generation annually. Toward its southern and lowest altitude range, however, there is a partial second generation and towards the highest altitude limit there is rarely time enough in the short season for the development of one generation in a year and there is evidence at hand to indicate that in some cases two or three years are required for the development of all of the broods of a single generation from the first eggs to the last beetles.

Control.—Owing to the slow development and late emergence of the broods of this beetle the critical period in which control operations can be carried on is much more extended than in the case of the southern pine beetle or the western pine beetle.

It is equally important, however, to know the limit of such a period for any given locality in order that the average date for the beginning and ending of the period for one locality may serve as a basis for computing the corresponding time constants for any other locality within the range of distribution of the beetle, except towards the highest altitudes where the overlapping of the broods of the one-, two- and three-year generations leave no choice as to taking advantage of a critical period.

The Pine Bark-Louse or Spruce Gall-Louse

A minute woolly plant-louse known as the pine bark-louse or spruce gall-louse (*Pineus strobi* Hrtg.) normally requires two species of host trees on which to complete its life cycle. One series of generations infests the bark of the trunks, branches and twigs of the white pine, and the other series of generations of the cycle infests the twigs and buds of the red spruce, causing the young twigs to develop into distorted galls which die and turn brown. In addition to the two generations which migrate from the pine to the spruce and back to the pine there is another form which continues on the white pine. Therefore, in localities where there is no red spruce it continues to develop on the pine.

Seasonal History.—The seasonal history of this insect is too complicated to be discussed in this connection; suffice it to say that the critical period in its seasonal activity on both the pine and spruce is when it is not protected by its covering of wax-wool on the pine or by the galls in which it develops on the spruce. This critical time is a short period after the young hatch and while they are moving about to find a location on the bark or in the opening buds.

Control.—It has been found that this and related species on other species of pine, spruce, larch and fir shade trees can be controlled by spraying the infested trees with kerosene emulsion or other contact insecticide, provided the application is made during the critical period of activity which is always coincident with the beginning of new growth on the infested pine and the opening of the buds on the spruce. This event varies with variations in geographical position, so that a calendar of date constants can be prepared to serve as a guide to the time to spray the trees in any locality. In this case, however, the beginning of growth on the pine and the opening of the buds on the spruce are alone reliable guides to the time to spray because the departures due to local influences need not be considered. No matter to what extent the accelerating or retarding influences may prevail in a given locality, they will affect alike both plants and insects.

Relation of Opening of Buds and Hatching of Chermes on Pike's Peak

Phenological records for the spring of 1916 at the forest insect station located at Colorado Springs, Colo., show that between Colorado Springs and timber line on Pike's Peak there is a close relation between the opening of the buds on the blue and Engelmann spruces and the hatching of the eggs of the gall-making *Chermes* that infests them, as shown in Table II.

It will be noted from Table II. that the recorded departures from the computed time constant for altitude at each station for both the spruce and the insect come well within the range of error. In other words, the number of days' departure from the constant are not sufficient to indicate that they are due to local influences. Therefore we can assume that during the spring of 1916 the general climatic conditions on Pike's Peak were about normal and that, unlike the results as shown in Table I., the facts conform with the altitude factor of the law.

Table II. shows not only a remarkably close agreement with the altitude time constant average of one day to 100 feet within an altitude range of 5,500 feet, but that a close relation between the periodical events of the opening of the buds on the spruce and the hatching of the eggs of the insects is maintained at all stations, being the same at the three higher stations but slightly different at the two lower stations.

TABLE II

Variation in the Dates of Opening of the Buds on Spruce and the Hatching of Eggs of the Spruce Gall-louse (*Chermes* sp.) at Different Altitudes of Pike's Peak. From Records by Pollock.

		Spruce			Chermes			
Stations (*a*)	Altitudes (*b*)	Constant (*c*)	Recorded (*d*)	Departures (*e*)	Constant (*c*)	Recorded (*d*)	Departures (*e*)	(*f*)
	Feet	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	
7	11,500	+55	+51	−4	+55	+48	−7	0
6	10,500	+45	+43	−2	+45	+40	−5	0
5	9,500	+35	+37	+2	+35	+34	−1	0
4	8,500	+25	+26	+1	+25			
3	7,500	+15	+19	+4	+15			
2	6,500	+ 5	+ 1	−4	+ 5	+ 3	−2	+5
1	6,000	May 8	May 8		May 11	May 11		+3

Explanation.—*a*, the number designations of the stations; *b*, the altitude of each station; *c*, the time constant in days computed from the base-station date; *d*, actual departures in days from the base date (May 8) for opening of the buds on the spruce and from May 11 for the hatching of the eggs of *Chermes; e*, departure of the actual (*d*) from the computed constant (*c*); *f*, difference between the departures for opening buds and hatching of eggs; (—) = days earlier and (+) = days later. The table is based on records made by J. H. Pollock, scientific assistant, who is making a special study of the *Chermes* of the Rocky Mountains.

The Hessian Fly

The distribution, seasonal history, and general methods of control of the Hessian fly are so well known that it is not necessary to discuss the details in this connection, except in so far as they relate to the application of the law to the investigation of the so-called fly-free dates for sowing winter wheat to avoid damage by the autumn generation and consequent further damage by the spring generation.

The critical period in the seasonal history of this great menace to wheat culture, during years when and in localities where it occurs in destructive numbers, is the period of its emergence in the fall. This, like all other periodical events of the seasons, is controlled primarily by climatic conditions and secondarily by the weather and local soil and topographical influences. The climatic influence is more or less constant, except in seasonal variations, while the other factors contribute to departure from the average.

It is generally recognized that if wheat is sown just at the close of the period of general flight of the fly, the danger of serious injury to the wheat before the following spring will have passed by the time the wheat is above the ground and exposed to attack. Therefore the problem that has claimed the attention of wheat growers and economic entomologists is how to determine and select the fly-free date for different localities and sections of the country, and for an average season. It would now seem that the problem is in a fair way of being solved through the application of the bioclimatic law in its investigation.

When the average fly-free date as determined by Webster for Wooster, Ohio, is taken as a basis for computing corresponding fly-free date constants for any other locality within the entire region of winter wheat culture in the United States, where the fly is or has been present, and when it is compared with the average dates that have been found in actual practise to be safe, the earlier or later departures from the constants are found to be within the range of error and the departure due to regional, local and seasonal influences. It is also found that the general influences and the general intensity of these influences can be determined by further investigations and so measured in terms of time that the computed constant can be corrected for any locality so as to be close enough to the actual to answer all practical purposes.

The preceding examples of research problems will suggest the application of the law to any line of entomological research that involves a consideration of geographical distribution, variation in seasonal history, and the best time to apply remedies under variations in geographical position.

Relation of the Law to Farm Practise

Any periodical farm practise conducted during the spring, summer or autumn which involves a more or less limited period in which the work must be begun and completed is controlled by the same laws as those which control the beginning, advance and ending of the seasons, and the consequent periodicity of animal and plant activities. Therefore a given periodical practise is subject to the same rate of variation in time with variations in geographical locations as that of the periodical events in the plants and animals involved in the practise. Consequently periodical farm practise in general is subject to the application of the law in its study and proper adjustment to geographical requirements for the attainment of the best results.

Some of the problems in farm practise which have a direct relation to the bioclimatic law are:

(*a*) Seedtime and harvest, as applied to a wide range of farm, garden and truck crops, and as adapted to the varying climatic conditions which prevail from the lowest to the highest latitudes and altitudes and from eastern to western longitudes of the United States.

(*b*) The application of remedies against insect pests and plant and animal diseases.

(*c*) The selection of varieties of domestic animals and cultivated plants and the types of agriculture best adapted to regional and local conditions of soil, climate, etc.

Under problems *a* and *b* there are more or less definite periods in which the work must be done to attain satisfactory results. Each period for a specified farm practise is limited to the earliest and latest dates that are permissible under various requirements of the season, weather, etc. Between these limits there is an optimum or *best time* to do the work to secure, other things being equal, the best results and this will vary with different geographical regions and positions and with different seasons, local weather conditions, etc. Heretofore there have been no reliable guides to the selection of this best time.

Some farmers in nearly every farming community are guided by the changes in the moon, the signs of the zodiac, etc., while some are guided by long experience and observations and consciously or unconsciously approximate closely the best time. The faith in astronomical events and signs is evidently based on occasional successes from chance adoption of the best time which coincided with some astronomical event, the successes being remembered while failures or poor successes at other times when the same guides were followed, were forgotten or charged to some adverse condition. That a given "change in the moon" or a sign in the zodiac can not apply to an extensive range of latitude or altitude is clearly apparent when it is considered that the generally recognized time to do certain farm work, such as the planting of corn, etc., varies a month or more between a southern and a northern section of the country or between valleys and adjacent high mountain plateaus.

Therefore, it is in the general designation of the best time to do the more important periodical farm and garden work in any section of the country, and in the utilization of coincident events in native trees and shrubs as guides to the departures in any season and locality, that the application of the principles of the bioclimatic law can perhaps render its greatest service to American agriculture.

The importance and value of the law in the designation of dates and periods for various farm practises applicable to different parts of the country appear to have been demonstrated in the results of our study of over 40,000 reports of wheat growers as to the beginning, general, and latest seeding and harvesting dates for winter wheat in nearly every county in the country where winter wheat is grown as a regular crop.

The tabulated results of these studies as in the example of West Virginia[1] show that between the county averages of the reported dates and the computed date constants for the same counties and events there was in most cases a difference of only a few days, except in regions and sections of the country where there is a general accelerating or retarding influence to cause decided departures.

The tabulated averages of the reported dates of the beginning of wheat harvest are of special interest and significance because the periodical event of the ripening of wheat and the beginning of harvest is controlled entirely by the climatic and other factors associated with geographical position except in so far as the beginning of harvest after the wheat is ready to cut is delayed by weather conditions or arrangements for machinery or help.

The averages of reported seeding dates are much less reliable because of their modification by the customs and conveniences of the growers of each community.

From these tabulated data on seeding and harvest of wheat, and by the aid of the geographical and time coordinates of the law, wheat-seeding calendars were prepared for all of the states and the entire country to show the date constants and periods of the general average *best* and *safest* time to sow winter and spring wheat. Other calendars were prepared to show the date constants on which wheat may be expected to ripen and be ready to harvest for any locality within the range of culture. Maps were also prepared with guide or isophanal lines (lines of equal bioclimatic phenomena at the same level) by means of which the proper date constant of the calendar could be found for any county or locality. In addition the average regional and state departures were shown on the maps to indicate the required correction of the date constant to approximate more nearly the actual average date.

It is significant as to the possibilities of the application of

[4] Supplement 9, *Monthly Weather Review*, 1918, p. 15.

the bioclimatic law in working out calendars for all periodical farm practises that it has been successfully accomplished in a broad general way in the case of seedtime and harvest for winter and spring wheat.

Geographical Adaptation

The proper selection of the kinds of domestic animals and cultivated plants or the type of agriculture best adapted to regional and local climatic and other conditions is of primary importance in the interest of progressive and prosperous agriculture. The relation of the law to these problems is the same as that to seedtime and harvest because the climatic conditions best adapted to various farm crops conform to the same law as that which governs the periodical phenomena of the animals and plants involved. Therefore, knowing the conditions as to altitude, latitude and regional climate under which a given kind of farm crop or type of farming succeeds best, it is possible by means of the time, altitude and latitude constants of the law to indicate the locations of other places where similar favorable conditions will be found so far as the climate is concerned. In like manner it would be easy to define the regions and sections of the country where the climatic conditions would be unfavorable. By this method it could have been predicted, long before it was determined by the slow and expensive process of experiments and practical experience, that certain crops could or could not be grown in Alaska.

In connection with the study of the reported dates of wheat harvest, it was found that the latest dates of harvest at the higher latitudes and altitudes and that the earliest dates at the lowest latitudes or altitudes, together with the periods between seeding and harvest, served as a reliable basis for tracing the latitude and altitude limits of winter wheat culture and the intermediate optimum zone where, other things being equal, it would succeed best.

A like study of spring-wheat data furnished evidences and facts as to the latitude and altitude limits of spring-wheat culture and the optimum zone where it should succeed best. The range and optimum thus determined not only included the areas where spring wheat is grown extensively, but indicated that there are areas of considerable extent farther east and south where spring wheat may be grown successfully, and subsequent experiments have furnished additional evidence that this is true.

AN ENTOMOLOGICAL CROSS-SECTION OF THE UNITED STATES. III

By Professor J. CHESTER BRADLEY
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From the west slope of the Dragoon Mountains the valley of the San Pedro came suddenly into view below us, an exhilarating sight. Some nests of *Atta*, the leaf-cutter ant, were on the hills. It had been raining, the road was steep and slippery, the slope on the outside precipitous and unguarded and the cars inclined to skid, especially the Buick with the trailer behind. We put on chains and descended carefully. At the bottom the bridge over the river gave us concern. Its foundation had been washed out a couple of days before, and it was in a very unsafe condition for heavily loaded cars. We crossed slowly but safely, dragging the trailer across by hand. In the mesa west of Vail on greasewood, *Covillea argentata,* I found considerable *Tachardia larreæ,* the American lac insect.

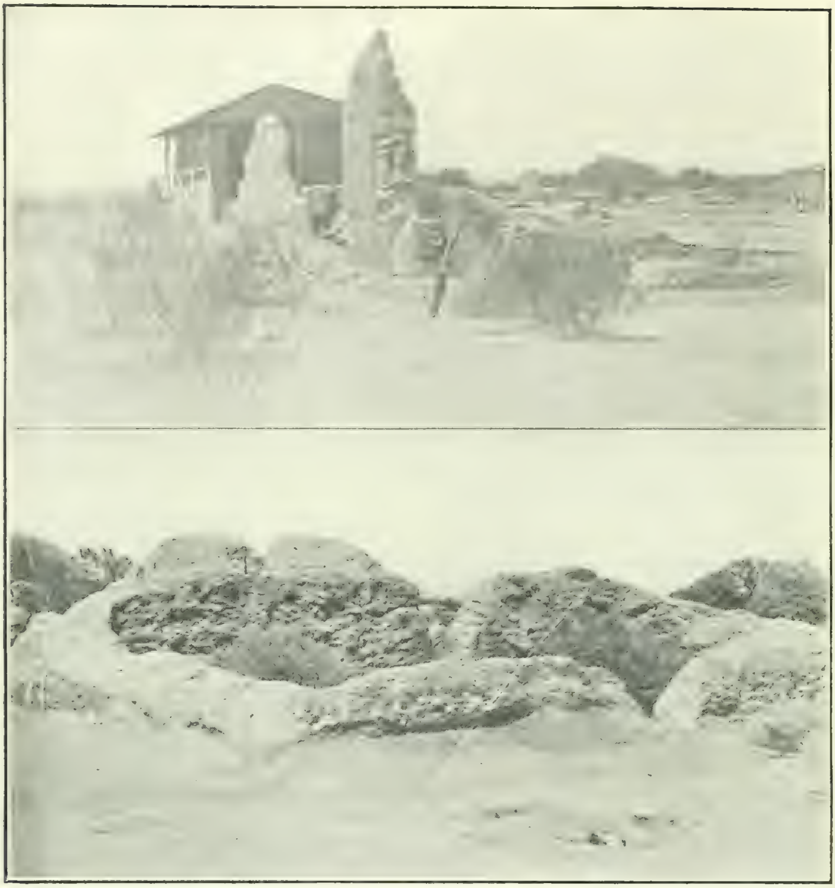
At Tucson we were welcomed by Professor Freeman, of the Genetics Department of the State College, and others, and invited to camp on Professor Freeman's premises, an invitation which we gratefully accepted. In company with Dr. and Mrs. Forest Shreve, of the Desert Botanical Laboratory, we made a most interesting trip to Sabinal Cañon. The large dytiscid, *Thermonectes marmoratus* Hope, elegant in its gorgeous orange-spotted livery, was rather common. Knight took five males of a new tibicen which Mr. Davis has since described and dedicated to him, *Tibicen knighti.* It had an unusual song, resembling, according to Knight, the loud rasping of an acridid grasshopper.

Another interesting trip from Tucson was to the fine old Mission San Xavier del Baç founded in 1692. In the garden, on cacti, were quite a number of curious black longicorns of the genus *Monilema* (*M. grandis*), looking like large pinacate beetles (*Eleodes*) out of place. They represented the third species of these rare beetles that we had captured.

North of Tucson lie the Santa Catalina Mountains, a well-forested range, culminating in Mt. Lemon at an altitude of about 10,000 feet. We planned for a three days' trip to high altitudes, partly by machine and partly by pack animals. Driving by night, we surprised numerous jerboas, and were able to capture quite a number, shining a flashlight upon them and running them down with a butterfly net. They are exquisite creatures, with their large eyes, ears and tail and beautiful silky fur. We spent the night in the foothills (bajadas) north of Oracle, in a very attractive region. A male *Stenaspis solitaria,* a large longicorn, was one of our good captures there; *Plateros nigerrimus* Schaeffer is also worthy of mention. The road up the mountain was badly washed, full of very steep pitches, and altogether a terrible

JUAREZ, MEXICO. Dressed in khaki, some of the boys crossing over into Mexico were mistaken for soldiers and got into trouble.

road. By dint of walking and pushing we got within two miles of the end, then had to abandon the trailer and Fords, but the Buick stuck it out to the finish. There the packers took charge of our outfit, carrying it up to Webber's camp in the pines, where we stayed two days. On the way up we encountered a terrific hail storm, accompanied by very severe lightning. Knight, Needham and myself were caught on an exposed slope, and crouching beneath some bushes were peltered with stinging hail the size of peas. In a few minutes the ground was white. Then, amongst the smaller hail, began to come at intervals great stones, the size of eggs. In all this misery our attention was attracted by what seemed like some one throwing rocks, but we soon discovered that they were conglomerations



CASA GRANDE, the ruins of a prehistoric civilization near Florence, Arizona. The most perfect building has been covered with a shed by the government, for protection. In it we found quarts of dead and dying winged harvester ants.

of hail stones, which hit the earth here and there with a crash and broke into fragments. Arrived at camp, a cabin was most kindly placed at our disposal and we were soon dry and comfortable. Next morning most of the party went to the summit, but I contented myself with the collecting in the transition forests around Webber's camp. Mr. Knight collected three new species each of *Platylygus* and of *Camtobrochis* from the pine trees on the very summit, and near our camp a new *Lopidae.* The horned toad up there on the mountain is the red-headed *Phrynosoma hernandesi,* while down at Oracle we found another species, with a circle of enormous spines around its head, from which its name, *P. solarie.* Dr. Wright induced a specimen of the latter to eject blood from the sinus of its eye, a habit of horned toads well known to dwellers in the west, but the existence of which has, nevertheless, been frequently disputed by herpetologists. Presumably it is a means of defense by terrorizing the aggressor, or it may be merely an apoplectic sort of phenomenon which occurs under the pressure of severe fright.

The Santa Catalina Mountains are about the most readily accessible of the desert ranges of southern Arizona. There is a summer settlement of cottages in the pines known locally as Summer Haven marked on the U. S. Geological Survey maps as Webber's Cabin. It is at an altitude of 8,000 feet above the sea. Regular trips are made by packers from Tucson up the steep south side of the mountain to this place during the season, and outfits may be sent up at so much per pound. Those who go up by foot or burro use this trail; but an auto road leads around by way of Oracle to the north side of the mountain, and thence up it, to an elevation of 6,000 feet, two or three miles only from Summer Haven. A new and much better road is being built, via this north side.

On the morning of July 29, near our camp in the outskirts of Florence, we found *Tibicen cinctifera* Uhler, very abundant on mesquite. The song is a continuous moderately shrill note, as recorded by Knight. This same species was found common as far west as Phœnix and northward to the Grand Cañon. Near Florence we visited the Casa Grande ruins, preserved by the federal government as a national monument. They are interesting relics of a prehistoric civilization. Within one of the chambers we found on the floor literally quarts of the freshly dead bodies of male harvester ants (*Pogonomyrmex barbatus rugosus* Emery). Dr. Morgan caught a beautiful specimen of the leopard lizard, *Crotophytus wislizenii,* a big-headed, mottled fellow, in a ditch close by our camp.

That afternoon the crossing of the Gila River, which was in flood, lent variety to our experience. The cars were driven up on to flat wagons, and we in them were carted across in style, with all the up-in-the-air sensations of a tally-ho party. On the other side I caught some fine Scoliidæ, and on the flowers of *Sueda,* three specimens of a *Parnopes* (cuckoo wasps). That night we camped on the desert, near a stand of giant cacti and tried their fruit as a delicacy.

The collecting at night was excellent, but the mosquitoes were unbearable, and the night suffocatingly hot. Four o'clock found us astir, ready for a quick departure. We witnessed a sight which has rarely been observed by entomologists, the nuptial swarming of the leaf-cutter ant, *Atta versicolor.* The air was full of them, and they congregated in great masses

Our youngest: The butterfly Boy. Photograph by R. C. Shannon.

along the sides of the road. Recent rains had flooded the country, and our progress for several miles was exceedingly difficult, through bad mudholes of a very trying nature. Dr. Wheeler has recorded this occurrence and also other marriage flights of ants observed on the trip, notably *Pogonomyrmex barbatus rugosus* at Casa Grande, *P. b. molifaciens* at Tempe, and *P.* (*Ephebomyrmex*) *inberbiculus* at Deming in a paper entitled "Notes on the Marriage Flights of some Sonoran Ants."[3] In another paper, "The Pleometrosis of *Myrmecocystus*,[4] he records another phenomenon which we witnessed later on the same morning. His interesting account will bear repetition here:

[3] *Psyche*, 1917, 24, 177–180.

[4] *L. c.*, pp. 180–182.

The following observation, made during the past summer while I was with the Cornell Biological Expedition, throws some additional light on primary pleometrosis. On July 29 the heaviest rain in six years fell in Phœnix, Arizona., and temporarily inundated parts of the desert south of that city in the neighborhood of Higley. On July 30 we left our camp about thirty miles north of Florence and proceeded along the road to Phœnix over soil which had been drenched by this rain, with the result that our three motor cars were repeatedly stuck in the mud. While the younger and lustier members of the party were extricating our cars and two others which had been stalled all night in deep puddles, I took advantage of the delay to study the ants along the roadside. Many colonies of various species, whose nests had been inundated, were moving to drier ground. My attention was especially attracted by dozens of incipient nests of *Myrmecocystus melliger* Forel subsp. *mimicus* Wheeler. The large reddish queens had evidently celebrated their nuptial flight immediately after the storm and were now busily digging into the wet adobe soil, making small craters about two inches in diameter with eccentric opening. The wall of the craters consisted of small pellets about one eighth of an inch in diameter, evidently carried up in the psammophore, or crate of peculiar stiff hairs with which the gular surface of the head is furnished in these ants. On seizing a queen just as she was carrying out and dropping her pellet on the wall of the crater I was surprised to see another queen leave the entrance with a similar burden. This led me to examine some twenty nests—all, in fact, that I had time to excavate before I was obliged to proceed with the party. My rather hurried observations showed that about half of the craters had been established by single queens, but that the others were each the work of two cooperating queens. One crater actually contained five queens, four dealated and one with intact wings! It appears, therefore, that about 50 per cent. of the colonies of *mimicus* are pleometrotic in origin [that is normally have several queens]. That they probably remain so is indicated by the fact that on former excursions in Arizona I have on several occasions taken more than one dealated queen from a single adult colony of this ant.

While the recent rains impeded our progress, it is undoubtedly the case that the excellent collecting which we had been experiencing throughout eastern Arizona was due largely to the fact that the rains at nearly every point had preceded us. An interesting capture in a mudhole of the gutter alongside the road at Higley was the enormous *Bufo alvarius*, a smooth-skinned species which inhabits the Gila and Colorado River valleys. We obtained several individuals.

At Phœnix the party divided for a week. Dr. Wheeler, Dr. Bequaert and myself remained at Tempe, nine miles east of Phœnix, while the others made a quick trip in the Fords to the Grand Cañon. The Federal Bureau of Entomology has a field station at Tempe and the men in charge, Messrs. Hogue and Bailey, made us welcome. The town is in the irrigated Salt River Valley. Along the sands of the river bottom, both here and at Phœnix, curious velvet-ants, *Dasymutilla gloriosa*

Sauss., were abundant. Covered with long erect white pubescence, they look like little balls of fur, or feathery seed capsules of a plant scurrying in the late afternoon, over the sand. In fact, they are undoubtedly mimics of the furry seeds of the abundant greasewood. On the flowers of a small *Euphorbia* (probably *serpyllifolia*) Dr. Bequaert discovered specimens of an exceedingly minute bee. It would crawl swiftly rather than fly, and was quite difficult to catch. I have never seen so small a species of bee. Dr. Bequaert writes me that it probably belongs to an undescribed genus near *Perdita*. He finds no species described as small as ours, or like it. Sunflowers were abundant along the roads and attracted many Hymenoptera, especially innumerable Philanthidæ of several species. We also captured a number of beetles of the curious Meloid genus *Nemognatha* on these flowers. These beetles have long tubular probosces. Fields and groups of other flowers yielded splendid returns in the way of Scoliidæ, Larridæ and other Hymenoptera. Dr. Wheeler found the ant fauna very meager. In fact, collecting on the desert away from the irrigated land was here exceedingly poor, everything being baked and lifeless. *Calephalis perditalis*, which we had taken also previously, was common at Tempe. At that time it was undescribed, but has since been made known, from Texas, by Barnes and McDunnough. At Phœnix I caught, by an arc-light, another enormous *Derobrachus geminatus*.

The party returning from the Grand Cañon, August 6, brought reports of an interesting trip and good collecting. Mr. Shannon obtained still another nemestrinid, probably a *Rhynchocephalus* and a *Cuterebra*, the only adult bot fly taken on the entire trip. Needham found *Papilio daunus* at the cañon.

That evening at dusk, we had to cross the Agua Fria as it was receding from flood. The water was almost too deep and the bottom treacherous. The Fords crossed in fine style, but the Buick, rushing across on low gear, under full headway, dropped the forward end of its mudpan just as it reached the deepest part of the river, scooping up the water and sand and pouring it over the engine. The bath was not relished, so the engine promptly struck, and the car stuck. Ralph Wheeler and Shannon, donning a negligée effect, went fishing for the mudpan, while others started off to find a rancher to come down with a team of mules. Presently the engine, beginning to feel ashamed at being peeved by a bath of muddy agua fria, showed signs of an intention to go. We coaxed and it sputtered, but finally ran. "Everybody push," and soon we were out on the western bank—just as the mules arrived. Our camp that night was a nightmare of mosquitoes. The rains preceding us by a few days had brought them out, and the following nights found them quite as bad.

From here on until we reached California the collecting was poor, the Buick engine out of sorts and very cranky, the heat terrific, mosquitoes innumerable and progress doleful. I shall quote an account written by Dr. Morgan in Needham's diary.

First part of the trip (August 8) was through the Gila Bend Mountains. We dropped gradually to the plain through which the Gila River flows. . . . Through the afternoon we traversed this plain, running through alkali flats and sand. Trouble with the Buick engine all the afternoon, probably sand or water in its alimentary tract. Camped on flat at 7 P.M. Traveller had advised us in the afternoon that Yuma was within one half mile of hell, but we found the spot described far short of Yuma, selecting it as an ideal camping spot for all of us. The mosquito prelude developed great proportions during the night, its music continuing until morning, interrupted only by a brief half hour of sand storm. (During and after the storm, various members of the party were engaged in recovering articles scattered widely over the desert.) During the night and early dawn the party gradually assembled from individual cussing expeditions. Strong coffee, watermelon, cleaning the engine, packing the trailer followed in orderly sequence. Departure at 11:00. Mr. Lobdell failed to appear, and his effects were assembled and conducted to the "John Harvard" (a Ford) by those who stand and wait. Later, Mr. Lobdell still with the birds. The Buick engine has snorted several times successfully.

At the camp which Dr. Morgan thus vividly described, not many miles from Palomas, we found numbers of a large buprestid of the genus *Gyascutus*, probably *G. planicosta* L., on *Covillea*. Also we found our only side-winder and observed with much interest its peculiar rapid lateral progression. The trap-lantern produced very large series of a pretty little white and black noctuid *Conochares arizonæ*, as well as of the brown *Fruva fasciatella;* another rarer species *Conochares hudsoni* was caught more sparingly. These species also turned up at Wellton the following night. The horned toad of this region is *P. platyrhinos.*

The valley of the Gila River merits more attention than we were able to give it, and some suggestions as to convenient places for stopovers may not be amiss to others who may contemplate a trip by rail to Yuma. Agua Caliente, on the river, we reached shortly after coming out of the Gila Bend Mountains the day before, and took lunch at the hotel. The waters are understood to have some medicinal value, and a hotel is maintained for those who may wish to try them. Stage connection is made daily with Sentinel on the Southern Pacific Railway. From general appearance and from the one meal

CACTI ON THE COLORADO DESERT. The numerous kinds of cacti are conspicuous features of the rocky and gravelly foothills and minor ridges.

that we had there, I should say that it would be a very comfortable place for a sojourn. As I recall the immediate surroundings, the situation is a mixed gravel and sand wash with rather tall and dense vegetation near the river. Our road paralleled the river on the north side until we came opposite Antelope Hill, where it crosses over a new bridge and in six more miles reaches Wellton, on the Southern Pacific, about thirty miles east of Yuma. There a Mr. Gamble keeps a store and tent-hotel where one can be very comfortable. He bade us welcome, and his shower baths were a very pleasant relief from the intense heat. Many bottles of "pop" mixed with a soft bubble-filled homemade ice were as inwardly refreshing as the showers were externally.

Last spring, very early in May, I stopped again two days at Wellton. On that occasion, on the sand of the desert at night, attracted to an electric flashlight, came scores of males of nocturnal Mutillidæ. My nephew and myself picked up over three hundred in a couple of hours. A trap-lantern obtained as many more, making over six hundred in all. It was necessary only to shine the light on the sand, when presto! they would come, on the instant, tumbling about in quick erratic fashion, now here, now there. That same night I observed six pale green scorpions crawling about over the sand, and a good many chubby pinacate beetles of the genus *Acida*. During the day I walked over toward the river, which is some three or more miles north, and collected many good things along the edge of a field, among which I may mention *Hesperopsis libya*, a skipper, and quantities of a very large and strikingly colored blister beetle, *Tegrodera erosa,* its head bright red and the elytra yellow and coarsely reticulate. Another meloid that I found here in abundance, crawling over the branches of creosote bush (*Covillea agentata*) and eating the flowers, is *Cysteodemus armatus*, entirely black, with reticulate elytra which are inflated like a balloon, making the beetle one of the most grotesque insects that I have seen.

On the late afternoon of August 10, we crossed the Colorado River at Yuma and started westward across the sand hills over the famous plank road, the "board walk" as it is called. No one had been over since the recent severe sandstorm, in fact the route is little used at present. These hills are enormous dunes of shifting sand, at times 200 feet in height. The board walk is like a pavement, where free from sand, but much of the way great drifts of sand have buried it. Then it is push,

Barrel Cactus, Colorado Desert.

General Sherman, the largest Sequoia. Giant Forest, in the high Sierras, California.

push, push until the cars are through. We unrolled chicken wire in front of the cars for the wheels to pass over, deflated the tires to twenty-five pounds pressure and shoved. We had counted on a well part way over, but the camp was abandoned and the well dry. Finally we reached the end of the "board walk" and practically the end of the road; from here on for thirty miles or more there is no beaten highway, but scattered tracks half a mile across. Each car that has traveled there, and they have been legion, has selected its own mark. These are never obliterated by rain, but together form the road through the interminable sand. For a little way progress would be good, then coming on deep sand we would have to push and lay out chicken wire. Once we detached the trailer and fitting it with a harness of chains pulled it by hand, but mostly the Buick had to pull it. In such manner we worked all night as we could not have done in the heat of the day. At 2 A.M. the Buick's clutch began to slip badly, and while Upton and I stopped to fix it, everybody else dropped in his tracks wherever he happened to stand and fell instantly asleep upon the sand. All we could do was to sprinkle the clutch with talcum powder, and then we too fell asleep. By daylight we were up and off, with only a hasty sandwich for breakfast, for well we knew that the overpowering rays of the sun would soon make such labor unendurable, and that many weary miles lay ahead between us and water. It appeared that the Buick with the trailer behind would come through best at full speed in second gear. Traveling this way when it hit a sand drift it would plough through it, shooting the sand to one side in a cloud like a rotary plow coming through a snowdrift. How blessed at last seemed the irrigation ditch which marked the end of the sand and the outskirts of the Imperial Valley. What a luxury to get out by the bridge and catch some Philanthidæ on the flowers growing by the bank!

In the desert that morning we made one of the notable lizard captures of the trip, obtaining specimens of the rare *Callisaurus notatus*, a sand gray species, its back mottled with black spots. The previous evening west of Yuma, we obtained an uncommon scaly lizard of the genus *Uta*, related to our eastern *Sceloporus;* it was the long-tailed *Uta, U. graciosa.* Another specimen was captured crossing the sand in the early morning. One of the most conspicuous features of the desert fauna is the gridiron-tailed lizard, *Holbrookia texana,* and another species which very closely resembles it, *Callisaurus ventralis ventralis.* Both of these have long tails barred alternately black and white, and have the habit of standing erect on their toes, tail aloft, and scooting over the sand with amazing

Moro Rock in the Giant Forest, Sequoia National Park, California.

Cliffs at La Jolla. The mighty Pacific before us brought home the realization that we had spanned the continent from tidewater to sea.

celerity. The *Holbrookia* we obtained at various places from New Braunfels to Tucson, and the *Callisaurus* from the region on Tucson westward to Jacumba on the Pacific side of the Colorado Desert.

So our trip approached an end. From tidewater of the Atlantic we were soon to see the Pacific. Across the Imperial Valley lay the coast range of mountains. In both the collecting was good. I may especially mention the beautiful gigantic meloid, *Tegrodera erosa,* of which we found many near our camp at Warrens, August 13. Proceeding through Pine Valley, we reached the sea and camped at Torrey Pines on a beautiful point of land looking directly out over and high above the ocean. This was the night of August 14, seventy-eight days after leaving tidewater on the Chesapeake. In the morning we skirted the sea northward to Laguna, camping by the seaside laboratory of Pomona College, bade welcome by the kindly hospitality of Dr. Hilton. Here the writer had to leave the party, and he must leave for others to tell of the trip northward to Berkeley, and the several days' stay at Alta Meadow, 9,000 feet up in the high Sierras, and the wonders of the Giant Forest and Sequoia National Park. The trip, totaling about 6,100 miles, ended for all at Berkeley, August 30, 1917, ninety-nine days from the time we left Ithaca.

DÉODAT DOLOMIEU

By Dr. GEORGE F. KUNZ

THAT one of the foremost mineralogists of our day should have devoted a part of his valuable time to rescuing from partial forgetfulness the memory of a former incumbent of the place he himself now so worthily fills in the Muséum d'Histoire Naturelle, is a grateful reminder of the close ties that bind scientific men together. We allude to the interesting paper by Professor Alfred Lacroix, secrétaire perpétuel of the Académie des Sciences, on his predecessor of revolutionary times, Déodat Sylvain Guy Tancrède de Gratet de Dolomieu, read at the annual meeting of the Institut, December 2, 1918.[1]

Dolomieu was born June 23, 1750, at Dolomieu, near La Tour-du-Pin, in Dauphiné. He was the son of Messire François de Gratet, chevalier, Marquis of Dolomieu, Count of Saint Paul d'Izeau, seigneur of Tuelin, Saint Didier-les-Champagnes and other places, and of the high and mighty dame, Marie Françoise de Béranger. His noble lineage freed him from any care in the choice of a career. When but two years of age, October 2, 1752, his father entered him in the Order of Malta; on March 15, 1762, he was permitted to present his proofs of nobility, and two years later he was engaged as a volunteer in the *carabiniers*. He became second lieutenant in 1766, and then left on one of the ships of the order to pass his novitiate. On the cruise, in 1768, an unfortunate incident revealed the impetuosity of his character. Regarding himself as offended by one of his comrades, he landed with him at Gaetà in Italy, engaged in a duel, and killed his adversary. The strict rules of the order were immediately invoked; he was taken to Malta and put upon his trial. The sentence was expulsion from the order and life imprisonment; but at the expiration of nine months, his protectors interceded for him, and under the influence of the Duc de Choiseul, who acted under instructions from the King of France, and of Cardinal Torrigiani, who spoke in the name of Pope Clement XIII., the Grand Master of Malta relented and Dolomieu was not only set at liberty, but was reinstated in the order.

[1] "Notice historique sur Déodat Dolomieu," Paris, Gauthier-Villars & Co., Imprimeurs, Libraires des Comptes Rendus des Séances de L'Académie des Sciences, 1918, 88 pp., frontispiece portrait, 8vo.

D. Déodat Dolomieu,

Membre de l'Institut National.

This incident probably had much to do with his later devotion to science, as it must have turned his mind to the more serious aspects of life. In Metz, where his regiment was garrisoned for a time, he associated with a man of scientific learning, Thyrion, who was in the pharmaceutical service and a demonstrator at the military hospital. With him, Dolomieu threw himself heart and soul into the study of chemistry and physics, but some unpublished correspondence shows that the young lieutenant was far from averse to the attraction of feminine society. It was also in Metz that he won the friendship of the Duke Alexandre de la Rochefoucauld, colonel of the regiment of the Sarre, and a member of the Académie Royal des Sciences, who was a fervent lover of mineralogy and who influenced the young man's studies in this direction. The duke introduced his protégé to the salon of his mother, the Duchess d'Enville, at the château de la Roche-Guyon in Paris, which was a favorite resort of the philosophers, scientists and leading politicians of that day. In 1775, he traveled in Brittany and sojourned for a time in Anjou. His manuscript notes give numerous descriptions of the mines and iron foundries of the province, and also present researches on the formation of saltpeter. It was at this time he published his first work: "Expériences sur la Pesanteur des Corps à differentes distances du centre de la Terre, faites aux Mines de Montrelay en Bretagne."[2]

In 1776, this Brittany trip was followed by a geological exploration in Sicily, succeeded by an Alpine excursion, after which, in 1778, Dolomieu returned to Malta, and was chosen as secretary by Prince Camille de Rohan, ambassador to Portugal. On August 19, 1778, the Académie des Sciences elected him as one of its correspondents, designating Daubenton as the member with whom he was to correspond. Two months later, he received the golden Spur as Knight of Malta, and in 1779 he was brevetted captain, but then retired from active service. The succeeding years brought him the title of Commandeur de Dolomieu. He now made a long journey in Sicily, and entered into friendly relations with Gioeni of Catania, and in 1782 traversed the Pyrenees on a botanizing tour in company with Picot de Lapeyrouse, the botanist of Toulouse. Returned to Malta, he pursued meteorological studies and wrote a memoir on the climate of the island which was printed with the approbation of the Académie.[3]

[2] *Journal de Physique*, Vol. VI., 1775, pp. 1–5.

[3] This forms part of the "Voyage aux Îles Lipari," etc., Paris, 1783.

At Malta, the principal dignities were regularly assigned to the chiefs of the different nations, or "tongues," constituting the order, and the office of marshal was given to the Langue d'Auvergne to which Dolomieu belonged. He was chosen to fill this place in 1783, thus becoming governor of the city and commander of the troops, but offended at a decision taken by the Grand Master of the Order that seemed to him to be an attack on the rights of his "tongue," and his respectful remonstrance having been disregarded, he sent in his resignation and voluntarily exiled himself to Italy, where he was at least able to carry on his geological investigations. Toward the end of 1786, he returned to Malta, and offered himself as candidate for a vacant place on the council of the order. His project was bitterly opposed by his enemies, who raked up some secret letters from the King of Naples containing accusations of political errors, and his name was withdrawn.

With the outbreak of the Revolution, Dolomieu became one of its most earnest partisans, but the excesses of the Terror almost shook his faith in the eventual success of the principles that had been proclaimed. On November 27, 1792, he writes:

> I had long believed that it was a blessing to live, since we had the hope of a happy future; now, however, I think that it is no misfortune to die. The only sentiment that still sustains me in the course of existence is that of curiosity; what will be the end, what will be the results of the strangest crisis that the peoples of Europe have ever traversed?

Still, this period was marked by a number of publications: his long "Mémoire sur les pierres composées et les roches" (1791–1794); a study, "Sur les pierres figurées de Florence" (1793); an adaptation of his "Distribution Méthodique des matières volcaniques" (1794); his "Mémoire sur la constitution physique de l'Egypte" (1793). His merits as a savant received full recognition. When in 1795 the Convention organized the Corps des Mines, he was named inspector; from the beginning of 1796, he was charged with the course of physical geography at the Ecole des Mines and his lectures were brilliantly successful. The year previous, he had been chosen a member of the newly founded Institut, created by the law of 3d Brumaire, An IV. (October 25, 1795).

When Napoleon Bonaparte sailed in 1798 on his adventurous expedition to Egypt, Dolomieu accompanied him, as did many other noted French savants, first having secured from Bonaparte the assurance that no hostile action would be undertaken against Malta. However, when the French fleet arrived there, the capitulation of the town was demanded and necessarily accorded. Although Dolomieu did what he could to make the situation less painful, and is said to have made a rather lively protest to Bonaparte, the event was not forgotten by his enemies in the order. In the short-lived Institut d'Egypte he was a member of the section of physics, and did much useful work during his brief stay in the land. However, his health began to give way, and on March 7, 1799, he embarked from Alexandria with Generals Dumas and Manscourt, and his young pupil Cordier, who later became a member of the Académie des Sciences. They escaped the danger from the watchful English fleet, but were assailed by a violent tempest and forced to take refuge in the Italian port of Taranto. Here the Counter Revolution had already broken out and the luckless passengers were straightway arrested and thrown into prison. Two months later they were taken to Messina, where, to satisfy the grudge entertained by some Sicilian Knights of Malta dwelling in the city, Dolomieu was separated from his companions and confined as a criminal on orders from Palermo. In the city prison, he was locked up in a dark cell and subjected to the most rigorous treatment by a cruel jailer. He had been able to smuggle in on his person a few books, and he managed to compose several works by writing on the margins and all other blank spaces in his books, using as a pen a sliver of wood and for ink, lamp-black made with the smoke of his lamp. Professor Lacroix informs us that he has found one of these unique books in the library of the Muséum. It is a copy of the "Minéralogie des Volcans," by Faujas de Saint Ford, and on the reverse side of the guard-leaf Dolomieu had written this touching appeal:

> I beg that any person into whose hands this book may fall, I supplicate him by all the motives which can touch his feelings or interest his honor or his delicacy, I supplicate him by all that he holds dearest, to have it taken to France to my sister, Alexandrine de Drée, born Dolomieu. She lives in Paris, Rue de Lille, near the Rue de Beaune, or at Chateauneuf, near Roanne, department of Saône-et-Loire.
>
> I beg my sister, Alexandrine de Drée to give ten gold louis, equivalent to sixty Neapolitan ducats, to the person who shall hand her this book, which is the last testimony of my affection for her.

On the title-leaf are instructions for his heirs, and farther on are notes relating to the beginning of the Egyptian expedition, to the capture of Malta, to his return to Europe, and then a plaintive litany as to his sufferings in his Messina prison. This is followed by many brief characterizations of those with whom he had been in friendly intercourse.

Although the relations between France and England, even during the succeeding short period of quasi-peace, were far from cordial, the Institut did not hesitate to seek the help of the influential Royal Society of London, addressing an earnest request to Sir Joseph Banks, president of the society, for his good offices. He in turn appealed to Sir William Hamilton, the English ambassador at Naples, to Lady Hamilton, a great favorite at court, and to Lord Nelson, then in command of the English fleet in the Mediterranean. Finally, an appeal was made to Charles IV. of Spain, who sent two personal letters to the King of the Two Sicilies, making an earnest appeal to his sense of humanity, and urging him to have Dolomieu set at liberty. However, it was not until after the victory of Marengo that real and effective help was given. On February 2, 1801, Bonaparte wrote to Talleyrand that the freeing of Dolomieu was to be made one of the express conditions to be imposed on the Sicilian monarch, and Article VII. of the armistice which was followed a few days later by the signature of the Peace of Florence, March 20, 1801, specified: "The Citizen Dolomieu, General Dumas and General Manscourt, and all the Frenchmen imprisoned on their return from Egypt, shall be immediately given up."

The short remainder of Dolomieu's life was marked by a triumphant return to Paris, where he began at the Muséum the course of lectures on mineralogy with which he had already been charged in January, 1800. Before many months had passed, he was seized with a longing to view again the mountains so dear to him, and he toured once again in Dauphiné, Savoy and Switzerland, receiving everywhere a warm welcome from his friends. Finally, he visited his sister and his brother-in-law, De Drée at Chateauneuf, in Charollais. It was while in their home that death overtook him after a brief illness, November 26, 1801. Without doubt his demise was the result of the rigors of his imprisonment at Messina.

The eventual fate of the collection of minerals that Dolomieu had so lovingly assembled during his travels became a considerable source of anxiety for him. At one time he thought of selling it to the University of Palermo, and again he entertained the idea of presenting the objects to the city of Grenoble, or to the Académie of Lyons. Finally, in a letter to Picot de Lapeyrouse, dated December 15, 1790, he expresses himself as follows:

Everything ripely considered, I have arrived at a decision which will surprise you. I propose to send it [my collection] to the Congress of the United States of America. I shall make this gift of the products of the old world on the condition that, a hundred years from now, there shall be sent to my country a collection of the products of America, that there will have been time to gather together and to arrange. In this way I shall render myself useful to those brave men who have learned to know the value of liberty. I shall supply them with objects of comparison between the old and the new world, and in a century, my country will receive the donation that I intend to provide for of the exchange collection from America. I shall, however, attach this condition, that America be not forced to make this return unless my country has preserved her liberty.

Although this generous project was never realized, Professor Lacroix adds that at the expiration of the century, the late J. Pierpont Morgan unknowingly fulfilled the wish of Dolomieu by presenting to the Muséum d'Histoire Naturelle in Paris, a complete collection of American gems. And since then the people of the United States have given to France something more precious than rare gems, the best of their sons, because France has preserved her liberty at the same time that she has striven for the defense of the world's freedom.

Dolomieu's field of study embraced all the knowledge that had been attained in his day on the different branches of mineral science—mineralogy proper, lithology, geology and terrestrial physics; but it was more especially in the study of volcanoes and volcanic products that he himself left an indelible trace. Already in 1752, Guettard, a member of the Académie des Sciences, in the course of a journey through Auvergne, discovered the first extinct volcanoes that had been remarked outside of the regions in which active volcanoes existed, and he determined that these extinct volcanoes resembled the actual ones in all respects except their activity. This opinion was confirmed ten years later by Demarest, another member of the Académie, who was able to establish the existence of a series of periods in the successive eruptions of these extinct volcanoes. He recognized the influence exerted upon them by atmospheric erosion; he reconstituted the progressive succession of the phenomena that have little by little destroyed the crater-cones, carried away the scoriæ, smoothed off the scoriated surface of the chimneys, disassociating these in scattered fragments, so as to reach at last their granitic substratum, and finally to hollow out deep valleys dominated on either side by horizontal levels, the last vestiges of powerful and continuous discharges in former times. Thus he demonstrated the identity of the black lavas forming the cones with the basalts, either massive or in fine prismatic colonnades, while before this time lavas and basalts had been regarded as rocks of diverse origin.

The main part of Dolomieu's descriptive work concerns the volcanoes of southern Italy. He had witnessed eruptions of Vesuvius and of Etna, and carefully studied the discharges, and he had never doubted that the lavas came from great depths; thus even before the term had been coined he was a "vulcanist." His first publication on this subject treats of the Æolian (Lipari) Islands.[4] From 1781 he had presented evidence that in these islands were volcanoes which had arrived at various stages of development; one of them, Stromboli, had been active from early times, though its eruptions were not violent, while another, Vulcano, offered the phenomena of occasional but exceedingly violent eruptions. There were also fumaroles and hot springs, as well as extinct volcanoes. Other extinct and eroded volcanoes are to be seen in the Ponza Islands off Naples. These were described by Dolomieu in 1784,[5] and he distinguished the varying character of the tufas, some having a miry origin while others were of submarine production. He studied as well the islands of Ischia and Procida, and completed the description given by Hamilton. Mount Etna and the Cyclopes furnished Dolomieu with material for many interesting memoirs; but more important is his study of that part of the island of Sicily called the Val di Noto, situated northwest of Syracuse.[6] Here he described the remains of volcanoes older than Etna. Finally, at the western extremity of Sicily, in an exclusively sedimentary region, between Aragona and Girgenti, he noted a strange phenomenon, the so-called "*macabula*," which he designated with the name "air volcano." In the midst of the plain, arise small hillocks of clay, whence issue jets of silicious, cold mud, which spreads over the sides of the hillock like lava. This mud is ejected by discharges of gas. Dolomieu appears to have been the first to describe this phenomenon correctly and at length.

In a letter of April 2, 1790, written to Gioeni, Dolomieu declared that "the most important part of mineralogy is lithology." In estimating his work in this branch of science, we must bear in mind the immensely greater resources at the command of the investigator of our day, as compared with what

[4] "Voyages aux Îles de Lipari fait en 1781, ou Notices sur les Îles Aeoliennes, pour servir à l'histoire des Volcans," by M. le Commandeur Déodat de Dolomieu, Correspondant de l'Académie des Sciences, etc., Paris, 1783, 208 pp., 8vo. German trans. by L. C. Lichtenstein, Leipzig, 1783.

[5] "Mémoire sur les Îles Ponce, et Catalogue raisonné des produits de l'Etna," Paris, 1788, vi + 527 pp., 1 plate, 4 maps, 8vo.

[6] "Mémoire sur les Volcans éteints du Val Noto en Sicile," by Déodat de Dolomieu, Commandeur de Malta, Correspondant de l'Académie des Sciences, *Journ. Phys.*, Vol. XXV., 1784, pp. 191–205.

was available toward the beginning of the nineteenth century. Then almost all the exact means of testing and experimentation were still to be discovered, and indeed the exact science of lithology dates back little more than a half-century. Dolomieu may, however, be credited with having accomplished all that was practicable with the feeble resources at his command, and the results he attained command our respect, in spite of occasional inexactitudes and lack of precision. What were qualified by him as the primordial rocks included not only granite, but also our eruptive rocks, with the exception of the volcanic ones, all our crystalline schists, and in a general way all the metamorphic rocks. These he considered to have resulted from the simultaneous crystallization of their constituent minerals in a fluid. As he well knew that these minerals are not soluble in water, he believed that this was accomplished by some chemical composition which rendered possible the dissolution of the minerals, and which then disappeared, leaving no trace behind. This shows that he had a certain conception resembling the later idea of mineralogizers. As to the volcanic rocks, whose igneous and intertelluric origin he always proclaimed, he did not look upon them as we do to-day, as resulting from the consolidation of a fused magma, he believed them to have resulted from the fusion, under the influence of subterranean fires, of deep-lying rocks, already consolidated and belonging to the primordial region. He rejected the theory held by his predecessors as to a purely granitic origin, and held that the diversity of these rocks depended upon the fact that each of them derived its origin from a special type of primordial rock, or else from a mixture of different primordial rocks. As is known, this idea has not yet entirely disappeared from science, there being still some geologists who consider granite as having been formed by the fusion of sediments at the bottom of geosynclinals.

In what regards the formation of lavas, Dolomieu resorted to the experimental method. In the glass-works, at Creusot, where an attempt had been made to form bottles out of fused basalt, he had seen the crucibles filled with a perfect glass; the lower part might sometimes indeed be rather dull, resembling black porcelain, but still differing much from the finely crystallized basalt that had been treated. Dolomieu overhastily concluded that the basalt did not result from a real vitrification comparable to that of glass, but had been produced by a special mode of fusion. However, if he could have used a petrographical microscope, he would have seen that the texture of the mass at the bottom of the crucible was due to the presence of crystals which were almost identical with those of natural lava.

Our limited space does not permit us to give more than the above details as to the researches of Dolomieu in his favorite domain, and in presenting so much, we have elected to follow very closely the words of Professor Lacroix. His publication is embellished with an excellent reproduction of a portrait of Dolomieu, painted in Rome, in 1789, by Angelica Kaufmann, and portraying her sitter as he appeared in his fortieth year. His oval face, lighted up by expressive blue eyes, his long blond hair, already slightly streaked with gray, gives a pleasing idea of his personal appearance. He was quite tall, his height being given on his passport as five feet eleven inches of the old French measurement. He was never married.

Professor Lacroix has provided a full and detailed bibliography of Dolomieu's publications, as well as a list of about two hundred unpublished letters from him, and gives us the assurance that he will issue these before long. In conclusion, there are twenty closely-printed pages of explanatory and illustrative notes.

WINDOW GLASS AS A FACTOR IN HUMAN EVOLUTION

By R. E. DANFORTH

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THREE years ago in a brief private publication, I mentioned the importance of window glass as a potential factor in the present and future evolution of the race. Since that time the subject has impressed me with increasing force. I wish to express my thanks to Professors J. H. Robinson, of Columbia, and A. M. Hyde, of Washburn, for valuable references throwing some light on the time when window glass came into general use. The more one hunts for such references the more one is impressed with two facts, namely, that very little has been recorded as to the time when window glass was commonly used, and that it was a surprisingly recent event, only a matter of some two centuries ago.

That window glass is a factor of prime importance in the evolution of man has not been sufficiently elucidated. Not that glass has had much to do with shaping his body and brain of to-day—it has not had time to do that—but that the thoughts filling his mind, that the greater part of his activities, and that the bodies and brains of generations to come are and will be greatly influenced by window glass; and that in it are serious dangers as well as boons. The thought is astonishing, yet simple of proof, and clear as the light which comes through the windows in question.

Before window glass became a common possession of the people there came into homes and shops the air and the temperature of outdoors through the openings which admitted the light of day. The air was beneficial but the temperature it brought with it not always so. When the outdoor temperature was not too low and the outdoor air not in too great activity, life and industries within could go merrily and well, but let either the air or its temperature be unfavorable and at once discomfort and a necessary cessation of certain activities ensued.

Think of the demoralizing effect of such uncertainty upon industry. Modern inventions could not have come in such marvellous profusion before the day of this one invention of a simple device admitting daylight and excluding to a great extent, the outer temperature.

Many other inventions should do homage to this one to which they unwittingly owe their existence. Even to-day if window glass should become one of the "lost arts," a large number of other inventions would at once cease to be useful or be forgotten through neglect, even despite the fact that artificial illumination has made remarkable strides since the universal introduction of window glass. When we boast that so many changes have taken place in our industrial life so very recently, and that our so-called "civilization" has had a mushroom-like growth, let us note that the chain of links of causes leads us quickly back to window glass as one of the prime permitters.

But, some one may object, was not glass manufactured and distributed by the ancient Phœnicians? Yes and probably before these by the Egyptians. How then can we attribute our very recent and radical changes to window glass? It is indeed surprising to think how new is the general use of glass in windows when the substance had been known so long and used for vases and gems and, now and then, in some sort of window. We read of ancient windows of perforated marble frames set with small plates of cast glass. There were the marvellous stained glass windows of medieval cathedrals. Back as far as the time of Pope Leo III. (795–816 A.D.) and probably earlier, colored glass was used for church windows. The common people, however, had no such luxury in their homes and shops. That which we now consider a necessity, was unknown to our forebears for many centuries thereafter. Recent terrific explosions in New Jersey, breaking windows in many hundreds of homes and other buildings, brought home to some for a few days our real dependence upon window glass to-day.

By 1302 the king of France used some window glass made in his own country at Bezu le Foret, Department of the Eure. Eneas Silvio, who later became Pope Pius II., expresses his surprise at finding glazed windows in Vienna in 1448. These were probably composed of those strange round panes that are sometimes imitated in modern windows.

Whatever window glass existed in Roman times was cast. The art of casting glass seems then to have been forgotten until 1688, after which it became possible to make much larger mirrors than could be made by blowing. Yet window glass was even then the prized possession of kings and wealthy nobility, and these had only a scant supply.

A writer in the time of Elizabeth speaks of glass windows displacing lattice-work, but so rare and costly was it at that time that some noble when he left his city residence had the glass windows carefully removed. A century later, in the time of Charles II., glass was not used in all of the rooms of the king's palace. It was therefore not before the eighteenth century that glass became at all common in the windows of the people. The writer would welcome facts throwing positive light upon the precise times when in various localities window glass became really common and cheap enough for all people to have all they wanted of it. In the light of such literature as I have looked into up to the present time it seems safe to assume that while many individuals may have had scant supplies of window glass by the middle of the seventeenth century or earlier, the commodity could hardly have been common before the eighteenth century, hence its effect upon human customs, industries and mode of life could not have begun to operate appreciably before that time, and it is with this far-reaching effect upon race evolution that we are now concerned, rather than with the question of when the first European cobbler may have put glass into the window of his shop or home.

Without some of these facts we might easily fall into the error, which is doubtless very prevalent to-day, that our ancestors had had glass windows a much greater proportion of the time elapsing since the invention of glass so many centuries ago. But the great change in home life and the change in industrial life and in the industries themselves could not begin until an abundance of cheap glass filled all homes with a flood of daylight, and all shops and offices and factories as well, keeping in the artificial heat at the same time. From that time the outdoor life rapidly lost its people while the world of indoors gained devotees, willing or unwilling, by thousands of thousands. A host of new industries sprang into being in the wake of window glass, and these begat other industries, scientific inventions and discoveries with magic rapidity. The general use of window glass is a thing of yesterday, and in its train there now follows a striking pageant of industrial revolutions. Large factories were made possible, big business began and the physical conditions of home life were completely changed. The air which all breathed, in home and shop and office, became at once far less pure, its oxygen was consumed and it became flecked with fine dust, and the pristine rigors of a temperate climate, with all that they had meant for the vigor of the northern peoples, were commuted to conditions of tropical evenness of temperature with what debilitation such brings and without the constant renewal of air which might be had in the tropics. Although this change came but yesterday, already a marked increase in physical debility in our most "civilized" populations is a matter of common comment and concern. How quickly our young men in army and navy camps respond to a more rigorous life, with much training in the open under all conditions of temperature and weather. We can fairly see the color and strength and sturdiness return to the youth of a civilization whose vital strength is ebbing while its inventions and industries fairly leap into being.

Before the days of universal window glass what conditions prevailed? There was not the same field for people in the industrial life that there is to-day, while the very lack of combination and cooperation in commerce and industry made it necessary for a far larger proportion of the population to raise their own food in part, thus the indoor life was not available and the outdoor life was a necessity to a larger extent than to-day for the majority of the people.

With window glass the habits of life and livelihood are completely changed, habits of thought are revolutionized and the field and scope of thought changed. The whole environment is changed for the species, including temperature, humidity, material environment, composition of air breathed, visual and mental horizons, and a change in the relative adjustments of human beings to disease germs. Such radical changes both within and without the human organism are bound to produce physiological changes in the individuals. They also set in motion new factors in the evolution of the race. Whether we accept the results of experiments like those, for instance, of Kammerer, the Viennese, upon the effects of climatic change upon the germ plasm of animals and their offspring, or whether we reject them as inconclusive, it is certain that climate and other environmental factors always do in the long run change the character of the inhabitants very radically in one way and another, although just how and in what ways may long remain a subject of dispute.

With window glass industry in shop or office can go on without a break caused by the weather, and what is of still greater consequence, without the long winter hiatus during which bright thoughts could be forgotten and the best of intentions could fade away. Most of our industries of to-day depend upon steady continuity for their existence, and without a guarantee of continuity it would be folly to start many of them. If bad days in summer could stop them and the long cold of winter interrupt them, few of them could be run profitably at all and none of them attain to anything comparable to their modern magnitude.

With window glass man leaves his outdoor or semi-outdoor activity and becomes a modern industrial worker or office server. With a sturdy foundation of outdoor health behind him he may not notice ill effects of degenerating muscles or dust-clogged respiratory tracts, and he may pass on to his offspring for two or three generations a vigorous heredity. This sturdy heredity came from thousands of generations, literally millions of years of outdoor life of the most strenuous sort. From time immemorial man had lived the kind of life which developed strength and hardiness, on the one hand, while, on the other, it weeded out weakness. The heritage of the ages is not lost over night, yet already we note inroads into the health and vigor of the people. Industries indeed evolved prodigiously, but "advance in civilization" is not necessarily human evolution.

How then is window glass a prime factor in human evolution? First, it changes man's environment and changes his field of thought. Secondly, it alters the temperature and humidity of his environment. Thirdly, it gives him air of a different quality and composition to breathe. Fourthly, it compels him to inhale fine dust constantly. Fifthly, it removes out-door activity from all women and most men in "up-to-date" communities. Sixthly, the germ content of the air in confined buildings is greater than normal, especially so in times when colds and other infectious diseases abound. The more frequent illnesses result in impaired health and reduced vigor. The inferior air also reduces vitality. The inhaled dust clogs minute bronchioles and alveoli of the lungs, causing thousands of cells to toil constantly to ingest foreign and insoluble particles. The muscular degeneration consequent to the changed manner of life will make its permanent change in the race of to-morrow; so will the reduced vitality resulting from the causes just mentioned. So also will the complete artificiality of thought and surroundings. The man of the future will be just as surely altered by these things as is the parasite altered by the environment in which it lives. Whether by direct and cumulative effect upon the organism, or whether by indirect selective agencies of one sort or another, environment in time makes all things new. Great care should be given to the kind of life we lead, and to the kind of factors which we allow our new discoveries and our new "civilization" to load upon us, lest we become the slaves and dupes of our enlightenment, even as the parasitic worm is the dupe of his unfortunate host. Great care should be given to the subject of window glass, that we may see to it that we reap the blessings it brings with it and avoid the bane.

THE EFFECTS OF THE WAR ON THE AMERICAN PEOPLE

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NATIONS, like individuals, are organisms. They too have their structure and organs, their functions, their well being and their diseases, and possibly even their life cycle. They are vulnerable, but have also an inherent power of recuperation, and injuries that do not surpass this power heal sooner or later without leaving any permanent impairment.

This nation has engaged in war and sustained certain casualties; what effects will these have on the whole body? What in view of present scientific knowledge is the prognosis? Has the collective wound reached any vital part, and how long will it remain open?

When our war began, we were, as our soldiers justifiably sang, one hundred million strong, and increasing by the excess of births over deaths alone, at the rate of approximately one million per year, among which were thirty thousand more males than females. In other words, a nation one hundred million strong with our birth and death rate, would show a natural increase each year of 515,000 males. Our total losses, from disease incident to the war as well as injury, and counting in the totally debilitated, may reach or perhaps even slightly surpass 100,000 men. It is hardly necessary to dilate on these general figures. They show that so far as numbers alone are concerned, the damage has really been quite immaterial, and the case could justly be diagnosed as but slightly wounded, with prospects of early and complete recovery.

The above, however, would be but a very crude and in a measure fallacious presentation of the facts. The figures given do not show who were lost. Actually the losses apply exclusively to young and selected manhood, and possibly even, as sometimes intimated, largely to the best of such manhood. Purely numerically, nevertheless, whichever way the matter is viewed, the losses remain relatively very moderate, easily reparable. The annual increase of the class from which practically all the losses occurred, namely, that of men between 20 and 29 years of age, amounts to nearly fifty thousand. But of these, as experience in the draft has shown, a little over one third would be excluded for various imperfections, leaving for the class from which the army was actually recruited, only a little over thirty thousand of annual accretion. Even thus, however, the losses of the war will be completely covered by the natural increase within the class from which the men came in a little over three years—an immaterial damage in the long run. The numerical loss, therefore, so far as this nation is concerned, is really such that no permanent deleterious effect of it on the body of the people needs to be apprehended.

But the objection may be raised that numbers alone do not count for much, and that if the losses incurred took in an undue proportion from the slowly multiplying older American stock than from the more recent and immigrant classes, or if, regardless of descent, they involved an undue proportion of the bravest and best, then the harm done may be much greater. To this it may be replied that such assumptions are in no way warranted in this country, although the latter may be so in England. Our army was not an army of volunteers, except to a small measure, and the draft took in equal proportions from all of our racial elements; the casual volunteers as a class may represent the most ardent fighters, but not necessarily the best group of youth in every respect; and the history of the engagements of our army, with the lists of casualties, fail to show any racial or class discrimination. The exact figures are not yet available, but when they are it will in all probability be shown that proportionately to their numbers in the States, just as many Poles died for this country, and even Germans, as Americans; while, as to bravery, it would be a rash statistician or officer who would want to demonstrate that any particular group or strain of our boys was braver or better than any other. The only group where racial, educational and high efficiency selection obtained, was that of the aviators, but this group was too small for its losses to be of much significance. A racial and educational preference played doubtless also some part in the selection of officers, and the final reports may show that a somewhat larger percentage of the officers have suffered casualties than was the case among the men in their charge; yet again the total will at most be quite insignificant, and can in no way affect the nation as a whole or any of its vital components.

The mass of the wounded and invalided need not be considered. There is no question but that there will be among them some whose constitution has been so shattered that they will never completely recover and may even transmit weakened powers to their progeny. Yet the large majority were wounded only slightly or moderately and from the biological standpoint inconsequentially, or have passed through illness that left no permanent impairment. Even the men who lost whole limbs have in general, it appears, suffered no loss of racial potentiality. The actual loss to the nation in this large group then is again small, when contrasted with the body of the nation as a whole. Taking the war loss in its entirety, therefore, it seems safe to say that no permanent harm whatever need be feared from it by the American people, and that even without immigration three or four years may completely suffice to obliterate its traces, except, of course, so far as individuals are concerned. And for this small loss there have been far-reaching compensations.

During the recruiting of the U. S. A., it was found that approximately 34 per cent. of those who were called for examination presented defects or pathological conditions of sufficient import to cause their rejection, and many were accepted with defects of lesser or more hidden nature. This showing made a profound impression. And it led to a vast amount of improvement and cure, both privately and in the army. It has also laid foundation to measures the object of which will be to make such a poor showing impossible in the future. It has greatly advanced an appreciation of the need of careful systematic physical education of our youth, and of extended medical inspection.

In the course of the same recruiting it was discovered that an important proportion of the white and especially of the colored men were infected with some sort of venereal disease, and numerous cases of secondary or tertiary syphilis developed later. Most strenuous efforts were at once undertaken to cure and curb these most harmful of diseases. Every man received instruction as to their exact nature and gravity, and every possible precaution was put in force to prevent new infections. The results were that venereal diseases in the U. S. Army fell to the lowest level probably ever reached in either the army or civil population of any country; and that four to five mililons of young men will carry into civil life a knowledge of these dangerous conditions, which not one in a hundred would have acquired otherwise, and which will safeguard many of them as well as their families.

Thousands of men from the south were found to be infected by the hookworm and leading a dragging existence; they were cured and became like new men. In many thousands of others defective teeth and concomitant poor digestion were corrected. The physical training and simple regular life of the soldier were of universal benefit, and in many cases worked wonders. The slouchy mountaineer became in a few months the willowy fine straight-forward looking youth whom we so admired in our marching legions, and in the less well-nourished a gain in weight of ten to fifteen pounds in a few weeks was the rule. The general and all-sided improvement in the drafted men was in fact such that it came to constitute the brightest feature of the otherwise very serious and difficult process of the formation of a great army in this country.

In addition, a great check was given alcoholism, and this check rapidly spread to the whole nation. The benefit to the American people from this factor alone must soon outweigh the total losses of all nature due to the war, and will tend to constitute such an advantage for the future that other nations, if not to be left behind, must inevitably follow with similar regulations.

And the mental returns of the war, so far as this country is concerned, are fully as rich as the physical. The men come back with their eyes opened, they come full of new knowledge, experience and ambition; and a good deal of what has been acquired is of practical useful nature. These men will make quite different citizens and Americans from what they would have made had there been no war, and, what is equally important, quite different fathers. They have progressed years and decades in as many months, in many instances.

It is not necessary to dilate on the above conditions, which may duly be regarded as the compensations of the war. They need no optimistic coloring, they are the simple facts well known to the scientific observer, as well as to every physician and probably every officer of the American army. They far outbalance the total losses in life and health occasioned by the struggle, together with such temporary social derangements (increase in juvenile delinquency, child labor, etc.) which took place internally. And to them must be added the industrial and medical progress, the political advance, and our great protective strengthening.

Taking everything into consideration, only one conclusion appears justified, and that is that the late war, so far as the American people are concerned, did no great or permanent biological harm to the organism as a whole or to any of its vital parts; and that, on the other hand, it resulted in many-sided compensations, which are bound to have a beneficial effect on the further development, biological and otherwise, of this nation.

All of which does not apply, unfortunately, to most of the European peoples who have participated in the war. They have been wounded deeply and their recovery is a matter of deep concern to all serious observers.

INDUSTRY AND FOOD PRICES AFTER THE WAR

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THE war's close brings to all the peoples of the allied nations the profound satisfaction of success, tempered though it may be by realization of staggering debt and subdued as it must be by thoughts of those myriad radiating centers of infinite grief. But even in our solemn contemplation of the grim glorious past, rationally inexplicable by our philosophies, comes too a sudden appreciation—perhaps apprehension—in regard to vast economic problems just ahead.

War solves no problem of industrial progress, though industrial progress may be forced to the limit to serve war purposes—war simply sweeps away political rubbish and makes way for new men and new things. At this time, in war's swollen turbid current sweep by the remnants of ancient dynasties uprooted, thrones overturned, political wreckage and tattered débris, once all gold and purple—and half of Europe's skies glow strangely red with the flaming wrath of outraged humanity—casting in a day the hateful reckonings of a hundred years. How great the contrast here, where with taut hawsers floats majestically the ship of state—as yet hardly tugging at the anchors. After the war, theirs are the problems of the expiation; ours are principally problems of taking up the slack.

Professor William Graham Sumner, the noted economist, was wont to remark that "the harvests of one year were eaten mostly before the harvests of the year following; little more than enough for everybody was raised even in prosperous countries; too little in lean times and in places of less affluence; then or there, somebody was always left out in the cold with nothing to eat." This statement in normal times is a true description of the close adjustment of consumption and production. At the close of a protracted war, production of food has fallen far behind consumption and great scarcity has caused prices to mount to unheard of heights. As food prices mount, labor demands higher and higher wages and with large numbers withdrawn by the war, industry is obliged to raise wages to higher and higher figures.

Rising prices and rising wages have continued during four years. Suddenly, these tendencies are reversed. Labor will soon be plentiful, but the food shortage can not be made up within two years. In the near future, millions of men will return to work both in Europe and in the United States. Will they temporarily be worth more to industry as hands to help than they will cost industry as mouths to feed? The answer to this question points the way to one solution of many of the problems of taking up the slack. Will soup kitchens be in order as they were in a similar situation following the Civil War in some of our large cities, or will the readjustment be properly provided for in advance?

Let us deal in plain statements. Never has the cost of living been higher since the Civil War. Food prices are now substantially double the prices prevailing at the beginning of the war and more than three times those of 1897, a year of low prices. To people who live in cities, the extraordinary prices charged for farm products make the average farmer look like a profiteer.

The economic effects of the war in Europe are now overwhelmingly more painful than in the United States. To-day, the cheapest commodity in Europe is human labor. In Europe, returning soldiers, ex-munition workers and countless widows will find pittances for wages and work hard to find. In Europe, liquid capital has been swept away. Reserve buying power is largely gone. Paper money days have come again to plague business in Europe. In their readjustment, low wages a little later will make for low cost of production of manufactures in many lines, because cost of production consists largely of human wages. On this account, Europe may shortly have an advantage over the United States in the foreign trade. If we lose our fair share of foreign trade through lack of preparedness, wages will fall violently here through closing down of industries. This will be hard in any event, doubly hard, unless cost of food shall fall more rapidly. It is after all the relative adjustment of wages and cost of food. If wages must fall, we want cost of food to fall more rapidly.

There is no reason why cost of food should not fall rapidly, if Congress promptly applies the natural remedies and business men take concerted action. There are three principal phases: (1) The prime necessities should be cheapened: (2) The standard of living should be protected: (3) Application of all improvements and inventions cheapening cost of production should be hurried.

The prime necessities are food, warmth and shelter. The fundamental forces making food, warmth and shelter cheaper, —aside from the influences of monetary inflation—are larger crops and cheaper transportation. Warmth and shelter, that is coal and building materials, are composed—costwise—chiefly of transportation charges and wages for labor. Cheapening the cost of food from the standpoint of our great manufacturing industries is, therefore, all important. To take up the slack caused by the abrupt cessation of war, every effort should be made to cheapen the cost of food. Wages will have to come down through the inexorable law of supply and demand. This will be painful and distressing unless food prices shall fall more rapidly. Not only must we produce more food at far lower prices, but we must bring the food from the ends of the earth to feed the great populations in our cities. There will be little opportunity to increase food production during the next six months. Therefore, since the food problem is immediate and fundamental, every other aid should be employed. Wherever surplus stocks of foods exist in the United States or elsewhere in the world, they should be transported at a nominal rate and the loss to the railroads should be borne by the government as a part of the cost of the war.

Heads of great industrial establishments, millions of workers dwelling in cities, the farming classes,—all are interested in securing cheaper food through lower transportation rates. The entire population needs the citrus fruits and sweet prunes of California, the apples of Oregon, the potatoes of Idaho and Maine, the corn of the West, bananas from the tropics, winter vegetables from Florida, coffee from Brazil, tea from China, beef from Argentine, mutton from Australia, sugar from Cuba and Hawaii—all now pegged at record figures partly through scarcity and largely through high transportation rates by rail and water and restricted service.

Instead of leaving the matter of freight rates on foods to the Interstate Commerce Commission and executive officials, Congress should enact a bill directing the Railway Administration to declare a reduction in rates on foods to at least one half the present rates, the same to apply during the next two years of the Peace Emergency; further, that shipments of fifty pounds shall travel at one half the rate of the hundred pound minimum rates; finally that parcel post rates on non-perishable foods for slow movement shall be one local zone rate plus the average first class freight rate reduced to a pound basis and adjusted to a workable zone system, such packages to pass through classification centers to insure full carloads moving as long distances as possible as freight.

Such emergency enabling legislation will accomplish far more than can the food regulations and restrictions of executive divisions. Such enabling legislation as cheapened transportation acts automatically. Henceforth, enabling legislation is preferable to the creation or even continuance of many of the present executive divisions. Since benefit is common to all classes, all classes may cooperate in insisting,—even though drastic measures may be necessary,—that the high cost of food must be broken and it is only proper that the government should shoulder the loss, if any. The situation was produced by the war and the cost belongs to the Peace Emergency caused by the war. It is doubtful whether losses would occur to any great extent, since the volume of business would increase considerably.

A series of municipal investigations of food prices would help to enliven the situation and to start action by Congress. The great value of our new merchant marine can now be demonstrated. Let ocean rates on foods be reduced in some relation to cost and let more attention be given to this real problem. It is spring now in Australia, South Africa and South America. It is always summer in the tropics. Immediate cheap transportation will help greatly. The more rapidly food prices fall, the less will unemployment develop, through our being able to hold a larger share of foreign trade. Wages will probably fall any way. Plenty of work even at lower prices is far better for labor than still lower wages and no work to be had.

It is obvious, beyond dispute, that we can not hope to sell our manufactures in foreign trade unless we can meet the world prices. We can not sell unless we also buy. We can neither buy nor sell to advantage unless we have available both ships and low freights. Why cancel the construction of shipyards at Alameda, California, if the location was well chosen originally? Ship construction, if economically conducted, was one of the few productive expenditures of the war. Moreover, ship construction continuing during the Peace Emergency would undoubtedly help the labor situation.

With restricted transportation, we have been trying to raise crops on every vacant lot, generally blest with indifferent soil and often too with disappointing results. This was necessary in war, but in peace, food should be raised where it can be raised the cheapest and cheap transportation is the lever to bring cheap food to the masses.

Transportation is capable of enormous cheapening in various fields,—railroads, automobiles, shipping. To take up this slack, it is desirable that there shall be farsighted planning on the part of Congress, as a result of which railroads, highways and shipping shall be linked up. Take a map of the Mississippi River and consider the area of the United States included by lines four hundred miles distant, in a general way north and south and parallel with the river. Consider the freight which could be moved by a system of permanent, hard surfaced highways at right angles with the river extending east and west and connecting with boat lines serving the highways at intersecting points. Trucking crops to river points from long distances compared with present conditions affords another source of revenue to the farming classes during the less active months. This is simply a question of useful roads. Again, narrow hard surfaced roads to railroad stations produce similar results in cheapening transportation and food costs. This development depends primarily on enabling legislation—a system of national highway bonds guaranteed by the federal government,—such bond issues by states limited by standardized requirements, for instance that such roads shall connect with railroads, and with water terminals served by public wharves and frequent shipping; shall serve sufficient population to justify the investment; and that the character of the improvement shall be really permanent.

Generous enabling legislation to cheapen transportation and to provide cheaper power through electrical development deserves every encouragement. Such enterprises, wonderfully productive, will furnish employment to many during critical times. Nor should enabling legislation such as that of the California Land Settlement Board be overlooked. Larger crops will result from more farms.

Next in importance to lower food prices is maintenance of living standards. The manufacturing industries, unlike agriculture, invest capital in special machinery for a given product. If the home market is lost to imported articles through lower cost of manufacture elsewhere on account of lower labor standards there prevailing, the home industry fails. Compensatory tariff duties are needed to equalize unusual labor conditions existing at home and abroad and so help to maintain existing industries during the Peace Emergency.

No less important is legislation to restrict immigration. The desire to leave tax-ridden Europe will be acute. There should be a rigid statistical limit set to such immigration, preferably not more than one per cent. of our population annually. The fallacy of altruism running wild is as mischievous as the pacifistic fallacy of non-resistance. Much damage may be done by some of the plans of amateur Santa Clauses in scattering too generously the money of investors and taxpayers to the four quarters of the globe—all the time actuated by the purest of motives.

No longer need economists hesitate to criticize the ex-cathedra economic pronunciamentos of some of our banking and financial oracles, if indeed economists have ever been timid in so doing. Have we not seen how most eminent financiers whose experience after all represented two or three decades of peace in an orderly country have proven themselves hopelessly fallible in the midst of the quicksands of conflicting international and racial forces. As illustration, when conservative bankers recommended to American investors shortly before the passing of the czar Russian securities yielding upwards of 20 per cent., were they justified in disseminating such ill-advised recommendations? What could have been the status of their information? Was it conservative to recommend such investments as safe? If the defense is a national emergency, was it on this hypothesis either patriotic or conservative to practise usury on a needy ally? Let us be chary in regard to too much international financing. It is sound economic policy to finance the United States first.

The rapid utilization of great new inventions not yet in the widest use, such as electrical power, the automobile, the tractor, specialized small machinery for small units,—many phases requiring heavy investment—deserve encouragement through enabling legislation, bringing safeguarded credit within the reach of greater numbers. The feasibility of the government issuing peace bonds for productive improvements under safeguards may in some cases prove promising. At any rate to introduce bonds widely, it may prove highly advantageous for the United States Government to issue small denomination bonds of fifty dollars paying as much as 6 per cent. so long only as held by the original purchaser and on selling dropping to 4 per cent. or to the prevailing rate for the negotiable issues, the amount to a single owner limited to a few hundred dollars. Unusually wide distribution of such a sound investment would educate an ever-increasing investing public and make mightily for social solidarity. In addition, bonds with the higher interest as above outlined would tend to stay sold instead of coming back on the market and would probably exert a far less influence in the direction of inflation of prices. The pioneer purchaser of a bond who buys to hold is entitled to a higher yield than the buyer who immediately resells.

Let us test all economic remedies in the light of sound fundamental principles. The time limit of war requires the yielding of many rights. Everything is staked on centralized action. Tremendous waste becomes an incident in the presence of overwhelming danger. But, progress comes through multiple initiative and the elimination of waste; needs above all freedom, leisure, all individual rights; and in times of peace, the test for every legislative measure should disclose that the proposed legislation enables individuals in private business to go ahead with the given problem and does not create governmental machinery for doing it. Let us recognize that war leaves behind a host of paternalistic offspring and the sooner that these are destroyed the better it will be for the people of this nation.

NERVOUS AND OTHER FORMS OF PROTOPLASMIC TRANSMISSION. II

By Professor RALPH S. LILLIE

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TRANSMISSION-PHENOMENA of a closely similar kind have in fact long been known in certain definitely constituted inorganic systems which, superficially considered, appear to have little in common with living tissues, namely, combinations of metals with electrolyte solutions. Many metals in contact with aqueous solutions of salts and other electrolytes readily undergo local chemical change which is accompanied and conditioned by the flow of electricity between the reacting regions of the metallic surface. The rusting of iron in water or salt-solution is a familiar example of this type of process. Such processes depend ultimately upon certain widely general conditions which have their seat at the surface of contact between metal and solution, and which are common, broadly speaking, to all surfaces of contact between chemically dissimilar liquids and solids. These conditions are present at the boundary between the living cell and its medium, as well as at the boundary between an oil droplet or colloidal particle and its suspension-fluid, or between a metallic surface and the adjoining solution, and their essential nature may be thus briefly defined. On account of the different relations which the ions present in either phase, or formed by reaction at the boundary, have to the two adjoining phases, there is usually a difference of electrical potential across the boundary. Potentials of this kind (interfacial potentials) indicate a tendency to spontaneous chemical change in the substances at the boundary, and if such changes occur they may give rise under certain conditions to electric currents which secondarily may form the condition of further chemical change either in the same or in adjoining systems. These conditions are exemplified in a typical manner in the phenomena of electrolysis, familiar wherever an electric current passes between a metal and a solution. A battery in which chemical and electrical change proceeds spontaneously (when the circuit is closed) will cause chemical decompositions or other reactions (including syntheses under certain conditions) in an otherwise inactive solution into which its electrodes dip. These electrically induced reactions take place at the surface of the electrodes, within the thin layer of material, presumably one molecule in thickness, where electricity passes between the two phases; *i. e.*, they are distinctively *surface phenomena;* and strict numerical proportion, defined by Faraday's law, exists between the quantity of electricity thus traversing the surface and the quantity of material chemically transformed. The degree of the interfacial potential-difference and the quantity of current passing the unit surface in unit time determine the nature and the rate of the chemical transformation.

Now there is no reason to limit phenomena of this kind to metallic surfaces. In consequence, however, of certain peculiarities of the metallic state, the potentials at metallic surfaces are usually much greater than at non-metallic surfaces, such (*e. g.*) as the surfaces of colloidal particles or living cells; moreover metals are the best conductors of electricity. Hence metals in contact with solutions can readily be made the source of electrical currents, and advantage is taken of this peculiarity in the construction of batteries. For example, in the Daniell cell, where zinc in dilute $ZnSO_4$ solution is connected with copper in concentrated $CuSO_4$ solution, the zinc surface readily gives off Zn^{++} ions which carry positive electricity to the adjoining solution, while the copper surface receives Cu^{++} ions which lose their positive charges and are deposited as metallic copper. And since under these conditions the tendency for zinc to ionize and pass into solution, and for copper to deionize and deposit as metal are both strong, a current with a considerable driving force or potential (*ca.* 1 volt) flows through the solution from zinc to copper when the circuit is closed. The Daniell cell is one typical example of the means by which chemical energy may be transformed into electrical energy through the intermediary of metallic conductors and solutions of electrolytes. The conditions under which this transformation takes place admit of infinite diversity in detail; but certain general features of constitution and arrangement are common to all such systems. There are always two reacting surfaces connected by conductors in such a manner that a circular flow of electricity is possible. At one surface (anode) positive electricity enters the solution from the metal; here the chemical changes in the solution are in general *oxidative* in character; at the other surface (cathode) the positive stream re-enters the metal and the chemical changes are of a *reducing* kind. Oxidations may themselves readily be made to produce electric currents; if two substances, one of which oxidizes (*i. e.*, is reduced by) the other, are dissolved in separate vessels connected by a bridge of salt solution, and the two solutions are placed in metallic connection through platinum electrodes, the one substance oxidizes the other just as if the two were in contact. This is an example of what is known as "chemical distance-action," and depends, as in other cases of electrolysis, on the passage of electricity between solution and electrode; positive electricity passes from the one electrode (anode) to the oxidizable substance and to the other electrode (cathode) *from* the reducible (or oxidizing) substance. Conversely an external current conducted by platinum electrodes through a solution containing oxidizable and reducible substances will effect oxidations at the anode and reductions at the cathode. Oxidation thus implies *gain,* and reduction *loss* of positive charges by the substances undergoing chemical change; and this general fact is one of the clearest indications of the intimate dependence of chemical upon electrical change. Intermolecular transfers of electricity (*i. e.,* of electrons) apparently take place in all chemical reactions; but it is only when the materials are so arranged as to permit of the formation of electrical circuits, in which the specifically electrical phenomena can be isolated and observed separately, that direct evidence of this transfer is seen.

These brief references to the fundamentals of electrochemistry seem necessary in order to make clear some of the conditions of chemical change under the influence of surfaces other than metallic, especially the surfaces of living cells. It is first to be noted that electrical circuits may readily arise between different portions of a *continuous* metallic surface immersed in a solution; *i. e.,* it is not necessary that the two regions acting as electrodes should be separate pieces of metal connected by a wire which passes outside the solution. Such circuits are known as "local circuits," and the processes of chemical change or electrolysis associated with them are often spoken of as "local action." The rusting of iron in an aqueous solution is an example of such local action. Similarly local circuits may arise between different parts of a living cell or nerve fiber; thus an active region is always negative (in the galvanometric sense) to an adjoining resting region. The presence of local areas of different potential at the surface of a piece of iron in contact with an electrolyte solution can readily be detected by both chemical and electrical means. At the anodal regions, where the iron cations enter solution, they may combine with whatever anions are present, *e. g.,* in ordinary water they interact with carbonate or hydroxyl ions to form rust, while the cathodal areas remain bright. A rust spot once formed tends to *spread*, because it forms itself a local cathode and hence induces reaction in the adjoining unrusted region which acts as the anode of the local couple. And similarly we may infer that at the surface of the living cell a local surface-oxidation, involving entrance of positive charges into the cell from the solution, may take place if simultaneously at another area of the cell-surface positive electricity is free to leave the cell or negative to enter. A local electrical circuit or bioelectric circuit would thus be formed; such circuits, as well known, are associated with all forms of physiological activity. The chemical and other effects of the local bioelectric circuit also tend to spread or to be transmitted to adjoining regions, as we have seen.[14]

The normal bioelectric circuits must be regarded from the same general point of view as the local circuits at metallic surfaces. They are apparently the expression of local chemical action which is associated with the passage of electricity between the cell-surface and the adjoining solution. Perhaps the simplest way of conceiving the situation is to regard the protoplasm as forming one, and the medium (lymph or physiological salt-solution) the other, of two adjoining phases; each of these is a good conductor of electricity and can furnish ions to the other phase. The general resemblance to the case of a metal in contact with an electrolyte solution is evident. Whenever the protoplasmic surface-layer exhibits at two different areas unequal tendencies to combine chemically with substances present in the adjoining medium or in the internal protoplasm, or unequal power of transmitting or combining with ions present in either protoplasm or medium, the conditions for an electric circuit are present. In other words, if the protoplasmic surface-film and its adjoining medium are *homogeneous* chemically and physically there will be no potential-differences between different areas and no bioelectric circuits, just as a homogenous metallic surface in a homogeneous solution exhibits no local circuits. But, if the protoplasmic surface is locally altered, *e. g.*, by a mechanical impact or some local chemical action, a local electrical circuit is formed; and the associated electrochemical effects of this circuit may be the direct or indirect means of profoundly altering the whole cell-activity. This, expressed in a very general way, appears to be the essential condition of the characteristic "irritability" of living protoplasm. The composition and hence the electromotor proper-

[14] In two recent papers in *Amer. Journ. Physiol.*, 1915, Vol. 37, p. 348, and 1916, Vol. 41, p. 126, I have discussed this parallel in greater detail.

ties of the protoplasmic surface-films are altered with a readiness which in many cases is extreme; the local electrical effects thus resulting induce chemical effects, by a process essentially identical with electrolysis, these effects are transmitted as already described, and a widespread disturbance of equilibrium may result, followed by some characteristic alteration of cell-activity. The sensitivity of protoplasm to outside influences appears to depend mainly upon the delicate and complex conditions of equilibrium, chemical and physical (including colloidal), existing in the complexly organized surface-film; for this reason the local composition and physical properties (*e. g.*, permeability) of the cell-surface are very readily altered, and local circuits arise. Here again there is a striking parallel with the conditions in metals; local circuits may be formed at many metallic surfaces under conditions similar to those causing stimulation in living cells; mechanical action (scratching, pressure, bending), light (photoelectric effects), change of temperature (thermoelectric effects), as well as direct chemical alteration or local changes in the concentration of the solution in contact with the metal (concentration-cell effects[15]), may all produce local circuits with associated chemical changes.

According to the foregoing theory of protoplasmic transmission, the current of the local bioelectric circuit which arises between the active and the adjacent inactive regions of the irritable element as the result of some local stimulus, affects the latter region in such a manner as to render it also active. A similar circuit then arises between this new region of activity and the inactive region beyond, and the latter is activated in its turn, and by a repetition of this process the state of activity is transmitted over the whole surface of the cell. It is evident that the current of any bioelectric circuit is partly intracellular and partly extracellular. The present theory implies that this current (positive stream) where it leaves the cell-surface to enter the medium, induces in the protoplasmic surface-film, by a process of which the first step is an electrolysis, a change of structure or composition which alters in a definite and constant manner the electromotor properties of that region of the surface, and hence gives rise to a new local circuit between it and the unaltered region beyond. The direction of the bioelectric current resulting from stimulation shows that the cell-surface during activity has characteristic electromotor proper-

[15] Osmotic stimulation in living cells may be directly due in many cases to such "concentration-cell" effects, rather than to the abstraction of water; in general the latent period of stimulation seems too short for the latter type of effect.

ties which are different from those which it has during rest; it is more *negative* (in the galvanometric sense), *i. e.*, the positive stream enters the cell at the active region; and this negative condition is induced locally, along with excitation, wherever a sufficiently intense current passes from the cell-surface to the outside. It has long been known that the electric current causes stimulation where it *leaves* the cell-surface, *i. e.*, at the cathode of a pair of stimulating electrodes. It is a matter of indifference, so far as the physiological effect produced is concerned, whether the stimulating current is derived from an outside source or is generated by processes within the cell itself. In the latter case, which is the case of normal transmission, the active and the inactive regions of the cell-surface represent, respectively, the two electrode areas (analogous to the local anode and cathode of the local metallic circuit) of the bioelectric circuit. The fact that stimulation is characteristically a polar process is thus explained; chemical processes of opposite nature take place where the current *enters* and where it *leaves* the cell surface. We should expect, therefore, that if we could obtain metallic surfaces covered by a thin surface-film, *e. g.*, of oxide, which is readily removed or altered by the processes of electrolysis associated with local circuits, such surfaces would exhibit chemical transmission-phenomena of a kind essentially similar to those observed in living cells.

Phenomena of this kind have in fact long been known, although their fundamental resemblance to the phenomena of protoplasmic transmission has only recently been recognized. For example, in the well-known rhythmical catalytic decomposition of hydrogen peroxide in contact with mercury, the rhythm of chemical activity is directly dependent upon the alternate formation and dissolution of a surface-film of oxidation-product ("peroxidate") which is formed by the interaction of the peroxide with the metal. This film is readily reduced electrolytically to metallic mercury at the cathode of the local circuit which is formed wherever the film is broken through so as to expose the unaltered mercury beneath; in this local electrolysis oxygen is liberated and the free mercury surface is reformed. When carefully purified mercury is used, and the concentration and reaction (H-ion conc.) of the peroxide solution are properly adjusted, the film becomes very sensitive to the action of such local circuits; a local rupture then initiates a reaction which is rapidly transmitted over the whole surface, causing progressive dissolution of the whole film. The latter is then reformed and the process is repeated in regular rhythm. Bredig and Antropoff have shown that the decomposition is most active near the boundary between the free and the film-covered mercury surface, *i. e.*, where the local current is most intense, and that the dissolution of the film takes place at the local cathode.[16] When the film reforms, the change of surface-tension, due to the altered electrical polarization, alters the shape of the surface and causes automatically a local rupture; a local circuit is thus formed and the reaction is again initiated and spreads because of the electrolytic effects at the margin, as just described. The wave of decomposition passing over the surface is associated with a variation of potential which may be registered with a string galvanometer; records thus obtained suggest electrocardiograms in the regularity of the rhythm and other features; the rate of this rhythm, like that of the physiological rhythms, may be modified by changes in the temperature or in the composition (*e. g.*, H-ion) of the solution. The potential-difference between the free and the film-covered portions of the surface is *ca.* 0.12 volt, the latter region being cathodal.

The whole process exhibits many striking biological analogies, which undoubtedly depend upon a close similarity in the fundamental physico-chemical conditions under which the chemical reactions take place in living systems and in non-living systems of this type. Reactions taking place at metallic surfaces appear to have a general tendency to fluctuations of tempo, often rhythmical in character; this is observed (*e. g.*) in the solution of many metals in nitric acid, and seems to be due essentially to the alternating formation and dissolution of resistant or polarizing surface-films of oxide or other material. Transmission-processes of the kind just described, associated with local electrical circuits and electrolysis, invariably form part of these phenomena. An especially striking instance of such transmission may readily be demonstrated in iron wires which have been exposed to strong nitric acid or other suitable oxidizing agent, so as to bring the metal into the peculiar temporarily non-reactive state known as *passivity.* When such a passive wire is placed in dilute nitric acid it remains unaltered as long as it is undisturbed; but if it be touched with a piece of normal or "active" iron a wave of chemical activity instantly sweeps over the whole wire, active effervescence and solution begin, and—if the acid is not strong enough to re-

[16] Cf. Bredig and Weinmayr, *Zeitschr. Physik. Chemie*, 1903, Vol. 42, p. 601; Antropoff, *ibid.*, 1908, Vol. 62, p. 513; Bredig and Wilke, *Biochem. Zeitschr.*, 1908, Vol. 11, p. 67.

passivate the metal—the reaction continues until the whole wire is dissolved. This "activation" of passive iron resembles the stimulation of living irritable cells in a number of essential respects;[17] it can be induced *mechanically, e. g.*, by bending or scratching the wire, or *chemically, e. g.*, by reducing substances, or *electrically, e. g.*, by making the wire, while immersed in the acid, the cathode in an electrical circuit of sufficient intensity. This last experiment is especially interesting since it shows clearly the polar character of the electrical activation-process. In order to activate passive iron electrically the metal must be made the *cathode;* if it is made the anode, not only is there no sign of activation, but the wire is rendered more than normally resistant to other forms of activation, *e. g.*, mechanical. In other words, the anodal influence is of a *passivating* instead of an activating nature, and in fact an active wire may readily be passivated by making it the anode in a circuit of sufficient intensity. The whole behavior of the metal reminds one irresistibly of the behavior of irritable tissues like nerve, which are stimulated and rendered more irritable at the cathode of a current led into the tissue from a battery, and inhibited and rendered less irritable at the anode (electrotonus).

In the case of the wire the explanation is essentially simple. When the wire is made cathode the protective surface-film of oxide, to which the passive condition is due, is altered or removed by electrolytic reduction, and the metal is then free to dissolve in the acid; while when the wire is made anode, surface-oxidation and the formation of the passivating surface-film are promoted. The other activating agents also produce their effects by electrical means. A mechanical influence like scratching breaks the film and exposes the normal or active iron beneath, thus forming a local circuit in which the exposed or active area is the anode and the adjoining or film-covered area the cathode. The latter region is at once electrically activated, *i. e.*, it becomes anodal in its turn, and by the automatic repetition of the same process at further regions the state of activity is propagated over the whole surface. Similarly a reducing substance activates by locally removing the oxide coating, thus forming a local circuit. Contact of active iron or a base metal like zinc activates for a similar reason, by the formation of a local circuit at the region of contact, in which the passive iron is cathode. Contact of a nobler metal like platinum not only

[17] For a more complete description and discussion of this parallel, cf. my recent article, "Transmission of Activation in Passive Metals as a Model of the Protoplasmic or Nervous Type of Transmission," *Science*, N.S., Vol. 48, p. 51.

fails to activate passive iron, but it prevents or inhibits activation in the neighborhood of the contact, and in fact will induce passivation in an active wire; the reason for this difference of effect is that the noble metal forms the cathode when in contact with either active or passive iron; the latter, being then anodal, is subjected to a passivating instead of an activating influence. Platinum will in fact readily passivate active iron by simple contact. If a piece of platinum is pressed tightly against an iron wire which is undergoing active effervescence and solution in dilute nitric acid, within a few seconds the reaction is seen gradually to subside, at first near the region of contact and then farther away, until by degrees the whole wire becomes inactive. On examination it is then found to be passive. This is a case of the transmission of a passivating instead of an activating influence, and as such has also interesting biological analogies.

Both passivation and activation in metals are thus dependent on *electrical* influences, which tend automatically to be transmitted from place to place over the surface because of the electrochemical effects at the boundary between the active and passive areas. Without this transmission, activation of the passive wire as a whole by local contact or mechanical change would be impossible, just as stimulation of the whole cell or nerve fiber without transmission of the excitation-state would be impossible. The lack of graded response in certain cellular elements like heart-muscle cells or nerve fibers, which exhibit the so-called "all-or-none" type of behavior, depends upon this propensity of the local disturbance to be propagated and to involve the whole cell; and it is interesting to note that the same peculiarity is exhibited by passive iron wires in nitric acid. Either the wire is not activated at all by a mechanical shock or a brief touch with another metal, or it is activated *completely*. Once the local reaction is started it tends inevitably to spread over the whole surface. The rapidity of this spread in an iron wire immersed in nitric acid may be very great; the main reason for this high speed is the low electrical resistance of the local circuit under such conditions, combined with the existence of a very considerable potential difference between active and passive iron, equal to *ca.* 0.7 volt; hence the local current is intense and rapidly removes the protective surface-film, so that under favorable conditions the transmission takes place at a velocity of several hundred centimeters per second. This speed is comparable with that of the most rapid forms of protoplasmic transmission.

Another feature in which the propagation of the active state in passive iron resembles protoplasmic transmission is the automatically self-limiting character exhibited by the local reaction under certain conditions. When a nerve is stimulated locally that region responds and transmits its state of activity to the adjoining region, and then immediately returns to the resting state. In other words, the local change of state is temporary and is rapidly reversed; this explains why a *wave* of activity appears to pass over the tissue. In a normal nerve the local variation of electrical potential—the index of the local disturbance accompanying the passage of the impulse—rises rapidly to a maximum and then immediately subsides; in the frog's sciatic this curve of electrical variation is nearly symmetrical and lasts *ca.* .002 second, an interval representing the total time occupied by the stimulation-process at any one region. Since the tissue at once returns automatically to rest when stimulation ceases, repeated stimulation is required to maintain its activity. Apparently the local process *itself* originates conditions which check or inhibit activity in the same region, *i. e.*, the activity is *self-limiting* as well as self-propagating. This appears to be the essential reason why nervous and other protoplasmic activities are typically not continuous, but rhythmical or alternating in their character; something analogous to a "cut-off" mechanism seems inherent in the local stimulation-process. Now the case of passive iron is especially interesting and instructive because under certain conditions it exhibits just this type of automatically self-limiting local reaction. In sufficiently strong nitric acid (of s. g. 1.25 or higher) the passive wire, when activated by any means, exhibits a temporary wave of activity which is rapidly transmitted over the whole wire; the local reaction ceases spontaneously, after an interval varying from a few seconds to a small fraction of a second (becoming rapidly briefer as the strength of the acid increases), and the metal becomes again permanently passive; after an interval it may be again activated and the same process is repeated. A further interesting resemblance to the conditions in irritable tissues is that after the metal has returned to the passive condition, a certain time always elapses before it can be again completely reactivated; immediately after the reaction has ceased the iron wire gives only a slight and local response to the contact of an activating metal like zinc; in other words, the iron is temporarily *refractory* to activation; but within a short time and by progressive degrees it recovers its former sensitivity and transmits activation as before. As is well known to physiologists, irritable living tissues like nerve and muscle exhibit a similar insensitive or so-called "refractory" period immediately after stimulation; this refractory state varies in its duration and degree in different tissues, being brief in nerve and voluntary muscle and relatively prolonged in "slow" tissues like heart muscle. Recovery of the sensitive condition after activation thus requires time, in both the metal and the living tissues; apparently in both cases some process of reconstitution takes place in the surface-layer during the interval.

In passive iron the spontaneous repassivation in strong acid depends largely upon electrical conditions of the same kind as those determining the transmission of activity; in brief, the self-limiting and passivating effect is also due to the current of the local circuit formed at the active-passive boundary, but takes place at the *anode* of this circuit, while the activation which determines transmission takes place at the cathode, as we have seen. In the local circuit arising at the boundary between the passive and active areas of the wire the passive region is cathodal, the active region anodal. Now, just as the activating influence at the cathodal region determines the transmission of activity to that region, so the passivating influence at the local anode tends to bring the reaction in this region to a rest and induce passivity. A curious situation thus arises wherever the activation-wave passes. The very process of activation itself, by rendering the newly active region anodal, brings into existence conditions which arrest the local activity and cause repassivation. This explains why there is only a temporary local reaction in acid of sufficient strength; the influence of the local current, added to that of the acid itself,[18] immediately repassivates the active region. Hence the local reaction is at once self-propagating and self-limiting, and activation travels as a wave along the wire, the local process being temporary and quickly reversed.

With regard to the refractory period immediately following repassivation, only a hypothetical explanation is possible at present, but it may be assumed that the newly formed passivating surface-film has not the consistency, thickness or other properties necessary for its rapid and complete alteration or removal by the local electrolysis; a certain time is therefore required for the recovery of the peculiar equilibrium on which this sensitive condition depends. Analogous considerations

[18] In weak nitric acid (s.g. 1.20 or less) there is no spontaneous passivation; the concentration of the acid must exceed a certain minimum for this to take place. But if any local region is rendered more than normally anodal by the adjacent contact of a noble metal, *e.g.* platinum, passivation will take place even in the weak acid and will spread to other regions of the iron wire, as already described.

apply in the case of an irritable tissue; the protoplasmic surface-film must be reconstructed in order to reacquire its former properties.

If, as we assume, the activation-process in the inorganic model is similar in its general determining features to the stimulation-process in the living tissue, we must conclude that in a nerve or similar conducting element the current of the local active-inactive circuit, at the same time as it activates the adjoining resting region, also cuts short activity at the active region itself and causes there a return to the resting state. We have seen that activation in metals depends upon the alteration of a continuous surface-film of peculiar composition (an oxide or oxidation-product not yet clearly defined), which, when present, prevents the interaction between the solution and the metal; its removal, which is readily effected by electrolysis at the local circuit formed wherever the continuity of the film is interrupted, enables interaction to take place. Now in living irritable tissues there is also definite evidence that stimulation is associated with a temporary alteration, structural and chemical, of the protoplasmic surface-film or "plasma-membrane," involving an increase of permeability. In the normal resting condition of the cell this membrane is semi-permeable, *i. e.*, the cell-surface behaves as if impermeable to diffusing water-soluble substances like sugar and neutral salts although permeable to water; during stimulation there is evidence that this semipermeability disappears temporarily, and that such substances then enter and leave the cell with greater readiness. The change in the electromotor properties of the cell-surface (negative variation) during stimulation is similar in direction and degree to that accompanying any marked increase in permeability, such as that resulting from injury, death, or the action of a cytolytic substance.[19] A local increase of permeability will therefore give rise to a local circuit whose current, if sufficiently intense, will cause stimulation, just as the local interruption of the passivating surface-film in iron causes activation. If this is a true conception of the stimulation-process in living tissues, it follows that the current of the local bioelectric circuit must affect the properties of the protoplasmic surface-film in a definite and constant manner through some process of local electrolysis. Where the current stimulates, *i. e.*, where the positive stream leaves the cell-surface, it induces increase of permeability; where it

[19] Cf. *Amer. Jour. Physiol.*, 1915, Vol. 37, pp. 357 seq., for a fuller reference to these phenomena, and a comparison with "local circuit" effects in metals; also *ibid.*, 1916, Vol. 41, p. 126.

arrests activity—*i. e.*, where it re-enters the surface from the medium—it restores (or is an essential factor in restoring) the resting condition of semi-permeability. It would thus appear that in typical protoplasmic transmission, as in nerve, processes of opposite kind take place in front of and behind the activation wave as it advances; beyond the wave-front, where the local current passes from cell to medium (see Fig. 1), the effect of the current is to increase the permeability (by inducing some unknown chemical or metabolic change in the surface-film); while behind the wave-front, where the current passes from medium to cell, it restores the altered surface-film to the original or "resting" condition. We see here again the characteristic physiological *polar* action of the electric current. At the two regions of the cell-surface, corresponding respectively to the anodal and cathodal regions of the metallic model, processes of chemically opposite kind are induced; hence the dependent physiological effects at the two regions are also opposite. Apparently the restoration of the surface-film is rapid in some tissues (*e. g.*, nerve) and gradual in others (*e. g.*, heart muscle); to this difference corresponds the difference in the duration of the refractory period. It is also interesting to note that the process of recovery or reconstitution takes place where the positive stream *enters* the cell-surface from outside; from general electrochemical analogies we should infer that oxidation-processes take place here, probably connected with synthesis. In general, oxidations appear to be essential to the processes of recovery in protoplasm,—*e. g.*, from fatigue, anesthesia or injury.

If we assume that the physico-chemical conditions at the cell-surface are similar, in the general manner indicated above, to those at metallic surfaces, the sensitivity, *i. e.*, chemical reactivity, of living protoplasm and its power of transmitting physiological influence lose much of their mysterious character and become in a measure intelligible. Oxidation at one region of the cell-surface, simultaneously with reduction at another region—as in the various oxidation-reduction elements of electrochemistry—may well be the condition of many metabolic processes. It should be noted that any such local surface-oxidation, implying entrance of the positive stream into the cell at that region, need not necessarily be associated with permanent chemical change (*e. g.*, reduction) at another region, since at the latter region the surface-film may conceivably act as a non-polarizable partition, giving off ions on the one face and receiving them on the other (like, *e. g.*, a zinc plate partitioning a $ZnSO_4$ solution interposed in a circuit). The cell-surface appears to act as a reversible electrode relatively to cations, as Macdonald's work, together with that of Loeb and Beutner, clearly indicates,[20] and this peculiarity may be an important factor in permitting the ready formation of bioelectric circuits wherever the cell-surface is locally altered.

The existence of electrical currents between regions of unequal physiological activity in living tissues has been known since the time of Volta and Galvani, and varied and extensive observational data exist in this field. It seems that we are now also in a position to construct a consistent general theory of these phenomena. The bioelectric currents are the expression of local inequalities of electrical potential, which are themselves dependent upon local inequalities of chemical action at different regions of the cell-surface; these currents are therefore an index of chemical change in the protoplasm, *i. e.*, of metabolism,—especially of surface-metabolism. Conceivably almost any kind of chemical or physical alteration of the surface-film may alter its electromotor properties and give rise to local circuits. These circuits having once arisen, secondarily affect chemical processes at other regions traversed by the current-lines; this will take place wherever the local intensity and current-density are sufficient. Similarly, the passage of an electric current from outside through the living tissue or cell will produce changes of the same kind in the living substance. It is well known that entirely normal physiological effects may result from artificial electrical stimulation; the reason for this appears to be simply that the passage of electric currents across the cell-surfaces is a normal and constant condition of vital processes in general. In other words, electrical stimulation is a physiologically normal process, hence the physiological effects produced by artificial electric currents are normal. Such currents are produced in the normal activity of the cell, and once having arisen, they themselves furnish the necessary conditions for other physiological activities. This is particularly true of the phenomena of transmission, the special process under consideration in this article.

We have seen that chemical "distance-action" is characteristic of chemical reactions taking place in solutions in contact with metallic surfaces. Distance-action is also characteristic of the chemical processes in living organisms. Oxidation at one area of a platinum surface immersed in an electrolyte solution will induce reductions at other areas if reducible sub-

[20] J. S. Macdonald, *Proc. Roy. Soc.*, 1900, Vol. 67, p. 310; Loeb and Beutner, *Biochem. Zeitschr.*, 1912, Vol. 41, p. 1, and later papers in the same journal.

stances are there present. The transmission of this influence is instantaneous, since it depends upon the production of electrical circuits associated with chemical change (electrolysis) at the regions where electricity passes between the metal and the solution. In the case of surfaces like those of living cells or nerve fibers, which resemble metallic surfaces in their fundamental electromotor properties, we may assume that similar condition exist, differing in degree but not in kind. This is the general type of process under which we have included above, as special cases of a peculiar kind, the various forms of protoplasmic transmission. The propagation of physiological influence appears in fact inevitable wherever the cell is sensitive to electrical stimulation; and the degree and rate of this transmission are limited only by the electrical sensitivity of the cell and the rate at which the bioelectric change develops. In the case of metallic surfaces it may readily be shown by a very simple experiment that the electrical circuits produced by local action will influence chemical processes at adjoining regions of the surface up to a distance of several centimeters beyond the region immediately affected.[21] A piece of iron wire placed in a solution of potassium ferricyanide (2–4 per cent.) in dilute gelatine-solution or egg-white (which favors structure-formation by acting as protective colloid) will quickly form slender blue filaments of ferrous ferricyanide at all points of the surface. If now another similar piece of wire, attached at one end to a small piece of zinc or other base metal, be placed in the same solution, the formation of filaments is found to be suppressed or retarded for a distance of five to ten centimeters (the effect decreasing with the distance) from the region of contact. In the local couple which is formed the zinc is anode and the iron cathode; the liberation of ions from the iron is thus hindered and the reaction prevented. Or, conversely, the contact of copper or platinum will hasten the formation of filaments for a similar distance from the region of contact. Similar experiments may be performed with other metals (zinc, cadmium, cobalt, nickel) which form insoluble ferricyanides. An experiment of this kind may be regarded as a simplified model illustrating in an elementary manner the means by which physiological influence may be transmitted from region to region of the cell-surface. As already pointed out, it is essential to the present theory of protoplasmic transmission that the local excitation-process in (*e. g.*) a frog's motor nerve should instantly induce excitation of the adjoining resting regions to

[21] Cf. *Biological Bulletin*, 1917, Vol. 33, p. 135, for a full account of these phenomena, with a discussion of their biological parallels.

a distance of about three centimeters from the active region. The potentials are smaller and the resistances greater in the bioelectric circuits than in those formed in the above metallic models, but in other respects the conditions are closely comparable.

In conclusion it may be again pointed out that the curious reciprocality of many physiological processes—a peculiarity probably connected with the tendency to rhythmical or alternating activity so frequent in organisms—in itself suggests a general explanation of this kind. Processes of growth, excitation, or metabolic activity at one region are often associated with prevention or inhibition of these processes at adjoining regions; the central nervous system is not the only living structure exhibiting this phenomenon of "reciprocal inhibition," although it is clearest here.[22] We must note the fact, which I believe is more than a coincidence, that a similar chemical reciprocality obtains between the two electrode areas of any electrical circuit dependent on chemical action. Oxidation at the one area involves reduction at the other area; similarly in living organisms, excitation at one region conditions the inverse process of inhibition at another region. Obviously these physiological processes have their underlying and determining chemical reactions. If these are in large part electrically controlled, the physiological reciprocality becomes at once intelligible; the essential chemical or metabolic processes are oppositely affected at the two regions corresponding to the electrode areas of the circuit. Activities controlled by such means may *alternate* but cannot take place simultaneously. Where we find, as we do in organisms, this reciprocality of control associated with the transmission of physiological or chemical influence to a distance, it is natural to ask the question if the essential determining conditions of the vital process are not of the same fundamental nature as those of the non-vital process which shows similar general peculiarities. Apparently in the transmission of excitation from region to region in an irritable cell or nerve fiber we have merely one instance of the control of physiological processes by means of the bioelectric currents produced in activity. The characteristic electrical sensitivity of living matter seems in itself to be an indication that the chief normal or physiological means of controlling and correlating cell-processes are electrical. A fundamental problem of general physiology is therefore to determine more definitely the physico-chemical basis of this electrical sensitivity.

[22] The phenomena of simultaneous contrast in vision form apparently another example of this influence. The processes in adjoining retinal areas affect one another reciprocally and the effect is greatest near the boundary of the two areas.

Rosa, Reid, Van Vleck, Stieglitz, Hall, Russell, Aitken, Walcott, Birkhoff, Benedict, Millikan, Webster, Boas, Jewett, A. A. Noyes, Mendel, Ames, Bumstead, Jennings, Lusk, Cattell, Pearl, C. H. Merriam, Morgan, Forbes, Ransome

THE PROGRESS OF SCIENCE

SCIENTIFIC MEETINGS AND THE NATIONAL ACADEMY OF SCIENCES

THE principal scientific meetings of the year are those held in Convocation Week under the auspices of the American Association for the Advancement of Science, when in New Year's week some thirty to forty national scientific societies meet each year in a different city with programs often containing more than a thousand papers. The chemists now hold their meetings in the spring and autumn and owing to the industrial applications of their science they are by far the largest group, the American Chemical Society having more than 12,000 members. The April meeting in Buffalo was able to demonstrate the great part chemists played during the war and the boundless importance of their work for the industrial future of the nation. Several societies devoted to the biological sciences had, owing to war conditions, postponed their meetings from Christmas to Easter, the anatomists convening in Pittsburgh and the physiologists and related groups in Baltimore.

Two scientific meetings of special significance held annually in the spring are those of the National Academy of Sciences and of the American Philosophical Society. The latter has its seat in Philadelphia, but was established by Franklin to be a national society on the lines of the Royal Society, as the Academy of Arts and Sciences was established in Boston with similar objects by Adams on the lines of the Paris Academy of Sciences. Both of these societies became local in character, but in recent years the American Philosophical Society has held an annual meeting with a program that is admirably arranged for a general audience of scientific men. The speakers are nearly always men of distinction who are invited to present reports on new work and timely subjects. The historic hall on Independence Square and the modern dinners at the Bellevue-Stratford are also pleasant for the elect.

The National Academy of Sciences, which holds its annual meeting in Washington in the last week of April, was organized during the Civil War to advise the government on scientific questions. In the present war it has been active through the National Research Council and the meeting this year was of interest in showing the service of these bodies to the nation in time of war and their plans of organization for the future.

The two addresses that attracted most attention were, however, on subjects remote from the war and from any obvious practical application. The William Ellery Hale Lectures, given by Professor James H. Breasted, of the University of Chicago, were an important survey of the origin of civilization, which we hope to have the privilege of printing in this journal. Dr. Irving Langmuir, of the General Electric Company, repeated the address which he gave twice before the chemists earlier in the month, containing ingenious hypotheses on the structure of atoms. These addresses might lead to the inquiry why a student of Mexican archeology is eligible to membership in the academy, but not a student of Egyptian archeology; why a metaphysician who calls himself a chemist is eligible, but not one who calls himself a student of philosophy.

H. S. White T. B. Osborne Dall Davenport Day Mayor H. F. Osborn Cannon Leuschner Hale Schlesinger

We are able to reproduce photographs, taken by Schutz of Washington, of the members of the academy on the steps of the United States National Museum.

THE ORIGIN OF CIVILIZATION

PROFESSOR BREASTED in his first lecture before the National Academy followed the long development which lies behind the pyramids of Egypt and leads up to them. They mark the culmination of a civilization advancing so rapidly that the thirtieth century B.C. saw a greater development of man's control over the forces of nature than any other century in human history, except the nineteenth century of our own era.

In his second lecture Professor Breasted said that the cemetery of Gizeh, especially the Great Pyramid, is the earliest and most impressive surviving witness to the final emergence of highly organized and efficient government, of which it is the product. Yet the great grandfathers of the men who built the Great Pyramid laid the first examples of stone masonry. We find it difficult to understand the rapidity of an advance in government, organization, mechanics, engineering and craftsmanship, which could lay out this vast building, covering thirteen acres, with an accuracy involving an error in the length of the sides of less than twelve-thousandth of the length of the side (755 feet), and error of 6/100 of a foot. Neither can we comprehend an efficiency in administration, which could quarry out, transport and lay in position, 2,300,000 blocks of limestone each weighing about two and a half tons. This pyramid, continued Professor Breasted, is the greatest building and engineering feat ever achieved by ancient man, and it was constructed at the outset of his historic career.

Professor Breasted then pointed out that later an amazingly refined pre-Greek civilization arose in the Ægean Islands, especially in Crete, as revealed by the excavations of Sir Arthur Evans and others. After 1500 B.C. the barbarian Greek shepherds who had been migrating southward through the Balkans for centuries, took possession of the country and the islands which we have so long been accustomed to know as theirs. They destroyed the wonderful culture of the Ægeans, which had been the first civilization on the soil of Europe, and thus in the centuries after 1200 B.C. civilization disappeared in Europe. Europe had thus to receive civilization a *second time* after 1000 B.C., and again it came from the Orient, where alone it was preserved after the Greeks had destroyed it in Europe. It came at first in the ships of the Phœnicians, and we recall the well-known fact that among many other things the Phœnicians carried an oriental alphabet to Europe From the Phœnicians the Greeks learned arts and crafts, decorative art, and especially ship-building. This last achievement enabled the Greeks to visit the great cities of the East themselves. In 600 B.C. there was not a Greek city anywhere which could not be crossed on foot from one edge to the other in ten minutes or much less. They were built of sun-dried brick, and the great monumental cities of the Near Orient made a tremendous impression on the Greek visitors.

Meantime Babylonian civilization by way of Asia Minor had brought in many important contributions to European life, like ordinary business customs, and conveniences like business credit, still a fundamental element of civilization. Such influences are especially noticeable in architecture. The Greeks adopted the colonnade from Egypt, and when they wished to erect a light-house tower at Alexandria, they put up a modified form of the temple towers they had seen in Babylonia, which thus became the ancestors of the church spires of Europe. When the Greek architects desired the model of an administrative building they adopted the clerestory of the Egyptian temple, and this important architectural element thus entered Europe to become part, and indeed the most characteristic part of the Christian cathedral.

THE STRUCTURE OF THE ATOM

At the meeting of the National Academy of Sciences, an hour was devoted to an address by Dr. Irving Langmuir, of the General Electric Company, which attracted much attention, it being said that there were present to listen to it as many as four hundred chemists and physicists from the Bureau of Standards. Dr. Langmuir's hypothesis on the arrangement of the electrons in atoms correlates a number of different proposals concerning the possible structure of atoms, and substitutes one general theory which indicates that the electrons do not revolve about the nucleus of the units of matter, but are stationary.

The new theory is based on the theory of Rutherford and the more recent theory of G. N. Lewis. It extends the original conceptions which assume that the atom is constructed on a nucleus of about a millionth of the diameter of the atom, which itself is about one hundred-millionth of an inch in diameter. The atom is made up of negative electrons arranged about the positively charged nucleus.

The atoms of different elements have different charges on their nuclei and they are thus capable of holding different numbers of electrons. This permits the arrangement of atoms of elements in a definite order with a difference of one electron each. For example, the first element in the scale is hydrogen, with an atomic number of one. Helium is next with a difference of one and is designated as 2. Thence up the scale through all the elements to uranium with 92 electrons.

Dr. Langmuir, starting with the known properties of the elements, has tried to determine what the arrangements of the electrons about the different nuclei must be to account for the properties of the elements themselves. He assumes that these electrons are not rotating about the nucleus, but that they are stationary and arranged in three definite dimensions in a lattice-work pattern of geometrical form.

All the atoms of the inert gases, such as helium, argon and radium emanations, are stable, and exist in a form having a symmetry like that of a tetragonal prism. With these and other simple assumptions, Dr. Langmuir finds the general features of atoms, their chemical and physical properties, well explained. Thus he discovers why iron and nickel are magnetic, and explains the properties of rare earth elements which chemists have never satisfactorily placed in the periodic table.

His theory leads to a new conception of chemical combination and modifies some of the simplest chemical facts and formulas. The structure of nitrogen, for example, with its inert properties, is explained. A molecule of nitrogen has a structure similar to that of an atom of argon. In organic or carbon compounds this theory applies particularly well. It explains the ordinary theory of valence and indicates when this must be modified.

Chemists have had trouble with organic compounds containing nitrogen. The structures of many compounds were puzzling, and never agreed upon. The new theory, how-

Wheeler Clarke — Conklin Schuchert — Nichols Davis — Abbot — W. A. Noyes — Moulton — Cross — J. C. Merriam ever, is said to clear up these points and show wherein the difficulty lay. Nitrogen was given a valency of 3 or 5, but the new theory shows that it is never 5, but 3 or 4. According to Dr. Langmuir no element can have a valency of over 4.

His theory leads to a new theory of valence, called the "Octet Theory," which is said to explain satisfactorily complex inorganic compounds, previously understood only by the application of Werner's theory. This theory has been received sceptically on account of its artificial assumptions, but the new "octet" theory shows the old theories were practically correct, but need modification in certain instances. The old organic and inorganic theories are correlated into one simple theory, indicating that electrons do not revolve. Dr. Langmuir also revises Bohr's theory of stationary states which was believed to explain the spectrum, showing that while his results were correct, the theory was wrong.

SCIENTIFIC ITEMS

We record with regret the death of Dr. George Ferdinand Becker, geologist of the U. S. Geological Survey since 1879; Joseph Barrell, professor of structural geology at Yale University, and of Charles Brinkerhoff Richards, for twenty-five years Higgins professor of mechanical engineering at Yale University.

The National Research Council announces the appointment of James Rowland Angell, dean of the faculties, and professor of psychology in the University of Chicago, as chairman of the council for the year commencing July 1, 1918. Dr. Angell succeeds Dr. George E. Hale, director of the Mount Wilson Solar Observatory of the Carnegie Institution of Washington, who has directed the affairs of the council during the war, and who resigned as chairman on April 30, to return to California. Dr. John C. Merriam, professor of paleontology in the University of California, who has been acting chairman of the council at various times, will direct its affairs until Dr. Angell assumes office in July.

The American Philosophical Society will procure a portrait of the late Edward C. Pickering to be hung in the hall of the society "as a token of the affectionate regard in which he was held by his fellow members." Professor Pickering was a vice-president of the society from 1909 to 1917.

The National Academy of Sciences has elected members as follows: Professor Joseph Barrell, whose death is recorded above; Professor Gary Nathan Calkins, zoologist, Columbia University; Professor Herbert D. Curtis, astronomer, Lick Observatory, University of California; Gano Dunn, electrical engineer, New York City; Professor Lawrence J. Henderson, biologist, Harvard University; Professor Reid Hunt, pharmacologist, Harvard University; Professor Treat Baldwin Johnson, chemist, Yale University; Professor W. J. V. Osterhout, botanist, Harvard University; Dr Frederick A. Seares, astronomer, Mount Wilson Observatory, Mount Wilson, California; Professor William A. Setchell, botanist, University of California; Major General George O. Squier, electrical engineer, chief army signal officer, Washington, D. C.; Professor Augustus Trowbridge, physicist, Princeton University; Professor Oswald Veblen, mathematician, Princeton University; Professor Ernest J. Wilczynski, mathematician, University of California; Professor Edwin Bidwell Wilson, mathematical physicist, Massachusetts Institute of Technology.

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