

5

C7C 96  
249  
Smith  
20419

28

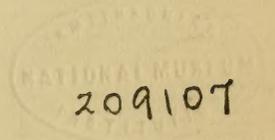
THE  
UNIVERSITY OF COLORADO  
STUDIES

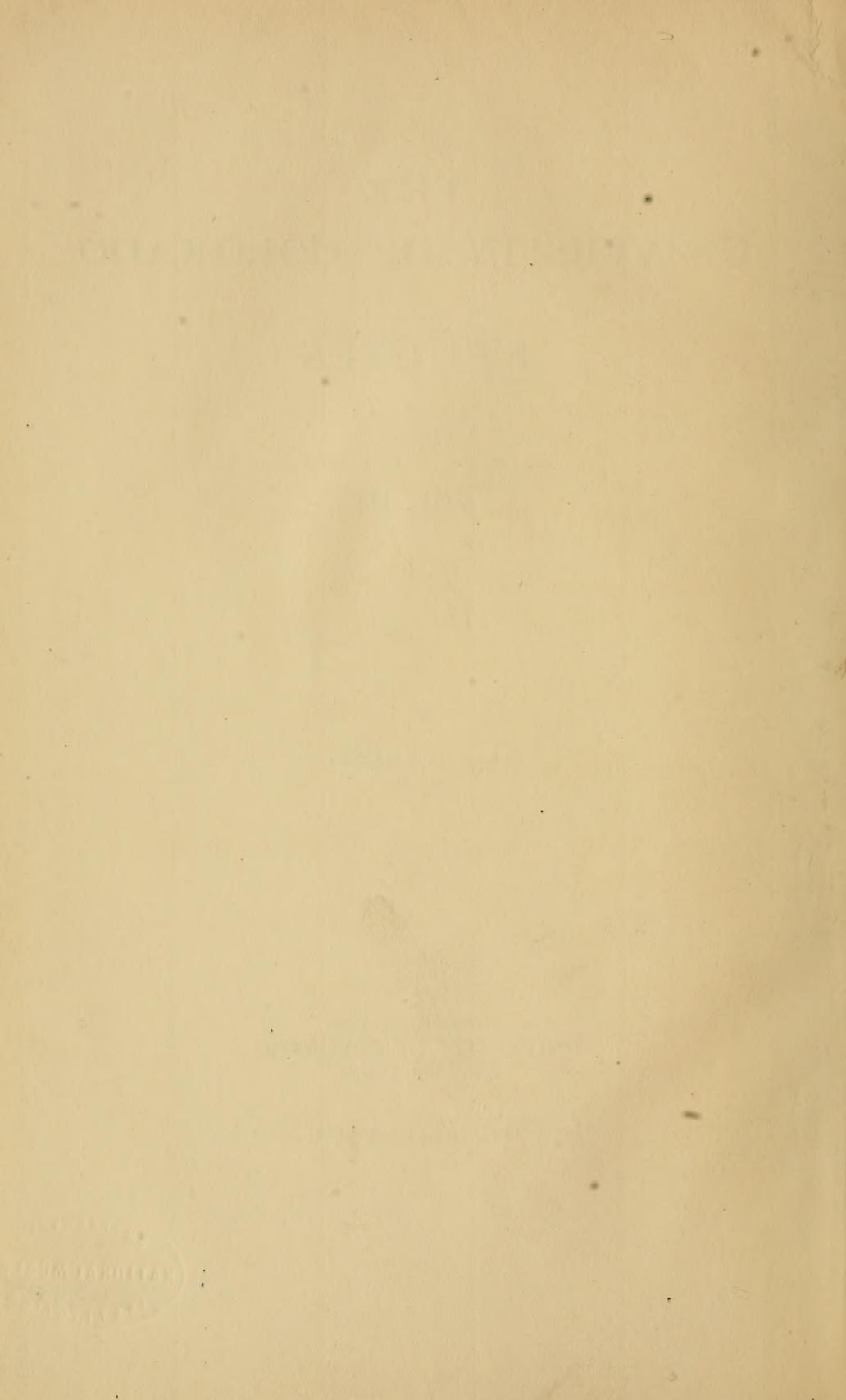
VOL. III

FRANCIS RAMALEY  
EDITOR

PUBLISHED BY THE  
UNIVERSITY OF COLORADO  
BOULDER, COLO.

NOVEMBER, 1905, TO AUGUST, 1906





# CONTENTS OF VOL. III

## No. 1.

	PAGE
1. SOCIOLOGICAL EFFECTS OF THE TRUSTS . . . . .	5
JOHN B. PHILLIPS, PH.D., Professor of Economics and Sociology	
2. THE TERRITORY OF JEFFERSON—A SPONTANEOUS COMMON-WEALTH . . . . .	15
FREDERIC L. PAXSON, PH.D., Professor of History	
3. THE HISTORICAL OPPORTUNITY IN COLORADO . . . . .	19
FREDERIC L. PAXSON, PH.D., Professor of History	
4. HUMAN INFANCY—ITS CAUSES, SIGNIFICANCE, AND THE LIMITS OF ITS PROLONGATION . . . . .	25
JOSEPH H. BAIR, PH.D., Professor of Psychology and Education	
5. THREE MIDDLE-ENGLISH RELIGIOUS LYRICS . . . . .	31
GEORGE C. TAYLOR, PH.D., Assistant Professor of English Language	
6. EXTINCT GLACIERS OF COLORADO . . . . .	39
JUNIUS HENDERSON, Curator of the Museum	
7. CONTRIBUTIONS TO THE NATURAL HISTORY OF THE ROCKY MOUNTAINS, I . . . . .	45
T. D. A. COCKERELL, Lecturer on Entomology	

## No. 2.

1. EDUCATIONAL QUALIFICATIONS OF VOTERS . . . . .	55
JOHN B. PHILLIPS, PH.D., Professor of Economics and Sociology	
2. SHAKESPEARE AND PSYCHOGNOSIS, ESSAY I. MINOR CHARACTERS OF "THE TEMPEST" . . . . .	63
MELANCHTHON F. LIBBY, PH.D. Professor of Philosophy	

3. ON THE IONIZATION DUE TO THE EMANATION OF RADIUM . . . 83  
 WILLIAM DUANE, PH.D.,  
 Professor of Physics
4. THE CRANIAL NERVES OF ONE OF THE SALAMANDERS (PLE-  
 THEDON GLUTINOSUS) . . . . . 87  
 GIDEON S. DODDS, M.A.,  
 Instructor in Biology
5. THE SEED AND SEEDLING OF THE MOUNTAIN GLOBE-FLOWER . . . 93  
 FRANCIS RAMALEY, PH.D.,  
 Professor of Biology
- No. 3.
1. A PRELIMINARY BIBLIOGRAPHY OF COLORADO HISTORY . . . 101  
 FREDERIC L. PAXSON, PH.D.,  
 Professor of History
2. ENGLAND AND MEXICO, 1824-1825 . . . . . 115  
 FREDERIC L. PAXSON, PH.D.,  
 Professor of History
3. LUCRETIVS AND HAECKEL BEFORE THE RIDDLES OF THE  
 UNIVERSE . . . . . 121  
 FRED B. R. HELLEMS, PH.D.,  
 Professor of Latin
4. TRYCORYTHUS, A GENUS OF MAYFLIES . . . . . 135  
 T. D. A. COCKERELL,  
 Lecturer on Entomology  
 AND  
 MARIE GILL
5. ON A NEW  $\alpha$ ,  $\delta$  DIHYDROQUINOXALINE . . . . . 139  
 JOHN B. EKELEY, PH.D.,  
 Professor of Chemistry
6. THE TERTIARY LAKE BASIN OF FLORISSANT, COLORADO . . . 145  
 JUNIUS HENDERSON,  
 Curator of the Museum
7. THE FOSSIL FAUNA AND FLORA OF THE FLORISSANT (COLO-  
 RADO) SHALES . . . . . 157  
 T. D. A. COCKERELL,  
 Lecturer on Entomology
8. PLANTS OF THE FLORISSANT REGION IN COLORADO . . . 177  
 FRANCIS RAMALEY, PH.D.,  
 Professor of Biology

CONTENTS

v

No. 4.

1.	SOCIAL AND INDUSTRIAL EFFECTS OF RAILROAD RATE- MAKING . . . . .	187
	JOHN B. PHILLIPS, PH.D., Professor of Economics and Sociology	
2.	THE COUNTY BOUNDARIES OF COLORADO . . . . .	197
	FREDERIC L. PAXSON, PH.D., Professor of History	
3.	LUCRETIOUS AND HÆECKEL BEFORE THE RIDDLES OF THE UNIVERSE . . . . .	217
	FRED B. R. HELLEMS, PH.D., Professor of Latin	
4.	SHAKESPEARE AND PSYCHOGNOSIS. ESSAY II. MAJOR CHAR- ACTERS OF "THE TEMPEST" . . . . .	229
	MELANCHTHON F. LIBBY, PH.D., Professor of Philosophy	
5.	TENDENCIES IN MODERN MUSICAL COMPOSITION . . . . .	249
	GEORGE M. CHADWICK Instructor in Music	
6.	A DEFINITION OF QUATERNIONS BY INDEPENDENT POSTU- LATES . . . . .	257
	RUBY L. CARSTENS, M.A. Assistant in Mathematics	
7.	AREAL GEOLOGY OF LOWER CLEAR CREEK (COLORADO) . . . . .	263
	JAMES UNDERHILL, M.A.	



## ALPHABETICAL INDEX TO VOLUME III

	PAGE
A Definition of Quaternions by Independent Postulates . . . . .	257
Areal Geology of Lower Clear Creek (Colorado) . . . . .	263
Bair, Joseph H. . . . .	25
Bibliography of Colorado History . . . . .	101
Botany . . . . .	45, 93, 177
Boundaries of Colorado, The County . . . . .	197
Carstens, Miss Ruby L. . . . .	257
Chadwick, George M. . . . .	249
Cockerell, T. D. A. . . . .	45, 135, 157
Colorado History, Preliminary Bibliography of . . . . .	101
Contribution to the Natural History of the Rocky Mountains . . . . .	45
County Boundaries of Colorado, The . . . . .	197
Cranial Nerves of One of the Salamanders . . . . .	87
Dihydroquinoxaline, A new . . . . .	139
Dodds, Gideon S. . . . .	87
Duane, William . . . . .	83
Educational Qualifications of Voters . . . . .	55
Ekeley, John B. . . . .	139
England and Mexico, 1824-1825 . . . . .	115
Extinct Glaciers of Colorado . . . . .	39
Florissant, Colorado, Fossils of . . . . .	157
Florissant, Colorado, Lake Basin (Geology) . . . . .	145
Florissant, Colorado, Plants of . . . . .	177
Fossil Fauna and Flora of the Florissant Shales . . . . .	157
Geology of Lower Clear Creek (Colorado) . . . . .	263
Gill, Marie . . . . .	135
Glaciers of Colorado, Extinct . . . . .	39
Hellems, Fred B. R. . . . .	121, 217
Henderson, Junius . . . . .	39, 145
Human Infancy, Causes and Limits of Prolongation of . . . . .	25
Lake Basin of Florissant, Colorado . . . . .	145, 157, 177
Leucetius and Haeckel . . . . .	121, 217
Libby, Melanchthon F. . . . .	63, 229
Middle English Religious Lyrics . . . . .	31
Mountain Globe-Flower, Seed and Seedling of . . . . .	93
Musical Composition, Tendencies of Modern . . . . .	249
Natural History of the Rocky Mountains . . . . .	45
On a new $\alpha$ , $\delta$ Dihydroquinoxaline . . . . .	139
On the Ionization due to the Emanation of Radium . . . . .	83

	PAGE
Paxson, Frederick Logan . . . . .	19, 101, 115, 197
Phillips, John Burton . . . . .	5, 55, 187
Plants of the Florissant Region in Colorado . . . . .	157
Plethodon glutinosus . . . . .	87
Quaternions, a Definition of . . . . .	257
Radium, Ionization Due to Emanation of . . . . .	83
Railroad Rate-Making . . . . .	187
Ramaley, Francis . . . . .	93, 177
Riddles of the Universe, Leucetius and Haeckel . . . . .	121, 217
Salamanders, Cranial Nerves of One of the . . . . .	87
Shakespeare and Psychognosis . . . . .	63, 229
Social and Industrial Effects of Railroad Rate-Making . . . . .	187
Sociological Effects of the Trust . . . . .	5
Taylor, George C . . . . .	31
"Tempest," Major Characters of . . . . .	229
"Tempest," Minor Characters of . . . . .	63
Tendencies in Modern Musical Composition . . . . .	249
Territory of Jefferson . . . . .	15
The County Boundaries of Colorado . . . . .	197
The Seed and Seedling of the Mountain Globe-Flower . . . . .	93
The Tertiary Lake Basin of Florissant, Colorado . . . . .	145
Three Middle English Religious Lyrics . . . . .	31
Trust, Sociological Effects of the . . . . .	5
Trycorythus, a Genus of Mayflies . . . . .	135
Underhill, James . . . . .	263

VOLUME III

NUMBER I

THE  
UNIVERSITY OF COLORADO  
STUDIES



FRANCIS RAMALEY  
EDITOR

PUBLISHED BY THE  
UNIVERSITY OF COLORADO  
BOULDER, COLO.

NOVEMBER, 1905

*Price, 50 Cents*



VOLUME III

NUMBER I

THE  
UNIVERSITY OF COLORADO  
STUDIES



FRANCIS RAMALEY  
EDITOR

PUBLISHED BY THE  
UNIVERSITY OF COLORADO  
BOULDER, COLO.

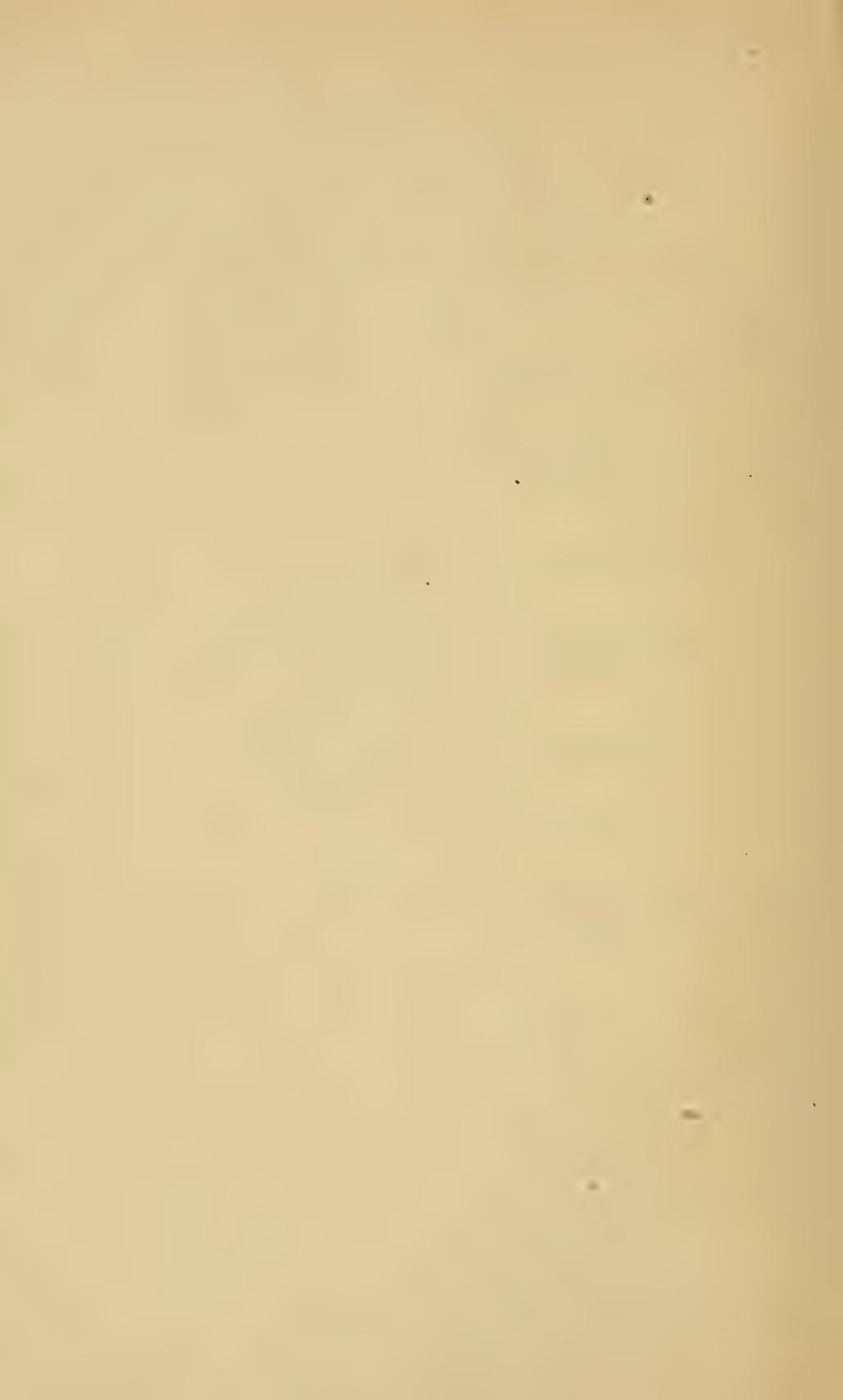
NOVEMBER, 1905

*Price, 50 Cents*

PRINTED AT  
THE UNIVERSITY OF CHICAGO PRESS  
CHICAGO, ILLINOIS

## CONTENTS

	PAGE
1. SOCIOLOGICAL EFFECTS OF THE TRUSTS . . . . .	5
JOHN B. PHILLIPS, PH.D., Professor of Economics and Sociology	
2. THE TERRITORY OF JEFFERSON—A SPONTANEOUS COMMONWEALTH . . . . .	15
FREDERIC L. PAXSON, PH.D., Professor of History	
3. THE HISTORICAL OPPORTUNITY IN COLORADO . . . . .	19
FREDERIC L. PAXSON, PH.D., Professor of History	
4. HUMAN INFANCY—ITS CAUSES, SIGNIFICANCE, AND THE LIMITS OF ITS PROLONGATION . . . . .	25
JOSEPH H. BAIR, PH.D., Professor of Psychology and Education	
5. THREE MIDDLE-ENGLISH RELIGIOUS LYRICS . . . . .	31
GEORGE C. TAYLOR, PH.D., Assistant Professor of English Language	
6. EXTINCT GLACIERS OF COLORADO . . . . .	39
JUNIUS HENDERSON, Curator of the Museum	
7. CONTRIBUTIONS TO THE NATURAL HISTORY OF THE ROCKY MOUNTAINS, I . . . . .	45
T. D. A. COCKERELL, Lecturer on Entomology	



## SOCIOLOGICAL EFFECTS OF THE TRUST

BY JOHN BURTON PHILLIPS

It is proposed in this paper to point out some of the effects on society of the trust method of conducting industry. No attempt is made to discuss the trust problem as a whole, nor to explain the economies in production that result from the formation of great industrial combinations. The effect of trusts on the prices of commodities is not considered. Aside from these particulars, there are certain important features in the operation of industry by great combinations that are well worth considering. There are improvements in modern business life that have resulted from the destruction of the small dealer and the organization of the business on a large scale. Since the decision of the Supreme Court in the Northern Securities case, so much feeling against every great combination has been stirred up that it may not be amiss to mention some of the services the organization of industry on a large scale has rendered to society. While the trust has brought many evils in its train, and while it is probable that a number of these combinations should be destroyed, it is perhaps wiser to seek for some method to regulate them than loudly to demand their entire abolition. A careful consideration of the manner in which they affect society will enable one to form a more intelligent opinion as to the best methods of dealing with this difficult problem.

Among other things, the trust has increased competition among its employees, eliminated the rule of the obstinate man who hindered progress, created new and high-class opportunities for specially gifted men, brought about a saving of social energy and a greater degree of specialization, provided a more speedy means of promotion according to merit, improved the moral tone of those it employs, and taught the world to undertake great enterprises.

The progress of civilization has been marked by increase of competition. In this way the right man has been selected for the place he could best fill. This is a great saving of social energy. The tendency is to eliminate the inefficient man. No society can afford to have its

men with a talent for baking kept at the business of making clocks, nor its men with capacity for clock-making working in a soap factory. By eliminating the effect of family and other influences in industry, and placing each man in a position according to his ability, and making his tenure and promotion depend upon his efficiency, the trust has greatly increased the opportunities for competition. Here is a quotation from Bridge's *Inside History of the Carnegie Steel Company* showing the methods adopted by that company, and in all probability still kept up by the United States Steel Corporation:

A workman was building a heating furnace. "There goes that — book-keeper! If I use a dozen bricks more than I did last month, he knows it and comes around to ask why." This was no exaggeration. The minutest details of the cost of material and labor in every department appeared from day to day and week to week in the accounts, and soon every man about the place was made to realize it. The men felt, and often remarked, that the eyes of the company were always on them through the books. If the workmanship was exceptionally good and the output of a high average, which was insisted upon, the head of the department received a letter of congratulation, and perhaps a present at Christmas time. If it fell behind either in quality or output, the fact was promptly brought to his notice and Captain Jones would see if the fault lay in the machinery; if it did, he generally knew how to remedy it. If the defect was in the human machine and reproof did not suffice to correct it, the man was replaced by an understudy, which Captain Jones usually had trained in view of such contingencies.<sup>1</sup>

The trust has a great advantage in the selection of its manager. Some men excel in organizing industries and in finding the work for which each man is best adapted. The great problem of modern industry is to find these men. A trust has a number of separate plants and each plant has its manager. Each manager is pitted against and compared with the others, and the most capable one selected to be the general manager of the entire trust.

Again, by this fierce competition between the trust's various plants the output is increased. The plants are matched against each other. Each man knows his work is measured by the work of some other man in another and similar plant. This knowledge makes him put his utmost energy into what he is doing. Such results are impossible in industry conducted on a small scale.

<sup>1</sup> BRIDGE, p. 85.

Much has been said about the destruction of individual liberty by the action of the trust. It is true that the gigantic production which results from the combination of many industries into one does destroy the opportunity for the small dealer to start an independent business. But this may happen without injuring industrial liberty. Industrial liberty does not mean freedom to carry on a business without interference. Like political liberty, it is a positive thing which results from the operation of law. The law is the expression of the desires of society. If the small dealer cannot render as great a service to society as those who conduct industry on a large scale, he has no right to complain if society does not guarantee him an abundance of opportunity to do business in a small way. Any society would be unwise to use its strength to maintain conditions favorable to the smaller industrial units when their combination would result in a saving of human energy in the production of those commodities which supply the communities' material needs.

The greatest good of the greatest number has always been the motto of modern progress. This is as true industrially as in any other respect. Industry should be so carried on that the greatest number of men conducting it may have a controlling voice in its management. This is the only way in which democracy in industry can be secured. A little reflection will convince anyone that in cases where the proprietor is managing his own business his obstinacy often stands in the way of progress. Some men are by nature opposed to many things the majority want. When such men are doing business in their own way, they are often able to block needed reforms. In his address before the American Economic Association in 1901, Professor Ely points out such a case among the barbers in the city of Madison. At that time there were twenty barber shops in the city. Of these nineteen wanted to close on Sundays. One was opposed to Sunday closing. The result was that they all kept open. Here was a case where one obstinate person was able to check a needed reform. One man poor in public spirit was able to rule nineteen better men. This is not an uncommon thing in the business world.

There are many factories in the hands of obstinate and unscrupulous

men. By working their employees long hours, or by employing women and children, they force other and better-disposed men to resort to the same bad practices, since the public will not stop to inquire about the conditions under which goods are made. Any unscrupulous method resorted to by one employer tends to extend itself to all employers in that industry. Thus the individual method of conducting industries tends to reduce them all to the level of business morality represented by the most unscrupulous manager. Now, suppose the various firms, or, as in the above case, the barber shops, combined into a trust. Each shop or firm takes stock in the trust, and the business is carried on by a manager. The policy of the business is determined by the votes of the firms composing the trust. It is decided by a majority vote. In this way the nineteen barbers that desired to close on Sundays, and the manufacturers that were opposed to the employment of women and children, might make their influence felt in the conduct of industry. At any rate, the influence of the unscrupulous man in business would be greatly reduced.

In the popular enthusiasm for opportunity for the small dealer the public often loses sight of the incidental benefits that result from the magnitude of an industry. When manufacturers have succeeded in producing a valuable article, they are not content to manufacture it without the effort to improve. The public demands more than a static condition of industry. To live and flourish, a manufacturing concern must constantly improve its productions. In order to do this, the great establishments of the country are employing physicists, chemists, inventors and experimenters of all kinds. Large manufacturing druggists employ many men continuously to make experiments and discover new remedies, in order that they may be able to put the newly discovered drug on the market and reap the financial reward. One such company has had a man working for several years to find a remedy for the cure of rabies. What is true of large drug companies is also true of great industries generally. The larger the industry, the greater the number of inventors and experimenters constantly employed.

The small firms or individuals that are carrying on any of these industries cannot employ inventors or specialists of any sort. They are

doing business on too small a scale to be able to afford it. Their profits are too small, and it is not possible for them to increase them without increasing their plant to a great magnitude. They are therefore doubly handicapped. The trust is able to secure the services of specialists and profit by the discoveries they are able to make. Great establishments do not employ specialists solely because they fear competition. They are employed fully as much to secure the benefits that may result from more economical processes as to gain an advantage in a competitive market. This being the case, it is not probable that there would be less employment of such persons even if the trust had a complete monopoly of the market.

It is clear from this account of the manner in which modern manufacturers are working for the improvement of their respective products that they have opened a new field of employment. In the early day there was no opportunity for the man who had the genius to invent or discover. He had to work amid the surroundings of poverty, and society often lost entirely the benefits that might have resulted to it from the labors of these specially gifted individuals. Such, however, is no longer the case. Any man with inventive power is able to find a place in the employ of a large firm where, in laboratories provided by the employer, he is able to make discoveries that will add greatly to the health and happiness of the race. In this way it appears that society gains most when its industries are conducted on the largest practicable scale.

It is quite true that the trust is enabled to dispense with the services of a great number of commercial travelers, but this is a social gain. It is also true that the advertising feature of trust-conducted industries is reduced to a minimum, but this is a gain when considered from the point of view of social welfare. The more men a society must employ in the distributive industries, the more wasteful is its organization. Every reduction in energy needed to bring goods from the producer to the consumer is an advance in industrial progress. If the entire population might engage in production, there would be a great increase in well-being.

A great deal has been written about the subordinate position of a

man who has always to work for a gigantic corporation. It is said that this will destroy individual initiative. In all probability this has been very much exaggerated. There would seem to be little reason for the belief that a man will not have the opportunity to show the same amount of ingenuity in working for the trust that he would have in working in an establishment owned by himself. Suppose a man is intrusted with the duty of working up trade for a great corporation, as, for example, the development of a taste for chewing gum among the Japanese. Mr. Flint testified before the Industrial Commission that the American Chicle Company were endeavoring to cultivate such a taste among the Europeans. Here is a field demanding all the originality that any man possesses.

It is not to be expected that all men should have the chance to develop industries in their own way. This is impossible. It is given to a few men to be leaders in politics and government. The others are glad enough to follow them. So it is in industry. Few men are capable of originating new things. There is no reason why society should insist on keeping industries small for the sake of allowing inefficient men to try to manage them. In this way these men waste social energy. This opportunity had better be taken from them. Some men think they can practice medicine without medical study. Society has declined to give them the opportunity. They must first prove their ability to practice skillfully the healing art. So it may be better for one first to prove his ability to manage a great business before he is allowed to experiment and fail at the expense of society. What society needs in the organization of industry is the prevention of the enormous wastes that are now so common, and if, by leaving this matter to the industries organized on a large scale, a great social saving can be made, there is no reason why it should not be done.

The destruction of some opportunities for private initiative is not a serious thing. If societies can manage more successfully industries that have been previously left to private parties, it is wise that the society undertake these enterprises. No one criticises the management of the postoffice by the government. This kind of governmental activity increases instead of curtailing the opportunities of individuals. Govern-

ment ownership of railroads tends to take away great opportunities for the investment of private capital, but, at the same time, may make it possible for the private investor to use his capital in different ways, and in ways that he is now prevented from using it by discriminating rates. It is well known that at the present time in many parts of the United States industrial development is greatly hindered by the freight rates that have been established by the railroads. Governmental regulation of rates might interfere with private rights in the railroad business, but might also open for investment many new opportunities in the localities that are now checked in their development by discriminating freight rates.

The trust and corporation forms of industry tend to increase opportunities for promotion according to merit. When business is conducted by a manager, as is the case in the corporate form of industry, the aim is always to secure greater efficiency in the employees. A man's position depends more upon his ability to do his work well than on his pull, or on his relationship to the head of the firm or to one of the partners, as was the case under the old method of management. Formerly the boy was taken into his father's or uncle's store or factory, and, even though more or less inefficient, was often continued in the position when the more efficient clerks were kept in subordinate places. In this way the sons have often dwindled along and made a living from the mere inertia of the business.

Under the trust this is all very different. The father's and uncle's business is no longer in their hands. It is in the hands of the manager of the trust, and he desires only to earn dividends for the stockholders. Anything that in any way tends to interfere with this is not likely to be tolerated by him. He will therefore have in his employ only the most efficient workmen. To get them he will select persons according to their fitness for the work. The boy who has no other qualifications except that he is the son of his father will not be able to work for the trust unless he can show by his ability that he is more efficient than some one else would be. Because of this the poor boy with ability is not so apt to be hindered in his promotion. Thus industry becomes more democratic.

The trust system of industry, working as it does wholly on the competitive method, is tending constantly to elevate the moral tone of its employees. As long as the trust asks of them only the question, "Are you efficient?" it is putting a premium on everything that tends to increase ability. The things that are constantly tending to increase ability are honesty and good habits. The man whose habits and character are such as to make him in any way less capable is very soon dismissed. The employee of the great corporations must be sparing in his use of liquors, if he uses them at all. He must not carouse nights. He must come to his work with a rested body and a clear brain. The great railroads have found that they cannot afford to keep intemperate men in their employ. They have issued orders to their agents to employ only temperate men.

The psychological effect of great industries upon national development should not be underestimated. A people among whom are carried on industries like those conducted by the Standard Oil Company, the American Sugar Refining Company, and the United States Steel Corporation will not be thinking of small things. Such a people has passed the stage of industrial evolution when traders thought only of selling in the local markets.

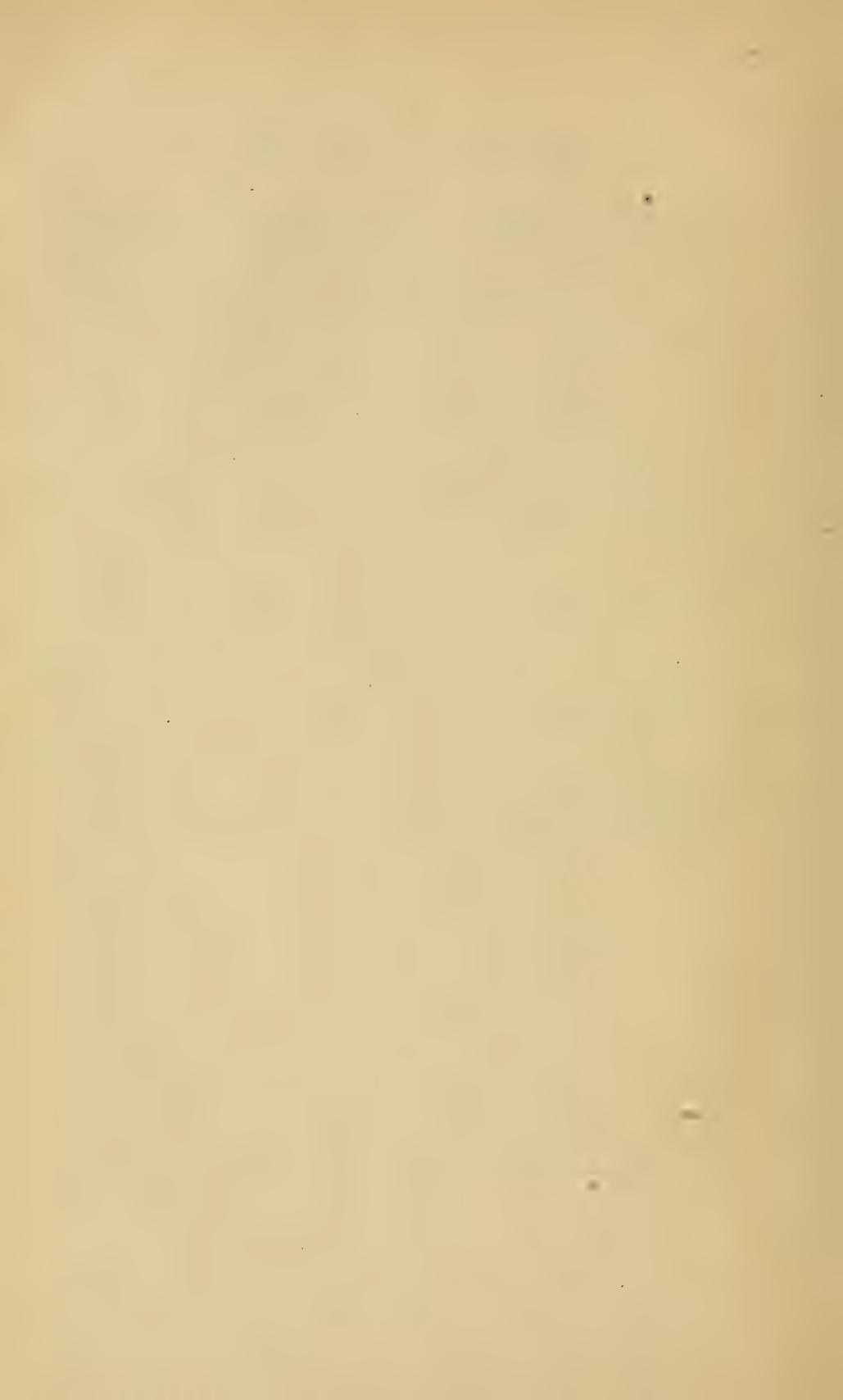
The American people are accustomed to think of great things in industry. The conduct of great businesses has added a certain stimulus to their intellectual operations. This is one of the distinctively American traits that place our people in a different class from those of European countries. So common to us is the idea of magnitude in business that as great an enterprise as the construction of the Panama Canal is regarded as a matter of course and undertaken with comparatively little discussion.

This characteristic of our people has greatly increased since the close of the Civil War. That war was a great influence in educating the American people to the knowledge of their own powers. War always awakens the nation which wages it to a realization of its capacity for great enterprises. It is not strange that this should be the case. When a nation is able to organize, discipline and maintain for a number of years an army of several hundred thousand men, a great deal of executive ability will be brought to light. When the war is over, these

men whose executive ability has been tested do not readily turn their attention to small industries. In fable and fiction, Cincinnatus may leave his plow, lead his countrymen to glorious victories, and again return to rural pursuits; but real human nature does not often act in this way. After the Civil War great industrial schemes were conceived. Railroad-building gave opportunity for the exercise of great administrative genius. When men conceived and executed plans for building railroads from Chicago to the Pacific, other industries were thought of in the same proportion.

The desire to dominate and excel is one of the most fundamental traits of human nature, and its exercise in the industrial field is one of the best signs of the higher civilization. In countries where there are no great industries, men born with the desire for leadership and domination have but one direction in which to turn their energies, and that is revolution. Industrial opportunity for men of great organizing ability is, therefore, a certain guarantee of the political stability of a nation.

Such are some of the more important effects on society when industry is conducted on a large scale. Since they are such as tend to the improvement of social conditions, careful study should be given to methods of controlling great industrial combinations. It is probable that the high prices maintained by trusts at the present time more than counterbalance the advantages enumerated in this paper, and unless some means of controlling these great industries can be found, their destruction should be insisted upon.



## THE TERRITORY OF JEFFERSON: A SPONTANEOUS COMMONWEALTH<sup>1</sup>

BY FREDERIC L. PAXSON

A great western scholar has well emphasized the significance of the frontier in the development of American history. He has pointed out the fact that the conditions of life along the edge of the wave of population moving to the West have been more nearly stable and uniform than those of any other portion of the United States, and that the men produced in this frontier have been a constant and positive force in the development of national life. But the time has been too short and the laborers too few for the vast field of western history to have received more than a most superficial treatment, and so it is that the searcher in this field comes daily to his rich reward. It was here that the territory of Jefferson lived and passed away.

In January of 1859 some grains of gold were brought to the Missouri River to prove to the world that a great gold field had been overlooked in the rush to California. For more than ten years the busy trails to Santa Fé and Oregon had carried their thousands past the fields of Colorado to the coast; but now the movement changed, and active life sprang into existence at the forks of Cherry Creek and the South Platte, while a restless population, hungry from the panic of 1857, filled the new mining camps of Colorado.

The mining camp at its best affords a problem in government, at its worst a study in anarchy; and these new camps at Auraria and St. Charles and Central City were no exceptions to the rule. In a legal way, the camps straddled the line of the fortieth parallel that then divided the territories of Kansas and Nebraska. But they were five hundred miles from a seat of government, and no political organization had ever been effected in their district. They needed law and civil rights and justice, but they had only the territorial organizations of a bleeding Kansas and an impotent Nebraska.

<sup>1</sup> A paper read before the Section of American History of the International Congress of Arts and Sciences, St. Louis, September, 24, 1904.

The first miners had reached the South Platte in the autumn of 1858. They realized their political opportunity, so that when a snow-storm drove them to cabins for a day or two, they emerged with a determination to demand a new state for the Pike's Peak region and to send delegates to Washington and Kansas. The spring of 1859 saw more statehood gossip, more delegates, and the arrival at once of a new population, a printing-press and a political platform. "We claim," wrote the pioneer editor of the *Rocky Mountain News*, "that any body of American citizens, which from any cause or under any circumstance, is cut off from, or from isolation is so situated, as not to be under any active and protective branch of the central government, have a right, if on American soil, to frame a government, and enact such laws and regulations as may be necessary for their own safety, protection, and happiness, always with the condition precedent, that they shall, at the earliest moment when the central government shall extend an *effective* organization and laws over them, give it their unqualified support and obedience." I have found no other statement so definite as this, that an American community has a right to an effective government.

An election of delegates to represent the Pike's Peak country in the legislature of Kansas and the halls of Congress was held early in November, 1858; and four months later the district organized itself as Arapahoe County, Kansas, although no such county possessed a legal existence. But the movement for an independent statehood was gaining force day by day, as the immigration of 1859 brought its thousands of gold-seekers into Denver. It culminated at last on the 11th of April, 1859, in a caucus, and on the 15th in a convention of delegates from five of the mining camps that issued a call for a constitutional convention to meet in Denver on the first Monday in June to frame a constitution for the State of Jefferson, between the 102d and 110th meridians and the 37th and 43rd parallels of north latitude. The miners proposed to rob the territories of Kansas and Nebraska, of New Mexico and Utah, to endow their own state.

Pursuant to the call, a convention met in Blake and Williams' hall in Denver on June 6, organized for business, created eight framing committees, and adjourned for two months that the idea of statehood

might develop. On the first of August it convened again to spend five days in the double work of framing a constitution and deciding whether to apply for state or territorial existence. Unable to choose between the alternatives, it evaded the decision by presenting at once a constitution and a territorial memorial, and referring the matter to popular vote. The election on September 5 rejected the constitution for the State of Jefferson.

Thus far the movement for a local organization had failed—while the need for it had become greater every month. But before September came to an end a call had been issued for another convention to frame a provisional constitution for the Territory of Jefferson. And on the 7th of November this movement terminated when its constitution was made effective, its legislature met for a first session, and Robert W. Steele, of Ohio, its first governor, read his inaugural message.

The Territory of Jefferson was an illegitimate commonwealth. It came spontaneously when the need for it was felt; and so long as it endured, it lived in defiance of the laws of Kansas and Nebraska, and without the sanction of the United States. Yet its life covered a year and a half. Its governor was twice elected; two legislatures met to transact its business; its courts were organized and respected; and it was only when it tried to collect its revenues that it showed its weakness. But for several months it was an effective instrument in the preservation of order and law, while its corporate existence was terminated when Congress in the spring of 1861 created the Territory of Colorado, and Lincoln appointed William Gilpin to be its governor. Then the old organization lived up to its platform, as it resigned its powers into the hands of the lawfully constituted authorities.

The Territory of Jefferson is only an episode in the process of commonwealth-building in the West. But it illustrates the constant quality of frontier citizenship and the spontaneous instinct for self-government that give to American life so much of its distinctive character. It was a government that originated in necessity; that, although illegitimate, bore every earmark of a reign of law; that served a useful purpose, and that died an honorable death after a not unhonorable life. "If there be any vestige of power yet remaining in the Provisional

Government of Jefferson Territory," proclaimed Governor Steele at the end of his career, "I, as its chief executive, would advise and counsel our citizens to remain loyal and firm to that old flag that has protected us from our infancy. Pay your debts when you can, live honorably with all men, but love your country and its flag even unto death, if required."

## THE HISTORICAL OPPORTUNITY IN COLORADO

By FREDERIC L. PAXSON

There is great danger lest the teacher of history in the far West should bewail the thousand odd miles that separate him from the source material of his profession, and so overlook the opportunity that lies at his feet. He is too liable to forget that the parallel to the course of his own country has rarely, if ever, been seen; that the external facts of the history of the West show to the thoughtful worker a field of amazing richness, and that the internal facts, so far as they have been exploited, confirm the first impression. The chance to investigate the workings of a civilization which in less than half a century has passed from wilderness through frontier and pioneer conditions to order and wealth is what he ought to see before him. And the opportunity to work out the causes and results in this concentrated life is his historical opportunity.

It is useless for the student of history in Colorado to mourn over the absence of great libraries. He may as well admit the fact that the historical library is a product of generations, and that, save for two or three working collections of various degrees of incompleteness, such a library is not within his reach. If he be a worker in any field of general history, be it European, mediæval, ancient, or even American, he must be content with a few secondary authorities. He cannot hope, even with access to all the libraries in the state, to produce a piece of original work that will add anything to the knowledge of the world. But if he admit this fact, and settle down to the belief that no productive work in history can be done in Colorado, he will overlook in the local field a historical opportunity that is hardly to be equaled in the United States.

The beginnings have been made in the writing of the history of Colorado, but the journalists have thus far monopolized the work, and it is only today that the trained historical scholar is coming to weigh the evidence and record a critical judgment. A small number of general works must be considered by anyone who undertakes to study the

history of the state; the production of monographs has begun, and new studies are appearing in increasing number; while the collection of the raw material for future studies is fairly well advanced.

The histories of Colorado begin with Hollister's handbook for miners,<sup>1</sup> published in the sixties and containing a brief sketch of the growth of the territory. Most of them have followed this work, accepting its conclusions and giving to it more or less credit. Fossett,<sup>2</sup> in his work of a decade later, is much indebted to his predecessor; and the monumental work of General Hall<sup>3</sup> is based upon the foundation of Hollister, supplemented by a knowledge of newspapers and the copious memory of one who was more than a spectator in the early days of the territory. The pages of Bancroft<sup>4</sup> on the state show a knowledge of the same source, while those of Byers<sup>5</sup> show the same indebtedness, reinforced by the memory of an active pioneer.

In a less general sense, Hollister is still used as a source, but the local antiquarians have provided much material for the future historian. Such books as those published by Baskin & Company of Chicago<sup>6</sup> for the subscription trade are by no means to be disregarded. Boyd's *History of Greeley*<sup>7</sup> is rich in documents and economic details. The biographical subscription works<sup>8</sup> record personal details for many a valuable footnote. And Smiley's *History of Denver*<sup>9</sup> is a conscientious attempt to tell the story that has had a large measure of success. It is the best of the works in print on the history of Colorado.

<sup>1</sup> OVANDO J. HOLLISTER, *The Mines of Colorado* (Springfield, Mass., 1867).

<sup>2</sup> FRANK FOSSETT, *Colorado: A Historical, Descriptive, and Statistical Work on the Rocky Mountain Gold and Silver Mining Region* (Denver: Daily Tribune Steam Printing House, 1876).

<sup>3</sup> FRANK HALL, *History of the State of Colorado* (4 vols., illustrated; Chicago, 1889).

<sup>4</sup> HUBERT HOWE BANCROFT, *History of Nevada, Colorado, and Wyoming, 1540-1888* (San Francisco: 1890; Vol. XXV of his *Works*).

<sup>5</sup> WILLIAM N. BYERS, "History of Colorado," in *Encyclopedia of Biography of Colorado*, Vol. I (Chicago: The Century Publishing and Engraving Company, 1901).

<sup>6</sup> *History of the City of Denver, Arapahoe County, and Colorado* (Chicago, 1890); *History of Clear Creek and Boulder Valleys, Colorado* (Chicago, 1890); *History of the Arkansas Valley, Colorado* (Chicago, 1891).

<sup>7</sup> DAVID BOYD, *A History of Greeley and the Union Colony of Colorado* (Greeley, Colo., 1890).

<sup>8</sup> See the *Encyclopedia of Biography*, noted above, and *Portrait and Biographical Record of Denver and Vicinity, Colorado, Containing Portraits and Biographies of Many Well Known Citizens of the Past and Present, Together with Biographies and Portraits of All the Presidents of the United States* (Chicago, Chapman Pub. Co., 1898).

<sup>9</sup> JEROME C. SMILEY, *History of Denver, with Outlines of the Earlier History of the Rocky Mountain Country* (Denver, 1901).

It may be said that the outlines of the history of the State have been defined in a superficial way, and that personal recollection, strengthened by an uncritical use of newspapers, has done as much as can be expected of it. The next step, which is the production of critical monographs on details of the history, is now being taken. The learned institutions of the state are showing a consciousness of their duty in respect to the local problem,<sup>1</sup> while the neighboring states that once embraced the territory of Colorado are aiding in the work,<sup>2</sup> and individuals within the state are doing something in the way of publication of personal reminiscences.<sup>3</sup>

As a means for aiding this production of monograph literature, the gathering of source material has not only been begun, but has resulted in at least two valuable collections of Coloradoana. The sources for the history of Colorado are to be found in several different classes, none of which may be neglected by the student. The documents of the state, which form the foundation for the legal portion of the history, include the printed statutes, journals and reports of both state and territorial periods, and the great mass of unpublished manuscript records which are to be found in the archives of the Capitol and the counties.<sup>4</sup> The statutes, documents and debates of Congress also throw much light on special phases of Colorado history. In the matter of non-official sources, the newspapers lead the way, subject always to the limitations upon material of this sort. The mistakes of both head and heart which abound in the daily press do not destroy its source value, but certainly do impose upon the student the necessity for more care and higher degrees of criticism than do any other of our modern sources. Personal recollections, biographies and other private works add greatly to the source material at the disposal of the scholar.

<sup>1</sup> ELMER H. MEYER (of the University of Denver), "The Constitution of Colorado," in *Iowa Journal of History and Politics*, Vol. II, pp. 256-274; FREDERIC L. PAXSON (of the University of Colorado), "The Boundaries of Colorado," in *University of Colorado Studies*, Vol. II, pp. 87-94; B. M. RASTALL (of Colorado College), "The Cripple Creek Strike of 1893," in *Colorado College Studies, Social Science Series*, No. 5, June, 1905, pp. 1-48.

<sup>2</sup> HELEN G. GILL, "The Establishment of Counties in Kansas," in *Kansas Historical Collections*, Vol. VIII, pp. 1-23; W. J. SPILLMAN, "Adjustment of the Texas Boundary in 1850," in *Quarterly of the Texas State Historical Association*, Vol. VII, No. 3, pp. 177-195.

<sup>3</sup> *Early Day Letters from Auraria (now Denver) Written by Libeus Barney to the Bennington Banner, Bennington, Vermont, 1859-1860* (n. d.).

<sup>4</sup> F. L. PAXSON, "The Public Archives of the State of Colorado," in *Annual Report of the American Historical Association for the Year 1903*, Vol. I, pp. 415-437.

The most notable collection of materials for the history of Colorado is to be found in the private library of the president of the State Historical and Natural History Society, Mr. Edward B. Morgan, of Denver. This collection is the result of a prolonged search for books and pamphlets written about Colorado, in Colorado or by Coloradoans. Its bound volumes go above five hundred, while its pamphlets run into the thousands. The labors of Mr. Morgan are being supplemented today by those of Mr. W. C. Ferrill, curator of the same society. The files of newspapers and the bundles of photographs gathered by him and guarded in the vaults of the Capitol form a nucleus for a great historical library at some future day.

This much has been done toward the writing of the history of Colorado: the general outline has been sketched, a few minor points have been cleared up in careful monographs, and the gathering of source material is progressing as rapidly as public and private means will allow. But this is only the beginning of the work that calls today for more laborers than the state has ever provided. In whatever field the local historian may choose to work, he can find the ground practically unbroken and the opportunity complete. It makes no difference whether he choose to investigate workings of the institutions of the state and the general activities of its government, or the development of local county or municipal institutions, or the larger problems of transportation, irrigation or politics that connect the state with its neighbor commonwealths and the United States. In every direction he may advance with the assurance that his contribution to history will be limited only by his industry and ability. The historical opportunity of Colorado lies in this field.

The central government of Colorado tempts the historical worker because of its rapid extension, highly concentrated in point of time. A period of forty-five years covers the whole of Colorado history, and and in this period there has developed, out of the barren frontier that had been the Great American Desert, a modern commonwealth with its various political, economic and social activities. Growth that has occupied a century in older states has occurred here in a generation, while in many directions the growth has been almost unique. A high-

school system with 83 per cent. of its instructors college graduates calls loudly for a historical explanation. A universal application of irrigation law gives a distinctive color and emphasis to legal history; while the relation of a state government to the control of mines can be studied here in all its aspects.

The field of local institutional history has never been worked to its extreme capacity in the United States. Much has been done in the far East, but even there the study has been fragmentary, and has been embarrassed in many cases by the historical remoteness of the origins. Throughout the West in general this remoteness does not exist. In Colorado it is still possible to supplement the documentary evidence as to historical beginnings with the recollection of historical participants. And the fact that the growth has been unduly rapid gives an unusual degree of continuity to the institutions. There is not a town or community in Colorado but has some economic or political reason for its existence and needs its careful historian. The mine and the watershed are still to be measured and estimated in their influences upon place and form of social life.

Transportation is perhaps the most significant element in the history of the West. It not only constitutes a large part of the cost of every commodity in use, but it possesses the power to build up or to destroy whole communities. Yet no one has written adequate histories of the wagon routes from the Missouri to the Rockies which made Colorado possible; no one has exhausted the subject of Federal policy towards continental railroads and public lands;<sup>1</sup> no one has even broken the ground in the development of transportation by road, trail, steam and electricity within the state. All these fields are crying for some one to exploit them.

The opportunity thus opening in Colorado makes it possible for every student of American history to do something in the field of historical research. Every topic that he works out strengthens himself, and every article or note that he prints makes smoother the path of his colleagues. Whether he work in connection with a great educational

<sup>1</sup> Two of the *Bulletins of the University of Wisconsin* reveal the possibilities in this general field. JOHN BELL SANBORN, "Congressional Grants of Land in Aid of Railways," *Bulletin No. 30* (Madison, 1899); JOSEPH SCHAFER, "The Origin of the System of Land Grants for Education," *Bulletin No. 63* (Madison, 1902).

institution, or in a local school, or in the privacy of his own study, the opportunity is the same. It is the chance to write a history that is yet fresh from the making and that presents its materials close to every hand.

Particularly in the case of the local schools is the opportunity attractive. For the senior year in the high school the ideal course in history is based on American history and civil government. It is thus possible, in the case of that majority of students whose scholastic education is now in its completion, to fill the mind with the actualities of local life. The mayor and the alderman possess a new interest when the student applies his theory of civics to the workings of his town. And if he thus realize the difference between the theory and practice, he is made thereby the better citizen. The basis of American history is more clearly understood if he identify some of its conditions as they have appeared in the making of his own community. And, fresh from this last year of the high school, he is thrown out into his later world with history and politics as real things, not as shadowy phantoms. From a practical standpoint of public morality, no man who has once learned to look historically upon his local government is likely to place himself in an embarrassing historical attitude. The judgment of the daily press is commonly personal or political—mistaken in either case—but the estimate of history must, in the long run of events, be right.

The student, the teacher, and the man in the street are only just beginning to appreciate the significance of the historical position of Colorado and the Rocky Mountain region. "Here," writes one of the workers, "is the virgin soil almost untouched by the student or the historian. Here, too, it is possible to study the frontier at close range, and to carry out for states and sections that magnificent line of research work which Professor Turner of Wisconsin and others are doing so admirably for the country as a whole."

\* PROFESSOR THOMAS K. URDAHL, in "Introduction" to RASTALL, *Cripple Creek Strike of 1893*, p. iii.

# HUMAN INFANCY: ITS CAUSES, SIGNIFICANCE, AND THE LIMITS OF ITS PROLONGATION

BY JOSEPH HERSHEY BAIR

By a study of comparative psychology and anatomy it will be found that there is a correlation between higher mental functions and the size of the cerebral hemispheres of the brain. As memory, discrimination and the power to learn by experience, as well as all the higher psychical factors, develop in animals, so does also the size of the cerebral cortex. In the primitive vertebrates the cerebrum and cerebellum do not exist as separate structures. In fishes they are very small. In the halibut, e. g., a fish weighing over one hundred pounds, the cerebral hemispheres are no bigger than peas, not nearly as large as the optic lobes. In birds and mammals the cerebrum becomes more and more conspicuous, until in the higher apes the brain pushes forward. This same process is continued in man until it attains its normally enormous size. The size of the cortex also increases by a process of furrowing which makes its area almost four times as great as if it were smooth. The higher up in the series we go, the deeper and more numerous these folds become, and these, too, are an index to general intelligence and mental capacity.

In the struggle for existence, the animal favored by variation with a larger and more deeply fissured brain than his fellows, is more intelligent, and consequently abler in the struggle for existence. This animal is maintained at the expense of his less intelligent fellows who do not survive. Natural selection operates in the direction of increased size of brain cortex. The gulf by which man is separated from the ape consists in the increase of his cerebral surface.

Psychical variations came to be of more use to animals in the history of the race than physical variations, and were seized upon and maintained. As a result the being possessing them had greater power of adapting himself to the conditions of life. He was enabled by his mental powers to keep, with an unchanged body, in harmony with an ever-changing environment. The being that varied most rapidly

mentally, and consequently that gained the ascendancy, was man. When he migrated he used fire, clothing, and shelter; he invented tools and stratagems, and aided his fellows. He lived by his wits. As man's intelligence increased and as he gained greater control over nature, his body changed less, except such parts as are correlated with intelligence (the cerebral hemispheres), which developed very rapidly.

In addition to the correlation between the size of the cerebral hemispheres and intelligence, there is another, viz.: between size of hemispheres and period of helplessness after birth. The more intelligent an animal, the larger its cerebral cortex, and also the longer the period of infancy.

Now, infancy has a double significance. It comes as the direct result of increased cerebral capacity, and it affords a basis for learning by experience. In the lower creatures with no cerebral development there is but one course which the stimulus can take, and that is the course phylogenetically open to it, the course through the lower centers. This creature, devoid of such higher connections as the cerebrum affords, is a reflex machine—an automaton. Development of the size of the cerebrum means a multiplication of the number of cells in the brain which may become connected with any stimulus. A creature with no secondary brain has no infancy. It reacts the same as the parent to the same stimulus. The infant possessed with a cortex does not make a definite response, but the impulse is diffused throughout the various possible channels afforded by the cortex. This is immediately a disadvantage, and the individual cannot survive unless cared for by the adult parents. If the parents with large brains also possess the parental instinct, their infants will survive, and the helplessness they manifest will be the means of adapting them to their environment.

If the impulse could go in but one direction, and thus give but one element of response, the individual could never learn to discriminate the difference between that and some other possible response. Where the impulse is diffused, and produces consequently various elements of response, the individual possessing them will have a basis for discriminating and, consequently, for valuing them. It is possible only at this stage of development to become a hedonic creature. Pliability lies in

the fact that any element or group of elements in the whole general response can be discriminated and seized upon by the individual. Training implies that elements from these random movements resulting from the diffusion of the discharge produced by a stimulus, are valued and selected. The interest is concentrated upon the pleasurable element, and more and more of the diffused discharge is led through the selected channel. The person by repeating a process a sufficient number of times becomes as automatic in the response as though controlled entirely by the lower centers.

It is obvious that the greater the number of cortical cells in the brain, the greater number of associations possible, and the greater the range, therefore, of psychological activity. Education and adjustment imply to a very large degree sensori-motor connection. The creature having only one sensori-motor path can have only the very most limited associative power, or power to learn by experience. The greater the number of possible connections the greater the teachableness, but at the same time the longer a period of time it takes also to make complete adjustment.

The lowest vertebrate animal, *Amphioxus*, has no infancy. The young do whatever the parents do, the only difference being the size. This animal has no cerebrum. It does not care for its young. Neither can it learn by experience. Fishes have very little cerebral brain. They have no perceptible helplessness at birth. In birds the brain develops, infancy extends, and the maternal instinct appears. Most birds are also quite teachable. Dogs, horses, and apes are teachable. The manlike apes of Africa and the Indian Archipelago have advanced beyond the mammalian world. They have greater brain capacity, greater intelligence, also a greater period of helplessness. These tailless apes are helpless for some three months. During this time they are unable to walk, to feed themselves or to grasp things with precision. The human infant has a very much longer period of helplessness than any of the other animals. And when we compare the size of man's brain and his achievements with those of other animals, we have demonstrated to ourselves in an overwhelming manner the above assumed correlations.

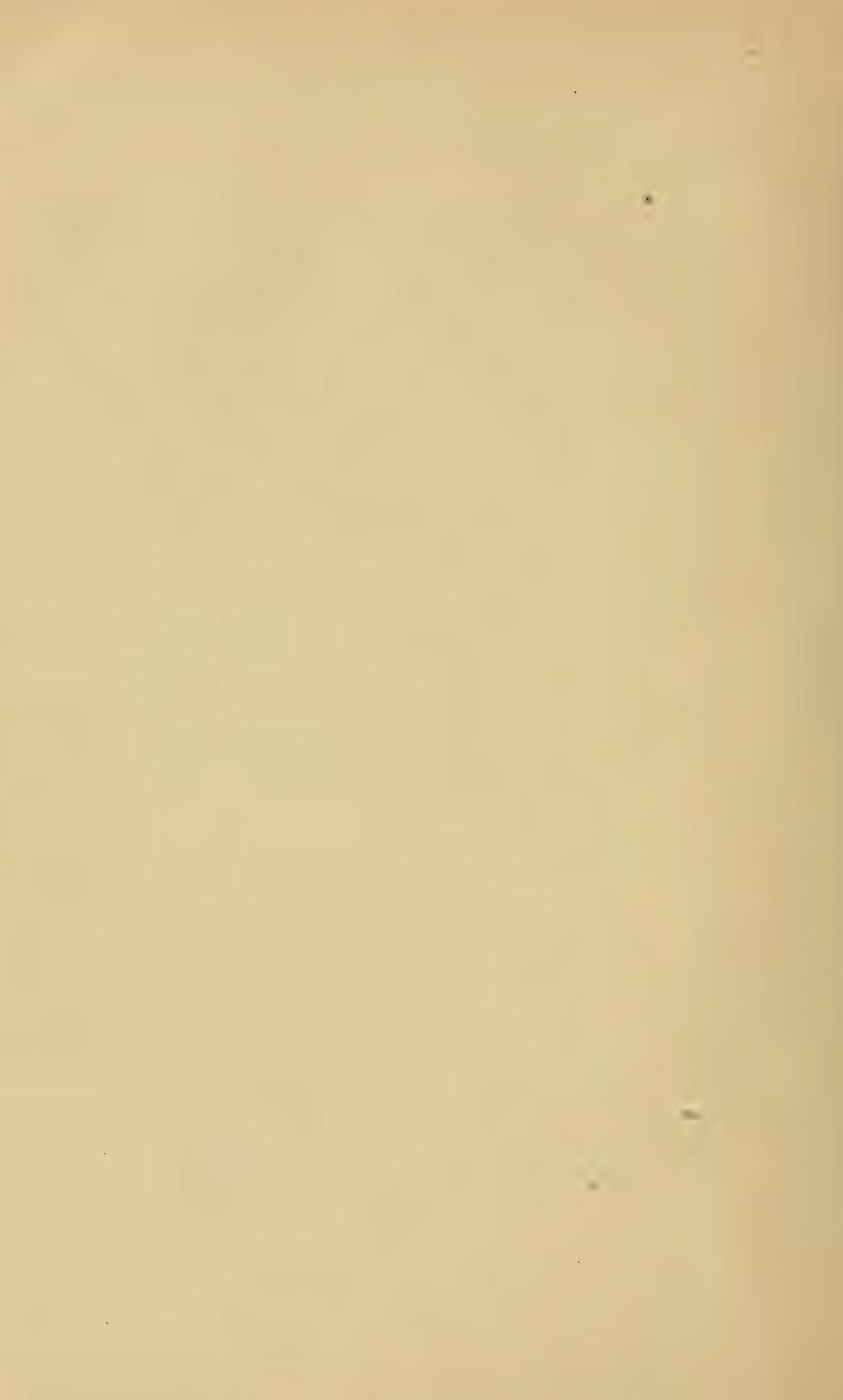
The question, Will the period of human infancy continue to lengthen? is an interesting as well as important one. The answer will also imply whether the size of the cerebral cortex will continue to increase, and whether the capacity for intelligence in the human race will continue to increase; and for this reason the solution is a doubly important and interesting one. If the conclusion reached from present indications is a sound one, the answer is not very encouraging, because it is in each case negative. In an article printed in the last issue of these *Studies* the author has attempted to show that man has about reached his physical and mental limit in evolution. Physical selection became more and more hampered as man became more and more intelligent, and ceased altogether when man gained complete control over nature. Mental selection developed for a long time the size of the brain cortex; but this, too, if it is changing at all—which is doubtful—is not changing rapidly enough to account for man's progress. In proportion as education becomes a general factor in the human race, cerebral selection also becomes less and less potent, and, where there is universal education, ceases entirely.

Present conditions maintain the unfit as well as the fit, both physically and mentally. Physical adaptation is by means of surgery and inoculation, and mental adaptation by means of education. The mediocre and even the mentally poor are, by means of education, adapted to their environment, and thus are enabled, like a normal individual, to marry and to bring up a family. The birth-rate among the lower classes is very great, and their natural increase is considerably greater than that of the upper classes. The lower races have smaller and less deeply folded brains than the higher. They also have shorter infancy. A Maori and even a Negro child matures younger than a white one. The Negro adolescent becomes sluggish and mentally inert. This is the age when the child of the white man becomes most active and pliable. There is also somewhat of a general difference between the children of the two classes (upper and lower) at this age. If it is true that the natural increase of the lower races and classes is greater than that of the higher, then the size of the cerebral cortex will tend to diminish, and also the length of the period of teachableness will decrease.

Butler<sup>1</sup> distinguishes between physical and spiritual adjustment. Physical adjustment is made after the child can walk alone, feed itself and use its hands. When physical adjustment is thus made, there remains yet to be accomplished the building of harmonious and reciprocal relations with those great acquisitions of the race that constitute civilization; and therefore the lengthening period of infancy simply means that we are spending nearly half of the life of each individual in order to develop in the young some conception of the vast acquirements of the past and some mastery of the conditions of the present. This view is only partially justifiable, because all acquisition involves sensori-motor activity. This acquisition or adaptation among the lower beings, or even among lower races or individuals, to the higher spiritual environment is impossible because of just this lack of pliability.

Civilization implies that the environment is becoming more complicated, that each generation is working at a higher level, and with better tools which our predecessors have handed down. Evolution has been transferred from the organism to the environment, and it is the accumulated structure which persists. This requires in each subsequent generation greater plasticity; but it is probable that the preceding generations have had a reserve, and that only under modern conditions, where there is universal education, is it called into activity.

<sup>1</sup> *Meaning of Education*, p. 13.



## THREE MIDDLE ENGLISH RELIGIOUS LYRICS

BY GEORGE COFFIN TAYLOR

Attention has not been called, I believe, to the fact that Nos. IX and X of Poems of Manuscript Cambr. DdV. 64, fol. 134-142,<sup>1</sup> taken together, comprise *The Love of Jesus*, from Lambeth MS. 583, pp. 90-102.<sup>2</sup> Aside from differences of dialect, occasional differences of phrase, and differences in the arrangement of material, the *Cambr.* and *Lamb.* poems are the same. Lines 1-136 and 229-284 of *Lamb.* comprise poem No. X of *Cambr.*, while lines 137-228 of *Lamb.* comprise poem No. IX of *Cambr.* Which of the two versions is the source of the other, one cannot say with certainty. Perhaps they are both based on a similar original. The *Cambr.* version is ascribed to Richard Rolle, who lived about 1300-1349. The *Lamb.* version is dated by Furnivall about 1340.<sup>3</sup> It would seem, however, that *Cambr.* is either the source of *Lamb.* or approximates more closely than *Lamb.* the original source, for the following reasons: First, the metre of *Lamb.*, where it differs from that of *Cambr.*, is generally uncertain, and forced as if it were the work of an unskilled versifier. *Cambr.*, on the contrary, is for the most part good metre, such as we should expect from Hampole's pen. Secondly, *Lamb.*, which is written in eight-line stanzas, though uniform in this respect throughout almost the entire poem, presents one irregularity of versification; lines 217-220 constitute a four-line stanza. *Cambr.*, on the contrary, written in long four-line stanzas, is uniform in this respect throughout. It is significant that just at the point above mentioned in *Lamb.*, where the irregularity occurs, lines 217-220, *Lamb.* departs most widely from *Cambr.* Thirdly, the arrangement of material in *Cambr.* is fairly logical, while in *Lamb.* it is confused. The opening stanza of *Cambr.* IX, for example, is, to one familiar with hymns of this type in Middle English, very evidently the conventional beginning of many

<sup>1</sup> C. HORSTMAN, *Library of Early English Writers*, Richard Rolle, Vol. I, pp. 75 ff.

<sup>2</sup> FURNIVALL in *Hymns to the Virgin and Christ*, E. E. T. S., pp. 22 ff.

<sup>3</sup> *Loc. cit.*, p. 18.

such poems. In *Lamb.* the stanza corresponding to this is imbedded in the middle of the poem.<sup>1</sup> Lines 69-96 of *Cambr.* X follow naturally the subject-matter preceding. The lines, however, corresponding to these in *Lamb.* there complete the poem, following very unnaturally the subject-matter immediately preceding it. For these reasons, I am inclined to believe that *Lamb.* is based on *Cambr.* Whether the peculiarly confused arrangement of *Lamb.* is due to the fact that the scribe purposely made the change, or made a mistake in copying from leaf to leaf, I am unable to conjecture.

I quote the two versions side by side:

## CAMBR. MS.

## IX

(I) Hesu god son, lord of mageste,  
Send wil to my hert anly to couayte þe;  
Reue me lykyng of þis land, my lufe þat þou may be;  
Take my hert in til þi hand, sett me in stabylte.

Ihesu þe mayden son, þat wyth þi blode me boght,  
Thyrl my sawule with þi spere, þat mykel luf in men  
hase wrought.  
Me langes, lede me to þi lyght, & festen in þe al my  
thought,  
In þi swetnes fyll my hert, my wa make wane till  
nocht.

Ihesu my god, Ihesu my keyng, forsake nocht my  
desyre,  
My thought make it to be meke, I hate bath pryde and 10  
Ire:  
Ði wil es my zhernyng; of lufe þou kyndel þe fyre.  
Dat I in swet louyng, with aungels take my herte.

Wounde my hert with-in, & welde it at þi wille:  
On blysse, þat neuer sal blyn, þou gar me fest mi  
skylle;  
Dat I þi lufe may wyn, of grace my thought þou fyllen.  
And made me cleue of syn, þat I may come þe tulle.

## LAMBETH MS.

Loue is lijf þat lastiþ ay  
Dere it is in crist made fest,  
Whanne wele ne wo it slake may,  
As writen han men wisest.  
De nyzt it turneþ in-to day,  
Traueile it turneþ in to rest:  
If þou wolt do as y þee say,  
Ðou schalt þanne be with þe best.

Loue is a þouzt with greet desir,  
And also of a fair loouynge; 10  
Loue y likne in-to a fier  
Dat slakeen may for no þing.  
Loue clensiþ us of oure synne,  
loue oure blis schal bringe,  
Loue þe kingis herte may wynne,  
loue of ioie euere may synge.

De socour of loue is lifid hie,  
For into heuen it ran;  
Me þenkiþ in herte þat it is sliþe,  
Dat makiþ þe peple hoþe pale & wan. 20  
De beed of blis it goiþ ful ny,—  
I telle þou it as y can,—  
Derof us þenkiþ þe wey to drie,  
For euere loue coupliþ god to man.

Loue is hetter þan þe cole  
To hem þat of it is fayn & frike,  
De flawme of loue, who myzte it þole,  
If it were euermore lijke:  
Loue us heliþ, & makiþ in qwart,  
And lifiþ us up in-to heuene-riche, 30  
And loue rauishiþ crist in-to oure herte,  
I wot nowhere no loue it is lijke.

<sup>1</sup> The stanza is there printed, however, *Ihesu* instead of *ihesu*.

Rote it in my hert, þe memor of þi pyne:  
 In sekeneſ & in quert þi lufe be euer myne;  
 My ioy es al of þe: my ſawle take it as þine;  
 My lufe ay waxand be, ſa þat it neuer dwyne

20

My ſang es in ſyghyng, whil I dwel in þiſ way;  
 My lyfe es in langyng, þat byndes me nyght & day,  
 Til I com til my kyng, þat I won with hym may,  
 And ſe his fayre ſchynyng, & lyfe þat laſtes ay.

Langyng es in me lent, for lufe þat I ne kan lete;  
 My lufe it haſe me ſchent, þat ilk a bale may bete.  
 Sen þat my hert was brent in Cryſte lufe ſa ſwete,  
 Al wa fra me es went: & we ſal neuer mete!

I ſytt & ſyng of lufe-langyng, þat in my hert es  
 bred:  
 Theſu my keyng & my ioynge, whyne war I to þe led?  
 Ful wele I wate in al my ſtate, in ioy I ſulde be fed:  
 Theſu me bryng til þi wonyng, for blode þat þou  
 haſe ſched.

30

Demed he was to hyng, þe faire aungels fode:  
 Ful ſare þai hym ſwyng, when þat he bunden ſtode,  
 His bak was in betyng, & ſpylt hys bliſſed blode,  
 De thorn corond þe keyng, þat nayled was on þe  
 rode.

Whyte was his naked breſte, & red his bloody ſyde,  
 Wan was his faire face, his woundes depe & wyde  
 De iew is wald not wande to pyne hym in þat tyde:  
 Als ſtreme does of þe ſtrande, his blode gan downe  
 glyde.

40

Leerne to loue if þou wolt lyue  
 Whanne þou ſchalt hens fare;  
 Al þi þouȝt to him þou zeue  
 Dat may þee kepe from care;  
 Loke þou þin herte fro him not twynne  
 Douȝ þou wandre euery where,  
 So þou may weelde him with-inne,  
 And loue him hertili euermore.

40

Theſu, þat me loue haſt lende,  
 In-to þi loue þou me bringe,  
 Take to þee al myn entente  
 Dat þou be to me myn ȝerninge,  
 And þat ſynne from me awei were went.  
 And loue come myn owne coucitynge,  
 Dat my ſoule hadde herd & hent  
 De ſonge of þi ſweete louyng.

Di loue is to us euerelaſtyng  
 Fro þat tyme þat we may verrili fele, 50  
 Derinne make we euere brennyng,  
 Dat no þing may uerrili keele.  
 Mi þouȝt, take it into þin hand,  
 And ſtable þou it ilke a dele,  
 Dat y be no þing hildande  
 To loue uerrili þe worldis wele.

If y loue ony erþeli þing  
 Dat þaiȝ to my wille,  
 And ſette my ioie in foule likinge,  
 Whanne it may come me tylle. 60  
 I may drede at my departyng  
 Dat it wole be attir & ille,  
 For alle my welþ is ben wepyng  
 whanne peyne my ſoule wolde ſpille.

60

De ioie þat men heere ſeen  
 Is ful likinge vnto þe iȝee;  
 Dat now is fair, freiſche, and grene,  
 And anoon attir is welkid away:  
 Dis is e world, alle men moun ſeen,  
 And wole be vnto domysday, 70  
 Ful greet traueile, & myche tene;  
 To flee þat is ful hard in fay.

70

If þou leue yuel in al þi þouȝt,  
 And hate þe filthe of ſynne  
 And ȝeue to him þat þee dere bouȝt,  
 Dat he weelde þee with-inne,  
 Al þi ſoule þi lord haȝ ſouȝt,  
 And þerof he wolde not mynne;  
 Dus ſchalt þou to bliſ be brouȝt,  
 And wonye heyene wiȝ-ynne. 80

80

Blynded was his faire ene, his flesh bloddy for-hette;  
His lufsum lyf was layde ful low, & saryful vmbesette.  
Dede & lyf began to stryf wheþer myght maystre  
mare,  
When aungels brede was dampned to dede to safe  
oure sauls sare.

Lyf was slayne & rase agayne, in faire-hede may  
we fare;  
And dede es broght til litel or noght, & kasten in  
endles kare.  
On hym þat þe boght, hafe al þi thoght, & lede þe  
in his lare;  
Gyf al þe hert til Crist þe qwert, & lufe hym euer-  
mare.

## X

(L)uf es lyf þat lastes ay, Ðar it in Criste es feste,  
For wele ne wa it change may, als wryten has men  
wyseste.  
De nyght it tournes in til þe day, þi trauel in tyll reste;  
If þou wil luf þus as I say, þou may be wyth þe beste.

Lufe es thoght, wyth grete desyre, of a fayre louyng;  
Lufe I lyken til a fyre þat sloken may na thyng;  
Lufe vs clenens of oure syn, lufe vs bote sall bryng;  
Lufe þe keynges hert may wyn, lufe of ioy may syng.

De settel of lufe es lyft hee, for in til heuen it ranne;  
Me thynk in erth it es sle, þat makes men pale and  
wanne.  
De bede of blysse it gase ful nee, I tel þe as I kanne,  
Ðof vs thynk þe way de dregh; luf copuls god &  
manne.

Lufe es hatter þen þe cole, lufe may nane be-swyke;  
De flawme of lufe wha myght it thole, if it war ay  
I-lyke?  
Luf vs confortes & mase in qwart, & lyftes tyl heuen-  
ryke;  
Luf rauysches Cryste in tyl owr hert, I wate na lust  
it lyke.

For-soþe þe kinde of loue is þis,—  
Þere it is trusty and trewe,—  
To stoonde euere in stablines,  
And chaunge neuere for no newe.  
Ðat wízt þat þat loue may finde,  
Or euere in herte it knewe,  
Fro care it turneþ þat kinde:  
Such a mirþe fyndiþ to fewe.

For-þi, loue þou as y þee rede;  
Crist is trewe loue, as y þe telle; 90  
Wiþ aungilis take þou þi stide;  
Ðat ioie loke þou not felle.  
In erþe hate þou no maner qweed,  
But loke þat þi loue may dwelle,  
For loue is more strengre þan deed,  
Loue is more harder þan helle.

Loue is list, & a birþun fyne;  
Loue gladiþ boþe þonge and oolde;  
Loue is wiþout ony pyne,  
As louers han me toolde. 100  
Loue is goostli deli-cious as wijn  
Ðat makiþ men boþe big & bolde;  
To þat loue y schal me so faste tyne,  
Ðat y in herte it euermore holde.

Loue is þe swettiste þing  
Ðat heere in erþe men may han;  
Loue is goddis owne derlinge;  
Loue byndiþ boþe blood & baan.  
In loue, þerfore, be oure likinge;  
I knowe no betere won; 110  
For me oonli, & my louynge,  
Loue makiþ boþe but oon.

But al fleischli loue schal fare  
As dooþ þe flouris of may.  
And schal be lastande na mare  
But as it were an hour of a day;  
And sorewen aftir þat ful sare  
Hir lust, her pride, & al her play,  
Whanne þei aren cast in care,  
In-to pyne þat lastiþ ay. 120

Whanne her bodies in þe fen liggen,  
Ðanne schulen her soulis be in drede,  
And up aʒen as men schulen risen,  
And answer for her mys dede.  
If þei be seen þan in synne,  
And now heere þer liif þei ledde,  
Ðan schulen þei ligge helle wiþ-inne,  
And derkenes haue to mede.

Lere to luf, if þou wyl lyfe when þou sall bethen  
fare.  
All þi thought til hym þou gyf, þat may þe kepe fra  
kare,  
Loke þi hert fra hym nocht twyn, if þou in wandreth  
ware,  
Sa þou may hym welde & wyn and luf hym euer-  
mare. 20

Ihesu þat me lyfe hase lent, In til þi lufe me bryng,  
Take til þe al myne entent, þat þow be my zhernyng.  
Wa fra me away wat went & comne war my couay-  
tyng,  
If þat my sawle had herd & hent þe sang of þi louyng.

Þi lufe es ay lastand, fra þat we may it fele:  
Dare-in make me byrnand, þat na thyng gar ti kele.  
My thought take in to þi hand, & stabyl it ylk a dele,  
Dat I be nocht heldand to luf þis worldes wele.

If I lufe any erthly thyng þat payes to my wyll,  
& settes my ioy & my lykynge when it may com me  
tyll,  
I mai drede of partyng, þat wyll be hate and yll:  
For al my welth es bot wepyng, when pyne mi saule  
sal spyll. 30

De ioy þat men hase sene, es lykend tyl þe haye,  
þat now es fayre & grene, and now wytes awaye.  
Swylk es þis worlde, I wene, & bees till domes-daye,  
All in trauel & tene, fle þat na man it maye.

If þou luf in all þi thought, and hate þe fylth of syn,  
And gyf hym þi sawle þat it boght, þat he þe dwell  
with-in:  
Als Crist þi sawle hase soght & þer-of walde night  
blyn,  
Sa þou sal to blys be broght, & heuen won with-in. 40

Riche men her hondis schal wrynge,  
And her wicked werkes abie 130  
In flawmes of fier bitterli brennyng  
Wiþ care and sorewe schamefastli.  
If þou wolt loue, þan may þou synge  
To þi lord crist in melodie:  
De loue of him ouercomeþ al þing;  
In loue lyue we & die.

Ihesu! god-is sone þou art,  
lord of moost hiȝ magiste,  
Sende verrili loue in-to myn herte  
Oonly to coueite þee! 140  
Reue me likinge of þis world,  
Mi loue þat þou may be;  
Take myn herte in-to þi ward,  
And sette þou me in stabilte!

Ihesu! þou, þe maidens sone,  
Dat with þi blood me bouȝte,  
Dirle my soule with þi spere anoon,  
Dat myche loue in men hast wrouȝt.  
Me longiþ þou lede me into þi siȝt,  
And fastne þere in þee my bouȝt; 150  
In þi swetnes make myn herte liȝt,  
Dat al my woo wexe to nouȝt.

Ihesu, my god & my loueli king!  
Forsake þou not my desir;  
Mi þouȝt make to be meekinge;  
I hate boþe pride & ire.  
Þi wil is al my desiryng;  
Of loue kyndeþe þou þe fier,  
Dat y with þi sweete louyng  
Wiþ aungils take myn hire. 160

Wounde þou myn herte wiþ-inne,  
And weelde me at þi wille;  
Of blis þat neuere schal blynne,  
þou fastne me þat y not stille.  
Dat y þi loue may wynne,  
Of grace my þouȝt þou fille,  
And make me cleene of synne  
Dat y may come þee tille.

Ihesu! putte in-to myn herte  
þe memorie of þi pyne! 170  
In sijknes, and eek in qwarte,  
þi loue be euere myne!  
Mi ioie is al of þee;  
My soule, take it as þine;  
Mi loue euere wexinge be,  
So þat y neuere dwynne.

De kynd of luf es þis, þar it es trayst and trew:  
To stand styll in stabylnes. & chaunge it for na new.  
De lyfe þat lufe myght fynd or euer in hert it knew,  
Fra kare it tornes þat kyend, & lendes in myrth &  
glew.

For now, lufe þow, I rede, Cryste, as I þe tell:  
And with aungels take þi stede-þat ioy loke þou  
nocht sell!  
In erth þow hate, I rede, all þat þi lufe may fell:  
For luf es stalworth as þe dede, luf es hard as hell.

Luf es a lyght byrthen, lufe gladdes zong and alde,  
Lufe es with-owten pyne, als lofers has me talde; 50  
Lufe es a gastly wynne, þat makes men bygge &  
balde,  
Of lufe sale he na thyng tyne þat hit in hert will  
halde

Lufe es e swetest thyng þat man in erth has tane,  
Lufe es goddes derlyng, lufe byndes blode & bane.  
In lufe be owre lykyng, Ine wate na better wane,  
Fore me & my lufyng lufe makes bath be ane.

Bot fleschly lufe sal fare as dose þe flowre in may,  
And lastand be na mare þan ane houre of a day,  
And sythen syghe ful sare þar lust, þar pryde, þar  
play,  
When þai er casten in kare, til pyne þat lastes ay. 60

When þair bodys lyse in syn þair sawls mai qwake  
& drede:  
For vp sal ryse al men and answer for þair dede;  
If þai be fonden in syn, als now þair lyfe þai lede,  
Ðai sal sytt hel with-in, & myrknes hafe to mede.

Riche men þair handles sal wryng, & wicked  
werkes sal by  
In flawme of fyre bath knyght & keyng, with sorrow  
schamfully.  
If þou wil lufe, þan may þou syng til Cryst in melody,  
De lufe of hym ouercoms al thyng, þarto þou traiste  
trewly.

My loue is euere in sijinge  
While y dwelle in þis way;  
Mi loue is in þee longyng,  
Ðat bindiþ me niȝt & day 180  
Tille y come vnto my king,  
Pere y wone with him may,  
And se his fair schynynge  
In lijf þat lastiþ ay.

Longinge is in me so lent  
For loue, þat y ne can lete;  
His oue he haþ me now sent  
Ðat euery bale may bete;  
Siþen þat myn herte was brent 190  
In cristis loue so sweete,  
Al woo fro me awei is went  
And we neuere aȝen schulen mete.

I sitte and syng of loue longyng  
Ðat in my brest is now bred.  
Ihesu, my king and my ioiynge!  
Whi ne were y to þee led?  
Ful weel y woot in al my ȝernyng,  
In al ioie, y schulde be fed.  
Ihesu! me bryng to þi woniynge,  
For þe blood þat þou hast bleed. 200

Demed he was on a crosse to heng,  
De fair aungelis foode;  
Wiþ scourgis þei gan him sore swing  
Whanne þat he bounden stode;  
His brist was bloo in betyng,  
Not spilt was his blood;  
De þorn crowned þat king  
Ðat doon was on þe roode.

White was his nakid breest,  
& reed his bloodi side, 210  
Wan was his face fairest,  
Hise woundis depe & wide.  
Dhe iewis wolde not þan reste  
To pyne him more in þat tide;  
Al he suffride þat was wisest,  
His blood to lete doun glide.

Blyndid were hise faire yȝen,  
And al his fleisch bloodi for-bete;  
Hise lousesum lijf al alle men siȝe [n],  
Ful myldeli he out gan lete. 220

Deed & lijf bigunne to striuen  
Wheþer myȝt be maister þere;  
Liif was slayn, & roos a-ȝen;  
In-to blis ful fair may we fare.  
He þat þee bouȝt haue al þi þouȝt  
And lede he it in to his loore;  
Ȝeue al þin herte to crist in qwarte,  
And so to loue him euermore.

Sygh & sob, bath day & nyght, for ane sa fayre  
of hew.  
Dar es na thynng my hert mai light, bot lufe, þat es  
ay new. 70  
Wha sa had hym in his syght, or in his hert hym  
knew,  
His mournyng turned til joy ful bryght, his sang in  
til glew.

In myrth he lufes, nyght & day, þat lufes þat swete  
chylde:  
It es Ihesu, forsoth I say, of all mekest & mylde.  
Wrreth fra hym walde al a-way, þof he wer neuer sa  
wylde:  
He þat in hert lufed hym, þat day fra eucl he wil hym  
schylde.

Of Ihesu mast lyst me speke, þat al my bale may  
bete.  
Me thynk my hert may al to-breke, when I thynk on  
þat swete.  
In lufe lacyd he hase my thought, þat I sal neuer for-  
gete:  
Ful dere me thynk he hase me boght, with blod  
hende & fete. 80

For luf my hert es browne to brest, when I þat  
faire behalde.  
Lufe es fair Dare it es fest, þat neuer will be calde.  
Lufe ve reues þe nyght rest, in grace it makes us  
balde;  
Of al warkes luf es þe best, als haly men me talde.

Na wonder gyf I syghand be & sithen in sorow be  
sette:  
Ihesu was nayled upon e tre, & al bloody for-bette;  
To thynk on hym es grete pyte, how tenderly he  
grette—  
Dis hase he sufferde, man, for þe, if þat þou syn wyll  
lette.

Dare es na tonge in erth may tell of lufe þe swet-  
nesse;  
Dat stedfastly in lufe kan dwell, his ioy es endlesse. 90  
God schylde þat he sulde til hell þat lufes & langand  
es,  
Or euer his enmys sulde hym qwell, or make his luf  
be lesse!

I siþe, y sobbe, boþe day & nyȝt,  
For oon þat is so fair of hue; 230  
Pere is no þing myn herte may liȝt  
But his loue þat is so true.  
Who so hadde him in his siȝte,  
Or in his herte him knewe,  
His moornyng schulde turne into ioie briȝt,  
His longyng into glewe.

In mirþe lyueþ he nyȝt & day  
Dat loue þat sweete childe;  
Wra þe wolde from him away,  
Were he neuere so wiede. 240  
It is ihesu, forsoþe to say,  
Of alle meekist & myelde;  
He þat in herte him loueþ þat day,  
From yuel he wole him schiede.

Of ihesu þanne moost list me speke,  
Dat may of al my bale be bote;  
Me þinkeþ myn herte wole al to-breke  
Whanne y þinke on þat soote.  
In loue lauȝt he haþ my þouȝt,  
Dat y schal neuere for-lete; 250  
Ful dere me þinkeþ he haþ me bouȝt,  
Wiþ bloodi heed, hondis, & feete.

For loue myn herte wole to-berste  
Whanne y þat fair loue biholde;  
Loue is ful fair Dere it is fest,  
Dat neuere wole be coolde  
Loue us reueþ þe nyȝtis rest;  
In grace it makijþ us boolde;  
Of alle wekis loue is þe beeste,  
As holi men he haþ tolde. 260

No wondir if y siȝhande be,  
And siþen in woo al bi-sett;  
Ihesu was nailid upon þe tree;  
Ȝhe, al bloody for-beet.  
To þinke on him is greet pitee,  
To se how tenderli he gret;  
Dis haþ he sufride, man, for þee,  
If þat þou wolt þi synnes leett.

Dere is no lijf in erþe may telle  
Of þis loue þe swetnes: 270  
Dat stidefastli in loue can dwelle,  
His ioie is euere cendeles.  
God schiede þat he schulde to helle,  
Dat of loue longinge kan not ceesse,  
Or cuere hise enemes schulde him qwelle,  
Or þat he so his loue schulde lese.

Ihesu es lufe þat lastes ay: til hym es owre langyng;  
 Ihesu þe nyght turnes to þe day, þe dawying in til  
 spryng.  
 Ihesu, thynk on vs, now & ay: for þe we halde oure  
 keyng;  
 Ihesu, gyf vs grace, as þou wel may, to luf þe with-  
 owten endyng.

Ihesu is þe loue þat lastiþ ay,  
 To him is oure longinge.  
 Ihesu þe nyȝt turneþ to day,  
 And derknes in-to day spryng. 280  
 Ihesu! þinke on us now and ay,  
 For þec we holde oure kyng!  
 Ihesu, ȝeue us grace þat weel may,  
 To loue þe with oute eendyng!—

A-M-E-N.

The most remarkable lines in the poems, *Cambr.* IX, lines 37 and 38, *Lamb.*, lines 209-212, have their origin in the *Meditation of St. Augustine*. They very obviously correspond to the lines edited by Furnivall with the following remarks: <sup>1</sup>

“In the 1866 issue of the stereotyped edition of Mr. Craik’s *Compendious History of the English Language*, v. 1, p. 193, is the following passage quoted from Sir Frederic Madden’s Preface to *Havelok*: ‘Between the years 1244 and 1258, we know, was written the versification of part of a meditation of St. Augustine, as proved by the age of the prior who gave the MS. to the Durham Library, MS. Eccl. Dun. A. iii. 12, and Bodl. 42.’ On my applying to the Librarian at Durham for further information about this piece of verse, the Rev. W. Greenwell answered: ‘It is upon a small piece of vellum, inserted, and forms no part of the original volume. I send you a correct copy.’ The Rev. H. O. Coxe, Bodleian Librarian, has also kindly sent me a copy of the Bodleian version, which I print side by side with the Durham one. Mr. Coxe dates the Oxford copy at from 1300 to 1320 A. D.

“MS. Eccl. Dun. A. iii. 12.

“Wyth was his halude brest  
 and red of blod his syde  
 Bleye was his fair handled  
 his wund dop ant wide

And his arms ystreith  
 hey up-hon e rode  
 On fif studes on his body  
 De stremes ran o blode.

“MS. Bodl. 42, fol. 250.

“Wit was his nakede brest  
 and red of blod his side  
 Blod was his faire neb  
 his wnden depe an uide.

Starke waren his armes  
 Hi-spred opon þe rode  
 In fif steden in his bodi  
 Stremes hurne of blode.”

<sup>1</sup> *Polit., Relig., and Love Poems*, E. E. T. S., p. 243.

## EXTINCT GLACIERS OF COLORADO

By JUNIUS HENDERSON

Although it seems quite probable that the ancient glaciers which have so profoundly modified the alpine regions of Colorado were coexistent with the great continental ice-sheet of the Glacial Epoch, which buried the Upper Mississippi Valley beneath a thick mantle of glacial drift, yet it can hardly be said that there is any direct, positive proof of it; and, even if the glaciers were synchronous, they seem certainly not to have been territorially connected. A glance at the geological map will show that Colorado is not within the limits of the continental ice-sheet as indicated by the lateral and terminal moraines, and there is abundant evidence that the mountain glaciers radiating from the alpine regions covered only a comparatively small portion of the state. There is no evidence of general glaciation, the greater part of the state being free from recognizable glacial phenomena. If it should be considered settled that the ancient mountain glaciers of Montana were connected with the continental glacier in point of time and space, it would merely add to the probability, but not actually demonstrate, that the same was true of the southern Rockies, for the glaciated areas of Colorado were isolated, not only from each other, but from the more northern areas, by wide stretches of unglaciated country.

Cross and Howe say: "It is commonly believed by specialists that the recognizable glaciation of the Colorado mountain region belongs to the latest main stage of the Glacial Epoch known as the 'Wisconsin Stage.' Evidence of more ancient stages has been observed in the Wasatch and Uinta Mountains of Utah, and elsewhere, and it is thought that an interval of great erosion preceded the Wisconsin stage."<sup>1</sup>

The conclusion as to the stage is largely a matter of inference, rather than direct evidence, but it is so reasonable as to force itself emphatically upon the attention.

Owing to the fact that mountain glaciers in cirques and valleys

<sup>1</sup> *Silverton Folio*, No. 120, p. 24, Geol. Atlas, U. S. Geol. Sur.

having precipitous walls not covered thickly with *névé* or ice, and consequently abundantly supplied with rock material, build their moraines rapidly and shrink, extend or change the shapes of their fronts quickly in response to fluctuations in the relation of precipitation to temperature, extreme caution is necessary in deducing successive widely separated periods of glacial extension and recession from the interference and crossing of distinct moraines. However, there is evidence of a much more reliable nature indicating at least two such periods near Leadville,<sup>1</sup> with a suggestion of a third.<sup>2</sup> It is exceedingly probable that as minute an examination in other parts of the state would bring forth further evidence of a trustworthy character, such as difference in material and amount of weathering of morainal matter, and indications of long periods of erosion between superincumbent and superimposed deposits.

A visit long ago to some unglaciated portion of the state led a writer in a responsible magazine to deny the existence of any evidence of the former presence of glaciers in the Rocky Mountain region<sup>3</sup>—an excellent illustration of the danger of generalization from limited knowledge of a region. Another writer, answering the first, was apparently able to point out but little evidence from the great abundance now known to science.<sup>4</sup>

It is true that the plains of the eastern portion of the state, the foothills and the lower portion of the mountain ranges seem wholly devoid of indisputable evidence of the former existence of glaciers, the ice streams having generally extended but little, if any, below what is now the 8,000-foot line, though whether the altitude was the same during the period of their maximum extension may be doubted.

There are beds of boulders in the Denver Basin which have been designated "glacio-natant drift" and "upland drift."<sup>5</sup> The explanation of these deposits suggested by those terms does not seem satisfactory, or, at best, other explanations seem just as satisfactory; so their origin

<sup>1</sup> *Second Annual Rept., U. S. Geol. Sur.*, p. 229; *12th Mon., U. S. Geol. Sur.*, p. 30; *Jour. Geol.*, Vol., XIII (1905), pp. 285-306.

<sup>2</sup> *Jour. Geol.*, Vol. XII (1904), p. 702.

<sup>3</sup> *Am. Nat.*, Vol. VI (February, 1872), pp. 73-75.

<sup>4</sup> *Ibid.* (May, 1872), p. 310.

<sup>5</sup> *Geology of the Denver Basin*, 27th Mon., U. S. Geol. Sur., pp. 265, 266.

is an open question. In the same basin a very important deposit of fine silt or loess is found.<sup>1</sup> Similar deposits in other parts of the world have been variously ascribed to subaërial, glacial, or glacio-aqueous origin. The Denver Basin loess is apparently continuous with that which extends across Nebraska and Kansas practically to the Missouri, and perhaps with that of Iowa and adjoining states. It overlaps glacial drift in Lancaster County, Nebraska.<sup>2</sup> There is some difficulty in assuming a body of water of sufficient size to furnish a settling reservoir for the detritus brought down by streams from beneath the ancient mountain glaciers or the continental glacier and spread it over such a large territory. Formation by dust blown across the mountains from the arid Great Basin is equally objectionable, as in such case many of the mountain valleys would have caught and held similar deposits. To one familiar from long association with the windstorms of the Great Plains and foothill region, æolian processes seem fully efficient to produce such formations on the largest scale. Every such storm which sweeps down from the mountains carries out to the plains many tons of finely divided materials, to be again picked up by the next storm and borne farther away, and being continually ground finer and finer. This process has been going on for ages, and the aggregate in the course of even a few centuries is of considerable importance; but of much greater moment is the work the winds have been performing for ages, assisted by streams, frost, chemical solution, alternating heat and cold, and other forces, in the disintegration, destruction and redeposition of the Tertiary formations of the plains. Since those formations were first exposed to atmospheric influences there has been time enough for the rocks to be disintegrated, and their component materials to be worked over and over by wind and water, until left in their present condition. The exact origin of the loess may never be definitely known, but surely the solution of the problem is well worth striving for. Whatever may be the ultimate conclusion, it cannot affect the statement that the glaciers of the Colorado Rockies did not extend to the plains, so far as the evidence goes.

<sup>1</sup> *Ibid.*, pp. 41, 258, 278.

<sup>2</sup> *Geology and Underground Waters of the Central Great Plains*, 32d Prof. Paper, U. S. Geol. Sur., p. 138.

Absence of county lines, towns, government subdivisions, and other useful data from early maps, vagueness in the designation of localities in early reports, and unstable nomenclature of streams and mountains, together with positive contradiction of maps by text in some instances, have made it difficult accurately to locate some glacial areas without a personal visit, which has been impractical. It seems certain, however, that the work of ancient glaciers has been reported in at least twenty-two of the fifty-nine counties of the state, as follows: Archuleta, Boulder, Chaffee, Clear Creek, Conejos, Dolores, Gilpin, Grand, Gunnison, Hinsdale, Lake, La Plata, Larimer, Montezuma, Ouray, Park, Pitkin, Routt, San Juan, San Miguel, Summit, Teller. There are also some remarks in the reports from which glaciation might be inferred in Custer, Fremont, Huerfano and Saguache Counties, and it is, of course, entirely possible that some reports may have been overlooked through faulty indexing and cataloguing of the literature of the subject. The easternmost area is the Pike's Peak region, near the center of the state from east to west, thus cutting out the entire eastern half of the state. The areas in some of these counties are very limited, in others more extensive; but probably the glaciers did not extend over the whole surface of a single county. These areas aggregate several hundred square miles. In the Leadville region alone a single party has somewhat carefully studied 250 square miles of glaciated territory,<sup>1</sup> and it is probable that in the Arapahoe and Long's Peak region there are at least 500 square miles of glaciation, practically continuous; but the aggregate is small compared with the total area of the state, about 103,925 square miles. It is not at all likely that all of the areas have yet been reported, and certainly few have been exhaustively studied. Probably a careful examination would reveal some evidence of glaciation in the vicinity of all mountains in Colorado which rise above 12,000 feet, and at least one place is reported where a glacier originated at an altitude of 11,000 feet. They generally occupied pre-existing valleys, changing the cross-sections from the V-shape characteristic of rapid stream erosion to the U-shape of glacial valleys, their work being confined to modifying rather than making valleys. Some of them reached a length of twenty miles

<sup>1</sup> *Jour. Geol.*, Vol. XII (1904), p. 698.

or more, but in the region most familiar to the writer they seldom extended more than ten or twelve miles from the top of the range.

The comparative recency of their retreat is attested by the freshness of their work in the upper courses, the fact that the small residual glaciers and *névés* are still shrinking, and the fact that the streams have deepened their channels but little since the ice disappeared. The subsequent modification, while plainly apparent, is superficial. The sides of mountain moraines are usually quite steep as a result of rapid building, hence are subject to rapid modification by erosion, and the metamorphic rocks constituting most of the mountain heights are easily disintegrated by atmospheric agencies, so that the rounded surfaces are soon broken up and the polish erased, making the glacial work in the lower portions of the valleys look much older than the upper portions, the apparent difference in age being perhaps greater than the real difference.

Lakes of various sizes, both rock basin and morainal, abound in the upper portion of the glacial valleys, those formerly existing in the lower portions having been filled or drained by the various agencies always laboring for the destruction of all lakes.

*Roches moutonnées* form prominent features of the landscapes and are much fresher in the upper valleys, where the disappearance of the ice has been so recent that vegetation has not yet been able to re-establish itself. Owing to the extreme ease with which gneiss and coarse granite are weathered, polished knobs and scratched boulders are not common. The best examples seen by the writer are in Camp Albion Gulch, north-east of Arapahoe Peak; but why they should be fresher than on the same kind of rocks in the same zone in adjoining gulches has not been satisfactorily explained, unless that glacier has retreated much more recently and rapidly than the others. The lack of morainal matter also suggests rapid retreat. There is no evidence that the polished rocks have been covered so as to prevent weathering.

The discussion of existing glaciers is not within the scope of this paper, and is therefore left to some future paper.

Following is a list of publications bearing upon the present subject, for the benefit of those who desire more detailed information:

- King's Survey of the Fortieth Parallel*, Vol. I, pp. 467, 486, Pl. V.  
7th, 8th, and 9th Annual Reports, Hayden Survey (1873, 1874, 1875).  
*Hayden's Geological and Geographical Atlas of Colorado*, Sheets No. 12, 13, 15, and 16.  
"Pike's Peak Folio," No. 7, *Geological Atlas, U. S. Geol. Sur.*, p. 5.  
"Ten Mile District Folio," No. 48, *Geol. Atlas, U. S. Geol. Sur.*, p. 2.  
"Telluride Folio," No. 57, *Geol. Atlas, U. S. Geol. Sur.*, pp. 9, 15.  
"La Plata Folio," No. 60, *Geol. Atlas, U. S. Geol. Sur.*, p. 6.  
"Silverton Folio," No. 120, *Geol. Atlas, U. S. Geol. Sur.*, p. 24.  
"Geology of Rico Mountains," *21st Ann. Rept., U. S. Geol. Sur.*, Pt. 2, p. 156.  
"Geology and Mining Industry of Leadville," *2nd Ann. Rept., U. S. Geol. Sur.*, p. 228;  
*Mon. U. S. Geol. Sur.*, Vol. XII, pp. 30, 128.  
"Geology of the Denver Basin," *Mon. U. S. Geol. Sur.*, Vol. XXVII, pp. 41, 265, 278.  
"Geology of the Aspen Mining District," *Mon. U. S. Geol. Sur.*, Vol. XXXI, pp. 244-250.  
"The Glacial Gravels and Their Associated Deposits" (containing a chapter on the extinct glaciers of Colorado), *Mon. U. S. Geol. Sur.*, Vol. XXXIV, pp. 338-355.  
"The Mountains of Colorado," *American Naturalist*, Vol. VI, pp. 65-75.  
"Glaciers in the Rocky Mountains," *American Naturalist*, Vol. VI, p. 310.  
"The Twin Lakes Glaciated Area, Colorado," *Journal of Geology*, Vol. XIII, pp. 285-312.  
(Refers to paper by Professor Davis in *Appalachia*, November, 1904, which the writer has not examined.)  
"Pleistocene Geology of the Sawatch Range, near Leadville," *Journal of Geology*, Vol. XII, pp. 698-706.  
"The Las Animas Glacier," *Journal of Geology*, Vol. I, pp. 471-475.  
"Extinct Glaciers of the San Juan Mountains," *Proc. Colo. Sci. Soc.*, Vol. I, pp. 39-46;  
*American Journal of Science*, Vol. XXVII, pp. 391-396.  
"Arapahoe Glacier," *Journal of Geology*, Vol. VIII, p. 647; Vol. X, p. 839; Vol. XII, p. 30.  
"Hallett Glacier," *Science*, Vol. X, p. 153.

# CONTRIBUTIONS TO THE NATURAL HISTORY OF THE ROCKY MOUNTAINS. I

BY T. D. A. COCKERELL

## ARACHNIDA

### A RARE SPIDER AT WARD, COLO.

Ortmann, writing on the distribution of crayfishes (*Cambarus*), remarks that a common and widely distributed species will often have distinct but allied species occupying smaller areas about the boundaries of its range. *Steatoda borealis* Hentz, a spider of the family Theridiidae, is such a widely distributed form; and in our region has been found at Fort Collins and West Cliff, Colo., and in the White Mountains of New Mexico. At Albuquerque, N. M., Mr. Soltau discovered a new species, *S. grandis* Banks, allied to *S. borealis*. This *S. grandis* has since been found in California, where it is the only known *Steatoda*; so it doubtless has a wide range in the Southwest. From Colorado, Thorell long ago described another species, *S. distincta*, collected at Manitou. This has remained very little known, but I was so fortunate as to rediscover it last July at Ward, the specimen having been identified by Mr. N. Banks. As Ward has an altitude of about 9,000 feet, the species is probably characteristic of the mountains.

### AN ADDITION TO THE SPIDERS OF NEW MEXICO

*Ariadne bicolor*, determined by Mr. N. Banks, was collected by Mrs. Cockerell and Miss Mary Cooper at San Geronimo, N. M., a few years ago. This adds a species, genus, and family (Dysderidæ) to the fauna of New Mexico. Since the publication of the list of New Mexico Arachnida,<sup>1</sup> Mr. Banks has described as new two spiders collected by myself: *Lycosa apicata* from Las Vegas and Las Cruces, and *Syspira pallida* from Mesilla Park.

## COLEOPTERA

### BETLES NEW TO COLORADO

An admirable list of the beetles of Colorado, by Professor H. F. Wickham, appeared in the *Bulletin of the Laboratories of Natural History* of the Iowa State University, in 1902. Mr. H. C. Fall has kindly identified a few beetles which I have recently collected in Colorado, and some of them appear to be worthy of record. The most interesting is a Carabid, *Bradycellus californicus* Leconte, found at Ward, 9,000 feet. This is a Californian species, quite unexpected in Colorado. Mr. Fall writes concerning the matter: "*B. californicus* and *B. tantillus* cover the country between them. The two are with difficulty separable and are quite likely not distinct. The Ward example is certainly not separable from Californian specimens in my collection."

*Oxaxis bicolor*, collected at Boulder, is new to Colorado, being the fourth species of *Ædemeridæ* in the list. The genus, which is also new to the list, is southern, and has three species in New Mexico.

<sup>1</sup> BANKS, *Proc. Acad. Nat. Sci., Phila.*, 1901.

*Neolytus approximatus* Leconte, is to be recorded from Boulder. The only previous Colorado record was Morrison (Osler).

*Orphilus ater*, found at Halfway House, Pike's Peak, is new for Colorado.

*Languria lata* Leconte, from Boulder, was only known previously in Colorado from near Fort Collins.

*Disonycha triangularis* Say, was obtained at Windy Point, Pike's Peak, 12,230 feet. This is much higher than the previous records.

## COCCIDÆ

### THE GENUS TRIONYMUS, BERG, IN COLORADO

Although the Coccidæ have such limited means of locomotion, many of the genera are exceedingly widely distributed. In a number of cases, this can be readily explained by the fact that they are carried from place to place on cultivated plants; but in other instances no such explanation will suffice. The small genus *Trionymus* contains at present four species, one found in France, one in Russia, one in the District of Columbia, and the fourth was discovered last year at Boulder, Colo., by Mrs. Cockerell. It may be that these insects are not all genetically related, but represent "convergent evolution," due to similar modes of life; but if this is the case, we have at present no proof of it. The Colorado species has been described as *T. nanus* Ckll. It is hardly  $1\frac{1}{2}$  mm. long, narrow, very pale yellowish, with yellowish secretion. It occurs under rocks in open grassy places. The microscopic measurements (all in  $\mu$ ) are as follows: Antennal joints: (1) 22, (2) 22, (3) 18, (4) 16, (5) 12, (6) 17, (7) 56. Labium: length about 75, breadth about 47. Anterior leg: femur+trochanter, 97; tibia, 50; tarsus (excl. claw), 40.

### THE GUTIERREZIA MEALY-BUG AT BOULDER

*Gutierrezia* is a small perennial composite plant, exceedingly common in New Mexico, and extending northward even to Montana. In New Mexico it was found to be commonly infested by a small mealy-bug (*Pseudococcus gutierrezia* Ckll.), easily recognized by the conspicuously white linear ovisac. This insect is now found to occur also in Colorado, as I collected specimens this year in Boulder, near the Sanitarium. It must be regarded as one of the distinctly austral elements which so plentifully mingle with the boreal types along the eastern base of the mountains, and which to my mind forbid the extension of the Transition zone so far east in Colorado as Dr. Merriam's map<sup>1</sup> shows. In the nature of things, this question of the limits of the Transition zone must remain largely a matter of opinion; but while the lower front of the mountains is unquestionably Transition, it seems to me that the austral forms approach the flanks of the range in such force as to entitle most of the country east of Boulder to be regarded as veritable Upper Austral. The females of *P. gutierrezia* collected at Boulder were found to be much infested by a parasitic fungus, which should be further investigated.

### A NEW COTTONY SCALE ON ROSE

In August, 1904, Mr. E. Bethel discovered a cottony scale on twigs of wild rose at Coulter, Middle Park, Colo. The female insects are rather dark brown,  $2\frac{1}{2}$ - $2\frac{3}{4}$  mm. long,  $2\frac{1}{4}$ - $2\frac{1}{2}$  broad, with a conspicuous white ovisac. Microscopical examination shows that the antennæ are eight-jointed, and that the species is in many ways similar to *P. amygdali*

<sup>1</sup> Bull. 10, Div. of Biological Survey.

Ckll., which occurs on peach. It is, however, certainly distinct, as the skin of *P. amygdali* is full of large round and oval hyaline spaces, which are not present in the Coulter insect; the latter has numerous small gland orifices, about 5-7  $\mu$  in diameter, each containing a small central dot. The antennæ also differ; for instance, in *P. amygdali* the second joint is 40  $\mu$  or less in length; in the Coulter insect it is 50. There are also differences in the legs. The rose cottony scale has accordingly been described as *Pulvinaria coulteri*.

## HYMENOPTERA

## NEW RECORDS OF COLORADO BEES

In the genus *Nomada* the males are often so unlike the females that it is difficult to match them. The male described below very nearly became the cause of a synonym, but fortunately the error was detected.

*Nomada (Xanthidium) collinsiana* Ckll.

♂ Length about 10 mm, some slightly more. In my table of Rocky Mountain species, it runs straight to *N. luteopicta*, but that is a much smaller species, and otherwise different. Head and thorax black, coarsely and as densely punctured as is possible, and clothed with rather long fox-red pubescence, the face, however, not being at all concealed by hair; eyes in life olive-green; head rather broad, the vertex strongly convex, clypeus prominent, facial quadrangle broader than long; clypeus except rather broad upper margin, triangular lateral face-marks (ending in a sharp point some distance below the level of antennæ), a narrow line under eye (not going up the cheeks), basal two-thirds of mandibles, and the rather stout scape in front, all bright lemon-yellow; first joint of labial palpi longer than the other three altogether; flagellum stout, black above and bright ferruginous beneath, the joints oblique and very distinct, not denticulate; labrum yellow; thorax entirely black, except that most of the tubercles, and a small spot on anterior part of pleura (not always present) are yellow; tegulæ yellow, with a reddish-hyaline margin and discal spot; wings yellowish, dusky at apex, stigma ferruginous, nervures fuscous; basal nervure going a short distance basad of t. m.; second s. m. higher than broad, receiving the first r. n. about its middle; legs black, yellow, and red; the hind coxæ, trochanters, and femora nearly all black, except a broad, dull reddish stripe, ending in a squarish yellow patch, on hind femora in front; hind tibiæ and tarsi red, the former with a yellow mark at end; anterior and middle femora yellow and red in front, behind black and red, with a yellow apical mark; anterior and middle tibiæ red and yellow, with a black mark behind; abdomen fusiform, dullish with a minutely tessellate surface, very bright lemon-yellow, with the basal half of the first segment (sending a projection backwards in the middle line) and the extreme (mostly overlapped) bases of the other segments, black; broad apical margins of segments 1 to 5 brown-black; apex with some fox-red hairs; apical plate ferruginous with black edges, narrow, and only faintly notched; venter with four extremely broad, entire bright yellow bands, and a yellow apical spot. Third antennal joint very much shorter than fourth.

Var. a. Apical plate of abdomen black, broader, and strongly notched.

*Hab.*—Boulder, Colo., abundant at flowers of *Ribes cereum*, flying along with males of *Andrena leptanhi* V. & C., which it resembles in the pubescence; April 29, 1905 (W. P. and T. D. A. Cockerell). This was taken for a new species, but the day following my wife took a female, which proved to be *N. collinsiana*, hitherto known only in the ♀ sex. The female, when quite fresh, has the same red hair on the head and thorax as the male.

The following new locality-records are interesting for various reasons:

*Spinoliella zebrata* (Cresson). Alamosa, Colo., Aug. 6, 1903 (S. A. Johnson). ♂, ♀. One male was taken "over Spanish peas, in meadow." This species was previously known only from a single female reported vaguely from "Colorado."

*Melanostelis pulchra* (*Stelis pulchra* Crawford, 1902); variety with dark flagellum and tegulae. Boulder, Colo., at flowers of a small vinelike *Astragalus*, June 12, 1905 (W. P. Cockerell). New to Colorado; previously known only from Nebraska.

*Halictus lerouxii* var. *ruborum* Ckll. (new to Colorado), *H. armaticeps* Cresson, and *H. pruinosus* Rob., all females, were taken by my wife at flowers of *Berberis repens* at Boulder, April 6, 1905.

*Perdita affinis* Cresson, ♀ (a small specimen), was found on a petal of *Argemone intermedia* at Boulder, June 24. It does not normally visit *Argemone*, and presumably its presence there was accidental.

*Gnathias lepida* (Cresson), ♀, was found May 24, on the campus of the University of Colorado, at flowers of *Drymocallis*. It had been captured on the flower by a grayish Thomisid spider.

*Bombomelecta fulvida* (Cresson). Boulder, May 17, 1902 (S. A. Johnson); Virginia Dale, June 19, 1901 (Colorado Exper. Station).

*Melecta miranda* Fox. Denver, June 8, 1901 (S. A. Johnson); Salida, Oct. 8, 1898 (C. P. Gillette); Fort Collins, July 8, 1904, bred from cells of *Anthrophora occidentalis* by S. A. Johnson.

*Pseudopanurgus athiops* (Cresson). Glenwood Springs, Sept. 15, 1903 (C. P. Gillette).

*Dieunomia xerophila* Ckll., ♂. Sterling, at sunflowers (S. A. Johnson). New to Colorado; previously known from New Mexico.

*Prosopis basalis* Smith, ♂. Steamboat Springs, August 6, 1904, on flowers below town along river, altitude 6,700 feet (S. A. Johnson). At the same time and place Mr. Johnson also took *Megachile manijesta* Cresson.

## FLOWERING PLANTS

### NEW MEXICO WEEDS

Few persons who have not paid especial attention to the matter realize the extent to which our flora is invaded by aliens. This is especially the case, of course, in towns and cultivated fields; and is best appreciated when one comes to examine land which has been disturbed and yet not occupied by any crop. At Las Vegas, N. M., the campus of the Normal School was thoroughly gone over, the surface being plowed and scraped, and altered to make suitable levels and slopes, so that no sign of the original rather scanty vegetation remained. During the last week of September, 1902, finding that the fallow ground had produced a new and rather varied flora, I collected everything growing there, finding the following species:

(1) Aliens from Europe: *Melilotus alba*, *Salsola tragus*, *Chenopodium album viride*, *Plantago major*, *Malva rotundifolia*, *Polygonum raiyi*, *P. persicaria*, *Chatochloa viridis*, *Hibiscus trionum*=9 species.

(2) Aliens from the South and Tropics: *Ipomoea hederacea*, *Panicum colonum*, *Amaranthus graecizans*=3 species.

(3) Aliens escaped from cultivation: *Medicago sativa*, *Pisum sativum*, *Zea mays*, *Avena sativa*, *Hordeum vulgare*, *Citrullus citrullus*=6 species.

(4) Natives of New Mexico: *Solanum elaeagnifolium*, *S. rostratum*, *S. triflorum*, *Chamaesaracha coronopus*, *Gartneria tenuifolia*, *Iva xanthiifolia*, *Xanthium commune*, *X. commune wootoni*, *Verbesina exauriculata*, *Grindelia inornata*, *Helianthus annuus*, *Cosmos parviflorus*, *Dysodia papposa*, *Bahia oppositifolia*, *Salvia lanceolata*, *Boucloua* 2 spp., *Amaranthus chlorostachys*, *Verbena bracteosa brevibracteata*, *Malvastrum cockerelli*, *Gaura coccinea*, *Spharalcea cuspidata*, *S. fendleri lobata*, *Crassina grandiflora*, *Gutierrezia sarothrae*, *Leptilon canadense*, *Eriocarpum spinulosum*, *Teucrium laciniatum*, *Ratibida tagetes*, *Stipa vaseyi*=29 species. Some of these, like the *Xanthium* and the *Leptilon*, may be aliens to the immediate region, which have established themselves so firmly that they cannot be distinguished from natives.

It would probably be worth while for botanists more frequently to put such facts as the above on record; for, although they appear insignificant taken singly, they would, if sufficiently numerous, afford valuable historical materials at a later date. Already it has become in some instances difficult to distinguish aliens from natives, because we lack information concerning past conditions. A list of the weeds growing under such conditions as the above in Las Vegas fifty years ago would be decidedly interesting; and fifty years hence it will be no less interesting to compare the weed-flora of the locality with that now recorded.

For an interesting discussion of plants growing on denuded areas, see Wallace's *Island Life*, 2nd Edn., pp. 513-15.

#### THE FLORA OF WARD, COLORADO

We are accustomed to think of the flora of our higher mountains as being entirely of a boreal type, but a careful analysis of the genera represented shows that this is not actually the case. In the Andes the fauna and flora of high elevations appear to have been derived from the surrounding lower lands,<sup>1</sup> whereas in the Rocky Mountains the circumpolar elements are so conspicuous that we are apt to forget the existence of any others. It is nevertheless a fact that southern and peculiarly American types do invade the mountain heights, one conspicuous genus, *Rydbergia*, being even characteristic of the Arctic-Alpine zone, though its allies are found in the species of *Hymenoxys*, a genus extending even to South America, and not known in the Old World.

When recently at Ward (alt. about 9,000 feet), I made a list of all the genera of flowering plants, exclusive of grasses and sedges, that I saw. It is not to be supposed that the list is complete for that locality, but it is sufficiently so to be highly characteristic. Ward is in the upper part of the Canadian zone, and yet an analysis of the flora gives the following results:

(1) Boreal or Circumpolar genera: *Aquilegia* (*A. carulea*), *Fragaria*, *Ribes*, *Dasi-phora* (*D. fruticosa*), *Campanula* (*C. rotundifolia*), *Epilobium*, *Chamaenerion*, *Nuphar* (*N. polysepalum*), *Rumex* (*R. salicifolius*), *Polygonum*, *Achillea*, *Pinus*, *Chenopodium*, *Artemisia*, *Senecio*, *Geranium* (*G. fremontii*), *Carduus*, *Arctostaphylos* (*A. uva-ursi*), *Rosa* (*R. sayi*), *Juniperus*, *Salix*, *Antennaria*, *Sambucus*, *Populus* (*P. tremuloides*) *Ranunculus*, *Bursa* (*B. bursa-pastoris*, no doubt introduced), *Urtica*, *Potentilla*, *Taraxacum* (*T. taraxacum*), *Trifolium* (*T. pratense* and *repens*, introduced), *Galium*, *Anemone*, *Pulsatilla*,

<sup>1</sup> Cf. BATES in the Appendix to Whympers work on his travels among the Andes of Ecuador.

*Scrophularia*, *Rubus* (*R. stigosus*), *Aragallus*, *Allium*, *Erigeron*, *Prunus*, *Astragalus*, *Acer* (*A. glabrum*), *Picea*, *Vaccinium*, *Arenaria*, *Betula*, *Arabis*, *Saxifraga*, *Draba*, *Mertensia*, *Gentiana*, *Solidago*, *Erysimum* (*E. alpestre*), *Thermopsis* (extends to Asia, but not to Europe), *Sedum* (*S. stenopetalum*),<sup>2</sup> *Lupinus* (not typically boreal), *Halerpestes* (extends to Asia and S. America), *Claytonia* (mainly American), *Capnoides*, *Androsace*, *Polygonum* § *Bistorta*, *Elephantella* (*E. groenlandica*), *Pedicularis* (*P. grayi*)=60 genera.

(2) American genera, nearly all, at least, austral types: *Calochortus* (*C. gunnisoni immaculatus*; Pacific Region genus), *Grindelia* (extends to Peru and Chile), *Gaillardia* (*G. aristata*; genus extends to South America), *Gayophytum* (*G. ramosissimum*; genus extends to South America), *Castilleja* (Western and Southwestern), *Rudbeckia* (extends to Mexico), *Gilia* (*G. pinnatifida*), *Pentstemon*, *Frasera* (Western), *Eriogonum*, *Chrysopsis*, *Phacelia* (*P. circinata*), *Phacelia* § *Eutoca* (*P. sericea*), *Symphoricarpos*, *Edwinia*, *Drymocalis*, *Ceanothus* (*C. lævigatus*), *Zygadenus* (but genus has one species in Siberia), *Agoseris* (*A. aurantiaca*; genus extends to South America), *Dodecalheon* (but extends to Asia; perhaps should be treated as boreal), *Machæranthera*, *Oreocarya*, *Thelypodium*, *Distegia*=23 genera.

*Distegia*, Raf., has been considered part of *Lonicera*, but it is a characteristic endemic American type, apparently of generic value. It consists of the following forms: *D. involucrata* (*Lonicera involucrata* Banks), *D. involucrata serotina* (*L. involucrata v. serotina* Koehne), *D. involucrata humilis* (*L. involucrata humilis* Koehne), *D. flavescens* (*L. flavescens* Dippel), and *D. ledebourii* (*L. ledebourii* Esch.). The range is from New Mexico to Alaska, east to Quebec and west to California.

The few day-flying Lepidoptera noticed at Ward were all of boreal types; namely, *Colias* (*C. eurytheme*, *C. alexandra*, *C. alexandra* var. *alba*), *Pyrameis* (*P. cardui*, an almost cosmopolitan species), *Chrysophanus*, *Lycæna*, *Pieris*, and *Autographa*.

Two small ichneumon-flies collected at Ward were sent to Dr. W. H. Ashmead, who will describe them as new species of the genera *Bathynictis* and *Catantenus*.

<sup>2</sup> The recently published *Sedum subalpinum* Blankinship, is probably identical with *S. stenopetalum rubrolineatum* Ckll., 1891. It is hardly to be considered a distinct species, I think; and I learn from Dr. Britton that he also doubts its validity.

VOLUME III

NUMBER 2

THE  
UNIVERSITY OF COLORADO  
STUDIES



FRANCIS RAMALEY  
EDITOR

PUBLISHED BY THE  
UNIVERSITY OF COLORADO  
BOULDER, COLO.

MARCH, 1906

*Price, 30 Cents*



VOLUME III

NUMBER 2

THE  
UNIVERSITY OF COLORADO  
STUDIES



FRANCIS RAMALEY  
EDITOR

PUBLISHED BY THE  
UNIVERSITY OF COLORADO  
BOULDER, COLO.

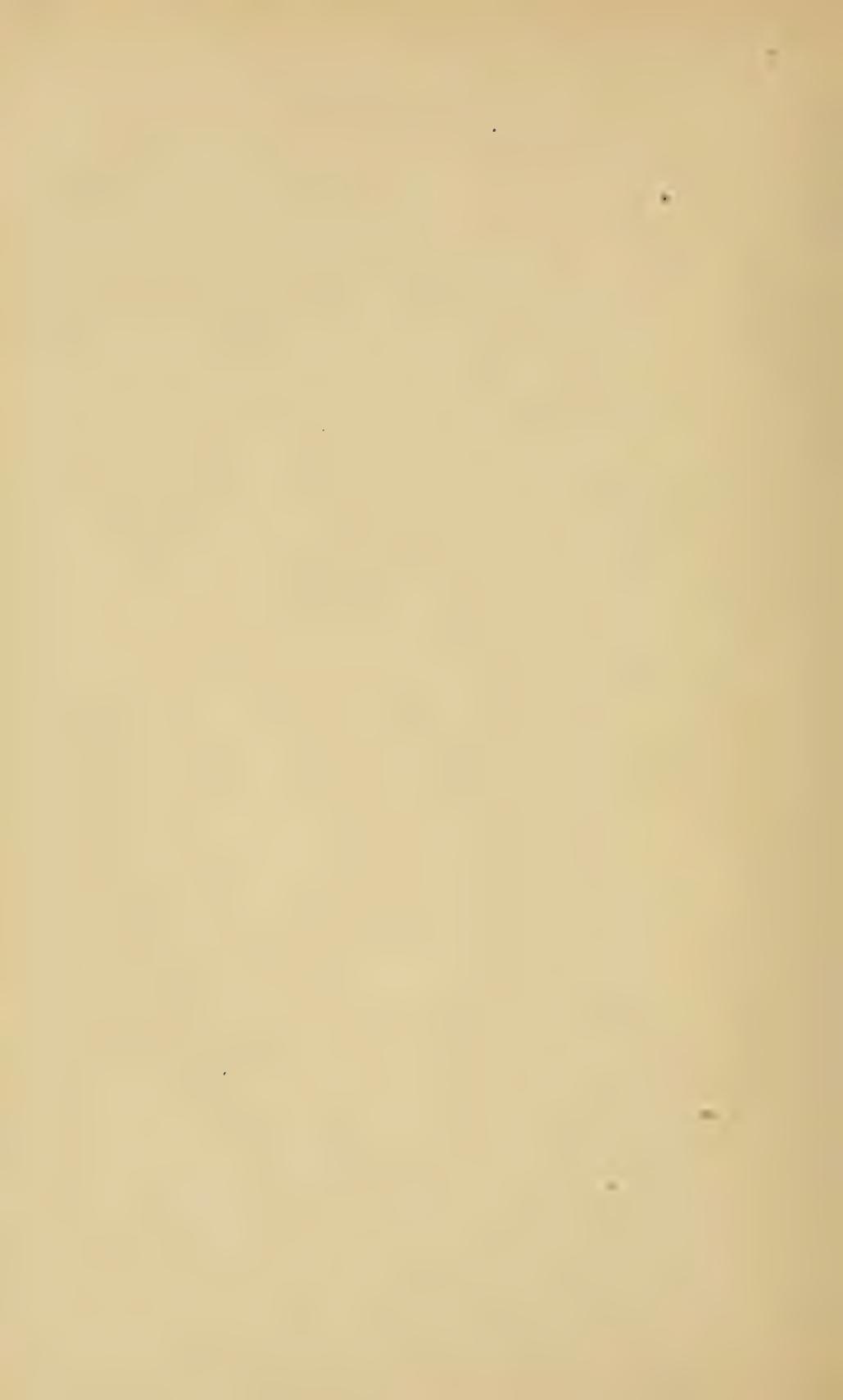
MARCH, 1906

*Price, 50 Cents*



## CONTENTS

	PAGE
1. EDUCATIONAL QUALIFICATIONS OF VOTERS . . . . .	55
JOHN B. PHILLIPS, PH.D., Professor of Economics and Sociology.	
2. SHAKESPEARE AND PSYCHOGNOSIS, ESSAY I. MINOR CHAR- ACTERS OF "THE TEMPEST" . . . . .	63
MELANCHTHON F. LIBBY, PH.D., Professor of Philosophy.	
3. ON THE IONIZATION DUE TO THE EMANATION OF RADIUM .	83
WILLIAM DUANE, PH.D., Professor of Physics.	
4. THE CRANIAL NERVES OF ONE OF THE SALAMANDERS (PLE- THEDON GLUTINOSUS) . . . . .	87
GIDEON S. DODDS, M.A., Instructor in Biology.	
5. THE SEED AND SEEDLING OF THE MOUNTAIN GLOBE-FLOWER	93
FRANCIS RAMALEY, PH.D., Professor of Biology.	



## EDUCATIONAL QUALIFICATIONS OF VOTERS

BY JOHN B. PHILLIPS

The old idea that in a land of liberty everyone should have a voice in the conduct of the government is gradually disappearing with the growth of intelligent citizenship. It is beginning to appear that the vital thing in democracy is equality of opportunity, rather than a share in the management of the government. As long as each has the same chance to succeed in life, it is not of great importance whether or not he has also the right to take part in the government by the exercise of the elective franchise.

Anything that tends to swell the floating vote does not augur well for the welfare of the country. It is well known that the immigrants who first get the right to participate in the elections are not familiar with the principles upon which the American theory of government rests. They are therefore obliged to rely upon some person for the information as to how they shall cast their votes. The person that advises them is the ward boss. His business is to control the immigrant vote. Unable to understand the principles of the political parties, these foreign-born must be appealed to in some other way than by eloquence, and this the boss is not slow to perceive. The laborious method of instructing them in American institutions is not resorted to, but other and more direct and effective methods are employed. In this way the purchasable vote is increased.

It is thus clear that by the unrestricted privilege of the franchise we are introducing into our citizenship a large floating vote. Reared under a different political system, and ignorant of our institutions and the policies of our political parties, these voters fall an easy prey to the arts of the unscrupulous politicians in our large cities and so contribute to establish there the conditions that are now the shame of our municipal politics. While it is not true that all the evils of municipal politics are to be laid at the doors of the foreign-born, yet it cannot be

denied that their presence has been a strong factor in the development of the political boss.

The requirement that all voters be able to read and write English in addition to the usual requirements of residence and citizenship, would tend very strongly in the direction of weakening the power of the boss. Tweed openly declared that he did not care what the New York papers said about him as his constituents could not read English.

Granting the right to vote to every man without regard to his intellectual qualifications is turning over the management of the affairs of the country to inefficient persons. It is true that it is giving each person an equality before the law as far as the right to vote is concerned, but the effect of this management of the government by illiterate and inefficient persons brings about a condition under which it is impossible for each person to have an equal opportunity for success in life.

It was formerly supposed that universal suffrage would mean equal opportunity, but when such suffrage results in the formation of a strong party machine controlled by one powerful boss who is responsible to nobody, it is clear that the opportunities which should be accessible to all are very much curtailed. The governments of certain of the great cities of the United States are good examples of the way in which equal opportunities are taken away from the people by means of a strong party machine built up by the votes of the ignorant, the foreign-born, and the indifferent voters. It is charged that in certain cities the boss must be "squared" with before perfectly legitimate business may be carried on without constant interruption and annoyance by the authorities. In cases of this kind the exercise of universal suffrage has had an effect just the opposite to that of establishing conditions of equality for all the citizens.

In the great cities of the country the foreign-born and children of foreign-born greatly outnumber the native-born of native parents. The following table shows the males of voting age and the percent of native-born of native parents for the eleven greatest cities of the United States:

## MALES OF VOTING AGE IN AMERICAN CITIES

	Aggregate Voting Population	Native-born of Native Parents	Percent. Native-born of Native Parents
New York . . . . .	1,700,670	178,900	17.6
Chicago . . . . .	511,048	103,674	20.2
Philadelphia . . . . .	386,953	141,741	36.4
Boston . . . . .	176,068	47,733	27.0
St. Louis . . . . .	171,798	42,588	24.8
Baltimore . . . . .	141,271	57,502	40.5
San Francisco . . . . .	128,985	27,179	21.6
Cleveland . . . . .	111,522	23,037	21.2
Buffalo . . . . .	97,938	20,418	20.8
Pittsburgh . . . . .	96,563	24,719	25.5
Cincinnati . . . . .	92,799	22,314	24.0

It thus appears that in our two greatest cities the foreign-born and children of foreign-born make up 80 percent of the voters. In the other cities, except Baltimore and Philadelphia, the pure American stock is seen to be as a rule about one-fourth of the voting population. It is in our greatest cities that the power of the political boss has developed on the most amazing scale. It is in the cities that the influence of American ideals is weakest, and one reason for this is apparent. If but twenty per cent of the population is native-born, it is clear that the foreigners and their children exercise four-fifths of the weight in the solution of political questions. This is why the excise question is the most troublesome problem in the city of New York, and also why the tenement house law is not enforced and the sweatshop not abolished.

Aside from the direct effect upon our politics, the requirement that all voters should have the ability to read and write English would undoubtedly tend to hasten the assimilation of the immigrants by our own people. The principal cause of the colonization of the foreign nationalities in the cities is the inability to speak the English language. A person unable to speak the language of the country in which he is obliged to have his domicile is greatly handicapped in his efforts to make a living. He will easily fall a victim to imposture. The great *desideratum* of the immigrant is the ability to speak the English language. It would therefore seem that the best possible program for

a state which is receiving a large amount of immigration annually would be to encourage as much as possible the learning of the native tongue.

At the present time the most serious problem of immigration that is confronting the United States is the question of getting the immigrants to go into the country or to the remoter cities instead of colonizing in the great Eastern cities and Chicago. There can be but little doubt that the educational requirement of the voters would give a strong impulse to many of these foreigners to acquire the native language, and, having once acquired this, there would not be the same tendency to congregate in the colony which the more ignorant and illiterate of their brethren had established in the city. Other parts of the United States, where their native tongue is not heard, would not repel them, and their assimilation would be comparatively easy.

A great advantage in favor of the enactment of a law requiring voters to be able to read and write the English language is the fact that such a law would require no administrative machinery to put it into execution. It would be a self-executory law, just as the other election laws are at the present time. Each political party sees to it that all voters of the opposite party comply with the statutes or they are not allowed to vote.

A number of the American states require certain educational qualifications of their voters. Following is the list, with a brief summary of the constitutional provisions.

**ALABAMA:**

Must read and write constitution in English language.

Following classes exempt:

- (a) Persons physically unable to read and write;
- (b) Owners or husbands of owners of 40 acres of land in state;
- (c) Owners of real estate assessed at \$300;
- (d) Owners of personal estate assessed at \$300, on which taxes have been paid for preceding year.

*Constitution of 1901, Art. 8, §181.*

**CALIFORNIA:**

Must read constitution in English and write name.

Following classes exempt:

- (a) Voters in 1894;

- (b) Persons physically unable to read and write;
- (c) Persons 60 years of age in 1894.

*Amendment to constitution*, Art. 2, §1. Adopted 1894.

**CONNECTICUT:**

Must read constitution or statutes.

*Amendment to constitution*. Adopted 1855.

*Amendments*, Art. 11.

Must read constitution or statutes in English language.

*Amendment to constitution*. Adopted 1897.

*Amendments*, Art. 29.

**DELAWARE:**

Must read constitution in English language and write name. Persons physically unable to read and write exempt.

*Constitution of 1897*, Art. 5, § 2.

**LOUISIANA:**

Must write and date application for registration as an elector in presence of registration officer. Following classes exempt:

- (a) Persons owning property in state assessed at \$300 on which, if personally, the taxes shall have been paid;
- (b) Foreigners naturalized before January 1, 1908, if they have resided in state five years and registered before January 1, 1908;
- (c) Voters January 1, 1867;
- (d) Sons and grandsons of such voters;
- (e) Persons physically unable to read and write.

*Constitution of 1898*, Art. 197, §§ 3, 4, 5.

**MAINE:**

Must read constitution in English language and write name.

Following classes exempt:

- (a) Persons physically unable to read and write;
- (b) Voters in 1893;
- (c) Persons 60 years of age in 1893.

*Amendments to constitution*, No. 29. Adopted 1892, effective 1893.

**MASSACHUSETTS:**

Must read constitution in English language and write name. Following classes exempt:

- (a) Persons physically unable to read and write;
- (b) Voters in 1857;
- (c) Persons 60 years of age in 1857.

*Amendments to constitution*, Art. 20. Adopted 1857.

## MISSISSIPPI:

Must read constitution or understand same when read to him, or give reasonable interpretation thereof.

*Constitution of 1890, Art. 12, § 244.*

## NEW HAMPSHIRE:

Must read constitution in English language. Following classes exempt:

- (a) Persons physically unable to read;
- (b) Voters in 1903;
- (c) Persons 60 years of age January 1, 1904.

*Amendment to Article II of Bill of Rights of constitution.*

Adopted 1903.

## NORTH CAROLINA:

Must read and write constitution in English language. Following classes exempt:

- (a) Voters under the law of any state where residing prior to or on January 1, 1867;
- (b) Lineal descendants of such voters, provided they register before December 1, 1908.

*Amendment to constitution, Art. 6. Adopted 1901, effective 1902.*

## SOUTH CAROLINA:

Must read and write constitution. Does not apply to persons owning property in state assessed at \$300 who have paid taxes of previous year.

*Constitution of 1895, Art. 2, § 4.*

## VIRGINIA:

Must read constitution and give reasonable explanation. If unable to read must understand and explain constitution when read to him. Following classes exempt:

- (a) Soldiers who have served in war in army or navy of United States or Confederate States or of any one of United States or Confederate States;
- (b) Sons of such soldiers;
- (c) Owners of property on which during preceding year state taxes of least one dollar have been paid.

*Constitution of 1902, Art. 2, § 19.*

## WASHINGTON:

Must read and speak English language. Does not apply to voters in 1896.

*Amendment to constitution, Art. 6, § 1. Adopted 1896.*

## WYOMING:

Must read constitution.

Following classes exempt:

- (a) Persons physically unable to read;
- (b) Voters in 1889.

*Constitution of 1889, Art. 6, § 9.*

A proposed constitutional amendment concerning the suffrage was rejected in Maryland November 7, 1905. It prescribed the following qualifications for voters:

MARYLAND:

Must read constitution or give reasonable explanation, or understand same when read to him and give reasonable explanation. Following classes exempt:

- (a) Voters January 1, 1869;
- (b) Lineal male descendants of such voters 21 years of age in 1906.

*Laws of Maryland, 1904, Chapter 96.*

The constitution of North Dakota says that the legislature shall require an educational qualification of voters, but as yet the legislature has not seen fit to comply with this provision of the constitution.

In the above requirements, the curious proviso which allows the suffrage without restriction to the lineal male descendants of persons qualified to vote during the years immediately following the Civil War is popularly known as the "grandfather clause." It prevails in Louisiana, North Carolina and Virginia. It is calculated to exempt the white voters from educational and other restrictions which effectively bar the negroes.

From the above compilation it appears that real educational qualifications for voters exist only in Delaware, Massachusetts, Maine, New Hampshire, Connecticut, California, Washington and Wyoming. In Delaware, Connecticut, and Massachusetts, practically every voter must read English. In the other states having educational qualifications, voters at the time the requirement was adopted have been exempted from its provisions. This was the case with voters in California, Maine, New Hampshire and Wyoming in 1894, 1893, 1904 and 1889 respectively. Massachusetts also exempted voters in 1857, the year the amendment was adopted, but few of such voters are now living.

The ability to read English as a qualification for voters is a recent development in United States constitutional law. Notwithstanding

its origin in Massachusetts in 1857, its spread to other states has been almost wholly within the last two decades. The advance in the educational system and the menace of immigration make both possible and desirable the extension of this educational requirement to the voters of the other states.

# SHAKESPEARE AND PSYCHOGNOSIS

## ESSAY I. MINOR CHARACTERS OF "THE TEMPEST"

BY MELANCHTHON F. LIBBY

### INTRODUCTION

The following essays are intended as a humble contribution, not to literary criticism, but to what may be called *concrete ethics*. Psychology, as has been pointed out by Professor Dessoir, has very little to tell us about human nature. Plutarch, Montaigne and Franklin have insight into human motive and character, but it is idle to call them psychologists. Bismarck, a consummate judge of men, or rather of certain kinds of men, may have been unable to pass a college examination in psychology. Let us call this insight into human nature *psychognosis*, as Professor Dessoir has suggested, and let us keep the word *psychology* for the designation of that special discipline which claims it. The names *characterology* and *ethology* have been used in the same sense as that in which we use psychognosis.

John Stuart Mill thinks that ethics can not become an exact science until we can estimate the moral or social reactions of individual men to given stimuli. In other words, we must be able to tell what any given man will do in any given situation, just as we tell what mercury will do on a hot day or a cold day. This correct estimate of a scientific ethics has proved pedantic and depressing. Ribot and others have attempted to classify human nature by tests in psychological laboratories.

Charlatans have attempted for money to advise parents regarding vocations for children. The more exact in appearance their methods have been, the less substantial truth they have possessed. A pretence of mathematically scientific method in estimating character is either ignorant or fraudulent in our present knowledge of physiology and neurology. Yet the history of civilization reveals a great thirst for this kind of knowledge. Astrology, palmistry, phrenology, physiognomy,

are only a few of the pseudo-sciences of human nature. The theory of humors in medicine, and even the pretentious utterances of novelists like Meredith and Crawford concerning human motive, are attempts to satisfy this craving without paying the price of such knowledge in scientific research. Child-study and the study of adolescence are crude beginnings of a real science of human nature.

Meanwhile, many generations must elapse before we can look for much in this direction that will satisfy the methodology of serious men of science.

The purpose of the present essays is to present a classification of human types drawn from an inductive reading of Shakespeare. I do not think that any one has employed this method at all thoroughly heretofore. There are great numbers of brilliant studies of the characters in Shakespeare, to all of which I am indebted in this work. But they are all subjective in their selection of the aspects of character to be treated; and none of them reaches the point of considering the significance of the minor characters. Anyone familiar with this field must know that the minor characters of Shakespeare have scarcely been considered by the great critics. Yet I hope to show that a careful appreciation of these foils and background figures gives valuable results in indicating the author's meaning in larger matters. Then, again, in Psychognosis, we must not only study a few striking types of character, but also the typical situations in which men find themselves in the world of real experience.

I offer no apology for the tediousness of my method, nor do I claim that it is free from subjective errors. It is an attempt, not indeed at a science of literature and character, but at some slight departure from the grossest subjectivity.

I have endeavored to bring together all the deeds and utterances of each character in the play, and to stand aside as far as possible while these collected facts gave a general resultant. This self-effacement is, of course, impossible. And therefore I shall be content with the judgment of the judicious. But though I may ignore some speeches too much, or emphasize some too much, that is inevitable. I have at

least *tried* to be objective, and I believe the method will prevail. By its use a great body of valuable knowledge could be extracted from writers like Balzac and Molière, which would go far to furnish content to the bald abstractions of a worn-out theoretical ethics, and to make the homilies of lecturers on "practical" ethics broader and more helpful.

But Shakespeare's facts about human nature are realities to the psychologist, because of the three hundred years' endorsement of all the thinking races, and in this sense his specimens are as valid as those of the botanist or the lithologist. We may accordingly study his book in the confidence that what we can say of it truthfully will be received as a real contribution to Psychognosis.

The results of this study of the minor characters have proved such as to require me to offer a new reading of the whole play, which will appear in later essays. The results for Psychognosis in general will be considered in the last essay, and those not interested in the inductive method nor in the meaning of *The Tempest* will do well to read that essay only.<sup>1</sup>

In conclusion let me say that Shakespeare, in the *Tempest*, has left the world *some thirteen types of human character*, and *some thirty types of human situation*, which he manifestly selects as the most clearly distinguishable and important to the student of his kind. And it is not at all improbable that this group of types is the most important chart of the conduct of life that we possess. In my last paper *I shall tabulate these types*.

#### GONZALO, A TYPE OF ALTRUISM

The five acts are divided into nine scenes. Gonzalo appears in four of these, the first, third, seventh, and ninth. His first speech is "Nay, good, be patient," addressed to the boatswain, who has been ordering the Duke and the King below. His first speech is a gentle remonstrance against the seaman's speech. His second speech again recommends respect for the nobles; but it, too, is kindly and sympathetic. After the boatswain's exit, Gonzalo makes a longer speech showing

<sup>1</sup> My study of *The Tempest* has yielded only one definite *scholium* which I consider worth offering: Act II, Sc. i., vss., 295, 296.

'And how does your content  
Tender your own good fortune?

This is like Macbeth's question to his hired assassins.

It means: How does your patience present your fortune to you? Are you so patient as to think yourself fortunate in your underling situation? Like all Antonio's speeches it is a sneer. Daniel's alteration of the folio shows no regard for the subtle style of this character.

humor, courage, and yet a clear appreciation of the peril in which the ship stood. After the re-entrances of the boatswain and of the nobles, Gonzalo composes a quarrelsome dialogue by a few words; Antonio and the boatswain are softened by his mild, jocular humor.

Gonzalo, when the fate of the ship appears imminent, recommends that all join the King at prayers; but before going he makes two more speeches, both showing humor and remarkable calmness of spirit. One may generalize these simple facts into the more comprehensive fact, that in a time of great peril, which shook the souls of some of the characters, Gonzalo appeared cool, kindly, sympathetic, unselfish and humorous; and that in spite of a clear grasp of the terror of the situation, he preserved, without noticeable effort, an admirable magnanimity, serenity, and composure of soul, suggesting great inward resources of some kind, with which to face circumstances trying to the bravest of men.

In the first scene of Act II Gonzalo appears again. He begins the dialogue by a speech of nine lines, in which he endeavors to make the best of things. He offers commonplace consolations, which are badly taken by the others, yet he persists in talking, and in a sense achieves his kindly purpose, inasmuch as he forces his companions to talk. He is mercilessly chaffed by Antonio and Sebastian, weakly supported by Adrian and snubbed by the King. After enduring this with unshaken good humor, and some wit in retort, for a while, he makes a sketch of an ideal commonwealth which he would like to establish on the island. This commonwealth shows his great good-will toward men and his love of purity and innocence, but is illogical and impracticable, and represents aspirations rather than serious thoughts, as Gonzalo soon admits by his joining in the ridicule of it. Still, though he calls it merry fooling, it does show that he had dreams or ideals on the subject of social well-being, and in a very humane and benevolent way. Under the influence of solemn music played by Ariel he quickly falls asleep. Immediately ensues the conscienceless conspiracy of Antonio and Sebastian involving the life of Gonzalo as well as of the King. It is in Gonzalo's ear that Ariel sings his summons to watchfulness, and the old Minister awakes, thinking only of his Master. He is not deceived by the story of the conspirators but confines his criticism to the somewhat wry expression, "Heavens keep him (Ferdinand) from these beasts." His concluding words, "For he is, sure, i' the island," are a mixture of prophetic faith and kindly optimism.

The facts of this scene extend our knowledge of Gonzalo. He is not only serene, kindly, courageous, humorous, but broadly benevolent, self-controlled, and devotedly trustworthy. He is conscious of his merry fooling, and talks garrulously only to serve some kind purpose. His intellectual humility is free from meanness or envy, and he accepts his position with a genuine belief that simple faithfulness cannot be despised. That he is not despised is evinced by the fact that he is hated by the conspirators.

Gonzalo reappears, after a long interval, in the third scene of Act III. He is still with Alonso. Being an old man, he is rather used up by the fatigues of the way. From the search for Ferdinand he rests, not because he would, but because he needs must. The conspirators, seeing Gonzalo and Alonso oppressed with travel, renew their plotting. The music introductory to the magic banquet pleases Gonzalo. Of the strange shapes bringing in the banquet he says, "Their manners are more gentle-kind than of our human generation you shall find many, nay, almost any,"<sup>1</sup> and he fears the Neapolitans would be skeptical if he were to tell them of this adventure. Prospero here speaks of Gonzalo as "honest Lord," which agrees with what he had reported of him to Miranda (in Act I, scene 2) where he had called him "A noble Neapolitan," who, out of his charity had given them garments, and out of his gentleness saved his books for the banished Duke<sup>2</sup>. While the others wonder at the magic table Gonzalo accepts it as if it were quite natural. After the terrible arraignment of the "three men of sin," Gonzalo is very serious; yet he beseeches those who can to follow the three and hinder them from desperate acts. This scene shows Gonzalo's facility in accepting the supernatural as not antecedently incredible, besides confirming former notions of his character.

He appears in the last scene of the play, accompanying Alonso. He is one of those who stand charmed within the circle which Prospero had made. But he is addressed by Prospero in the following terms:

"Holy Gonzalo, honourable man,  
Mine eyes; even sociable to the show of thine,  
Fall fellowly drops;"

and shortly after, in terms really remarkable,

"O good Gonzalo!  
My true preserver, and a loyal sir  
To him thou followest, I will pay thy graces  
Home, both in word and deed."

Gonzalo says little during this long scene. After the exit of Ariel he expresses a wish that "Some heavenly power guide us out of this fearful country." When Prospero addresses him again, it is in words that Prospero could use of no common man. —

"First, noble friend,  
Let me embrace thine age, whose honours cannot  
Be measured or confined."

To this great praise Gonzalo replies with customary equanimity, but professes himself puzzled. After a long interval he says,

"I have inly wept,  
Or should have spoke ere this."

<sup>1</sup> Cf. the idealism of *In Memoriam*.

<sup>2</sup> Cf. the service of the church to philosophy.

He is moved that the work of mediation, forgiveness and charity, which had so long devolved upon himself, is so ably borne by another. He is moved by the joy of the lovers: "Look down, you gods, and on this couple drop a blessed crown, for it is you that have chalked forth the way which brought us hither." He points out in a longer speech how all their actions, even the worst, have worked together toward a good conclusion, and especially he rejoices that their experiences have given them self-knowledge, a quality in which he professes himself to have been deficient along with the others. His last words, in response to a good wish uttered by Alonzo, are:

"Be it so: Amen!"

In this last scene the immense authority of Prospero confirms the impressions already received of the character of Gonzalo. Prospero is actuated by personal gratitude; but his firm utterances are not the exaggerations of sentiment, and a closer observation of his praises show that he ascribes no powers to Gonzalo which have not been clearly displayed by the counsellor's career.

Gonzalo is to be judged by his actions, his utterances, and his reputation among his associates. In the first scene, he appears cool and self-possessed in a moment of the utmost peril, where action is impossible. He shows great fortitude, the virtue of a situation of that nature. In the third scene he exerts himself to cheer and revive the spirits of his comrades. It is true he falls asleep in innocent trustfulness though his master is in peril, yet it cannot be said that his sleeping was in the circumstances blameworthy, nor out of harmony with the strictest sense of duty to the King. It may, however, be said that a more suspicious and vigilant counsellor would have taken greater precautions to protect the King from such a friend as Antonio. In the latter part of this scene Gonzalo acts promptly and wisely.

In the seventh scene we learn that he has kept up with the younger nobles in their search "through forthrights and meanders," and that he is fatigued by his exertions for Alonso. After the magic banquet and the searching exhortation of Ariel, Gonzalo acts promptly and kindly in despatching the younger followers of the King to preserve him.

In the ninth scene no action is called for on the part of Gonzalo, and he bears himself with quiet and respectful attention in the presence of a greater and equally benevolent man. The striking common quality of the actions of Gonzalo is that they result from a hearty acceptance of charitable duty as the rule of life: he does all he can to make others better and happier because unselfish devotion is his nature.

His utterances in the four scenes agree with his actions: they are uniformly gentle and moderate, long-suffering without meanness, good without cant, humble without hypocrisy. His patience is boundless, and hence he recommends patience with sincere faith in its transcendent benefits. When the others are in trouble he thinks only of them and not of himself. When forgiveness and joy crown the

tale Gonzalo is a deep rejoicer. Not one word of his suggests that he ever considers his own troubles or pleasures. His words are not only gentle, they are reverent and inspired with awe for the unseen, faith in the future, deep respect for whatever is of good report. Once he lets us see that contemporary manners are not gentle-kind, yet he would soften them by example rather than precept.

Adrian is his friend. Sebastian and Antonio hate him past reason. They really have no charge against him except garrulity; yet they would kill him that "Sir Prudence" should not afterwards upbraid their course. Alonso accepts his services with dignified courtesy, occasionally showing a slight impatience of his tediousness. Ariel sings to him as he sleeps, and wakes him to renewed vigilance. Miranda says, on hearing how he had assisted her father in the earlier tempest and preserved the learned works: "Would I might but ever see that man!" Prospero speaks of him repeatedly, and always in words of the most sterling respect and affection. What greater praise can Prospero give than that which he solemnly utters in the significant words, "My true preserver!"

To draw the facts thus accumulated together into a statement true of them all is not difficult. Gonzalo is not a complex character; the clearness of the type together with the absence of self-assertiveness may have made Gonzalo seem of small consequence in the plot. But the evidence of Prospero as to his positive worth is conclusive. Gonzalo is an unselfish man. He is a living concrete example of the hearty acceptance of the golden rule of living with ideal kindness and forbearance in a selfish world. He does not unite a powerful head with his excellent heart, but he is on this account only a clearer and simpler example of one of the two great factors in human relations — unselfishness. If the common estimate of the critics regarding Gonzalo seems to agree rather with that of Antonio than with that of Prospero, the presumption is that their estimate is not Shakespearean and that it has not been arrived at by careful induction but rather by attaching undue importance to the chaff of the villains in the third scene. Gonzalo's quiet, conservative efficiency is a cause of Prospero's learning, and hence of Prospero's magic power. Gonzalo is the type of all that is meant by pure unselfishness in human society.<sup>1</sup>

#### ANTONIO, A TYPE OF INTELLECTUAL EGOISM

Antonio appears in the same scenes as Gonzalo. His first words are "Where is the Master, boson?" — a repetition of the King's question; but Antonio does not tell the boatswain to have care, or to play the man. His second speech is, "Hang, cur, hang! You whoreson, insolent noisemaker, we are less afraid to be drowned than thou art." Later he says, "We are merely cheated of our lives by drunkards." But in fact it appears that the sailors used skill and that no blame attached to them. "This wide-chapped rascal — would thou might'st lie drowning the washing

<sup>1</sup> It seems to me that Moulton's fine study of the *Tempest* loses the quest mainly through ignoring the unobtrusive greatness of this talkative old man.

of ten tides!" is his wish for the sailor. Finally, at the catastrophe, he suggests, "Let's all sink with the King!" The impression received from observing the facts about Antonio in this scene is that he is shrewd enough to see that the sailors will do all they can to save themselves, whatever they may think of the fate of the nobles; that he does not interfere with them or abuse them until he sees that their efforts are unavailing; and that his feeling in peril shows as anger and pride, rather than open fear. He clings to class distinctions, though perceiving that the imminence of death had practically abolished them. He takes a selfish view of the disaster when he says that they, meaning himself and his friends, are cheated of their lives by drunkards, inasmuch as the sailors worked with skill and energy for the common good.

In the third scene, Antonio's first speech is, "The visitor will not give him o'er so." This is a sneer, both at Gonzalo and at philanthropists in general. His next speech is "Fie, what a spendthrift is he of his tongue!" This sneer implies, not that Antonio condemns the free use of words by Gonzalo, but that Gonzalo talks for nothing. Endless volubility for a selfish purpose is clever, but Gonzalo has no purpose in his talk, according to the opinion of Antonio. When Adrian says the island is of a subtle, tender and delicate temperance, meaning climate, Antonio retorts that "Temperance was a delicate wench." There is a good deal of shrewd sense in his criticism of the well-meant consolations of Gonzalo and Adrian. He protests manfully against the slur cast upon Dido. But every word is a sneer, whether true or frivolous. He and Sebastian riddle Gonzalo's fancy commonwealth with most practical objections; one feels that they pronounce authoritatively upon the impossibility of an ideal commonwealth without new provisions against the evils arising from idleness. In this purposeless skirmish of wits Sebastian is more aggressive than Antonio, who says but little, and that mostly in echo of his friend. It is not until the others are asleep that Antonio displays his true ability. He suggests the plot to Sebastian with flattery, and rouses his ambition with promises; he grows animated, eloquent even; politic, insinuating, adroit, he pours his spirits into the ear of Sebastian. Boldness, acuteness, conscienceless logic are mingled with sarcastic humor, scorn, and a splendid but evil resoluteness. He does not spare words where he has a purpose to effect. Prospero sends Ariel to thwart their project. When they are thwarted Sebastian is the bolder, and Antonio's excuses are a weak and even ridiculous echo.

In this scene Antonio appears as lost to all sense of decency and humanity. He is ambitious, selfish, cunning, dangerously clever. His vigilance, energy, adroitness, animated eloquence, sarcastic wit, are admirable; and, better directed, might be great. Less bold in action than Sebastian, he is far bolder in designing and conspiracy.

In Act III, scene 3, he reappears, and our observation of his vigilance and persistence is confirmed by his first two speeches. Whatever his amazement on seeing

the magic banquet and the shapes, he cannot doubt the evidence of his senses and accepts them as facts quite as fully as Gonzalo. Alonso is profoundly moved by the exhortation of Ariel, but Sebastian's aggressive boldness enables him to say:

" But one fiend at a time,  
I'll fight their legions o'er."

Antonio adds, "I'll be thy second." He is the cleverest and worst of the "three men of sin."

In the ninth scene Antonio is with the others in the magic circle. From his entrance to the end he speaks only once, when roused to something of his old sarcastic humor he answers the question of Sebastian regarding the purchasability of the monster Caliban and his friends,

" Very like; one of them  
Is a plain fish, and, no doubt, marketable."<sup>1</sup>

In Scene 2 of Act I Prospero had given Miranda a long account of the manner in which Antonio had robbed him of his birthright. He says that Antonio used foul play, that he was perfidious, that he treated his brother's simple faith as simplicity and violated the trust reposed in him, that his selfish ambition grew till he believed himself rightful Duke, and that he banished father and daughter with treachery and cruelty. (This was the occasion upon which Gonzalo had done all that his position allowed to save the rightful Duke..)

In the ninth scene Prospero confronts Antonio,

" Flesh and blood,  
You, brother mine, that entertained ambition,  
Expelled remorse and nature.  
I do forgive thee;  
Unnatural though thou art!"

Later, when he has doffed his magic robe, as rightful Duke of Milan, he says, —

" For you, most wicked sir, whom to call brother  
Would even infect my mouth. I do forgive  
Thy rankest fault; all of them; and require  
My dukedom of thee, which, perforce, I know,  
Thou must restore."<sup>2</sup>

In this scene we see the moral prostration of Antonio, who has no single word of defence or palliation, nor even the rude ignorance of Sebastian to give him courage.

The chief actions recorded of Antonio are his usurpation and his conspiracy against the lives of Alonso and Gonzalo. His words are marked by insolence, sneering, flattery, duplicity, craft, and shrewd wit. But his actions and speeches show vigilance, energy, and adroitness, and a clear conception of the value of facts

<sup>1</sup> Cf. Renan's *Caliban*, where the monster stands for the venal rabble.

<sup>2</sup> In his magic robe Prospero is purely philosophic in judgment. When without it, he takes his role in a less detached spirit. This remark applies to other scenes as well.

and physical force. His friend and companion is Sebastian. He is morally guilty of the murder of Alonso and Gonzalo, and even Prospero and Miranda were spared merely from selfish policy. He is incapable of repentance or any generous sentiment. Prospero declares him to be an unnatural character. Hence he has the contempt of Prospero as a fellow man, whose complete self-knowledge, however, enables him to forgive his enemy, through a philosophic comprehension of causes.

The character of Antonio appears in the light of facts to be clear and simple. Not one word or action is unselfish, no scruple suggested by the sense of a common humanity softens his hard purposes. Friendship, brotherhood, loyalty, honor, law, self-respect, are bonds long since eaten through by ambition. The true human instinct is a vital union of selfishness and unselfishness. Antonio is the type of reason separated from human sympathy, of the reason that has no reason because it is not fused with sympathy. Antonio embodies, like a figure in a new mythology, the character of the rationally selfish. He is less a soldier than a schemer, and hence we may conclude by saying that he is an intellectual egoist.

He is a living embodiment of the second great social force — selfishness. Far superior to Iago in purpose and ambition, he is equally a villain. Far inferior to Richard III in courage, he is less capable of remorse.

Looking at Gonzalo and Antonio, one wonders whether they were not, as types of the extreme forces by which society moves forward, the greatest achievements of their creator. It may appear that all former portrayals of devotion and villainy tended toward the separation and clarification of these two pure types, marking as they do the extremest departures from the middle line of human instinct.

These characters are contrasted in a symmetrical manner rather unusual in great literature. They are contrasted in their treatment of Prospero and Miranda at the time of the banishment; in their bearing during the tempest; in their interview in the third scene where the contrast culminates in the murderous attack of Antonio. In the seventh scene the weakness of Gonzalo is contrasted with the energy of Antonio. But the great and authoritative contrast is found in the pictures of the two offered by Prospero in the final scene; where language is strained to accentuate this antithesis.

It may be said that all degrees of goodness and badness, as far as these terms denote unselfishness and selfishness, lie between Gonzalo and Antonio; and yet it would seem at a superficial glance that power belongs rather to Antonio.

#### SEBASTIAN : THE EGOISM OF MERE FORCE

Sebastian appears in company with Antonio. His first speech in the shipwreck scene, is —

“A pox o’ your throat, you bawling, blasphemous, incharitable, dog.”  
As the catastrophe approaches, he says, “I am out of patience.” When Antonio

<sup>1</sup> Tout comprendre, c'est tout pardonner.

says "Let's all sink wi' the King," Sebastian replies, "Let's take leave of him." There seems to be a certain dignity in these two speeches, both men desiring to die in a manner becoming to their rank.

In the first half of the third scene Sebastian regularly takes the lead in bantering Gonzalo and Adrian. He addresses his wit chiefly to Antonio, who rather indifferently echoes him. Concerning the marriage of his niece Claribel, he is grossly sarcastic. "'Twas a sweet marriage, and we propser well in our return." But when Antonio takes a somewhat analogous interest in the historic sacrifice of the affections of Dido, Sebastian replies, "Good Lord, how you take it!"

To his royal brother he is equally harsh. He reproaches him bitterly for bestowing Claribel upon a barbarian. Reproached by Gonzalo, he merely growls "very well." He is quick in debate, and exposes the inconsistency of Gonzalo's ideal commonwealth. Yet in spite of his roughness and bluntness he is not altogether bad and cold-blooded. His words to the drowsy King sound fraternal and sincere:

" Please you, sir,  
Do not omit the heavy offer of it:  
It seldom visits sorrow, when it doth  
It is a comforter."

It is a bold, impartial stroke of characterization to ascribe this speech to Sebastian, for it is a matter of observation that excessive aggressiveness is occasionally touched by womanly tenderness, in a moment of weakness.

After Sebastian has come to understand the evil suggestions of Antonio he says:

" Well; I am standing water."

He accuses himself of hereditary sloth; meaning evidently intellectual sloth. He shows no initiative in intrigue. He is neither good nor bad. In practical affairs he is energetic, and in banter or debate very wide-awake.

When Antonio asks him how his slothful content paints his good fortune, he awakes to the sense of his subordinate position, and the ambitious spirit of Antonio lays hold upon him. He has some conscience still, but he is quickly satisfied by the sneer of Antonio, "I feel not this deity in my bosom." When they are surprised in their murderous attempt, Sebastian shows more boldness and self-possession.

Once entered upon a certain course, this standing water flows steadily enough.

In the seventh scene Sebastian still follows Antonio's lead. Instead of taking the lead in the dialogue, he is now the able henchman of the wily conspirator. The magic banquet and the shapes do not seem to move him very deeply. Lacking the power of original judgment, he accepts all his senses present with equal heartiness. After the vanishing of the shapes he exclaims bluntly :

" No matter, since  
They have left their viands behind; for we have stomachs."

After the denunciation of Ariel, he shouts :

“ But one fiend at a time,  
I'll fight their legions o'er.”

In Act V Ariel, reporting the condition of the prisoners, tells Prospero “ The King, his brother, and yours, abide all three distracted.” When Sebastian stands in the charmed circle made by Prospero, he is charged with having furthered the plans by which Prospero and Miranda were so cruelly banished. He is spoken of as suffering most strong inward pinches of remorse.

When Prospero reveals himself he alludes threateningly to his knowledge of the later conspiracy against Alonso. But throughout the scene he is much harsher toward Antonio than toward Sebastian. When Ferdinand is found Sebastian exclaims, “ A most high miracle!” Though this discovery greatly lessened his prospect of becoming his brother's successor.

After the entrance of Caliban and his boon companions Sebastian is found jesting light-heartedly enough with them, laughing, and endeavoring to rouse the spirits of the silent Antonio.

Sebastian is “ high-stomached.” He has a blunt, aggressive manner and, up to a certain point, has great ability as well as courage. But a certain coarseness of conception makes him offensive to finer natures, to whom he, in turn, stands in a relation of suspicious irritation. Not naturally bad, he has, however, no purpose except to live suitably in his position as the brother of Alonso. Led by a deep and conscienceless associate, clever to brilliance, he feels that he has discovered his true nature and becomes positively bad. His is the spirit of mercenary soldiers, or of a standing army, an immense force, capable of good or evil. Under the guidance of Antonio he appears as an extreme illustration of selfish aggressiveness as distinguished from selfishness of a more distinctly intellectual order.

#### ALONSO : CONVENTIONAL EGOISM OF RANK.

In the shipwreck scene the King's conduct is marked by dignity and propriety. “ Good boatswain, have care. Where's the master? Play the men.” Having seen that the duties of the situation are in the proper hands, he retires to his cabin and does not reappear.

Gonzalo reports the king and prince at prayers. It is clear that his example commands the respect even of Antonio and Sebastian, though they shortly after conspire to assassinate him ; such is the power of courtly discipline.

In the third scene Alonso is manifestly overcome with grief for his lost son and preserves a depressed taciturnity. After a long speech by Gonzalo, meant to comfort him, he says briefly, “ Prithee, peace.” After a prolonged silence, he is provoked to a longer reply by Gonzalo's well-meant persistence :

“ You cram these words into mine ears, against  
The stomach of my sense. Would I had never

Married my daughter there! for coming thence,  
 My son is lost; and, in my rate, she too,  
 Who is so far from Italy removed,  
 I ne'er again shall see her. O thou, mine heir  
 Of Naples and of Milan! What strange fish  
 Hath made his meal on thee?"

When Sebastian reproaches his course in bestowing Claribel upon an African, he replies, "Prithee, peace." When he dwells upon the daughter's loathing, and concludes harshly, "the fault's your own," the King with admirable manner retorts "So is the dearest of the loss." His sole comment upon the honest old counselor's dream of a Kingless Commonwealth is: "Prithee, no more; thou dost talk nothing to me."

The solemn music of Ariel brings sleep to his careworn mind: While lamenting, in the manner of Bolingbroke, his restlessness, he becomes drowsy—

"What, all so soon asleep! I wish mine eyes  
 Would, with themselves, shut up my thoughts;  
 I find they are inclined to do so."

When aroused from a position of imminent peril he is dignified and vigorous. Having inquired of his officers regarding the disturbance, he thinks again of his son and begins further search for him.

The same scene makes very prominent the fact that the marriage of Claribel to the African was the cause of the disastrous voyage, and Sebastian persistently connects the violation of the girl's wishes with this misfortune. Alonso is made responsible for the match. Gonzalo confirms the truth of Sebastian's opinion, while regretting his cruel language. This sacrifice of a princess to selfish interest is the cause of the tempest.

In the seventh scene Alonso appears still searching for Ferdinand, but almost in despair. In a courtly speech to Gonzalo he says:

"Old lord, I cannot blame thee,  
 Who am myself attached with weariness,  
 To the dwelling of my spirits: Sit down, and rest.  
 Even here I will put off my hope, and keep it  
 No longer for my flatterer: he is drowned  
 Whom thus we stray to find; and the sea mocks  
 Our frustrate search on land. Well, let him go."

On hearing the music announcing the magic banquet he says: "What harmony is this? My good friends, hark!" and again, "Give us kind keepers, Heavens! What were these?" Later he says:

"I cannot too much muse,  
 Such shapes, such gesture, and such sound, expressing,

Although they want the use of tongue, — a kind  
Of excellent dumb discourse.”

He declines Sebastian's rude invitation to taste of the banquet, but afterward with royal common sense he says:

“ I will stand to and feed,  
Although my last ; no matter, since I feel  
The best is past. — Brother, my lord the duke,  
Stand to and do as we do.”

The heavy indictment of Ariel and his awful threat crush Alonso to the earth.

“ O it is monstrous ! monstrous !  
Methought the billows spoke and told me of it ;  
The winds did sing it to me ; and the thunder,  
That deep and dreadful organ-pipe, pronounced  
The name of Prosper ; it did bass my trespass.  
Therefore my son i' the ooze is bedded ; and  
I'll seek him deeper than e'er plummet sounded,  
And with him there lie mudded.”

This is the perfect rhythm of despair, remorse and self-condemnation. The shattered nerves seem to moan forth an echo of Nature's most doleful harmonies through the words of Alonso.

In the last scene Alonso stands with the rest before Prospero's judgment-seat. It is observable that Ariel in Act III is more severe in his treatment of Alonso than is Prospero in this scene.

“ Most cruelly  
Didst thou, Alonso, use me and my daughter.”

When Prospero appears as the wronged Duke of Milan, he treats the repentant King with real kindness. Alonso's speech in reply to Prospero's welcome is marked by a sincerity and decency which single him out from the “ three men of sin ” as the one capable of benefiting most by Ariel's words.

Alonso is curious to learn all from Prospero, but chiefly his mind dwells upon the fate of his heir ; he is again in despair —

“ I wish  
Myself were mudded in that oozy bed  
Where my son lies.”

On seeing Ferdinand he fears to trust his senses. Being assured, he exclaims : —

“ Now, all the blessings  
Of a glad father compass thee about ! ”

He questions Ferdinand promptly about “ this maid, with whom thou wast at play.” Being satisfied that she is a desirable young person for Ferdinand's queen, he wel-

comes her, but expresses his embarrassment at the obligation his noble manners put upon him of asking her forgiveness for his cruelty to her in her childhood. He says "Amen" to Gonzalo's pious wishes for the success of the young couple: "On this couple drop a blessed crown." He finds it difficult to accept what he now sees and hears as "natural events." Caliban amazes him, "This is as strange a thing as e'er I looked on." Caliban surely cannot be "natural."

He is on good terms with Prospero as the play ends, and desires to learn his whole story. These are all the chief facts narrated concerning Alonso. In no case does he fail in dignity of language or bearing. His constant references to his children suggest paternal love, but mingled with this is the love of making them powerful sovereigns who will perpetuate the greatness of his rule. He was willing to part with Claribel, and commanded her obedience in spite of her loathing, that she might marry a powerful barbarian. It is less his son than the heir of Naples and of Milan that he mourns. And it was through his intense pride of power and place that he took part in the cruel plot that won Milan for this heir; a dukedom which Ferdinand eventually inherits through his love for the princess so basely set adrift. A state such as Gonzalo dreams of with "no sovereignty" is repulsive to him. The world must offer kingdoms for himself and his children to rule. Nothing seems of so great consequence to him as the perpetuation of his royal dynasty; hence there is no misfortune equal to the loss of his heir. He desires to be royal in his graceful language, in his manners, in his courage, in his respect for religion, and he succeeds so far as external forms reveal him. But when Ariel shows him his real worth and makes him the most prominent of the "three men of sin," his forms crumble into nothing and his convention is not a rock of strength. Here it is seen that he is rather here dicitarily and passively bad, than black-hearted. And his nobility and severity, mingled with repentance and remorse, lend him a true royalty of character which quite reconcile us to him as the father of the hero.

Alonso is a faultless example of that form of pride and selfishness which is most consistent with dignity and a code of honor, formal and somewhat superficial, however bracing and constraining. He is the incarnation of respectable, conventional selfishness and formality.

#### STEPHANO AND TRINCULO: TWO TYPES OF DEGENERATION

"I the commonwealth," says Gonzalo in Scene 3, "I would by contraries execute all things . . . ."

No occupation; all men idle, all."

In the fourth scene we find two men idle, Stephano, the king's butler, and Trinculo, the king's fool. They had accompanied the king and the court to Africa, where it may be supposed their humor had increased the gayety of the wedding-feast. They do not appear in the shipwreck scene. In the dispersion following they are separated, to be reunited in Sc. 4. Prospero in Sc. 2 has insisted upon the necessity of active service, and the idleness of these renegades heightens the effect of his words.

This necessity seems to be a phase of universal society, and not of dubious, provincial, or accidental morals.

Trinculo discovers Caliban, jests and moralizes. "When they will not give a doit to relieve a lame beggar, they will lay out ten to see a dead Indian." This is the philanthropic vein.

Stephano enters drinking, and singing a "scurvy tune." Seeing Caliban he declares himself a man of courage: "It hath been said, as proper a man as ever went on four legs cannot make him give ground; and it shall be said so again while Stephano breathes at 's nostrils." This is comical egotism. Stephano takes active measures to assist the monster to be sociable, and discovers Trinculo under the gaberdine. After much excellent foolery poor Trinculo comes forth and his joy upon seeing Stephano shows his kind, foolish heart. "And art thou living, Stephano? O Stephano! two Neapolitans 'scaped!" The need of a wine-bottle had developed Stephano's ingenuity, and he had made it with his own hands out of the bark of a tree.

The last fifty lines of the scene show Stephano attaching Caliban to himself by means of his bottle, his overbearing manner, and his humorous trick of playing on Caliban's superstition. In spite of their superior knowledge and very considerable experience of life, the two comrades appear inferior in integrity of instinct, and in simple enthusiasm, to the ridiculous monster. Trinculo's speeches throughout this part of the scene are all to the one effect — "an abominable monster."

The points common to Stephano and Trinculo are clearly indicated. Both are ignorant, low drunkards; both are humorous, and take the situation lightly; both are inclined to be good companions to the monster, but to gain money by the discovery of him. But the points of difference are not less definite. Stephano is coarse, egotistic, aggressive; Trinculo is effusive, weak, critical. Stephano refers everything he observes to himself and promptly asserts himself as master of the situation, "Here, bear my bottle." Trinculo is interested, theoretically at least, in the relief of lame beggars, and can only complain of Caliban's abominable ignorance in making a wonder of a poor drunkard: he cannot think so well of himself as Stephano.

In the sixth scene Stephano tells a different story of his escape from the shipwreck. In the fourth scene it was Trinculo who swam ashore like a duck; Stephano escaped upon a butt of sack. But now Stephano says:

"I swam, ere I could recover the shore, five-and-thirty leagues, off and on, by this light." This gives point to Trinculo's pun "But you'll lie like dogs, and yet say nothing neither." Stephano in Sc. 4 calls Trinculo "fellow Trinculo," but having the support of his lieutenant Caliban he now says: "If you prove a mutineer, the next tree!" Whereafter Trinculo's place in this republic rapidly becomes one of extreme subordination. When Stephano and Caliban have arranged the plot against the life of Prospero, Stephano says, "Dost thou like the

plot, Trinculo?" But Trinculo, whatever his sentiment concerning lame beggars, is constrained to reply: "Excellent." When Ariel's music is heard, Trinculo exclaims, "O, forgive me my sins;" Stephano says, "He that dies pays all debts; I defy thee, — Mercy upon us!"

In the eighth scene Trinculo and Stephano are equally agitated by their misadventures, and especially by the loss of their bottles. Trinculo is commanded to give up a gown to which he has a fancy. He promptly obeys. When Trinculo makes a jest, Stephano rewards him with a garment as grandly as a great monarch might give a pension to a man of genius.

The glittering garments have more value in the eyes of these court dependents than in those of the savage Caliban.

Toward the end of the fifth act Ariel enters, driving in Caliban, Stephano, and Trinculo, in their stolen apparel. Stephano's first words are: "Every man shift for all the rest, and let no man take care for himself, for all is but fortune." Prospero says to Alonso: "Two of these fellows you must know and own," these were conventional productions.

Trinculo's experiences in idleness conclude with the words, "I have been in such a pickle since I saw you last that, I fear me, will never out of my bones; I shall not fear fly-blowing." Stephano, whose humor is quite equal to that of the professed jester, replies to Prospero's "You'd be the King of the isle, sirrah?" "I should have been a sore one then." The irresponsible light-hearted conduct of these two fellows redeems in some degree their vileness; but their murderous plot shows them to be dangerous elements in the society of the island.

The weak, silly buffoonery of Trinculo, stamps him as a degraded and backward character of the unselfish class, bad through his lack of virtue and force rather than through the desire to injure anyone. With virtue and enlightenment one may fancy him kindly and charitable.

Stephano is equally degraded and sensual, but has some force, given him by a strong selfishness.

Both are jolly and sociable in spite of their disgusting villainies, and both their good and bad qualities seem to be intensified by their excessive love of the celestial liquor.

#### ADRIAN AND THE MINOR CHARACTERS

Adrian has no spoken part in the first scene. Almost all the facts recorded of him are found in the third scene. Gonzalo is making conversation in his cheerful, if tedious, manner when Sebastian and Antonio begin to scoff openly at his efforts. It is Antonio who says, "Which of he or Adrian, for a good wager, first begins to crow?" "The old cock," replies Sebastian; Antonio chooses "the cockerel." Adrian's speech, interrupted by the chaff of the others, runs as follows: "Though this island seems to be desert, uninhabitable, and almost inaccessible, yet it must needs be of subtle, tender, and delicate temperance. The air breathes upon us

here most sweetly." Gonzalo comes to his rescue and mentions more substantial benefits of nature in order to silence their ridicule. Adrian takes no part in the discussion of the incredible preservation of the garments. But he gently opposes Sebastian's sarcastic allusion to the marriage of Claribel: "Tunis was never graced before with such a paragon to their queen." This is, in the words of Sebastian, "most learnedly delivered." But the next speech of Adrian is an illumination: "Widow Dido, said you? You make me study of that; she was of Carthage, not of Tunis." Gonzalo boldly answers: "This Tunis, sir, was Carthage." But the learned Adrian, who speaks with such discrimination of the subtle, tender, and delicate temperance of the island, and who knows the history of Tunis, merely raises his eyebrows and protests gently, "Carthage?"

In the seventh scene Adrian speaks but once. His words echo the request of Gonzalo to those of suppler joints to follow and preserve the King and the two other "men of sin."

In the last scene Sebastian and Antonio enter into the magic circle, attended by Adrian and Francisco. The character of Adrian is thus slightly, but rather firmly, sketched. His shy, retiring manner is vividly contrasted with the bold aggressiveness of Sebastian, who delights in teasing him. His belief in the sufficiency of Nature, or rather of mere landscape, to supply man with sufficient pleasure to arouse his gratitude and satisfy the longings of his heart; his pedantic accuracy concerning Dido and Carthage; his timid but too expressive manner of asserting his dissent; his friendly attitude toward Gonzalo, than whom, however, he is much less robust, indicate a character of the most refined and delicate culture. He corresponds to that phase of Prospero which is associated with his library, and his solitary studies on the island: he is a mingling of learning and gentleness.

Francisco speaks twice in the course of the play. In the third scene he endeavors to inspire the King with hope concerning Ferdinand, after Gonzalo has been unsuccessful.

" Sir, he may live;  
I saw him beat the surges under him,  
And ride upon their backs; he trod the water,  
Whose enmity he flung aside, and breasted  
The surge most swoln that met him; his bold head  
'Bove the contentious waves he kept, and oar'd  
Himself with his good arms in lusty stroke  
To the shore, that o'er his wave-worn basis bow'd,  
As stooping to relieve him. I not doubt  
He came alive to land."

This speech produces no effect upon Alonso.

In the seventh scene Francisco, upon the disappearance of the shapes, remarks : " They vanished strangely." Upon this very slight evidence it is possible to form but a vague idea of the character of this lord. The turgid weakness of the speech to Alonso indicates a strong desire to please and cheer his sovereign. His language suggests that he is an admirer and imitator of fine expression. He is loyal to the convention that shelters him, and a harmless, well-meaning gentleman ; but in the action rather a typical nonentity ; a formalist, but not selfish.

---

The sailors appear in the first and ninth scenes of the play. The master says nothing after summoning the boatswain, warning him of the peril, and cailing for active exertions. The commands given concerning the management of the ill-starred ship are such as to rouse the approval and admiration of Elizabethan seamen critically observing from the pit of the theater.

The boatswain gives a great air of reality and simple interest to the first scene. It is perhaps worth notice that the king calls him " boatswain," while Antonio calls him " boson." Such a distinction illustrates the refined quality and artistic significance of the characterization of the play ; for it can hardly be accidental that the dignified Alonso uses the longer form.

The boatswain is prompt, obedient, cheerful, breezy, bold : " Here master, what cheer?" he says, and to the men, " High my hearts ! cheerly, cheerly, my hearts! yare, yare! Take in the topsail. Tend to the master's whistle." But turning to the storm he says, " Blow, till thou burst thy wind, if room enough!" He saw at a glance the danger that they might drift onto the rocks in trying to make their way out to sea. Stephano's story of swimming five and thirty leagues shows a capacity for boasting that reminds one of Falstaff's men in buckram.

In a word, the boatswain is vigilant, capable, and on excellent terms with the men. He does his duty perfectly without philosophizing about it. He resents the selfish interference of the nobles. They must think their lives more important to him than his own, and he feels this distinctly enough. When Mr. Pickwick fell through the ice, Miss Arabella desired him to save himself for her sake ; but Mr. Pickwick could think of another strong reason for his best endeavors. Self-preservation is an instinct. Stephano's " every man shift for all the rest, and let no man take care of himself," in spite of its humorous cunning egoism, is not further from the normal human instinct than the injunctions of the nobles to the boatswain. There is none aboard that the sailor loves more than himself. In this peril all are on a natural footing ; if the superiority of those in authority is real and not conventional, let them save the ship. Such is his illogical argument, and not without a kernel of plain truth.

When the boatswain has done his best for the general weal and the sailors have lost hope, the brave tar inquires, " What, must our mouths be cold?" and for this he is called a drunkard and charged with cheating the nobles of their lives.

In the ninth scene the honest sailor reveals his true feelings and they have no stain of malice.

“The best news is that we have safely found  
Our king and company ; the next, our ship, —  
Which but three glasses since we gave out split, —  
Is tight and yare and bravely rigg'd as when  
We first put out to sea.”

His account of his liberation is marked by the same hearty interest in his experiences, childlike unconsciousness of himself, and simple manly good-will.

The boatswain is briefly portrayed, but the details are rich in significance. (The subtle truth, with which the primary human instinct, refined by the labor and discipline of a wholesome sea-faring life, is made the dominant note of this character, requires study for its appreciation.) The boatswain illustrates a class of plain, honest people who find their own good in humbly serving the society to which they belong, but value themselves as men in spite of their subordinate place. It is a long cry from the Boatswain to Prospero, but eqally from Caliban to the Boatswain.

# ON THE IONIZATION DUE TO THE EMANA- TION OF RADIUM<sup>1</sup>

BY WILLIAM DUANE

If radium emanation is introduced quickly into a suitable testing vessel, the saturation current that can be made to pass through the air contained in the vessel increases rapidly during the first ten minutes, then more slowly, and attains a maximum value at the end of about three hours. Theoretically, the relation between the current  $i$  and the time  $t$ , counted from the moment the emanation enters the vessel, should be of the form

$$i = A + Bf(t). \quad (1)$$

The second term corresponds to the progressive production of the induced radio-activity.  $A$  and  $B$  depend upon the form of the testing vessel and upon the quantity of emanation employed; they remain constant as long as the emanation has not diminished perceptibly. Using the expression for  $f(t)$  given by MM. Curie and Danne<sup>2</sup> we may write:

$$i = i_0 \left\{ a - \beta \left[ \lambda e^{-at} \mu \left( \frac{c}{b-c} \frac{a}{a-b} e^{-bt} - \frac{b}{b-c} \frac{a}{a-c} e^{-ct} \right) \right] \right\} \quad (2)$$

with the conditions:

$$a - \beta = 1, \quad \lambda - \mu \left( \frac{c}{b-c} \frac{a}{a-b} - \frac{b}{b-c} \frac{a}{a-c} \right) = 1$$

The constants  $b$  and  $c$  are known very accurately. In order to determine the two ratios  $a/\beta$  and  $\lambda/\mu$ , the saturation currents were measured in suitable testing vessels by means of an electrometer and a piezo-electric quartz, the readings being taken each minute during the first ten minutes and thereafter less frequently. The following table contains the observed currents, and those calculated from equation (2), using the values

$a = .00401$	$b = .000538$	$c = .000413$	$i_0 = 43.1$
$a = 2.37$	$\beta = 1.37$	$\lambda = .570$	$\mu = .438$

and the second as the unit of time.

<sup>1</sup>An account of the experiments described in this article was presented to the French Academy on February 27, 1905. The experiments were made in M. Curie's Radium Laboratory.

<sup>2</sup>*Comptes Rendus*, March 14, 1904.

Time $t$	1	2	3	4	5	6	7	8	9	10	20	30	180
Measured Current	50.3	56.1	60.5	63.9	66.6	68.6	70.4	71.8	72.9	73.8	77.7	80.9	100
Calculated Current	50.3	55.9	60.3	63.6	66.4	68.7	70.4	71.7	72.9	73.8	78.3	80.8	...

The measured currents are the means of value obtained in ten separate experiments, and, as a matter of fact, agree with the calculated values to within  $\frac{1}{2}$  per cent during the first ten minutes and to within 1 per cent during the following twenty minutes.

In equation (2)  $i_0$  is the value of  $i$  when  $t=0$ , and in what follows we assume that  $i_0$  represents the saturation current due to the emanation alone.  $\beta$  is approximately equal to the ratio of the currents due respectively to the induced activity and to the emanation when they are in radio-active equilibrium, and  $\lambda/\mu$  is practically equal to the ratio of the currents due, respectively, to the first and third of the successive components of the induced radio-activity (in the theory of transformations.)

The constants  $\alpha$ ,  $\beta$ ,  $\lambda$  and  $\mu$  are functions of the dimensions of the apparatus, although they vary little if large testing vessels are employed, such as was the case in the experiments described below. When the current has reached its maximum value, about 42 per cent of it is due to the emanation, 33 per cent to the first and 25 per cent to the third of the components of the induced radio-activity.

The quantity of emanation produced by a radium salt is proportional to the weight of the salt and to the time. We define the unit quantity of emanation to be that emitted during one second into a large volume of air from a solution of small volume containing one gram of radium bromide. If the time during which the emanation is allowed to accumulate is not short, it is necessary to make a correction for the amount of emanation transformed during that time.

It is important to know the amount of ionization produced by the unit quantity of emanation, for this datum may be used in quantitative tests for radium.

If the emanation is enclosed in a testing vessel a part of its radiation is absorbed by the sides of the vessel. In order to determine the effect produced by the sides, three cylindrical vessels of zinc were constructed. In the axis of each cylinder an insulated zinc rod was

fastened to serve as an electrode. The largest cylinder contained 51 liters of air and the smallest about one-half a liter. The length of each cylinder was about twice its diameter. The saturation currents in these vessels were measured at intervals after the introduction of a known quantity of emanation, and from these data the initial value of the current was calculated by means of equation (2). These initial currents are quite accurately represented by the equation

$$I=I_0-k\frac{S}{V}, \quad (3)$$

$S$  being the surface of the vessel,  $V$  its volume and  $I_0$  and  $k$  constants. If each vessel contains unit quantity of emanation, the value of  $k$  is .326 and that of  $I_0$  .63 in electrostatic units and at 18° C. and 76 cm. pressure.

Equation (3) may be interpreted as follows: We may assume that the radiation absorbed by the sides and the secondary radiation produced at the metal surface are proportional to the area of the surface and to the quantity of emanation contained in a cubic centimeter of air. If each vessel contains the same total quantity of emanation, the quantity per cubic centimeter is inversely proportional to the total volume. The effect produced by the sides is therefore proportional to the ratio of  $S$  to  $V$ . The quantity  $I_0$  is the saturation current that would be produced by the unit quantity of emanation, if all its rays were absorbed in air. The constant  $k$  is positive, which shows that the absorbing effect of the sides is greater than the effect caused by any secondary radiation that may be produced.

In obtaining the above values of  $I_0$  and  $k$  the emanation evolved during two hours by a solution of .0001096 gram of radium bromide, *i. e.*, about .79 of a unit, was used. The volume of the solution was one cubic centimeter and that of the reservoir of glass that contained it about thirty cubic centimeters. In order to establish a permanent state the precaution was taken of drawing air several times through the reservoir at intervals of two hours before collecting the emanation for use in the experiments. Two other solutions also have been used containing respectively .000110 gram and .0000127 gram of radium bromide dissolved in five cubic centimeters of water. The correspond-

ing values found for  $I_0$  were .61 and .60, and for  $k$  .316 and .311. These results are quite close to those given above. However, the measurements are more regular when the radium salt is dissolved in a smaller quantity of water, as in the first experiments.

## THE CRANIAL NERVES OF ONE OF THE SALAMANDERS (*Plethodon glutinosus*)

BY GIDEON S. DODDS

Among Urodelan brains, probably those of *Necturus* and *Proteus* have been most studied. Work has also been done upon *Diemyctylus viridescens*,<sup>1</sup> *Desmognathus fusca*, *Amblystoma tigrinum*, *Amphiuma*, and others. The family Plethodontidæ, comprising thirty-five species,<sup>2</sup> has been little studied. So far as I can learn, the only work done in this family is a study of the cranial nerves of *Spelerpes bilineatus* by Mary A. Bowers.<sup>3</sup>

The brain of *Plethodon glutinosus* presents no very striking differences from those of other Urodelans. The general appearance of the dorsal aspect of the brain, and the place of origin of the cranial nerves is shown in figure 1. This brain measures 7 to 9 mm. in length and 2 to 2.5 mm. in width at the widest part. Owing to its small size, it is necessary to use microscopic methods in its study. The present investigations were made from serial sections through decalcified heads. In the following account is given a brief description of the cranial nerves of *Plethodon glutinosus*, including their apparent place of origin and relations of the principal branches. These features are shown in figure 2.

I. The mode of origin of the *olfactory* nerve varies in Urodela, sometimes arising by one root, and sometimes by two. In *Plethodon glutinosus* it arises by two roots. The main root arises from the cephalo-lateral angle of the olfactory lobes toward their ventral aspect. The second, very much smaller root, arises some little distance back, from the lateral surface of the brain. After a short course forwards, the nerve divides into two branches, which innervate the roof and floor

<sup>1</sup> The writer is indebted to Prof. Burt G. Wilder, through whose kindness he secured a valuable paper bearing on the subject.

<sup>2</sup> D. S. JORDAN. *Manual of the Vertebrates, etc.* Eighth edition. 1899.

<sup>3</sup> Noted by COGHILL. *Jr. Comp. Neur.*, 12: 285. 1902.

of the olfactory capsule. This is the largest of the cranial nerves. It contains no medullated fibers.

II. The fibers of the optic chiasma lie sunken in the ventral surface of the diencephalon. This is common in Urodela, in distinction to the condition in Anura, where the chiasma makes quite a prominence. The fibers of the optic nerve, after crossing, spread out to form the surface layer of white matter of the roof and sides of the mesencephalon. Beyond the chiasma, peripherally, the nerve passes antero-cephalad to its foramen. After leaving the cranium, it turns abruptly downwards and passes under the ophthalmic branch of V, and after a short lateral course enters the eyeball. The fibers of this nerve are, in the main at least, non-medullated. Throughout its course, the nerve has a core of glia cells. These are a direct continuation of the cells lining the preoptic recess, and are a remnant of the cells of the primitive eye-stalk. In *Necturus*, a more primitive form, the eyes and optic nerve are not so well developed, and the embryonic condition is more strongly suggested than in *Plethodon*.

III. The *oculo-motor* nerve arises from the ventro-lateral aspect of the mesencephalon. At its exit from the brain it is about 75 microns in diameter. It takes a course forward and dorsalward to its foramen, some distance in front of the exit of V. In its foramen it divides into the superior and inferior rami. These pass forward for some distance, one just above and the other just below the ophthalmic branch of V. Then they turn outward to the muscles of the eye.

IV. The *trochlear* is the smallest of the cranial nerves, measuring 36 microns in diameter and consisting of about twenty fibers. It arises from the line of union between the mid-brain and cerebellum near the mid-dorsal line. In some Urodela this nerve has not been observed, and in others it has not been traced to its exit from the cranium. In *Plethodon*, though small, its course can be clearly traced. From its place of origin, it takes a course latero-cephalad till it comes in contact with the Gasserian ganglion. It passes forward just beneath the mesial surface of the ganglion as a small but distinct bundle, and neither gives nor receives fibers from the ganglion. From here it leads forward and upward along the inner surface of the cranium and

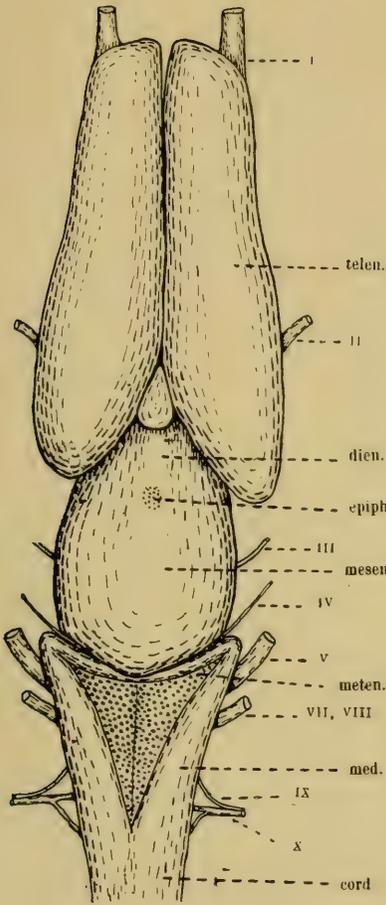


Fig. 1

Fig. 1. Dorsal view of the brain of *Pletchedon glutinosus*. x 12

I-X, the cranial nerves; telen, telencephalon; dien., diencephalon; mesen., mesencephalon; meten., metencephalon; med., medulla oblongata; cord, spinal cord; epiph., epiphysis.

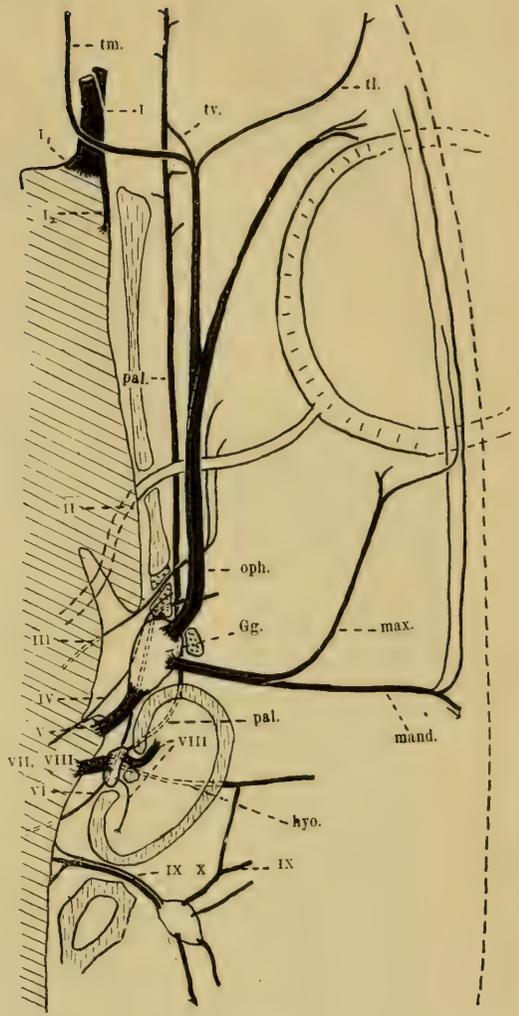
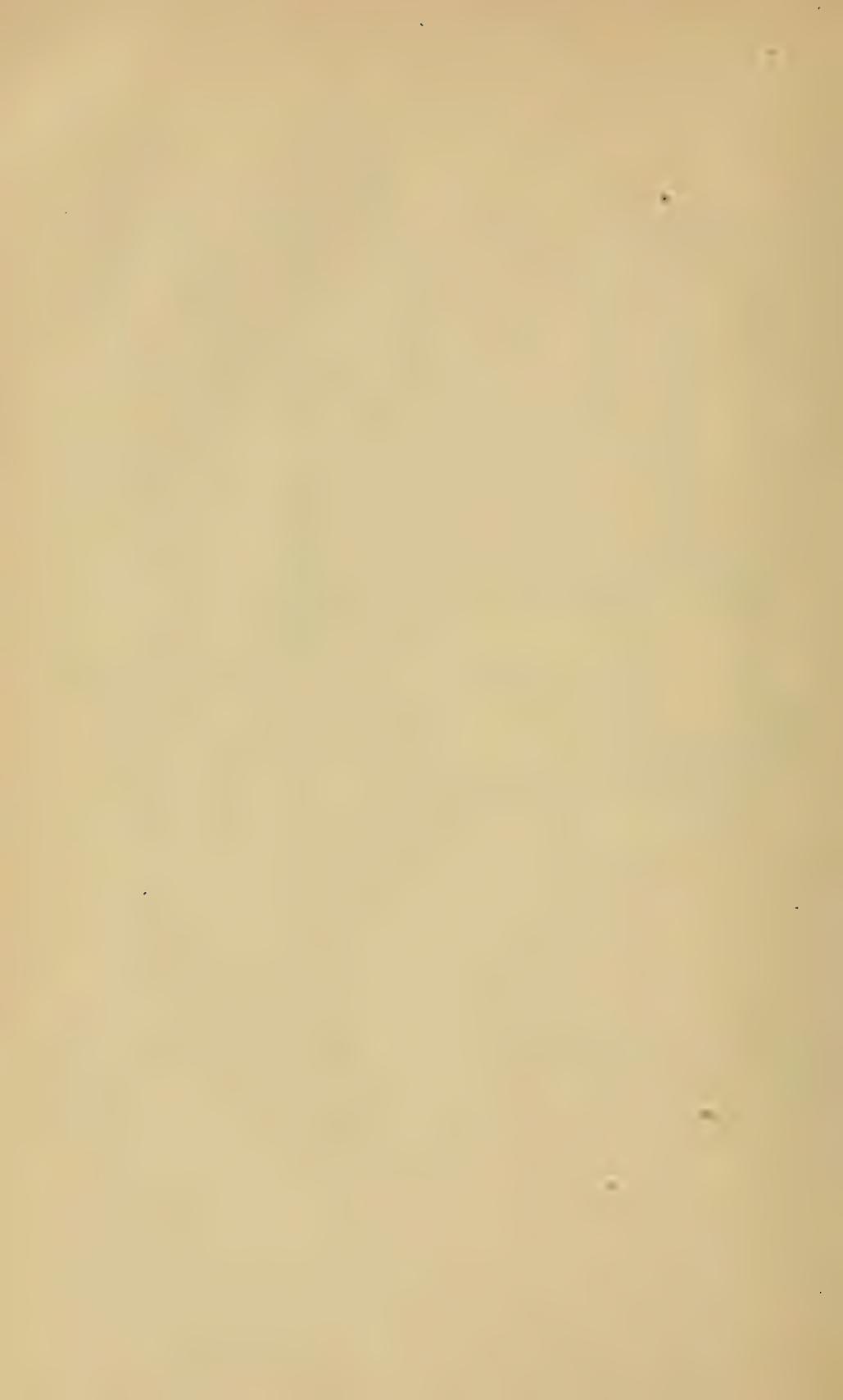


Fig. 2

Fig. 2. Diagram of the cranial nerves of *Pletchedon glutinosus*. x 12

Oblique shading represents the brain; vertical shading, bone; dotted shading, cartilage. The broken line represents the outline of the head; I-X, the cranial nerves; Gg., Gasserian ganglion; hyo., hyomandibular; max., maxillary; mand., mandibular; oph., ophthalmic; pal., palatine; tl., tm., and tv., lateral, mesial. and ventral, terminal branches of V.



makes its exit through the lateral edge of the parieto-frontal bone. Outside the cranium its course was traced only a short distance.

V. The *trigeminus* is, next to the olfactory, the largest of the cranial nerves. It arises from the antero-lateral angle of the medulla, and passes forward and outward to the Gasserian ganglion. This large ganglion lies inside the cranium just back of the posterior extension of the cerebral hemispheres. In some Urodela, it is described as lying inside the cranium, in some as lying in the foramen, and in others as lying outside the cranium. Arising from the ganglion are the three usual branches. They make their exit by two foramens. In the manner of exit of these branches there is considerable variation in Urodela. They may pass out through one, two, or three foramens. In *Plethodon* the maxillary and mandibular branches leave the cranium through a common passage in a lateral direction and the ophthalmic by a separate passage in a forward direction.

The ophthalmic takes a course directly forward just outside the cranium. It soon divides into two branches. One of these extends dorso-lateral and breaks up in the muscles in front of the eye. In the accounts of this nerve in other Urodela, I find no description of this nerve. It is probable, however, that it is represented in *Amblystoma* by three small twigs described by Coghill.<sup>1</sup> The other branch of the ophthalmic continues forward, and at about the level of the anterior part of the brain it breaks up into three terminal branches, mesial, lateral, and ventral. The mesial terminal branch turns inward and then extends forward in the floor of the nasal capsule to innervate the gland of the snout. The lateral terminal branch passes forward near the surface of the antero-lateral part of the snout. The ventral terminal branch soon unites with the palatine branch of VII. From here it continues forward to innervate the anterior part of the roof of the mouth.

As before noted, the maxillary and mandibular make their exit by a common foramen. The maxillary is dorsal, and is by far the smaller of the two. It passes off laterally and curves forward in two parts.

<sup>1</sup> G. E. COGHILL. "The Cranial Nerves of *Amblystoma tigrinum*." *Jr. Comp. Neur.*, 12: 220, 221. 1902.

One branch (infra-orbital) breaks up back of the eyeball, and the other (maxillary) passes forward a little above the maxilla. The mandibular passes off laterally and soon curves ventralward to the maxilla, where it breaks up into three branches. Two of these remain in the upper jaw and pass forward well into the snout, one just external to, and the other just internal to the maxilla. The distribution of this nerve in *Plethedon* seems to be exceptional. I am unable to find an account of any other form in which this large part of this nerve remains in the upper jaw. These two branches may possibly represent a part of the maxillary ramus. The third branch, about equal in size to the other two combined, passes ventralward into the lower jaw.

VI. The *abducens* arises, as usual, from near the mid-ventral line of the medulla, a short distance back of VIII. It is a slender never, raveaging about 65 microns in diameter. It takes a course forward and dorsalward and passes just below the ganglion of VII-VIII, and below the Gasserian ganglion. In this respect *Plethedon* seems to be exceptional, inasmuch as this nerve is usually described in amphibia as passing through the Gasserian ganglion. It makes its exit from the cranium in front of the ophthalmic branch of V.

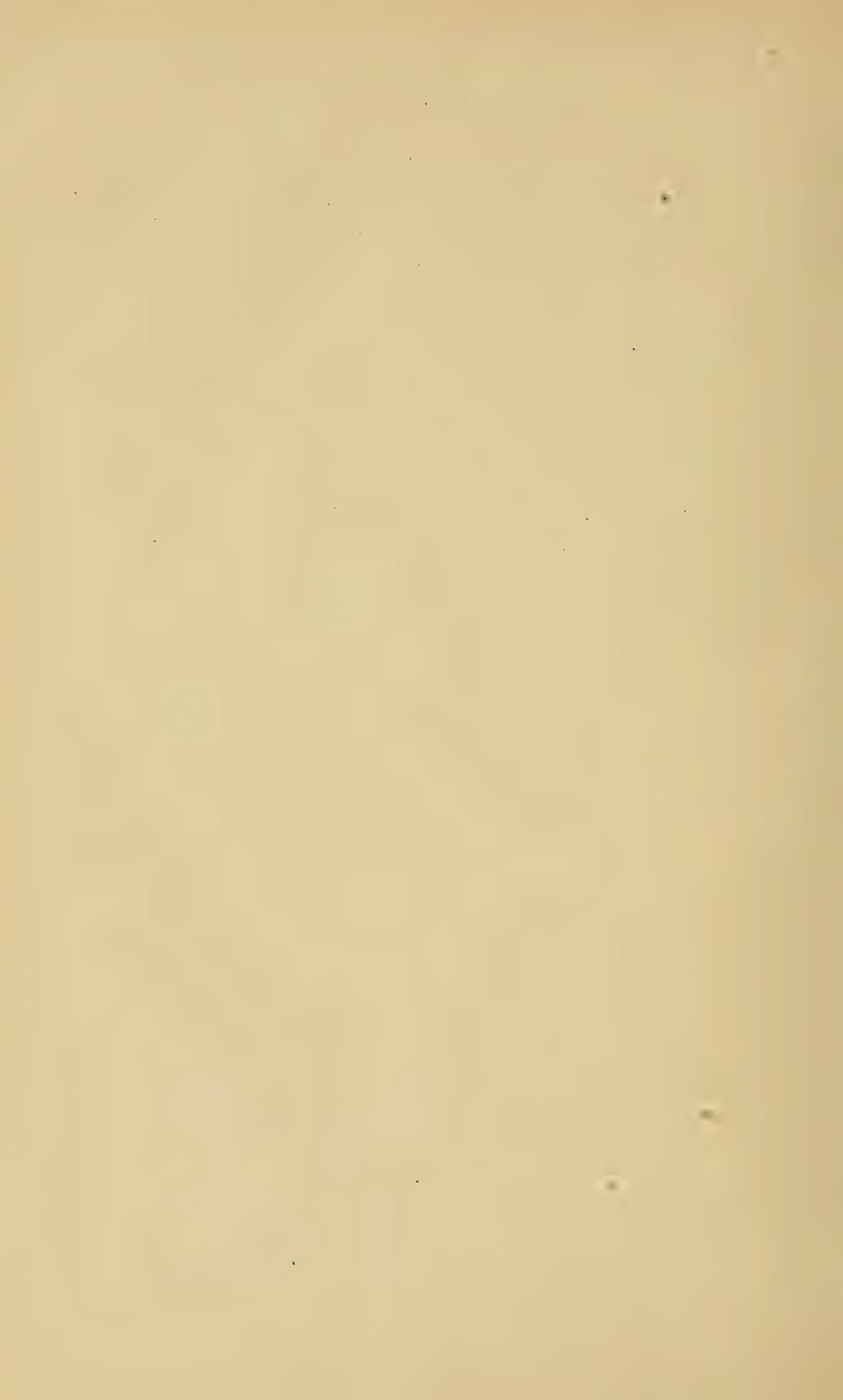
VII, VIII. The *facial* and *auditory* arise by a common trunk, from the lateral surface of the medulla just back of V. The combined trunk, after a short course in an antero-lateral direction, enters its ganglion, which is composed of the geniculate and auditory ganglia. From the ganglion, four nerve trunks make their exit, two of which belong to VII and two to VIII.

The branches of VII are the palatine and hyo-mandibular. The palatine passes forward in the roof of the mouth, to which it gives off branches. Its union with the ventral terminal branch of V has been described under V. The hyo-mandibular trunk of VII passes outward under the ear capsule and then curves downward to the lower jaw. A little distance from its foramen, it gives off a branch backward which, after a short course, unites with IX. This anastomosing branch between VII and IX is quite common in amphibia. A branch of VII uniting with the Gasserian ganglion is uniformly described for amphibia. I failed to find this branch in *Plethedon*.

The auditory nerve enters the ear capsule in two parts. The main part turns forward to the anterior part of the capsule, and the other part, a small twig, enters by a separate foramen and turns backward. Kingsbury<sup>1</sup> describes in *Necturus* a small part of VIII, which enters by a separate foramen and immediately unites with the main part of the nerve. In the accounts of this nerve in all other Urodela only one part is mentioned.

IX-X. Just back of VII-VIII there arise three separate roots from the lateral part of the medulla. The nerves arising from these roots unite later in a common ganglion. These are the roots of the *glossopharyngeal* and *vagus*. The anterior of these roots is the smallest and enters the ganglion as a separate nerve. The other two unite into a common trunk before entering the ganglion. Near the inner end of the ganglion there arises from its anterior surface a nerve composed, largely at least, of fibers from the anterior root. It passes off in a latero-ventral direction. Not far from the ganglion, it receives the branch from VII. This nerve is probably the glossopharyngeal. The remaining three branches constitute the *vagus*.

<sup>1</sup> B. F. KINGSBURY. "On the Brain of *Necturus maculatus*." *Jr. Comp. Neur.*, 5: 148. 1895.



## THE SEED AND SEEDLING OF THE MOUNTAIN GLOBE-FLOWER

BY FRANCIS RAMALEY

The mountain globe-flower, *Trollius albiflorus* (A. GRAY) RYDBERG,<sup>1</sup> is limited in range to the mountain districts of western North America. It grows in wet or swampy ground, where the water is cold, and is often found with our white-flowered *Caltha* (*C. rotundifolia*). Frequently it occurs in slow-running water under spruce trees. The writer has not seen it in Colorado at an altitude of less than 9,500 feet. In Montana, according to Rydberg, it occurs at 6,500 feet. When in full bloom a mass of these plants forms a striking feature of a forest scene. The flowers are white, and there are many on each plant.

Each carpel of the flower produces a great many of the small, ovoid black seeds. A ripe seed is about 1.7 mm. long, somewhat angled, and striate with irregular ribs. The embryo is small and placed at the narrow end of the seed (Fig. 1). The endosperm cells are densely packed with aleuron grains. A considerable amount of oil is present. The cells immediately surrounding the embryo are somewhat more oily than the rest. This region is marked by the dotted line in Figs. 2 and 3. The embryo, carefully dissected out, is found to show but slight differentiation (Fig. 3). The cotyledons may be recognized, but they show no similarity to leaves. At this stage in its development the young plant has no vascular tissue.

The seedling is peculiar in that the cotyledon-stalks are united from the base upward for about half their length. The stem axis is thus surrounded and covered over by the united bases of the stalks. It is through a slit in this "cotyledonary sheath" that the plumule escapes. A similar condition obtains in *Trollius ledebouri* as described by Lubbock.<sup>2</sup> Certain other Ranunculaceæ also have the cotyledon-

<sup>1</sup> *Cat. Flora of Mont. and Yellowstone Nat. Park*, 152. 1900.

<sup>2</sup> *Seedlings*, 1: 91. 1892.

stalks thus united. Miss Ethel Sargent<sup>1</sup> has recently published a provisional list of plants which show this peculiarity.

From a glance at Fig. 4 the general structure of the seedling will be understood. The hypocotyl is short; the primary root is soon replaced by a number of adventitious roots. All parts of the plant are glabrous, or nearly so, although the leaves bear a few short trichomes to be seen only with the compound microscope (Fig. 8). From the very first the leaves are palmately cleft and toothed; later leaves are more deeply incised (Fig. 13). The cotyledons have the usual Ranunculaceous form, being oval or elliptical in outline. In texture they are herbaceous. Veins in the cotyledons are only recognized with ease after the specimens have been in alcohol for a time.

Certain differences are apparent in the structure of the epidermis of the leaves and cotyledons, as will be seen by a glance at the figures. In the cotyledon, the epidermis of the upper (Fig. 5) and lower (Fig. 6) surfaces is much alike. The cell outlines are quite wavy. Some stomata are present on the lower surface, while none are to be seen above. As would be expected, the leaf shows a more specialized condition. The cells of the upper surface have only a slightly wavy outline (Fig. 7), and there are no stomata. On the other hand, the lower epidermis is made up of cells with very wavy outlines, and there are numerous stomata and some short, club-shaped trichomes (Fig. 8).

In studying vertical sections of the leaf-lamina (Fig. 9) and blade of the cotyledon (Fig. 10) marked differences are seen. A distinct palisade of vertically elongated cells is found in the former, and a few of these palisade cells are branched above so as to be **V** or **Y** shaped. No true palisade is formed in the cotyledon, but instead there are about two rows of rather spherical cells very loosely arranged with large intercellular spaces. The vascular tissue of the cotyledon is slight in amount, the bundles being quite small.

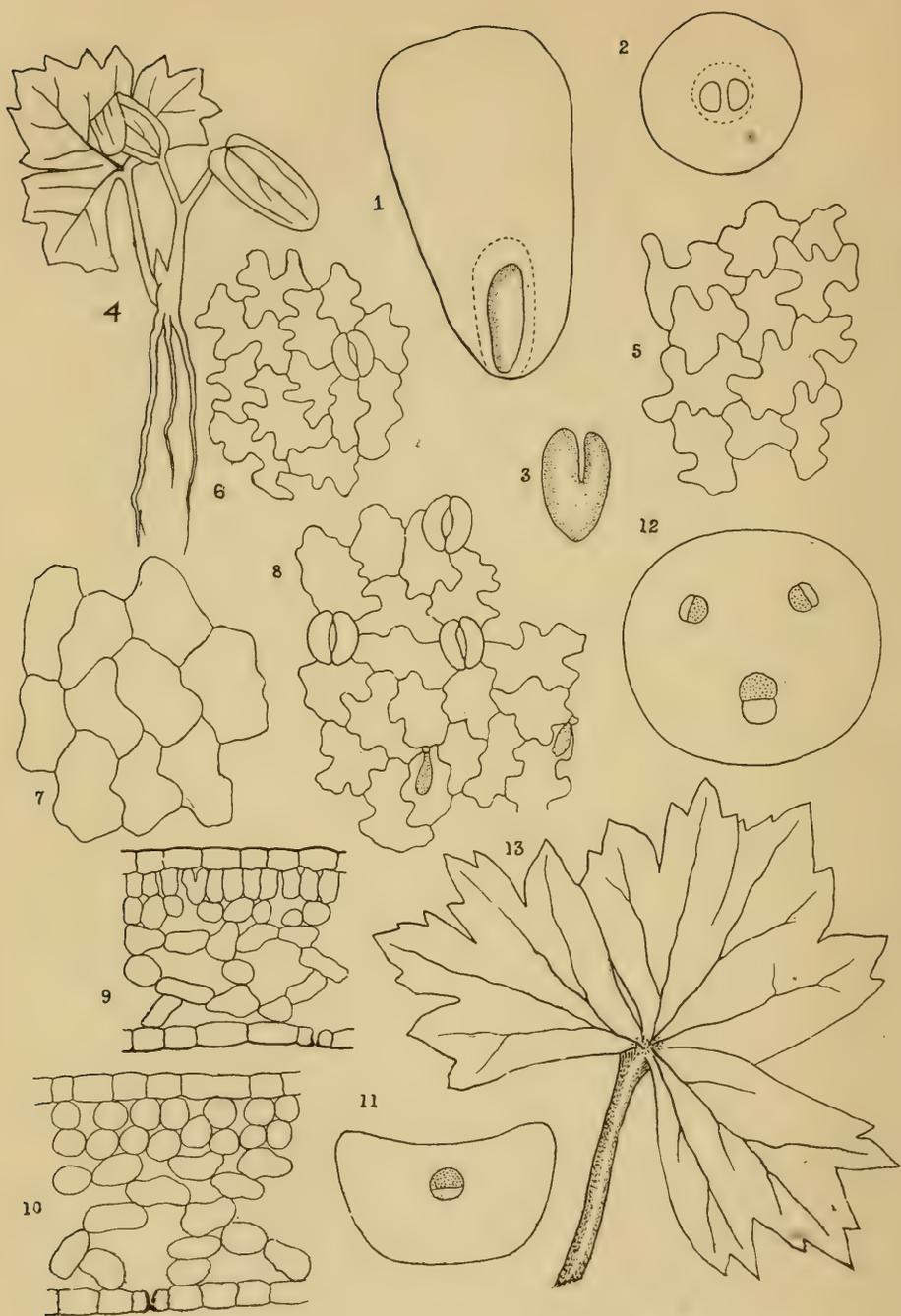
The cotyledon-stalks are united for about half their length in the same way as those of *Delphinium occidentale*, described by the present writer.<sup>2</sup> A similar condition has recently been noted by Miss Neata

<sup>1</sup> *Annals of Bot.* 17: 73. 1903.

<sup>2</sup> *Minn. Bot. Studies.*

2: 417-421. 1900.





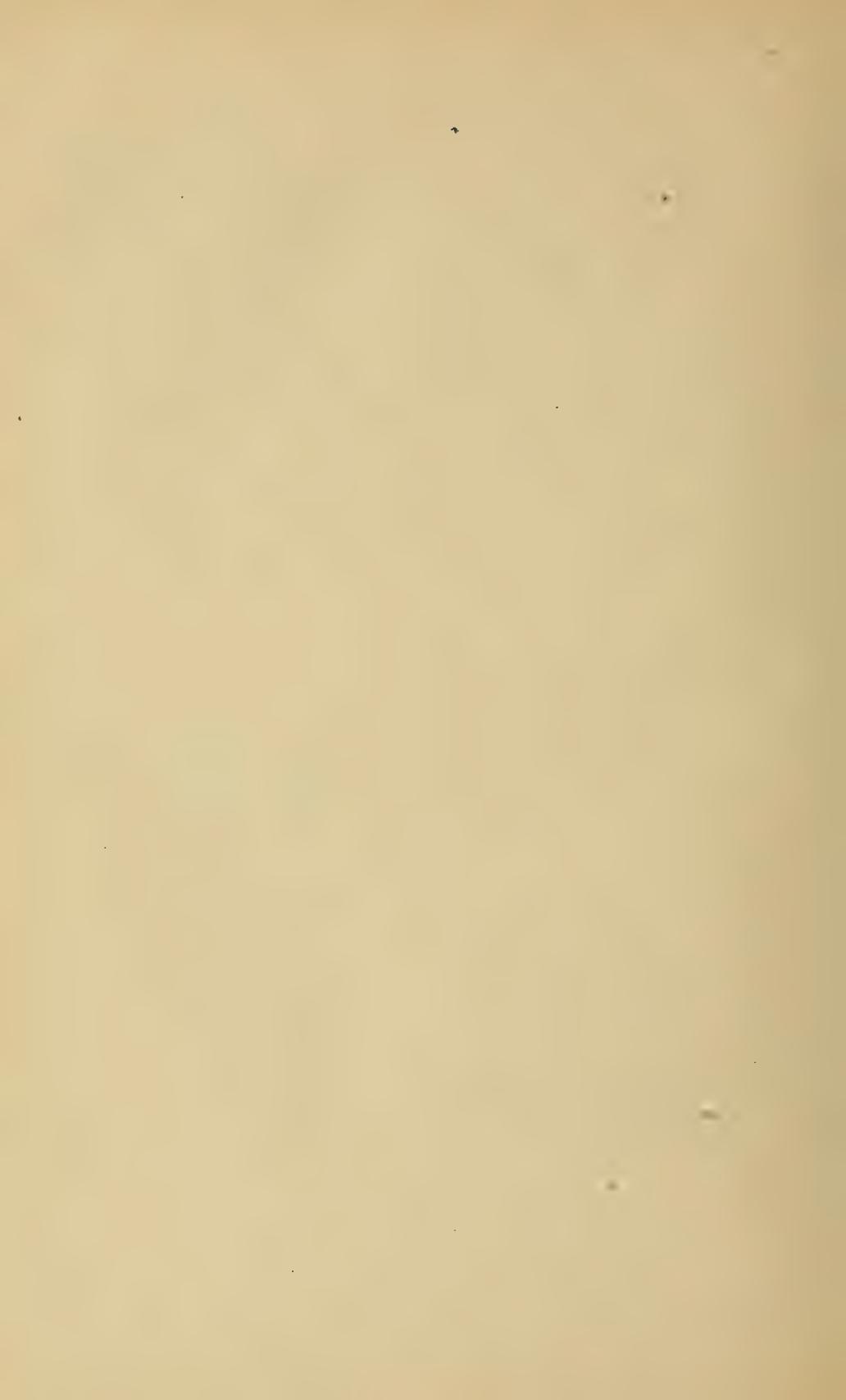
Clark<sup>1</sup> in *Oxygraphis cymbalaria*. Each stalk (Fig. 11) is channeled above and contains a single small vascular bundle. The petiole of the first foliage leaf is semi-terete. It has three vascular bundles, the lower one the largest. In later leaves the bundles are numerous, as many as six or eight large ones and a number of smaller size.

The principal points of interest in the foregoing account may be briefly summarized. *Trollius albiflora*, in germination, offers an example of united cotyledon-stalks. The plumule makes its appearance through a slit at the base of the connate stalks. Although the cotyledons are foliaceous in appearance they are very different in shape from the leaves. A more specialized structure is observed in the leaf than in the cotyledon, the former having a well-marked palisade and the epidermis being strikingly different on the upper and lower surfaces. The cotyledon-stalks have each a single vascular bundle, while the leaf-petiole of the first leaf has three bundles and later leaves still more.

#### EXPLANATION OF FIGURES

1. Vertical section of the seed x 55. The embryo is seen, imbedded in endosperm, which is somewhat more oily close to the embryo.
  2. Cross section of the seed, through the embryo, x 55. The cotyledons are shown surrounded by the more oily portions of the endosperm.
  3. Embryo, dissected out x 55.
  4. The seedling x 2. Note the absence of main root; the connate cotyledon-stalks; the first leaf and bud appearing through a slit in the cotyledonary sheath. In shape, the first leaf is seen to differ from the later leaf (Fig. 13).
  5. Surface view of upper surface of cotyledon. All the cells of the epidermis have wavy outline.
  6. Surface view of lower epidermis of cotyledon. This has much the same appearance as Fig. 5. Stomata are, however, present.
  7. Surface view of upper epidermis of leaf. In this the cell outlines are less wavy than in the corresponding epidermis of the cotyledon.
  8. Surface view of lower epidermis of leaf. Here are found very wavy cell outlines, numerous stomata, occasional short, clavate trichomes.
  9. Vertical section of leaf-lamina. A distinct palisade layer is present. In this layer one cell is shown which is branched above.
  10. Vertical section of blade of cotyledon. In place of the distinct palisade found in the leaf, there are two rows of nearly spherical cells with large spaces between them.
  11. Diagram of cross section of cotyledon-stalk, made above the region where the two stalks are connate. There is one small vascular bundle.
  12. Diagram of cross section of petiole of first leaf. In this there are three vascular bundles. Attention should be called to the fact that in later leaves the vascular bundles are numerous.
  13. Drawing of an adult leaf, one-half natural size. It is interesting to note that the shape is quite different from that of the first leaf.
- All the drawings were made by the author from his own preparations. Figures 5 to 10 show a magnification of about two hundred and fifty diameters.

<sup>1</sup> Torreya, 5: 164-166. 1905.



VOLUME III

NUMBER 3

THE  
UNIVERSITY OF COLORADO  
STUDIES



FRANCIS RAMALEY  
EDITOR

PUBLISHED BY THE  
UNIVERSITY OF COLORADO  
BOULDER, COLO.

JUNE, 1906

*Price, 50 Cents*



VOLUME III

NUMBER 3

THE  
UNIVERSITY OF COLORADO  
STUDIES



FRANCIS RAMALEY  
EDITOR

PUBLISHED BY THE  
UNIVERSITY OF COLORADO  
BOULDER, COLO.

JUNE, 1906

*Price, 50 Cents*



PRINTED AT  
THE UNIVERSITY OF CHICAGO PRESS  
CHICAGO, ILLINOIS

# CONTENTS.

	PAGE
1. A PRELIMINARY BIBLIOGRAPHY OF COLORADO HISTORY	101
FREDERIC LOGAN PAXSON, PH.D., Professor of History	
2. ENGLAND AND MEXICO, 1824-1825 . . . . .	115
FREDERIC LOGAN PAXSON, PH.D., Professor of History	
3. LUCRETIVS AND HAECKEL BEFORE THE RIDDLES OF THE UNIVERSE . . . . .	121
FRED B. R. HELLEMS, PH.D., Professor of Latin	
4. TRYCORYTHUS, A GENUS OF MAYFLIES . . . . .	135
T. D. A. COCKERELL, Lecturer on Entomology AND MARIE GILL	
5. ON A NEW $\alpha$ , $\delta$ DIHYDROQUINOXALINE . . . . .	139
JOHN B. EKELEY, PH.D. Professor of Chemistry	
6. THE TERTIARY LAKE BASIN OF FLORISSANT, COLORADO	145
JUNIUS HENDERSON, Curator of the Museum	
7. THE FOSSIL FAUNA AND FLORA OF THE FLORISSANT (COLORADO) SHALES . . . . .	157
T. D. A. COCKERELL, Lecturer on Entomology	
8. PLANTS OF THE FLORISSANT REGION IN COLORADO . . .	177
FRANCIS RAMALEY, PH.D., Professor of Biology	



## A PRELIMINARY BIBLIOGRAPHY OF COLORADO HISTORY

BY FREDERIC LOGAN PAXSON

The materials relating to the history of Colorado have never been described in a systematic manner and remain unnoticed in our libraries in the form of books, chapters, and magazine articles. The official records of the state have received some attention in "The Public Archives of the State of Colorado," by F. L. Paxson, in the *Annual Report of the American Historical Association*, 1903, Vol. I, pp. 414-437. A beginning has also been made in the bibliography of formal books relating to the history of the state, by the same writer in his "The Historical Opportunity in Colorado," in the *University of Colorado Studies*, Vol. III, pp. 19-24. But no attempt has thus far been made to arrange the magazine articles and public documents in any sort of order. This last work is the purpose of this present paper, but no claim for an exhaustive bibliography is here made. It is hoped that the most important articles have been found and listed, but in some directions the collection is avowedly partial, while in all it is only preliminary.

The land which is incorporated in Colorado has been acquired at various times from France, Mexico, and Texas, the steps being recorded in F. L. Paxson, "The Boundaries of Colorado," in the *University of Colorado Studies*, Vol. II, pp. 87-94. The actual survey of the southern boundary touching New Mexico and Oklahoma was long deferred, the attempts to provide for it being described in H. Doc. 604; 57C.1; Serial 4377; May, 1902,<sup>1</sup> and H. Doc. 120; 57C.2; Serial 4489; December, 1902. So much of the land as lies between the Rio Grande and the Arkansas, and the meridians of their sources, was bought from Texas on September 9, 1850. The existence of various Mexican grants in this region has been a source of

<sup>1</sup> This reference, and all others to the public documents, should be expanded in this manner: House Document 604; Fifty-seventh Congress, First Session; Serial No. 4377.

annoyance to the United States because of a confusion as to lands east and west of the Rio Grande, the latter having been acquired from Mexico in 1848, and the grants therein being under the guarantee of the treaty of Guadalupe Hidalgo. In 1886 the Committee on Private Land Claims recommended the erection of a special tribunal to handle these claims, H. Rep. 1380; 49C.1; Serial 2439. Two years later this same committee presented a second report to the same effect, stating that three millions of acres of Colorado lands were claimed under grants from Spain and Mexico, H. Rep. 675; 50C.1; Serial 2600; and finally in 1892 the same committee again reported to the House on the status of litigation over the Vigil, Maxwell, St. Vrain, and other grants, calling attention to the fact that the land policy of the United States had overlooked the Texan origin of the Colorado lands east of the Rio Grande, H. Rep. 1253; 52C.1; Serial 3045.

The geographical and geological foundations for the history of Colorado are well laid in the government documents. In general, it is necessary to call attention to the irrigation papers among the *Bulletins of Experiment Stations, Department of Agriculture*, and to the *Bulletins of the United States Geological Survey*, many of which relate to Colorado. There is a good bibliography of the various exploring parties that have worked in Colorado in pp. 18-26 of G. H. Girty, "The Carboniferous Formations and Faunas of Colorado," H. Doc. 479; 57C.2; Serial 4511; pp. 546. A resolution of the legislature of Colorado asking for a federal department of mines, with the comment of the Director of the Geological Survey upon the request, is in Sen. Doc. 170; 55C.1; Serial 3563; pp. 8. The Secretary of War reported to Congress in 1897 upon reservoir sites in Wyoming and Colorado, giving a general history of irrigation works, H. Doc. 141; 55C.2; Serial 3666; pp. 110; while A. L. Fellows, in *Water Supply and Irrigation Papers*, No. 74, has an exhaustive description of the "Water Resources of the State of Colorado," H. Doc. 200; 57C.2; Serial 4500; pp. 151. The economic historian will find much comfort in the annual *Statistics of Mines and Mining*, prepared by the federal Commissioner of Mining Statistics, the eighth annual being 1875, H. Ex. Doc. 159; 44C.1; Serial 1691.

The first few years of the life of the Territory of Colorado were passed in an obscurity that has rarely been driven away. Little interest was shown in the territory at the time, or since, and thus few articles have to be recorded for the period. Among the most interesting articles upon the period of settlement is the avowed forgery by "Fitz-Mac," which appeared in the *Colorado Magazine*, Vol. I, pp. 281-297, July 1893. This local magazine, which lived for only five months in the summer of 1893, was far beyond most similar journals in typographical and literary character. The article in question purported to be a series of six letters, written chiefly in the years 1859-1860, by early settlers in Denver. Although the author admitted that the letters were an honest fabrication, the descriptive value of the series is great, for "Fitz-Mac" showed an intimate acquaintance with the personnel and conditions of the short-lived territory of Jefferson.

Much of the literature produced in these first years was called forth by the various attempts at statehood made in the Pike's Peak country. As early as February, 1861, this matter was stirred up by B. D. Williams, who appeared in Washington and sought recognition as a territorial delegate. The memorials which he presented to Congress contain descriptions of the new settlements and a copy of the message of Richard W. Steele, governor of the provisional territorial organization of Jefferson Territory. They may be found in H. Misc. Doc. 10; 36C.1; Serial 1063. The same spontaneous territorial movement is described in a brief paper on "The Territory of Jefferson," by F. L. Paxson, in the *University of Colorado Studies*, Vol. III, pp. 15-18. The original materials for the period are not copious. The message of General Gilpin, the first territorial governor, is printed in H. Ex. Doc. 56; 37C.2; Serial 1131; while in the same month, February, 1862, a six-page report from the Committee on Ways and Means, H. Rep. 36; 37C.2; Serial 1144, advocates the establishment of a branch mint in Denver. The great production and use of raw gold, together with the existence of a private mint, were the reasons leading the committee to its recommendation.

From 1864 to 1867 various attempts to bring Colorado into the United States occupy most of the time. An enabling act was passed

in 1864, but the constitution framed in accordance with it was rejected at the polls. The following summer saw a change of feeling, bringing with it a new and ratified constitution; but President Johnson declined to issue the proclamation of admission on receiving it, on the ground that the time for such action had expired. He transmitted the constitution with extracts from the reports of the convention and his reasons for refusing to act in Sen. Ex. Doc. 10; 39C.1; Serial 1237, on January 12, 1866. Congress followed this message by passing a second enabling act for the territory, only to receive back this act with a veto message of May 16, 1866. The printed message, Sen. Ex. Doc. 45; 39C.1; Serial 1238, contains a copy of the vetoed act. A third enabling act was passed the following January by this same Congress, and was likewise vetoed by the President. The second veto message, Sen. Ex. Doc. 7; 39C.2; Serial 1277, contains elaborate reasons for the veto, the chief ground being the small population of the territory, its recent shrinkage in numbers, and the injustice of such admission to the older states.

While the statehood agitation was in progress, the territory suffered from constant Indian attacks. Incidental to these attacks are the investigation into the Indian finances of Governor A. B. Cummings, H. Misc. Doc. 81; 39C.2; Serial 1302, and the statement of the expenses of the First Colorado Regiment in a campaign of 1865, H. Ex. Doc. 7; 40C.2; Serial 1330.

The interest of Congress in the territory and its Indian troubles is followed by the beginning of popular curiosity as to the new country. Among the articles which cater to this demand are two which are found in *Harper's Magazine* for June and July, 1867. In the latter issue, Vol. XXXV, pp. 137-150, there is an account of the trip across the plains by F. R. Davis, entitled "A Stage Ride to Colorado." The life of the pioneer emigrant is described in this account of a journey by the Smoky Hill route from Omaha to Denver. Some interesting statements are made as to the condition of the railroad end of the route. A month earlier than the account of Davis, A. W. Hoyt has in the same magazine, Vol. XXXV, pp. 1-21, a brief description of a similar trip "Over the Plains to Colorado," of which the more impor-

tant part consists of a description of the mining camps then existing in the territory.

Greeley, settled in 1869, is remarkable among frontier communities in that it was deliberately planted in lands which could easily be put under ditch. The village from the start was occupied by an eminently moral and temperate population, under the leadership of Meeker, and under the countenance of Horace Greeley. Its resulting prosperity is described by Richard T. Ely in "The Story of a 'Decreed' Town," in *Harper's Magazine*, Vol. CVI, pp. 390-401, February, 1903.

The census of 1870 gave some support to the contention of President Johnson, since it reported a population of only 39,841 for the territory. But the figures were attacked by the settlers in Colorado. There is to be found in Sen. Misc. Doc. 40; 41C.3; Serial 1442, a statement signed by territorial governor McCook, which denies the accuracy of the census. It gives various tables showing taxable values, agricultural statistics, railway growth, etc., and closes with an inaccurate abstract of the legislative history of the statehood movement. The early years of the seventies saw considerable settlement in the territory, and twice between 1870 and 1875 did the House Committee on Territories report in favor of the admission of Colorado. The former report is in H. Rep. 8; 42C.3; Serial 1576, dated January 6, 1873. The second comes May 28, 1874, in H. Rep. 619; 43C.1; Serial 1626. This latter report, by Chaffee, gives valuable figures as to the condition of the territory, based on a census of 1873. Its figures of railways are specially interesting.

Colorado became a state in 1876, and the framing of its constitution is the subject of an article by E. H. Meyer in the *Iowa Journal of History and Politics* for April, 1904, Vol. II, pp. 256-274, with the title "The Constitution of Colorado." The admission of the state was by presidential proclamation, in accordance with an act passed at the end of the Forty-third Congress. In the following Congress the point was raised as to the constitutionality of this method of admission, and the House Committee on Judiciary presented majority and minority reports to the house upon the propriety of seating James W. Belford as representative from Colorado without further legislation, H. Rep.

67; 44C.2; Serial 1769; pp. 24. The majority report advised the seating of the delegate, while both reports went into the details of the territorial policy of the United States.

The admission of the new state brought into a new prominence the problem of the military control of the Southwest, with the result that exploration and survey of new routes advanced rapidly. The lines of communication between southern Colorado and points in Arizona and New Mexico inspired a report from the Secretary of War on March 31, 1876, H. Ex. Doc. 172; 44C.1; Serial 1691; pp. 34. The next Congress saw a similar report on communication between Colorado and New Mexico, based upon a reconnaissance of the San Juan country in 1877, H. Ex. Doc. 66; 45C.2; Serial 1806; pp. 38. This report includes three maps, one of which shows the outlines of the Ute Indian reservation at the time. And another map, published in a report of the same department in May, 1878, H. Ex. Doc. 88; 45C.2; Serial 1809, shows all the surveys and explorations made west of the hundredth meridian during the ten years then ending.

The earliest prominence of Colorado in the magazines came with the discovery of the large deposits of silver in and near Leadville, about 1877. Before these discoveries, the federal surveys had inspired a description of the work of the "Wheeler Expedition in Southern Colorado," by W. H. Rideing, in *Harper's Magazine*, Vol. LII, pp. 793-806, May, 1876. But this account of a party which started from Pueblo and crossed to the southwest in search of wagon routes, is exceptional, and it is not until about 1880 that a real interest is aroused. The new Leadville camp drew visitors from all the United States, and among them was Helen Hunt Jackson, who then lived in Colorado Springs, and told of her trip "To Leadville" in the *Atlantic Monthly* for May, 1879, Vol. XLIII, pp. 567-579. This, like other articles from the same pen, is light and discursive, valuable not for its contribution to facts, but for its contribution to color. E. Ingersoll's "Camp of the Carbonates," in *Scribner's Monthly* for October, 1879, Vol. XVIII, pp. 801-824, is more serious than Mrs. Jackson's article, and gives some useful accounts of definite conditions in Leadville. "Grub Stakes and Millions," by A. A. Hayes, in *Harper's Magazine*, for Febru-

ary, 1880, Vol. LX, pp. 380-397, is of similar character. More serious than any of these is an article on "Colorado" which appeared in the *Fortnightly Review* for January, 1880, Vol. XXXIII, o. s., pp. 119-129, over the name of J. W. Barclay. Here, prepared for an English public, is an account of the conditions prevailing throughout the state, with special and conservative reference to the possibilities of the state in mining, agriculture, and grazing; while the appeal of the mountains to the hunter and sportsman is sounded by the Earl of Dunraven in the *Nineteenth Century* for September, 1880, Vol. VIII, pp. 445-457, with the title "A Colorado Sketch."

The silver interests are not the only ones which attracted the visitor about 1880. A. A. Hayes described "The Cattle Ranches of Colorado" in *Harper's Magazine* for November, 1879, Vol. LIX, pp. 877-895. The grazing possibilities of the Arkansas valley are exploited in this paper, while its general argument is carried a step further by the same author in *Harper's* for January, 1880, Vol. LX, pp. 193-210, with the similar title, "Shepherds of Colorado," and his "Vacation Aspects of Colorado" found place in the issue for May, Vol. LX, pp. 542-556. The same year which saw these articles of Hayes saw further papers from Mrs. Jackson, who journeyed out from her home in Colorado Springs to various points of interest, and continued to write little discursive sketches of camps and scenery and people. Her "A New Anvil Chorus," in *Scribner's Monthly* for January, 1878, Vol. XV, pp. 386-395, tells of a visit to Fort Garland and the San Juan valley, of racial types and railway construction; "Little Rose and the House of the Snowy Range," in the same monthly for May, 1878, Vol. XVI, pp. 55-58, carries her to the Sangre di Cristo range and the Wet Mountain valley; and finally she contributed to the *Atlantic*, in December, 1883, Vol. LII, pp. 753-762, an account of her trip to Crested Butte and the Gunnison fields of 1880, with the title "O-Beloyful Creek and Poverty Gulch."

Parallel to the mining interest of the Leadville boom came a desire to explore the lands of the southwestern part of Colorado, and a demand that the Ute Indians be removed from the state by the federal government. The Secretary of War replied to a resolution of the House

with a message of May 23, 1878, H. Ex. Doc. 91; 45C.2; Serial 1809; pp. 4, in which he described the means taken for the protection of residents of western Colorado and gave a map showing parts of the Ute reservation, with the portion in dispute in the Uncompahgre country. As a result of this pressure the removal was provided for by Congress, and the lands in question were ceded by the Utes June 15, 1880. A letter to the Commissioner of Indian Affairs tells of the condition of the Indians to be removed, H. Misc. Doc. 57; 45C.2; Serial 1820; pp. 5; while after the bill had been passed, the Committee on Public Lands, through T. M. Patterson, advocated the survey of the boundary between Colorado and New Mexico, on the ground that the mineral deposits in the new territory made such a survey necessary, H. Rep. 708; 45C.2; Serial 1825. Four years later, the removal having been accomplished, on August 28, 1881, the Committee on Public Lands again brought up the matter of the Ute agreement, and asked for legislation to protect the settlers in their titles in the old reservation, its boundaries not having been surveyed, and the land itself not yet having become a part of the public lands, H. Rep. 561; 47C.1; Serial 2066. The same report, with slight verbal changes, is found also in Sen. Rep. 186; 47C.1; Serial 2004. The question of titles in these lands was long a matter of confusion, a homestead bill for them being considered in 1902, and advocated by Shafroth of Colorado, H. Rep. 1275; 57C.1; Serial 4403.

The decade of the eighties is one of rapid development in all directions, bringing as a by-product many difficult questions concerning the administration of the public lands. The common occurrence of agricultural school lands turning out to be mineral lands produced in 1880 a report from the Committee on Public Lands, Sen. Rep. 256; 46C.2; Serial 1893, and another in 1898, H. Rep. 792; 55C.2; Serial 3719. Similarly, the confusion among the railway land grants to the Union Pacific and the Denver Pacific Railways is responsible for a bill introduced to protect purchasers of such lands in their titles, H. Rep. 2846; 50C.1; Serial 2605. All of the agricultural lands received a new value as irrigation progressed. The proposal to lease the arid lands of Colorado evoked in 1882 majority and minority reports from

the Committee on Public lands, H. Rep. 197; 47C.1; Serial 1065. The Secretary of the Interior made an estimate in 1889, the year after the formal irrigation survey had begun under the Geological Survey, of the irrigation capacities of the Platte and Arkansas valleys, Sen. Ex. Doc. 120; 50C.2; Serial 2612, in response to a call from the Senate; and the House Committee on Public Lands, in the same session, recommended the establishment of three new land offices in Colorado, to meet the demands of increasing sales, H. Rep. 3617; 50C.2; Serial 2673. The establishment of forest reserves created complications in mining lands, a bill to open such reservations to mining claims receiving in 1896 favorable reports from both of the committees, Sen. Rep. 191; 54C.1; Serial 3362, and H. Rep. 152; 54C.1; Serial 3457.

The early nineties saw a considerable degree of interest in Colorado, inspired by the great discoveries at Cripple Creek, and the prominent part played by the great discoveries at Cripple Creek, and the prominent part played by the state in the prevailing monetary discussions. The general question of mining and mining education came in for consideration, and the latter extracted from the House Committee on Mines and Mining a recommendation that a portion of the proceeds from the sale of public lands should be turned over to the aid of the School of Mines in the state in which the lands were sold, H. Rep. 1136; 51C.1; Serial 2810. The *Nation* on October 5, 1893, Vol. LVII, pp. 245-246, gave space to a geographical and romantic description of "Pike's Peak and Colorado Springs" by Mabel L. Todd; and *Harper's Magazine* for May of that year had already printed, Vol. LXXXVI, pp. 935-948, a description by the New York correspondent of the *London Times*, Julian Ralph, of "Colorado and its Capital." More specific accounts of the mining excitement of this year are Cy Warman's "Story of Cripple Creek," in the *American Review of Reviews* for February, 1896, Vol. XIII, pp. 161-166, with its description of the early rush into the camp and the resulting construction of railways; and his similar article in the *Colorado Magazine*, Vol. I, pp. 67-76, April, 1893. Warman had already contributed to the *Colorado Magazine*, Vol. I, pp. 163-172, May, 1893, an article on "Crede," describing the discovery of the Amethyst vein in 1891, the

extension of the Denver & Rio Grande tracks to the camps in the autumn of that year, and the resulting fortunes for Crede, the discoverer, and Moffat, his partner. A little later, Francis Lynde published in *Scribner's Magazine*, which is to be distinguished from the earlier *Scribner's Monthly*, a narrative description of "Cripple Creek" in the issue for May, 1900, Vol. XXVII, pp. 603-616. And, finally, the *Colorado College Studies*, General Series, No. 17, June, 1905, pp. 1-48, presents a paper on "The Cripple Creek Strike of 1893," by B. M. Rastall, with an introduction by Professor T. K. Urdahl.

On the monetary situation there are magazine articles without number, only a few calling for mention here. In September, 1893, when the question of silver had come into existence, the *Review of Reviews* presented a friendly account of "The Silver Situation in Colorado," Vol. VIII, pp. 276-280, by E. W. Bemis, of the University of Chicago. The *North American Review* brought out in January, 1894, Vol. CLVIII, pp. 24-29, an article by the new Populist governor of Colorado, Davis H. Waite, on "Are the Silver States Ruined?" and in its next number, February, 1894, Vol. CLVIII, pp. 247-249, allowed J. E. Leet to reply to Governor Waite with "Colorado's Bright Outlook". The "Situation in Colorado" was again discussed in May, 1896, in the *Yale Review*, Vol. V, pp. 50-57, by L. R. Ehrich, who saw the manner in which gold production was gaining upon silver, and changing the financial balance of the state.

The struggle for women's suffrage in Colorado began long before the admission of the state, but became successful only during the Populist period in 1893. James H. LeRossignol, in the *Annals of the American Academy of Political and Social Science*, Vol. XVIII, pp. 552-556, has a brief article on "Woman's Suffrage and Municipal Politics," with a useful bibliography. Later, Elizabeth McCracken contributed to the *Outlook*, Vol. LXXV, pp. 737-744, November, 28, 1903, in her series "The Women of America," a distinctly witty and unfriendly statement upon the workings of "Women's Suffrage in Colorado," which evoked from Mary G. Slocum, wife of the president of Colorado College, an indignant, but dignified, refutation in the *Outlook*, Vol. LXXV, pp. 997-1000, December 26, 1903. Women's

suffrage, like the silver question, cannot receive more than a suggestive bibliography in this place.

In an international way Colorado provoked remonstrance from Baron Fava, the Italian minister, and from Secretary of State Olney, when certain Italian subjects were lynched in Walsenberg in March 1895. The lynching arose out of a murder of an American saloon-keeper named Hixon, and became the occasion of an extensive correspondence between the United States, Italy, and Governor McIntire of Colorado, parts of which are printed in H. Doc. 195; 54C.1; Serial 3420, pp. 20. Six years later a mob destroyed a fish hatchery belonging to one William Radcliffe, a British subject, at Delta, and again the intervention of the federal government was provoked. In this case President Roosevelt, in a message of March 14, 1904, recommended an indemnity of \$25,000 to the victim, and transmitted the documents in the case to Congress, Sen. Doc. 271; 58C.2; Serial 4592; pp. 40.

Of slight importance in the history of Colorado, but of some consequence in its sociological aspect, is the attempt of the Salvation Army to found and conduct a community at Fort Amity, Colorado. Because of an alleged inability of this body to pay promptly for the arid lands purchased from the United States and irrigated by the settlers, it is the occasion of a number of public documents, especially H. Rep. 364; 56C.1; Serial 4022; February, 1900, Sen. Rep. 1135; 56C.1; Serial 3894; May, 1900, and Sen. Rep. 2950; 57C.2; Serial 4412; February, 1903. All of these documents are very brief, but they give some notion of the scope and activity of this type of poor-relief. The journalistic reports of the same settlement, as in "Making Successful Farmers out of City Failures," in *World's Work*, Vol. VI, pp. 3929-3930, and in the *Outlook*, Vol. LXXIV, pp. 640-641, show much success at Amity, and require some reconciliation with the statements of the public documents.

Miscellaneous items of Coloradoana in the middle nineties are a favorable report on a pipe-line bill for Colorado and Wyoming, H. Rep. 1563; 54C.1; Serial 3462; a report favoring the grant to Colorado of the abandoned Fort Lyons military reservation for a sol-

diers' and sailors' home, H. Rep. 1847; 54C.1; Serial 3464, and another, on granting to the Cripple Creek District Railway Company a right of way through the Pike's Peak timber land reserve, H. Rep. 1592; 55C.2; Serial 3722. About 1900 came Shafroth's report on the preservation of pre-historic ruins in Colorado, H. Rep. 1104; 56C.1; Serial 4025; Hansbrough's recommendation of permission to Montrose to enter 160 acres of public lands for reservoir purposes, Sen. Rep. 2955; 57C.2; Serial 4412; and Palmer's report recommending the erection of terms of federal circuit and district courts at Montrose in place of Del Norte, H. Rep. 3378; 57C.2; Serial 4414. Finally, there is in 1901 a long report of a committee named by the General Assembly of Colorado, on the Australasian system of taxation and the revenues of Colorado, Sen. Doc. 209; 56C.2; Serial 4043; pp. 36. The *Outlook* during these same years calls attention to the sociological work under Dr. R. W. Corwin of the Colorado Fuel and Iron Company, Vol. LXXII, pp. 149-150; to the "Religious Life in Colorado," Vol. LXXII, pp. 365-371 to the home-rule charter of Denver, Vol. LXXV, p. 97, and to the franchise amendment Vol. LXXVI, pp. 249-250.

The great mining strike of 1903-1904 caused much attention to be given to industrial and constitutional conditions in Colorado. Beginning with the sympathetic strike of the Cripple Creek miners in August, and continuing through the calling-out of troops, the explosion at the "Vindicator" mine, the recall of troops, the Independence disaster, and the deportations, there is a long series of pertinent articles to be recorded. The *Outlook*, Vol. LXXV, p. 390, October 17, 1903, comments upon the beginning of the strike, and its provocation in the eight-hour agitation. In later issues it calls attention to the less important strike of the coal miners, and to the complications produced by the appearance of the Citizens' Alliances, Vol. LXXV, p. 763\*; to the general support given by the business interests at Cripple Creek to the drastic measures of Governor Peabody, Vol. LXXVI, pp. 143-144; and to the dangerous social cleavage which divided the mining communities into the hostile Mine Owners' Association and the Western Federation of Miners, Vol. LXXVI, pp. 1001-1003. As the spring

of 1904 advanced, *Current Literature*, Vol. XXXVI, pp. 482-484, called attention to the attempt at an ending of martial law while "G," writing to the *Outlook*, Vol. LXXVII, pp. 21\*-22,\* commented upon the arbitrary assumption of powers as well by the state authorities as by the leaders of the Western Federation. The terrible disaster at Independence station produced paragraphs in the *Outlook*, Vol. LXXVII, pp. 384-385, and in *Current Literature*, Vol. XXXVII, pp. 3-5. The deportations of miners following close upon this disaster created what *Current Literature* Vol. XXXVII, pp. 104-106, characterized as a "carnival of crime," in which, Vol. XXXVI, pp. 594-596, both sides were largely to blame—a conclusion with which the *Outlook*, Vol. LXXVII, pp. 394-396, agreed. *Current Literature* suggested a little later, Vol. XXXVII, pp. 303-305, the possibility of federal intervention in Colorado. A socialistic view of the strike is to be found in *Wiltshire's Magazine*, May, 1904, pp. 219-224, by Henry O. Morris, under the title "The Conspiracy against Labor in Colorado." It is accompanied by editorials on the "Mine Owners' Infamous Purpose." On the other side is "The Supremacy of Law," by William M. Raine, in the *Reader Magazine*, Vol. IV, pp. 399-409, September, 1904. These paragraphs and editorials by no means comprise the whole output upon the strike. All the weekly papers give some attention to it.

The proportions which the strike came to assume in its constitutional bearings ultimately produced three important missions to Colorado. The brilliant report of Ray Stannard Baker on "The Reign of Lawlessness, Anarchy, and Crime in Colorado" appears in *McClure's Magazine*, Vol. XXIII, pp. 43-57, May, 1904. The Rev. Washington Gladden made a similar report for a syndicate of newspapers beginning with the *Columbus Press Post*, and appearing, among others, in the *Denver Times*, for April 22 and 23, 1904. It is worthy of note that the *Denver Republican* did not consider these letters worthy of any considerable mention. The third special report was by William English Walling, a resident of the New York University Settlement, and appeared in the *Independent*, Vol. LVI, pp. 539-548, March 10, 1904, with the title "The Great Cripple Creek Strike."

In Congress the political aspect of the strike had its result in three documents which are of high value as sources for the history of 1903-1904. A statement of the employers' side, prepared by C. C. Hamlin, secretary of the Mine Owners' and Property Owners' Association of Cripple Creek, and at once attacking the Western Federation of Miners and defending the administration of Governor Peabody, was presented to the Senate by Scott, of West Virginia, in January, 1904, Sen. Doc. 86; 58C.2; Serial 4588; pp. 19. It produced later in the same session, a reply from the Western Federation, through Patterson, of Colorado, Sen. Doc. 163, 58C.2; Serial 4590; pp. 41, which denies most of the allegations of the earlier document, and reviews the history of strikes since 1894 in an attempt to throw the responsibility for them upon the owners and employers. It contains many extracts from contemporary newspapers and correspondence, but is far surpassed in completeness by the "Report on Labor Disturbances in Colorado, 1880-1904," made by an agent of the Commissioner of Labor, and printed as Sen. Doc. 122; 58C.3; pp. 363. This document, because of the originals which it prints, and because it is fairly non-political in tone, is the best single source for the history of the labor troubles.

The situation brought forth also an editorial by B. O. Flower, in the *Arena*, Vol. XXXII, pp. 187-194, August, 1904, on the "Breaking Down of Democratic Government in an American Commonwealth," which reviews the special articles on the strike, and develops the initiative and referendum as cure for such ills as those of Colorado. The *Arena*, in the autumn of 1905, ran a series of papers by J. W. Mills on "The Economic Struggle in Colorado," which is a long tract on municipal ownership of corporations.

## ENGLAND AND MEXICO, 1824-1825<sup>1</sup>

BY FREDERIC LOGAN PAXSON

The activities of Great Britain in Mexico during the years 1824 and 1825 were inspired, not only by a desire to ascertain the actual conditions prevailing in that republic, with a view to ultimate recognition, but also by an anxiety lest the United States should profit by proximity and interest, and thereby acquire undue advantages in Mexico. These facts are clearly developed by the Foreign Office correspondence of these years, and the following extracts from the correspondence tell the story, with but little need for comment.

It was with difficulty that Canning preserved in his Mexican agents the neutral attitude which he desired to show to all the Latin-American colonies. The most imperative instructions often failed to direct the actions of the men on the ground. "You are sent," he instructed one of them,<sup>2</sup> "to ascertain the Fact of Mexican Independence, not actively to promote it; and to form and report an Opinion of the Stability of the Government, not to prescribe its form or attempt to influence its Councils." Yet there was a quality in the Mexican influence to which none of his agents was impervious. Whether it was a corrupt attack, or a sympathy with the spirit of independence, or a truer view based upon better information, is hard to say; but certain it is that the English agents cannot be accused of failing to see certain dangers taking shape along the northern frontier, or of failing to try to inspire both Mexico and the Foreign Office to resist them.

As early as January, 1824, the agent, Lionel Hervey, had announced to Canning that Mexico was ready to enter into exclusive trade arrangements with Great Britain, and had advised strongly in favor of such an arrangement. Spain had been expelled, he said, and Mexico was too poor and too weak to stand alone. "Hence the Mexicans are looking anxiously around them in quest of an Alliance with one of the

<sup>1</sup> Reprinted from the *Quarterly of the Texas State Historical Association*, October, 1905, Vol. IX, pp. 138-141.

<sup>2</sup> Canning to Morier, July 30, 1824, *Foreign Office MSS.*

great Maritime Powers of Europe, and if they should be disappointed in their hopes, they will ultimately be forced to throw themselves into the arms of the United States, already opened wide to receive them."<sup>1</sup>

In particular, the danger arising from the American colonization of Texas, then in progress, was realized by the English agents. Hervey, in the dispatch already mentioned, called attention to the introduction of American capital, and to the building of American roads, as well as to the immigration of American citizens. And Ward, the chargé who succeeded him, repeated his cries of warning. On the 1st of June, 1825, the latter assisted<sup>2</sup> "at the reception of Mr. Poinsett, who has presented his credentials as Envoy Extraordinary, and Minister Plenipotentiary, from the United States," and was particularly impressed by "the length of Mr. Poinsett's speech, which occupied near a quarter of an hour. After paying the highest compliments to General Victoria, to whose courage and constancy, Mr. Poinsett attributed the present prosperous state of Mexico, he congratulated the Mexicans in general upon the choice which they had made of a republican form of Government, which, he said, was most particularly agreeable to the President and citizens of the United States. He spoke in the most flattering terms of the manner in which the struggle for Independence had been conducted, and added that it was to the great qualities which had been displayed in the course of this struggle that they must attribute the justice which was now done them by the *first* nation of the Old World, and the nation, which had *first* sown the seeds of liberty in the New.

"Mr. Poinsett concluded by giving an analysis of the object of his mission, which, he said was to conclude a Treaty of Commerce, and Boundaries—an intimation, which appeared, by no means so palatable as the preceding part of his speech, if one might judge by the looks of the Spectators, who were well aware of the difficulties with which the question of boundaries is likely to be attended.

"General Victoria's reply was very concise, but as, I expect to be able to enclose a translation of it, I do not think it necessary to trouble you with any details upon the subject here."

<sup>1</sup> Hervey to Canning, January 18, 1824, *Foreign Office MSS.*, Mexico, VI.

<sup>2</sup> Ward to Canning, June 1, 1825, *Foreign Office MSS.*, Mexico, XIII.

The relations between Ward and Poinsett during the summer of 1825, and after, would make an interesting study, and one for which materials lie ready to the hand of the worker. In the manuscripts of the Foreign Office are preserved the original letters of the British agent, while the fourteen folio volumes of the papers of Joel R. Poinsett which are in the library of the Historical Society of Pennsylvania have hardly been even touched. Yet in these papers is to be found the detailed story of the struggle between British and American influence in Mexico. Both of the competitors emerged from the contest with high opinions of the abilities of their respective opponents.

During the struggle of 1825 the British agent became further convinced of the inevitable conflict between Mexico and the United States along the Rio Grande, and his despatches are truer than most historical prophecies.

"The treaty," he writes to Canning, on the 6th of September, 1825,<sup>1</sup> "between the United States and this country, advances but slowly, though I am at a loss to understand, in what the cause of the delay consists . . . while the Mexicans are . . . jealous in guarding against encroachments in the shape of a treaty, they are suffering, on the other hand, by an absurd mixture of negligence, & weakness, the whole disputed territory, and an immense tract of country beyond it, to be quietly taken possession of by the very men, whose claim to it, they are resisting here:—you will perceive Sir, by a reference to the Map, that the whole of the lands between the rivers Sabine and Brazos, have been granted away to American Settlers, and that the tide of emigration is settling very fast in the direction of the Rio Bravo. These grants have been made by the provincial Government of Texas, and retailed by the Original speculators to the hordes of their countrymen, which have already arrived there, at a moderate price of half a dollar an acre, by which however they have cleared 150 per cent. profit. On the most moderate computation, six hundred North American families are already established in Texas; their numbers are increasing daily, and though they nominally recognize the authority of the Mexican Government, a very little time will enable them, to set at

<sup>1</sup> Ward to Canning, September 6, 1825, *Foreign Office MSS.*, Mexico, XIV.

defiance any attempt to enforce it. . . . General Wavell has, I believe, a considerable share, [of the land] but he is, I understand, almost the only Englishman, who has applied for land in Texas. The rest of the settlers are all American—Backwoodsmen, a bold and hardy race, but likely to prove bad subjects, and most inconvenient neighbors. In the event of a rupture between this country and the United States, their feelings and earlier connections will naturally lead them to side with the latter; and in time of peace their lawless habits, and dislike of all restraints, will, as naturally, induce them to take advantage of their position which is admirably adapted for a great smuggling trade, and to resist all attempts to repress it. In short, Mexico, though she may gain in point of numbers, will not, certainly, acquire any real strength, by such an addition to her population. . . . Not knowing in how far His Majesty's Government may conceive the possession of Texas by the Americans, to be likely to affect the interests of Great Britain, I have not thought it right to go beyond such general observations upon the subject, in my communications with this Government, as appeared to me calculated to make it perceive the danger, to which it is wilfully exposing itself. Were but one hundredth part of the attention paid to practical encroachment, which will be bestowed upon anything like a verbal cession, Mexico would have little to fear."

There is reason to believe, from this correspondence, that the tendencies of the western movement in Texas were recognized by England before even the settlers realized that which was coming to pass.



"For even as children are flurried and dread all things in the thick darkness, thus we in the daylig t fear at times things not a whit more to be dreaded than those which children shudder at in the dark and fancy sure to be. This terror, therefore, and darkness of mind must be dispelled, not by the rays of the sun and glittering shafts of day, but by the aspect and law of nature."—*De Rerum Natura*, II, 55-61.

"The older view of idealistic dualism is breaking up with all its mystic and anthropistic dogmas; but upon the vast field of ruins rises, majestic and brilliant, the new sun of our realistic monism, which reveals to us the wonderful temple of nature in all its beauty."—*Welträthsel*, 381-82.

"Lucretius, even in the Judgment of the Antients is both a very great Poet and Philosopher, but full of Lies: for having follow'd the Epicurean Sect, his opinions concerning God, and of the Creation of Things, are quite different from the Doctrine of Plato, and of the other Academicks; for which Reason some believe that he ought not to be read by Christians, who adore and worship the true God. But since Truth the more it is inquir'd into, shines the more bright, and appears the more venerable, Lucretius, and all that are like Lucretius, even tho' they be Lyars, as they certainly are, ought in my opinion to be read."—*Aldus Pius* in a letter to Albertus Pius.

# LUCRETIUS AND HAECKEL BEFORE THE RIDDLES OF THE UNIVERSE

BY FRED B. R. HELLEMS

## PART I. THE IMMORTALITY OF THE SOUL<sup>1</sup>

That there are striking coincidences in the theories of Lucretius and of Haeckel has been frequently stated and much more frequently felt. It is clear, however, that many thorough-going admirers of the great German monist, as well as most of his opponents, whether honest or captious, have contented themselves with a vague knowledge of the resemblance between the two men without recalling the number and nature of the detailed parallels. Classical men, too, I fear, have been satisfied to enjoy the golden verse of him who "died chief poet on the Tiber-side" without correlating his views to modern monistic theories. Accordingly, having seen no adequate comparison, in a purely academic spirit, of the solutions of the *Welträthsel* proposed by Lucretius and Haeckel and the arguments thereto appurtenant, I have conceived the hope of setting them forth with some clearness and accuracy in the present paper. My object will be to compare or contrast the views of these kindred spirits, without making any systematic attempt to evaluate the conclusions they have reached. Furthermore, there is no desire on my part to emphasize Haeckel's indebtedness to Lucretius. The writer of the *Welträthsel*, who speaks most cordially of the "grosse römische Dichter und Naturphilosoph," would be the first to acknowledge whatever indebtedness there may be, and in any case it is inevitable that the representative of the latest stages of monistic thought should bear many traces of the journey through which that thought has reached its present inn. It is true that we shall find more and closer resemblances to Lucretius than we had expected; but, after all, the step from the Tiber of two thousand years ago to the Rhine of to-day is short indeed compared with

<sup>1</sup> Part II, dealing with the remaining riddles, will appear in the next number of the "Studies."

the flight beyond the "flammanitia moenia mundi" in the infinities of time and space with which these master-minds are ultimately concerned.<sup>1</sup>

The larger kinship of spirit between the author of the *De Rerum Natura* and the author of the *Welträttsel* is stamped upon their works from the very beginning, for both men announce their firm belief that the great and pressing evils of our political, social, and moral worlds are to be met only by the development of clear views as to man, and his relations to life and death and the universe.<sup>2</sup> More striking is the appearance so early in their books of the arraignment of religion as responsible for many of the greatest evils.<sup>3</sup> Correspondingly early is given the general solution for the problems, and our authors are thoroughly at one in the belief that if you can shed the light of nature and nature's law into the human mind to replace the blindness of ignorance and the terror of superstition, you will have a better moral life as inevitably as the day follows the night. Through the exposition of both men there run—forming, as it were, a master motive—the words "law" and "reason." Neither could be more insistent than the other upon a "doctrine of law and steadfast universal order in nature" operating from the least conceivable particle of matter to the utmost bounds of the universe and the highest development of the human mind. Just as applicable to the *De Rerum Natura* as to the

<sup>1</sup> Lucretius will be considered as the representative of monistic or materialistic philosophy as developed by the middle of the first century B. C., and no distinction will be made between his own contributions and what he accepted from his predecessors, such as Democritus, Empedocles, and Epicurus. As representing Haeckel's message on these subjects put in accessible form for the general reader, the *Welträttsel* will be followed throughout. For convenience quotations will be made from the English edition of the *Welträttsel* (Harper and Brothers, 1901), and the translation of Lucretius by Munro. (Deighton Bell & Co., 1891.)

<sup>2</sup> *WR.*, chap. 1, *et al.*; *De R. N.*, I, 107-109, 127-135, 146-148, *et al.*

<sup>3</sup> To understand the sternness, or even ferocity, of their attitude towards religion, one may compare these passages: "Of all the wars which nations have waged against each other with fire and sword the religious wars have been the bloodiest; of all the forms of discord that have shattered the happiness of families and of individuals, those that arise from religious differences are still the most painful. Think of the millions who have lost their lives in Christian persecutions, in the religious conflicts of Islam and of the Reformation, by the Inquisition, and under the charge of witchcraft."—*WR.*, p. 303, cf. 318-319. "This is what I fear herein, lest haply you should fancy that you are entering on unholy grounds of reason and treading the path of sin; whereas on the contrary often and often that very religion has given birth to sinful and unholy deeds." Then he instances the sacrifice of Iphigenia before the departure of the Greek fleet for the Troad. "Nor aught in such a moment could it avail the luckless girl that she had first bestowed the name of father upon the king. For lifted up in the hands of men she was carried shivering to the altars, not after due performance of the customary rites to be escorted by the clear-ringing bridal song, but in the very season of marriage, stainless maid mid the stain of blood, to fall a sad victim by the sacrificing stroke of a father, that thus a happy and prosperous departure might be granted to the fleet. So great the evils to which religion could prompt."—*De R. N.*, I, 80-101.

*Welträthsel* are Goethe's lines,<sup>1</sup> with which Haeckel concludes his work:

Nach ewigen, ehernen  
Grossen Gesetzen  
Müssen wir alle  
Unseres Daseins  
Kreise vollenden.

But this scientific spirit with its insistence on law and reason does not prevent the kindling in their breasts of a missionary zeal for the salvation of a lost world. Though they argue never so formally and dispassionately, both of their beings are at a white heat of enthusiasm for the evangel of science. Never prophet or martyr was surer of his vision or of its redeeming value to frail humanity than these two representatives of what most people call materialism. "Come unto us and we will set you free," is the eager cry on their apostolic lips; "with us you may find, not the mystic peace that passeth understanding, but the unconquerable peace that only understanding can bestow."

General resemblances, however, are never very hard to find, and we may now turn to our particular riddles, treating them with all possible brevity, and resisting the temptation to stray either into other fields of resemblance or into the more exhaustive treatises of Haeckel. The seven quoted by Haeckel from Emil duBois-Reymond are: (1) the nature of matter and force; (2) the origin of motion; (3) the origin of life; (4) the (apparently preordained) orderly arrangement of nature; (5) the origin of simple sensation and consciousness; (6) rational thought and the origin of the cognate faculty, speech; (7) the question of the freedom of the will. To these we may add two of Kant's postulates, the third being No. 7 above, and we shall have: (8) the existence of God; (9) the immortality of the soul. Of course, Haeckel classes these last three as mere dogmas, but in his discussions they have quite as much prominence as in Lucretius.

Accordingly, we may take up at once the central question, the

<sup>1</sup> I have never seen the lines adequately translated. The English edition gives the accepted rendering:

"By eternal laws  
Of iron ruled,  
Must all fulfil  
The cycle of  
Their destiny."

immortality of the soul. As a starting-point for our discussion thereof we should have before us the conception of the soul that our writers unite in combating, and we may quote it from Haeckel: "The prevailing conception of the psychic activity, which we contest, considers soul and body to be two distinct entities. These two entities can exist independently of each other; there is no intrinsic necessity for their union. The organized body is a mortal, material nature, chemically composed of living protoplasm and its compounds. The soul, on the other hand, is an immortal, immaterial being, a spiritual agent whose activity is entirely incomprehensible to us."<sup>1</sup> To this conception our authors are radically opposed. They both hold that the soul has no existence apart from the body, and is therefore mortal. They differ from each other in that Haeckel regards the soul as merely a psychic activity, while Lucretius in his excessive refining thinks of it as an entity within the body. This difference, however, may be practically neglected when you read the reiterated statement of Lucretius that "the mind and soul are kept together and make up a single nature."<sup>2</sup> "Do you mind to link to one name both of them alike; and when, for instance, I shall choose to speak of the soul, showing it to be mortal, believe that I speak of the mind as well, inasmuch as both make up one thing and are one united substance?"<sup>3</sup> Both insist that all psychic activities, like all other phenomena, have a material basis. By Haeckel this is called psychoplasm—"a body of the group we call protoplasmic bodies, the albuminoid carbon combinations, which are at the root of all vital processes."<sup>4</sup> By Lucretius it is said to be "seeds exceedingly round and exceedingly minute in order to be stirred and set in motion by a small moving power."<sup>5</sup> It is hardly necessary to point out that this divergence is a matter of chemical and physiological advance rather than a real difference of position.

With this statement of their general conception of the soul before us we shall easily understand their attitude and arguments, and it

<sup>1</sup> *WR.*, 89-90.

<sup>3</sup> *De R. N.*, III, 421-424.

<sup>2</sup> *De R. N.*, III, 136-137.

<sup>4</sup> *WR.*, 90-91.

<sup>5</sup> *De R. N.*, III, 186-188. We need not concern ourselves with his rather metaphysical attempt to subdivide this nature. (See III, 231 *seq.*)

will probably be profitable to take up first four phases of attack which we may conveniently treat as preparatory, although Lucretius does not so distinguish them from the three phases which we shall consider later.

### I. EXAMINATION OF METEMPSYCHOSIS<sup>1</sup>

Lucretius: "Again if the nature of the soul is immortal and makes its way into our body at the time of birth, why are we unable to remember besides the time already gone, and why do we retain no traces of past actions? If the power of the mind has been so completely changed, that all remembrance of past things is lost, that methinks differs not widely from death; therefore you must admit that the soul which was before has perished and that which now is has been formed."<sup>2</sup>

Haeckel: "As Plato postulated an eternal life before as well as after this temporary association [of body and soul], he must be classed as an adherent of 'metempsychosis' or transmigration of souls; the soul existed as such, or as an 'eternal idea,' before it entered into a human body. When it quits one body it seeks such other as is most suited to its character for its habitation. The souls of bloody tyrants pass into the bodies of wolves and vultures, those of virtuous toilers migrate into the bodies of bees and ants, and so forth. The childish naïveté of this Platonic morality is obvious; on closer examination his views are found to be absolutely incompatible with the scientific truth which we owe to modern anatomy, physiology, histology, and ontogeny; we mention them only because, in spite of their absurdity, they have had a profound influence on thought and culture."<sup>3</sup>

### II. EXAMINATION OF SOME THEORIES OF PSYCHOGENESIS

Lucretius: "Again if the quickened power of the mind is wont to be put into us after our body is fully formed, at the instant of our birth and our crossing the threshold of life, it ought, agreeably to this, to live, not in such a way as to seem to have grown with the body and together with its members within the blood, but as in a den apart by and to itself: the very contrary of what undoubted fact teaches; for

<sup>1</sup> This has been the subject of some of the finest Lucretian poetry, and any reader will be well repaid both poetically and philosophically if he will renew his acquaintance with *De R. N.*, III, 830-870.

<sup>2</sup> *De R. N.*, III, 670-678; *cf.* III, 740-775.

<sup>3</sup> *WR.*, 197. Metempsychosis is again dismissed as a myth by Haeckel on p. 135.

it is so closely united with the body throughout the veins, flesh, sinews, and bones, that the very teeth have a share of sense; as their aching proves and the sharp twinge of cold water and the crunching of a rough stone, when it has got into them out of bread. Wherefore, again and again I say, we must believe souls to be neither without a birth nor exempted from the law of death; for we must not believe that they could have been so completely united with our bodies, if they found their way into them from without, nor, since they are so closely inwoven with them, does it appear that they can get out unharmed, and unloose themselves unscathed from all the sinews and bones and joints. But if haply you believe that the soul finds its way in from without and is wont to ooze through all our limbs, so much the more it will perish thus blended with the body; for what oozes through another is dissolved, and therefore dies. As food distributed through all the cavities of the body, while it is transmitted into the limbs and the whole frame, is destroyed and furnishes out of itself the matter of another nature, thus the soul and mind though they pass entire into a fresh body, yet in oozing through it are dissolved, whilst there are transmitted, so to say, into the frame through all the cavities those particles of which this nature of mind is formed, which now is sovereign of our body, being born out of that soul which then perished when dispersed through the frame. Wherefore the nature of the soul is seen to be neither without a birthday nor exempt from death."<sup>1</sup>

"Again for souls to stand by at the unions of Venus and the birththroes of beasts seems to be passing absurd, for them the immortals to wait for mortal limbs in number numberless and struggle with one another in forward rivalry, which shall first and by preference have entrance in; unless haply bargains are struck among the souls on these terms, that whichever in its flight shall first come up, shall first have right of entry, and that they shall make no trial of each other's strength."<sup>2</sup>

All similar views are summarily dismissed by Haeckel as merely "psychogenetic myths worthy only of primitive races." His statement runs as follows:

"*The myth of the implanting of the soul.*—The soul existed independently in another place, a psychogenetic store, as it were (in a

<sup>1</sup> *De R. N.*, III, 679-712.

<sup>2</sup> *De R. N.*, III, 775-783.

kind of embryonic slumber or latent life); it was taken out by a bird (sometimes represented as an eagle, generally as a white stork), and implanted in the human body.

“*The myth of the creation of the soul.*—God creates the souls, and keeps them stored—sometimes in a pond (living in the form of *plankton*), according to other myths in a tree (where they are conceived as the fruit of a phanerogam); the Creator takes them from the pond or tree, and inserts them in the human germ during the act of conception.”<sup>1</sup>

### III. AS TO THE FORM OF THE SOUL IN ITS IMMORTAL EXISTENCE AFTER THE DEATH OF THE BODY

a) That it has a more or less incorporeal, but still material, nature. Haeckel, with a by no means winning flippancy, insists that such an entity is essentially gaseous, and inasmuch as practically all gases have been reduced to liquids, it should be possible to liquefy the soul by the application of a high pressure at low temperature.<sup>2</sup> “We could then catch the soul as it is breathed out at the moment of death, condense and exhibit it in a bottle as ‘immortal fluid’ (*Fluidum animae immortale*). By a further lowering of temperature and increase of pressure it might be possible to solidify it—to produce ‘soul snow.’ The experiment has not yet succeeded.” Lucretius<sup>3</sup> insists that if the soul is to have a conscious existence—that is, if it can feel—it must be provided with the organs of sense. “Painters therefore and former generations of writers have thus represented souls provided with senses. But neither eyes nor nose nor hand can exist for the soul apart from the body; nor can tongue, nor can ears perceive by the sense of hearing or exist for the soul by themselves apart from the body.” That Haeckel also maintains the absolute necessity for material instruments of feeling need only be recalled.

b) That the soul is still clothed with the body it had in life. This conception is dismissed by Haeckel as pure dogma. “The impossibility of ‘the resurrection of the body’ is clear to every man who

<sup>1</sup> *WR.*, 135.

<sup>2</sup> *WR.*, 199-201. This sort of trifling, conscious as it is, seems to me quite as puerile as the unconscious humor of Lucretius when he thinks that worms generated in our dead bodies may receive their life from some of the “soul-stuff” still remaining therein. *Cf. De R. N.*, III, 713 *seq.*

<sup>3</sup> *De R. N.*, III, 624-633.

has some knowledge of anatomy and physiology."<sup>1</sup> To Lucretius death is a dissolution of the body once and for all, unless by mere hap the same fortuitous combination of atoms recur in infinite time; but with that combination we should have no concern, for the train of self-consciousness is broken.<sup>2</sup> Our very bodies are needed as material for after-generations to grow, and nature must have the atoms composing our frames. "Thus one thing will never cease to rise out of another, and life is granted to none in fee-simple, to all in usufruct."<sup>3</sup>

c) A purely immaterial soul (for which some thinkers find a certain analogy in recent conceptions of ether in the physical world) neither of our writers could admit any more than the form discussed above under *a*. Haeckel dismisses it formally, Lucretius by implication.<sup>4</sup>

#### IV. THE ARGUMENT OF "EMOTIONAL CRAVING"

All arguments advanced by athanatists not capable of direct, definite rational treatment, such as the teleological and cosmological, are summarily thrust out by both men; but neither is able to pass in silence the deep-rooted feeling of our human hearts that final separation from those we love is so great an evil that it can not be a part of the order of things. The passages quoted will serve at the same time to make clear the greater dignity and humanity of the olden poet whose strain so often is "fraught too deep with pain." "'Now no more shall thy house admit thee with glad welcome, nor a most virtuous wife and sweet children run to be the first to snatch kisses and touch thy heart with a silent joy. No more mayst thou be prosperous in thy doings, a safeguard to thine own. One disastrous day has taken from thee luckless man in luckless wise all the many prizes of life.' This do men say; but add not thereto 'and now no longer does any craving for these things beset thee withal.' For if they could rightly perceive this in thought and follow up the thought in words, they would release themselves from great distress and apprehension of mind. 'Thou, even as now thou art, sunk in the sleep of death, shalt continue so to be all time to come, freed from all distressful pains; but we with a sorrow that would not be sated wept for thee, when,

<sup>1</sup> *WR.*, 196,

<sup>2</sup> *De R. N.* III, 847 *seq.*

<sup>3</sup> *De R. N.*, III, 964 *seq.*

<sup>4</sup> *WR.*, 199-200.

close by, thou didst turn to ashes on thy appalling funeral pile, and no length of days shall pluck from our hearts our ever-during grief.' This question therefore should be asked of this speaker, what there is in it so passing bitter, if it come in the end to sleep and rest, that any one should pine in never-ending sorrow."<sup>1</sup>

In Haeckel we read: "The best and most plausible ground for athanatism is found in the hope that immortality will reunite us to the beloved friends who have been prematurely taken from us by some grim mischance. But even this supposed good fortune proves to be an illusion on closer inquiry; and in any case it would be greatly marred by the prospect of meeting the less agreeable acquaintances and the enemies who have troubled our existence here below. There are plenty of men who would gladly sacrifice all the glories of Paradise if it meant the eternal companionship of their 'better half' and their mother-in-law. It is more than questionable whether Henry the Eighth would like the prospect of living eternally with his six wives; or Augustus the Strong of Poland, who had a hundred mistresses and three hundred and fifty-two children."<sup>2</sup>

If we turn now to the more direct arguments against the immortality of the soul, we shall find an even more obtrusive agreement in their main features.

#### I. THE PHYSIOLOGICAL ARGUMENT

If the soul consists of very minute atoms contained within the mortal vessel of this body, and that body be destroyed, the soul will dissolve into its first bodies much more quickly than water will flow from a shattered vase, or than mist and smoke pass into air.<sup>3</sup> Similarly, if your psychic activity depends on "albuminoid carbon combinations," it will cease with the dissolution of these combinations by the death of the body.<sup>4</sup> This phase could be enlarged upon; but, although it is fundamental, it is so simple as to need no further statement here.<sup>5</sup>

#### II. THE ONTOGENETIC ARGUMENT

Lucretius: "Again we perceive that the mind is begotten along with the body and grows up together with it and becomes old along

<sup>1</sup> *De R. N.*, III, 894-911.

<sup>2</sup> *WR.*, 208.

<sup>3</sup> *De R. N.*, III, 426-444.

<sup>4</sup> *WR.*, 91.

<sup>5</sup> See p. 124 of this article.

with it. For, even as children go about with a tottering and weakly body, so slender sagacity of mind follows along with it; then when their life has reached the maturity of confirmed strength, the judgment too is greater and the power of mind more developed. Afterwards when the body has been shattered by the mastering might of time and the frame has drooped with the forces dulled, then the intellect halts, the tongue dotes, the mind gives way, all faculties fail and are found wanting at the same time. It naturally follows then that the whole nature of the soul is dissolved, like smoke, into the high air; since we see it is begotten along with the body and grows up along with it, and, as I have shown, breaks down at the same time, worn out with age."<sup>1</sup>

Haeckel: "The ontogenetic argument puts before us the facts of the development of the soul in the individual; we see how the child-soul gradually unfolds its various powers; the youth presents them in full bloom, the mature man shows their ripe fruit; in old age we see the gradual decay of psychic powers, corresponding to the degeneration of the brain."<sup>2</sup> Inasmuch as the full significance of this sentence is rather more easily grasped in connection with Haeckel's chapter on consciousness, I append in a note the passage of which this is really a summary.<sup>3</sup> A driving-home of this ontogenetic argument by Haeckel in another place belongs as naturally to Lucretius,

<sup>1</sup> *De R. N.*, 445-458.

<sup>2</sup> *WR.*, 204.

<sup>3</sup> *WR.*, 185-186: "As everybody knows, the new-born infant has no consciousness. Preyer has shown that it is only developed after the child has begun to speak; for a long time it speaks of itself in the third person. In the important moment when it first pronounces the word 'I,' when the feeling of self becomes clear, we have the beginning of self-consciousness, and of the antithesis to the non-ego. The rapid and solid growth and progress in knowledge which the child makes in its first ten years, under the care of parents and teachers, and the slower progress of the second decade, until it reaches complete maturity of mind, are intimately connected with a great advancement in the growth and development of consciousness and of its organ, the brain. But even when the pupil has got his 'certificate of maturity,' his consciousness is still far from mature: it is then that his world-consciousness first begins to develop, in his manifold relations with the outer world. Then, in the third decade, we have the full maturity of rational thought and consciousness, which in cases of normal development yield their ripe fruits during the next three decades. The slow, gradual degeneration of the higher mental powers, which characterizes senility, usually sets in at the commencement of the seventh decade, sometimes earlier, sometimes later: memory, receptiveness, and interest in particular objects gradually decay; though productivity, mature consciousness, and philosophic interest in general truths often remain for many years longer.

"The individual development of consciousness in earlier youth proves the universal validity of the biogenetic law; and, indeed, it is still recognizable in many ways during the later years. In any case, the ontogenesis of consciousness makes it perfectly clear that it is not an 'immaterial entity,' but a physiological<sup>1</sup> function of the brain, and that it is, consequently, no exception to the general law of substance."

and should be quoted here: "Another insoluble difficulty faces the athanatist when he asks *in what stage of their individual development* the disembodied souls will spend their eternal life. Will the newborn infant develop its psychic powers in heaven under the same hard conditions of the 'struggle for life' which educate men here on earth? Will the talented youth who has fallen in the wholesale murder of war unfold his rich, unused mental powers in Walhalla? Will the feeble, childish old man, who has filled the world with the fame of his deeds in the ripeness of his age, live forever in mental decay? Or will he return to an earlier stage of development? If the immortal souls in Olympus are to live in a condition of rejuvenescence and perfectness, then both the stimulus to the formation of personality and the interest therein disappear for them."<sup>1</sup>

### III. THE PATHOLOGICAL ARGUMENT

Lucretius: "Moreover we see that even as the body is liable to violent diseases and severe pain, so is the mind to sharp cares and grief and fear; it naturally follows, therefore, that it is its partner in death as well. Again, in diseases of the body the mind often wanders and goes astray; for it loses its reason and drivels in its speech and often in a profound lethargy is carried into deep and never-ending sleep with drooping eyes and head; out of which it neither hears the voices nor can recognize the faces of those who stand around calling it back to life and bedewing with tears face and cheeks. Therefore you must admit that the mind too dissolves, since the infection of disease reaches to it; for pain and disease are both forgers of death: a truth we have fully learned ere now by the death of many. Again, when the pungent strength of wine has entered into a man and its spirit has been infused into and transmitted through his veins, why is it that a heaviness of the limbs follows along with this? His legs are hampered as he reels about, his tongue falters, his mind is besotted, his eyes swim, shouting, hiccuping, wranglings are rife, together with all the other usual concomitants, why is all this if not because the overpowering violence of the wine is wont to disorder the soul within the body? But whenever things can be disordered and hampered, they

<sup>1</sup>W.R., 208-9.

give token that if a somewhat more potent cause gained an entrance, they would perish and be robbed of all further existence. Moreover it often happens that some one constrained by the violence of disease suddenly drops down before our eyes, as by a stroke of lightning, and foams at the mouth, moans and shivers through his frame, loses his reason, stiffens his muscles, is racked, gasps for breath fitfully, and wearies his limbs with tossing. Sure enough, because the violence of the disease spreads itself through his frame and disorders him, he foams as he tries to eject his soul, just as in the salt sea the waters boil with the mastering might of the winds. A moan too is forced out, because the limbs are seized with pain, and mainly because seeds of voice are driven forth and carried in a close mass out by the mouth, the road which they are accustomed to take and where they have a well-paved way. Loss of reason follows, because the powers of the mind and soul are disordered and, as I have shown, are riven and forced asunder, torn to pieces by the same baneful malady. Then after the cause of the disease has spent its course back and the acrid humors of the distempered body return to their hiding places, then, he first gets up like one reeling, and by little and little comes back into full possession of his senses and regains his soul. Since, therefore, even within the body mind and soul are harassed by such violent distempers and so miserably racked by sufferings, why believe that they without the body in the open air can continue existence battling with fierce winds? And since we perceive that the mind is healed like the sick body, and we see that it can be altered by medicine, this too gives warning that the mind has a mortal existence. For it is natural that whoever essays and attempts to change the mind or seeks to alter any other nature you like, should add new parts or change the arrangement of the present, or withdraw in short some tittle from the sum. But that which is immortal wills not to have its parts transposed nor any addition to be made nor one tittle to ebb away; for whenever a thing changes and quits its proper limits, this change is at once the death of that which was before. Therefore, the mind whether it is sick or whether it is altered by medicine, alike, as I have shown, gives forth mortal symptoms."<sup>1</sup>

<sup>1</sup> *De R. N.*, II, 460-522.

Haeckel: "Pathological experiment yields the same result, the decay of some known area (for instance, the center of speech) extinguishes its function (speech). In fact, there is proof enough in the most familiar phenomena of consciousness of their complete dependence on chemical changes in the substance of the brain. Many beverages (such as coffee and tea) stimulate our powers of thought; others (such as wine and beer) intensify feeling; musk and camphor reanimate the fainting consciousness; ether and chloroform deaden it, and so forth. How would that be possible if consciousness were an immaterial entity, independent of these anatomical organs? And what becomes of the consciousness of the 'immortal soul' when it no longer has the use of these organs?"<sup>1</sup>

Naturally we do not expect to find in Lucretius any *histological* argument, "based on the extremely complicated microscopic structure of the brain," nor a *phylogenetic* argument, "deriving its strength from paleontology, and the comparative anatomy and physiology of the brain," nor any strictly *experimental* argument as to areas of function; but it is safe to say that not a single reader who fails to be convinced by Haeckel's other arguments would be moved by the three enumerated in this sentence, e. g., by the "quantitative and qualitative development of the brain of the placental mammals during the tertiary period."<sup>2</sup>

It would seem to me also safe to say that not a single reader who would fail to be converted by the *De Rerum Natura* would be seriously moved by the *Weltr thsel*. Of course, the latter marshals all the argumentative panoply of our wonderful modern science, with its countless facts and illuminating theories, and the mere enumeration of the arguments given above suggests the arms that a modern monist may take into his hands; but the new arms, it seems to me, would reach

<sup>1</sup> *WR.*, 184. Of course, the localization of the organs of thought in the modern sense is entirely unknown to Lucretius, so that his arguments are naturally drawn from "the most familiar phenomena of consciousness." He actually thought of the breast as the central seat of consciousness with the vital principle extending through every part of the body. "Now I assert that the mind and soul are kept together in close union and make up a single nature, but that the directing principle which we call mind and understanding, is the head, so to speak, and reigns paramount in the whole body. It has a fixed seat in the middle region of the breast; here throb fear and apprehension, about these spots dwell soothing joys; therefore here is the understanding or mind. All the rest of the soul disseminated through the whole body obeys and moves at the will and inclination of the mind."—*De R. N.*, III, 136-44.

<sup>2</sup> *WR.*, 204-205.

only the breasts that would have been reached by the old. In this fact, for so I consider it, the reader who feels that a monistic attitude towards immortality is hostile to the best progress of humanity must find no little comfort. Such a person, after carefully examining the arguments in these two representative thinkers, must inevitably cry out in joy that monism's vaunted science leaves its latest and greatest exponent quite as unconvincing as the comparatively unschooled Roman of two thousand years ago. "Here," he would say, "is after all the same old crying in the night, with no more convincing power in the cry." On the other hand, he who compares the two men with a feeling that their monistic attitude towards immortality is essentially right will insist that, while Lucretius and Haeckel so fundamentally agree, the latter brings to bear a tremendous advance in detailed scientific proof. He will point out that Haeckel represents the clear light of mid-morning, whereas Lucretius speaks from a dim and early dawn; but he must feel that they greet the same sun and belong to the same day.

## TRICORYTHUS, A GENUS OF MAYFLIES.

BY T. D. A. COCKERELL AND MARIE GILL

The genus *Tricorythus* was proposed by Eaton in 1868, to contain a mayfly from Egypt, described by Pictet in 1843-1845 as a *Cænis*. Subsequently a species described by Burmeister in 1839 as *Oxycypha discolor*, from the Cape of Good Hope, was added. Burmeister's genus *Oxycypha* consisted of two species of *Cænis* and one of *Tricorythus*; as *Cænis* Stephens dates from 1835, by the "elimination method," followed by many zoölogists, we should be obliged to use the name *Oxycypha* for *Tricorythus*. The first species of *Oxycypha*, however, was *Cænis dimidiata*. A third *Tricorythus* was reported by Eaton in 1884 as coming from the Malay Archipelago, but the species was not named, the material being inadequate for a satisfactory description.

So far, no species of the genus had occurred in America; but in the *Biologia Centrali-Americana* (1892) Eaton described a new species, *T. explicatus*, collected by Morrison in "Northern Sonora," which, it is understood, may mean northwestern Mexico or southern Arizona. The same species was recorded from Jalapa, Mexico, by Banks in 1901, and from Copper Basin, Ariz., also by Banks, in 1903. On October 7, 1905, many mayflies were found emerging from a stream a few miles from Boulder, Colo. At the same time and place nymphs were collected, but no flies were bred from observed nymphs. When we came to examine the insects, we believed that we had a new species of *Cænis*; but Dr. Needham, to whom we sent specimens, kindly pointed out that they were apparently Eaton's *Tricorythus explicatus*, and later enabled us to examine Eaton's description and figures, which had not been accessible. Upon comparing our material with the published account of *T. explicatus*, it was evident that the species was the same, and that the range must be extended some hundreds of miles northward. It is probable that Boulder represents nearly

one extreme of climate possible for the insect, as with us maturity seems only to be reached quite at the end of the season.

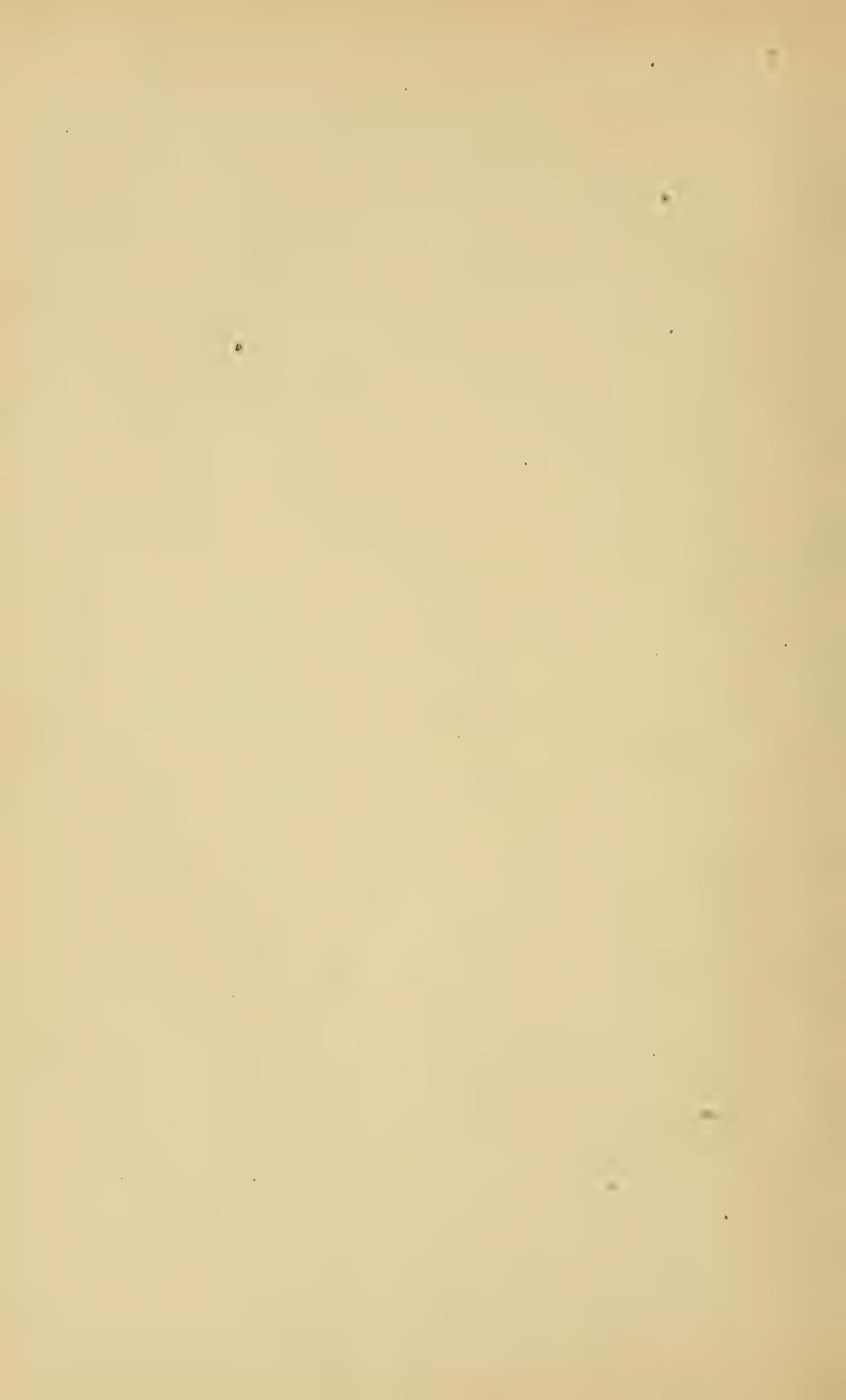
The genus *Tricorythus*, nevertheless, has a much more northern range; for Dr. Needham also pointed out that his *Cænis* (?) *allecta*, from Ithaca, N. Y., should be known as *Tricorythus allectus*.

The nymph of *Tricorythus* is not certainly known. The *Cænis maxima* Joly, from France (near Toulouse) was referred by Vaysière to *Tricorythus*, and is provisionally accepted as such by Eaton, though with considerable hesitation. It is known only from the nymph, which is figured in detail by Eaton, and it is significant that no adult *Tricorythus* has ever been seen in France or nearer thereto than Egypt. This nymph has all the essential characters of a *Cænis*, differing only in slight details from the known members of that genus. Dr. Needham (*Bull.* 86, *N. Y. State Museum*, p. 48) has described the nymph of *T. allectus*, not, however, going into very minute details. He has very kindly sent us some of these nymphs, stating, however, that they were not bred, and that he is now doubtful whether they should not be referred to *Cænis hiliaris*, which was found at the same place. We find these nymphs to agree, so far as can be seen, with *Cænis*, and it is perhaps safe to dismiss them as not pertaining to *Tricorythus*.

There now remains the nymph collected near Boulder, at the locality of *T. explicatus*. It certainly has no intimate relationship with *Cænis maxima*, or with Dr. Needham's specimens. These have the large maxillary palpi of *Cænis*, while ours has the same palpi greatly reduced, and altogether as in the *Ephemerella* series. The mandibles of our nymph greatly resemble those of *Cænis maxima*, but they are not unlike those of other allied genera. The maxillæ are about as in the "nameless ally of *Ephemerella*," figured by Eaton in his monograph, Plate 38, Figs. 4, 5. The labrum presents nothing especially remarkable; the claws have about ten little denticles on the inner side; the gill lamellæ are not fringed; and while there is a large elyteroid lamella, as in *Cænis maximus* and in true *Cænis*, it is not subquadrangle, but triangular. There are no rows of dorsal hooks on the abdomen, so that in Needham's table of nymphs of the *Ephemerella* type ours falls

with the nameless one from Colorado, figured by Eaton on his Plate 39. It agrees with that also in the robust form, but differs in the structure of the head, etc.

If the Boulder nymph really belongs to *Tricorythus*, as seems hardly doubtful, it apparently follows that that genus has been derived from the *Ephemerella* series by the loss of the hind wings and reduction of the venation, and has really no intimate relationship with *Cænis*.



## ON A NEW $\alpha$ , $\delta$ DIHYDROQUINOXALINE

BY JOHN B. EKELEY

The author, in conjunction with R. J. Wells,<sup>1</sup> has shown that, when orthophenylenediamine reacts with acetone or with mesityloxide in the presence of dry hydrochloric acid gas, a condensation takes place with the formation of a new dihydroquinoxaline. The substance was interesting in that it was the first member to be isolated of a theoretically possible series of dihydroquinoxalines having two imido groups. It therefore ought to be possible to produce other members of the series by using other diamines. Numerous trials with orthotoluylenediamine (1:3:4) and with para-ethoxy-orthophenylenediamine have been barren of results, and from these no base up to the present has been isolated. In the case of orthoxylylenediamine (1:3:4:5), however, the reaction takes place with almost the same ease as in the case of orthophenylenediamine, and the base formed shows similar properties. It is a di-acid base, yields characteristic salts, and without doubt is another member of the series.

Ten grams of orthoxylylenediamine<sup>2</sup> were dissolved in an excess of mesityloxide, cooled, and a stream of dry hydrochloric acid gas passed through the solution. In a short time the hydrochloric acid salt of the base was precipitated. This was pressed out on a porous plate, dissolved in water, filtered, and treated with a strong solution of potassium hydroxide. The straw-colored precipitate of the new base was filtered off, pressed out on a porous plate, and recrystallized from dilute acetone. It yields straw-colored needles, extremely soluble in most organic solvents and in acids. Melting point, 82°-83°.

### CARBON AND HYDROGEN DETERMINATION

.2931 grm. substance yielded .8356 grm. CO<sub>2</sub> and .2475 grm. H<sub>2</sub>O.

C<sub>14</sub>H<sub>20</sub>N<sub>2</sub>, C = 77.75% Found, 77.77% Calc.

“ H = 9.41 “ 9.26 “

<sup>1</sup> This journal, Vol. II, No. 2, p. 123, and *Berichte der Deutschen Chem. Ges.*, 38, 2250.

<sup>2</sup> The diamine may be obtained with a splendid yield by the reduction of orthonitrometaxylidine with zinc dust and sodium hydroxide by the method of Hinsberg.

## NITROGEN DETERMINATION

.2544 grm. substance yielded 35.1 c.c. Nitrogen at 615.6 m.m. and 18°.

$C_{14}H_{20}N_2$ , N=13.16% Found, 12.98% Calc.

## SALTS OF THE BASE

*Hydrochloric acid salts.*—A stream of dry hydrochloric acid gas was led into a solution of the base in ether. At first a lemon yellow precipitate was formed, which quickly changed to white. The white precipitate, which was made up of minute crystals, proved on analysis to be a di-hydrochloric acid salt.

## HYDROCHLORIC ACID DETERMINATION

.2654 grm. substance, dissolved in water, required for neutralization 13.7 c.c. of a .13572N.NaOH solution.

$C_{14}H_{20}N_2$ , 2HCl, HCl=25.54% Found, 25.26% Calc.

The yellow salt first precipitated could not be separated pure on account of the speed with which it changed to the white salt. It is, however, without doubt a mono-hydrochloride, as several analyses of the impure substance showed.

*Hydrobromic acid salts.*—From an ether solution of the base, dry hydrochloric acid gas precipitates first a yellow mono-hydrobromide which also quickly takes on more hydrobromic acid and becomes a white crystalline di-hydrobromide.

## HYDROBROMIC ACID DETERMINATION

.1944 grm. substance, dissolved in water required 7.55 c.c. of a .13572 N.NaOH solution.

$C_{14}H_{20}N_2$ , 2HBr, HBr=42.68% Found, 42.85% Calc.

*Action of hydriodic acid gas.*—Hydriodic acid gas precipitates from an ether solution of the base, first a yellow and then a white salt, but, at the same time, some decomposition takes place so that the salts can not be obtained pure for analysis.

*Action of hydrochloric acid gas upon a chloroform solution of the base.*—A rather peculiar phenomenon appears when dry hydrochloric acid gas is passed through a chloroform solution of the base. Instead of a crystalline precipitate of the salt being thrown down, apparently a

colloidal solution of the salt in chloroform is formed, which has very much the appearance of a thick starch solution. A comparatively dilute chloroform solution of the base becomes semi-solid. If water is added to a portion of this in a test tube, the colloidal solution assumes the form of a sphere, within the outer chloroform shell of which floats a nucleus of undissolved salt. This will last a long time, even though the water be hot. If the colloidal solution be allowed to evaporate upon a watch-glass, a tough parchment-like residue remains behind, which retains the odor of chloroform for days. This residue dissolves in water to the ordinary aqueous solution of the salt.

*Comparison of the above salts of this base with those of the base from orthophenylenediamine.*—The halogen acid salts of this base are, like those of the base from orthophenylenediamine, yellow and white. Their aqueous solutions are, like those of the other base, yellow when dilute and colorless when concentrated. They can serve as their own indicators on titration with alkalis, the change of color of the solution from yellow, due to the complex kation,  $C_{14}H_{22}N_2$ , to colorless being very sharp. Hydrochlorplatinic acid gives with the salts of this base no precipitate, the chlorplatinic being extremely soluble in water.

*Picric acid salt.*—When an ether solution of the base is mixed with an alcoholic solution of picric acid, beautiful lemon yellow crystals of a picrate of the base separate out.

#### NITROGEN DETERMINATION

.2102 grm. substance yielded 36.5 c.c. Nitrogen at 613.2 m.m. and 20°.

$C_{14}H_{20}N_2 \cdot 2C_6H_2(OH)(NO_2)_3$  N=16.39% Found, 16.61% Calc.

#### ACTION OF NITROUS ACID

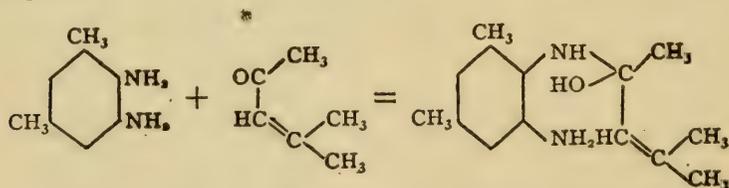
If a potassium nitrite solution is added to a dilute acetic acid solution of the base, a nitroso product is formed. It becomes gummy, and looks very much like the corresponding product from the base from orthophenylenediamine. In this case, however, the impurities could not be removed, so that no crystals were obtained. The impure substance shows the Liebermann's blue coloration, and is without doubt an impure nitroso compound.

No benzoyl derivative could, as with the former base, be obtained, nor was an acetyl derivative formed. The base, however, forms precipitates similar to those from the other base with certain metallic salts. With copper sulphate solution at first a green coloration is produced by an alcohol solution of the base; a green precipitate then forms, which becomes black upon warming, probably with the formation of copper oxide. From a mercuric chloride solution a bright yellow precipitate is produced. Ferric hydroxide is also precipitated from ferric solutions.

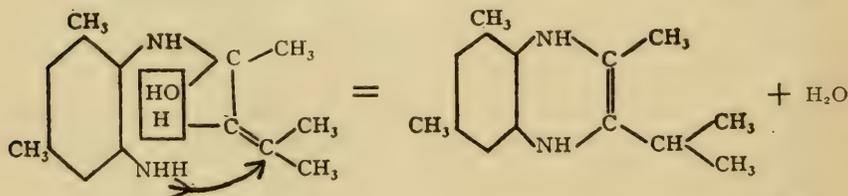
From the above facts there seems to be no doubt that we have here a second member of a series of  $\alpha$ ,  $\delta$  dihydroquinoxalines. Comparing the two members of the series, at present known, with the  $\alpha$ ,  $\beta$  dihydroquinoxalines, we find that, whereas the latter give green-yellow fluorescent solutions, these give golden yellow; the  $\alpha$ ,  $\delta$  series is more basic in character, its salt solutions are yellow when dilute and colorless when concentrated, while those of the  $\alpha$ ,  $\beta$  series are bright red.

The reaction between orthoxylylendiamine and mesityloxyde may be represented by the following equations:

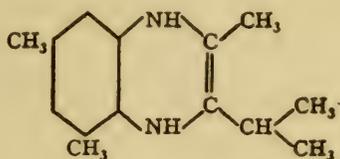
First an addition of the amine to the carbonyl group of the ketone takes place,



Water is then split off with the formation of the quinoxaline ring.



Of course the constitution could just as well be



It is the intention to study the action of other orthodiamines, both aliphatic and aromatic, upon mesityloxide and upon other unsaturated ketones, with the hope of isolating other members of this series.



# THE TERTIARY LAKE BASIN OF FLORISSANT, COLORADO

BY JUNIUS HENDERSON

During the summer of 1905 an expedition, under the auspices of the University of Colorado, visited the ancient lake basin at Florissant, Colo., about 40 miles west of Colorado Springs and 20 miles from Cripple Creek. Large and valuable collections of both fossil and recent plants and animals were secured. As a result, some hitherto unnoticed species have already been described from that region, and it is hoped that further information of importance may be given to the scientific world as work progresses.

The literature of the Florissant formation is scattered through numerous monographs, reports, and other publications which are not much read except by those engaged in special geological or biological studies. Consequently this interesting region is not well known to the general public. It is therefore deemed best to publish this account setting forth in a general way some of the principal facts observed by us or hitherto published by others, with a few comments thereon, together with hints as to unsettled questions and a bibliography of the literature of the subject, so far as known to the writer.

The Tertiary lake beds of Florissant have long been known to geologists, and particularly to paleontologists, because of the great number and variety of fossil plants and insects they contain, besides some fossil fish, mollusks, and birds. The basin is one of the most important in the world for fossil insects, and fossil leaf impressions may be easily collected by thousands.

These beds have generally been assigned to the Oligocene division of the Tertiary age, but it is perhaps more in accordance with modern American usage to consider the Oligocene merely the upper part of the Eocene, and hence to call the Florissant formation Eocene. The determination of the age of this formation necessarily depends entirely upon paleontological methods. As the deposits were formed in a

mountain valley, and are underlaid by granite and completely isolated from all other sedimentaries by several miles of crystalline rocks, stratigraphy can throw no light whatever upon the subject. Any deformation which may have occurred in the valley would be difficult to locate or to follow at all through the granitic complex, even if it extended to rocks of known age, so that no help could reasonably be expected from that source. The presence of masses of rhyolite along and near the margins of the ancient lake is of no assistance, because of the impossibility of determining their age exactly in the crystalline mass, and the character of the materials composing the lake beds themselves is wholly valueless as evidence of age, as similar materials might have been available at periods long prior and subsequent to the lake period.

The fossils have been considered indicative of a much milder climate than that which now prevails in the region. It has been stated that the fossil flora and fauna of the vicinity are in a general way similar to the present-day flora and fauna of the Gulf states, though specifically, and to a considerable extent generically, distinct. Scudder has shown that, while the fossil insect fauna exhibits distinct tropical affinities, there is also a very definite relation to the present insect fauna of the region. The latter relation applies also to the fossil and recent flora. The fluctuation in climate since Eocene time has been much greater than indicated by the difference in plant and animal life as shown by the fossils of Florissant. The glacial epoch has intervened, during which time, although glaciers apparently did not actually reach this valley, they were in such close proximity and so extensive through the higher mountains that the climate was probably considerably colder than now, and differed in other respects, such as precipitation, relative humidity, etc., from that of either Tertiary time or the present day.

Many giant fossil *Sequoia* stumps and logs are found in the southern part of the lake basin. These have been visited by hundreds of tourists, and large quantities of the "petrified wood" have been carried away by relic-hunters. Several years ago an effort was made to cut the largest stump into three or four sections for transportation and exhibition, but the attempt met with failure, and portions of the broken

saws still remain in the stump. A photograph of one of these stumps is reproduced in Fig. 3.

It was long ago pointed out that the drainage and destruction of the lake were probably brought about by the tilting of the region from the southeast, reversing the drainage and causing the lake to overflow its northwestern rim and cut down its barrier at that end. It is believed that the valley formerly drained southward into the Arkansas River, but now, with the exception of the extreme southern portion, the drainage is westward into the South Platte. The southeastern end of the basin, instead of being lower than the northwestern extremity, is now about 800 feet higher.<sup>1</sup> If the lake was in fact thus drained, it is interesting to note that at present the basin formerly occupied by it still drains partly to the south, as a glance at the accompanying map will show. This means either: (1) that the drainage was not wholly reversed, but that the axis of the deformation crossed the lake near the southern end, thus dividing it into two portions, one draining into the Arkansas and the other into the South Platte; or (2) that the drainage of the southern portion has been captured in more recent times by the headward progression of the channel from the south.

In the literature of the subject there appears to be no hint as to the origin of the lake, and in the field we have found nothing to suggest any of the known causes of mountain lakes except the warping of the earth's crust. As there is evidence of a general tilting of the region either during or subsequent to the deposition of these beds, it seems quite possible that it was only a continuation of the process which originally created the lake. The great majority of mountain lakes of Colorado are glacial, in this respect differing from the lakes of the plains. Lake Florissant was certainly not glacial. The geological map shows a volcanic accumulation south of the basin in such position as to act as a possible barrier. This we did not visit. It should be examined with reference to this problem before any final conclusion is reached. Barriers of gravel and boulders produced by the outwash from high-grade lateral gulches and in other ways would not seem sufficient to account for this lake and its deposits.

<sup>1</sup> Twelfth Ann. Rept., *Hayden Survey*, Part 1, p. 274.

The whole topography of the region indicates that the basin was formerly a mountain valley and its laterals, formed in granite by stream erosion, and hence thoroughly drained, in this respect resembling the original valleys of glacial lake basins. This is obvious to the physiographer from an examination of the accompanying map. The ramification of the lake into lateral valleys and consequent tortuous outline gives a great length of shore line in proportion to the area. It consisted of two somewhat distinct bodies of water connected by a narrow strait and placed at such an angle with each other as to form a rude **L**; or, to state it another way, the lake was nearly divided at the angle by two promontories which jutted into it from opposite shores.

It seems certain that a lake could originate and continue its existence in such a valley for a sufficient length of time to permit the deposition of these beds only by the formation of a very resistant barrier in such a position as to interrupt the drainage. Such a barrier of rock could have been formed in several ways: (1) by volcanic accumulations choking the valley, (2) by a sharp fold thrown across the channel, (3) by the general tilting of the region resulting either from an uprising to the southeast or a depression to the northwest, or both. From the evidence so far at hand, it seems more likely that the last is what occurred. As soon as such a change in level had progressed far enough to raise a downstream portion of the valley to a position higher than any portion further upstream, the water would begin to accumulate, the vertical longitudinal section of such a valley being concave. The accumulation would continue until either the tilting ceased or the lake overflowed its rim at some point other than its original outlet; but that does not necessarily mean that the lake would attain great depth. The character of some of the fossils, the *Sequoia* stumps standing erect in the deposits, and reported sun-cracks in the shales indicate that the filling of the lake by detritus progressed approximately as rapidly as the supposed tilting, so that the lake was maintained in a rather shallow condition.

In the accompanying diagram (Fig. 2) an effort is made to illustrate graphically this supposed change of level and its effect, the vertical

scale being grossly exaggerated in proportion to the horizontal scale, in order to appeal more readily to the eye.

That the time of the existence of this lake was one of great volcanic activity in the region is quite evident. This conclusion does not depend merely upon the stratigraphic relations of volcanic rocks to the lake beds, but more particularly upon the character of the sedimentary deposits themselves. These beds are composed chiefly of volcanic ashes, mud and sand, the component particles of which are generally somewhat, though not very much, worn by the action of the water. The conclusion reached in both field and laboratory is that the deposits were formed largely by volcanic ashes from repeated eruptions falling upon the surface of the water and settling to the bottom, assorted by the sluggish lake currents; also by volcanic mud and ashes falling or flowing into positions where they were rapidly washed into the lake by rains, streams, and waves without very much grinding.

The strata of the upper deposits differ greatly from each other in composition, fineness of material, and thickness. At least the whole fossiliferous portion examined has been deposited in water, is thin-bedded, and very distinctly stratified. It often weathers out in large scales little thicker than ordinary writing-paper. During the periods of deposition large numbers of insects and plants were sometimes entombed and preserved in great perfection. While there is a general sameness to the formation in various parts of the basin, yet, upon more particular examination of the strata, great dissimilarity in minor details forces itself upon the attention. Especially is this true when one compares a vertical section in the northwestern basin with one in the southeastern basin.

The lower part of the formation seems wholly non-fossiliferous, is of a drab color, quite homogeneous, thick-bedded, and has a decidedly conchoidal fracture. Our limited examination of that portion of the formation left the impression that it was formed by mud flows without much assortment by moving water. This is offered merely as a suggestion for future work, not as a final conclusion, and its investigation may throw important light on the history of the lake. Near the northwestern end of the basin a shaft has been sunk for some

distance into the non-fossiliferous beds, and in other places wells have been sunk, affording excellent sections and showing that the floor deposits extend to considerable depth—just what depth we have not learned. The fossiliferous beds above the floor deposits are approximately twenty feet in thickness.

The dip of strata is in most places to the northwest, as would be expected in view of the supposed tilting, and is not usually very marked. The beds are not entirely free, however, from local disturbance. In one place we found a very decided change in both direction and angle of dip within a few yards, but the intervening rocks were deeply buried by débris, so we were unable to ascertain whether it was a fault or fold. Near the southern end of the basin the shales seem to be involved with igneous rocks, but limited time prevented a thorough examination as to the nature of the disturbance.

Volcanic rocks bordered and projected into the lake in many places. To a layman perhaps the most interesting feature of the igneous rocks is an exposure a few rods north of Florissant post-office. The deposit is much shattered, the cracks varying from a fraction of an inch to several feet in width. It is reported that these crevices afforded hiding-places for the Indians in their wars with neighboring tribes before the advent of white men, and rude fortifications remained there long after the settlement of the valley.

Since the deposition of the beds and the drainage of the lake, the valley has been subjected to extensive erosion. The fossiliferous part of the lake formation, consisting chiefly of soft, yielding shales, has mostly been cut away, leaving remnants, however, along nearly the whole margin, not only of the main shore, but also of the granitic hills which once formed islands in the lake. There is no reason to doubt that at many of the outcrops the top of the formation still remains intact, so that a complete section of the entire formation is obtainable. The exposed shales are usually so badly weathered that the contained fossils cannot be obtained in good condition, but upon steep slopes it is easy to excavate sufficiently with pick and shovel to reach unweathered deposits in which may be found fine specimens. The floor deposits are mostly covered by alluvium and talus, and are thus hidden from view.



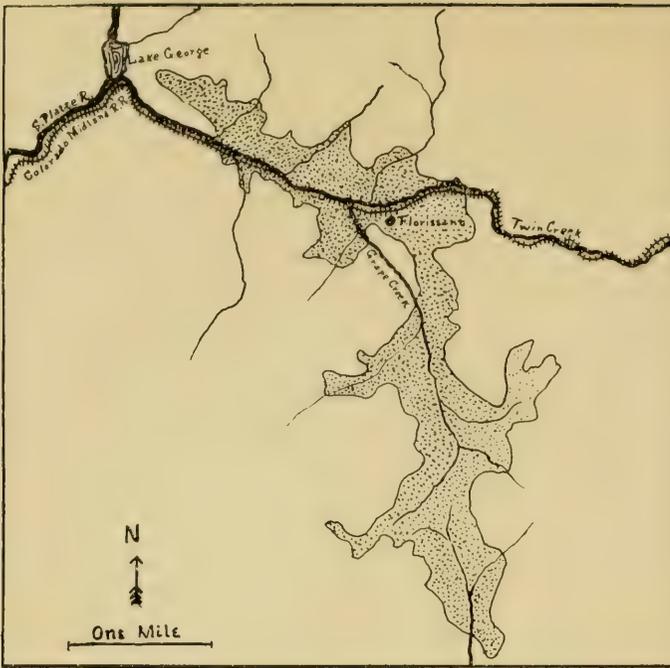


FIG. 1

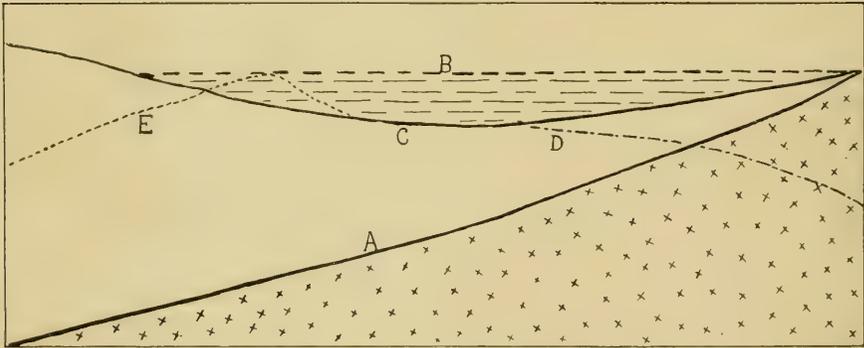


FIG. 2



FIG. 3

THE TERTIARY LAKE BASIN OF FLORISSANT, COLORADO  
See "Explanation of Figures"

Many of our smaller mountain "parks" or meadows in Colorado are the result of the silting up and drainage of glacial lakes, though if stratified deposits were formed in the lakes, they have usually been almost wholly worked over and destroyed by the subsequent meandering of the streams. Such parks in many respects resemble the Florissant valley. Compared with Estes Park, South Boulder Park, Nederland meadows, and other more northerly valleys which are becoming well known to the traveling public, the Florissant basin is more open, not as well defined, and presents an aspect of greater age. The surrounding mountains are neither as high nor as abrupt, being for the most part rounded into gentle slopes, without deep, sharp, V-shaped gorges. The highest point within a radius of several miles is only 1,000 feet above the village of Florissant, which is situated on the present floor of the valley, a little over 8,000 feet above sea-level.

Two other Tertiary lake basins are noted on the maps of the Pike's Peak folio, but they are of later origin, being considered Neocene. One is called Alnwick Lake, the other High Park Lake. They are a few miles south of Florissant, one immediately northwest and the other southwest of Cripple Creek. Their deposits are very different from those of Florissant, consisting of sandstones and conglomerates, and seem to be devoid of fossils.

#### EXPLANATION OF FIGURES

FIG. 1.—Outline map of Florissant Tertiary lake basin, following Folio No. 7, *Geological Atlas of the United States*. The present extent of lake beds is indicated by dotted area. Drainage at present is shown by the courses of the streams.

FIG. 2.—*A*, original slope of valley floor. *B*, water level at beginning of overflow at northwest end. *C*, valley floor after supposed tilting. *D*, valley floor after cutting down of barrier and draining of lake. *E*, dotted line represents the possibility of the axis of deformation having divided the lake near the southern extremity. Vertical scale is greatly exaggerated. Left of figure is southeast; right of figure is northwest.

FIG. 3.—Fossil *Sequoia* stump. The framework was erected at the time that an attempt was made to cut sections of the stump for exhibition.

## BIBLIOGRAPHY

The subjoined list includes all publications which have come to the attention of the writer from an extended search of the literature of the subject, wholly or in part dealing with the geology and paleontology of the Florissant Basin. The United States Geographical and Geological Survey of the Territories is herein designated the Hayden Survey, by which name it is commonly known, in order to avoid confusion with the present United States Geological Survey. The Final Reports of the Hayden Survey are designated Monographs, in accordance with common usage. Some confusion has heretofore resulted from references to Castello's Ranch, which is the same as Florissant.

- ALLEN, J. A. "Description of a fossil passerine bird from the insect-bearing shales of Colorado." *Bull. Hayden Survey*, Vol. IV, No. 2, 1878, pp. 443-445. Describes *Paleospiza bella*, a finch. See also *Amer. Journ. Sci.*, Vol. XV, 1878, p. 381; *Amer. Nat.*, Vol. XV, 1881, p. 253; *Coues' Key to North American Birds*, 2d, 3d, 4th, and 5th editions.
- BECHLER, GUSTAVUS R., "Geographical report on the Middle and South Parks, Colorado, and adjacent country." *Ninth Ann. Rept. Hayden Survey*, 1875, pp. 369-440. Briefly describes Florissant topography at p. 421, and includes the vicinity in one of the outline drainage maps opposite p. 440.
- BUCKTON, G. B. *Monograph of the British Aphides*. London, 1875-1883, Vol. IV, pp. 144-178. Discusses antiquity of Hemiptera, including Florissant species.
- COCKERELL, T. D. A. "A new fossil ant." *Entomological News*, January, 1906, p. 27.
- \* \* \* \* \* "A new Tertiary Planorbis." *The Nautilus*, Vol. XIX, January, 1906, p. 100.
- \* \* \* \* \* "Rhus and its allies." *Torreya*, Vol. VI, No. 1, January, 1906, pp. 11-12. Discusses the species from Florissant and the division of the genus.
- COPE, E. D. "Fishes of the Tertiary shales of South Park." *Bull. Hayden Survey*, Vol. I, 2d Ser., No. 1, 1875, pp. 3-5.
- \* \* \* \* \* "The Amyzon Tertiary beds." *Amer. Nat.*, Vol. XIII, 1879, p. 332. The South Park fossil fish referred to in this paper probably include the Florissant specimens, as Florissant is often referred to as part of South Park.
- \* \* \* \* \* "On a wading bird from the Amyzon shales." *Bull. Hayden Survey*, Vol. VI, No. 1, 1881, pp. 83-85. Describes *Charadrius sheppardianus*, a shore bird. See also *Amer. Nat.*, Vol. XV, 1881, p. 253; *Coues' Key to North American Birds*, 2d, 3d, 4th and 5th editions.
- CROSS, WHITMAN. "Pike's Peak folio, geological atlas of the United States." *Fol. U. S. Geol. Sur.*, No. 7, p. 2 and maps.

- Geological and geographical atlas of Colorado and portions of adjacent territory*, Hayden Survey, Sheet No. XIII.
- HOLICK, ARTHUR. "Fossil Salvinias, including description of new species," *Bull. Torr. Bot. Club* Vol. XXI, 1894, pp. 253-257. This gives a revision of nomenclature of Florissant species.
- KIRSHNER, W. C. G. "Contributions to the fossil flora of Florissant, Colorado." *Trans. St. Louis Acad. Sci.*, Vol. VIII, 1898, pp. 161-188. Includes a catalogue, as well as descriptions of new species. The Hayden publications are incorrectly attributed to the U. S. Geol. Sur.
- KNOWLTON, F. H. "A catalogue of the Cretaceous and Tertiary plants of North America," *Bull. U. S. Geol. Sur.*, No. 152, 1898.
- LESQUEREUX, LEO. "Lignitic formation and fossil flora." *Sixth Ann. Rept. Hayden Survey*, 1872, pp. 317-427. Enumerates and briefly describes fossil plants from Florissant, among others.
- \* \* \* \* \* "The Lignitic formation and its fossil flora." *Seventh Ann. Rept. Hayden Survey*, 1873, pp. 210, 365-425. On page 210 occurs a very brief description of the basin and its geology. On pages 409 to 418 are mentioned and described about 15 species of fossil plants from Florissant.
- \* \* \* \* \* "On the Tertiary flora of the North American Lignitic, considered as evidence of the age of the formation." *Eighth Ann. Rept. Hayden Survey*, 1874, pp. 275-315. On pages 309 to 313 are described two species of fossil plants from Florissant.
- \* \* \* \* \* "On some new species of fossil plants from the Lignite formations," *Bull. Hayden Survey*, Vol. I, 2d Ser., No. 5, 1876, pp. 363-389.
- \* \* \* \* \* "Contributions to the fossil flora of the western territories. Part II, The Tertiary flora." *Mon. Hayden Survey*, Vol. VII, 1878.
- \* \* \* \* \* "Contributions to the fossil flora of the western territories. Part III, The Cretaceous and Tertiary flora." *Mon. Hayden Survey*, Vol. VIII, 1883. On page 132, in transposing centimeters of the original tabulated cross-section into feet and inches, the measurements were apparently stated in inches and fractions thereof, but unfortunately the column was headed in such a way as to indicate that the inches are feet and the fractions are inches, thus greatly multiplying the thickness of strata.
- NEWBERRY, J. S. "Brief descriptions of fossil plants, chiefly Tertiary, from western North America." *Proc. U. S. Nat. Mus.*, Vol. V, 1882, pp. 502-514.
- SCUDDER, S. H. "Critical and historical notes on Forficulariæ." *Proc. Boston Soc. Nat. Hist.*, Vol. XVIII, 1876, pp. 287-332. Includes two fossil forms from Florissant.
- \* \* \* \* \* "Fossil Orthoptera from the Rocky mountain Tertiaries." *Bull. Hayden Survey*, Vol. I, 2d Ser., No. 6, 1876, pp. 447-449.
- \* \* \* \* \* "Fossil Coleoptera from the Rocky mountain Tertiaries,"

*Bull. Hayden Survey*, Vol. II, No. 1, 1876, pp. 77-87. Includes several species from Florissant.

- \* \* \* \* \* "Brief synopsis of North American earwigs, with an appendix on the fossil species," *Bull. Hayden Survey*, Vol. II, No. 3, 1876, pp. 249-260. Discusses one species and describes another from Florissant.
- \* \* \* \* \* "Note on fossil ants from South Park, Colorado." *Amer. Nat.* Vol. XI, 1877, p. 191. Mentions that about 40 species have been found at Florissant, but does not describe them.
- \* \* \* \* \* "An account of some insects of unusual interest from the Tertiary rocks of Colorado and Wyoming." *Bull. Hayden Survey*, Vol. IV, No. 2, 1878, pp. 519-543. Species discussed are mostly from Florissant. Strongly urges tropical affinities.
- \* \* \* \* \* "The Tertiary lake basin at Florissant, Colorado, between South and Hayden Parks." *Twelfth Ann. Rept. Hayden Survey*, Part 1, 1878, pp. 271-293. Reprint from *Bull. Hayden Survey*, Vol. VI, although it antedates the completed Vol. VI. Topographical and geological description, with map and discussion of fossils.
- \* \* \* \* \* "The insect basin of Florissant." *Psyche*, Vol. III, 1880, p. 77.
- \* \* \* \* \* "The Tertiary lake basin at Florissant, Colorado, between South and Hayden Parks." *Bull. Hayden Survey*, Vol. VI, No. 2, 1881, pp. 279-300. A general account of the basin, its geology and fossils, with map. Reprinted in *Twelfth Ann. Rept.*, and *Thirteenth Mon.*, of same survey.
- \* \* \* \* \* "White ants in the American Tertiaries." *Harv. Univ. Bull.*, Vol. II, 1881, p. 219. Discusses relations of six Florissant species to those from other localities and notes indications of warm climate.
- \* \* \* \* \* "Insects of the Amyzon shales of Colorado." *Amer. Nat.*, Vol. XVI, 1882, pp. 159-160. Discusses climatic conditions.
- \* \* \* \* \* "Fossil spiders." *Harv. Univ. Bull.*, Vol. II, 1882, pp. 302-303. Reprint: "Our knowledge of fossil spiders." *Field Nat.*, Vol. I, 1882, pp. 61-63, Manchester, Eng.
- \* \* \* \* \* "Notes on some of the Tertiary Neuroptera of Florissant, Colorado, and Green River, Wyoming." *Proc. Boston Soc. Nat. Hist.*, Vol. XXI, 1882, pp. 407-409.
- \* \* \* \* \* "Description of an articulate of doubtful relationship from the Tertiary beds of Florissant, Colorado." *Mem. Nat. Acad. Sci.*, Vol. III, 1885, pp. 85-90.
- \* \* \* \* \* "Systematic review of our present knowledge of fossil insects, including myriapods and arachnids." *Bull. U. S. Geol. Sur.*, No. 31, 1886.
- \* \* \* \* \* "Fossil butterflies of Florissant." *Eighth Ann. Rept. U. S. Geol. Sur.*, 1889 pp. 433-474. Reviewed in *Nature*, Vol. XIII, 1890, p. 18, and *Amer. Geol.*, Vol. VI, 1890, p. 197.

- \* \* \* \* \* "A classed and annotated bibliography of fossil insects." *Bull. U. S. Geol. Sur.*, No. 69, 1890.
- \* \* \* \* \* "Physiognomy of the American Tertiary Hemiptera." *Proc. Boston Soc. Nat. Hist.*, Vol. XXIV, 1890, pp. 562-579. Shows definite relation of western Tertiary fauna to that at present occupying the region, with, however, distinct tropical affinities.
- \* \* \* \* \* "The Tertiary insects of North America." *Mon. Hayden Survey*, Vol. XIII, 1890, pp. XI, 127-217. Includes the descriptive matter and map from *Bull.* Vol. VI, in addition to descriptions and plates of fossil insects.
- \* \* \* \* \* "Work of a decade upon fossil insects, 1880-1889." *Psyche*, Vol. V, 1890, pp. 287-295.
- \* \* \* \* \* "The Fossil insect localities in the Rocky Mountain Region." *Psyche*, Vol. V, 1890, p. 362. Discusses relative abundance of individuals of different orders.
- \* \* \* \* \* "Index to the known fossil insects of the world, including myriapods and arachnids." *Bull. U. S. Geol. Sur.*, No. 71, 1891.
- \* \* \* \* \* "Brief notes of a new fossil butterfly." *Psyche*, Vol. VI, 1891, p. 101. (*Barbarothea florissanti*).
- \* \* \* \* \* "Fossil insects." *Psyche*, Vol. VI, 1891, p. 118. Discusses fossil plant-lice from Florissant and remarks on *Barbarothea*.
- \* \* \* \* \* "Some insects of special interest from Florissant, Colorado, and other points in the Tertiaries of Colorado and Utah." *Bull. U. S. Geol. Sur.*, No. 93, 1892.
- \* \* \* \* \* "Tertiary Rhynchophora of North America." *Proc. Boston Soc. Nat. Hist.*, Vol. XXV, 1892, pp. 370-386. Apparently a preliminary sketch of his monograph on the same subject published shortly afterwards by the U. S. Geol. Sur.
- \* \* \* \* \* "American Tertiary Aphidae." *Thirteenth Ann. Rept. U. S. Geol. Sur.* 1892, pp. 341-366.
- \* \* \* \* \* "The Tertiary rhynchophorous Coleoptera of the United States." *Mon. U. S. Geol. Sur.*, Vol. XXI, 1893.
- \* \* \* \* \* "Tertiary Tipulidae, with special reference to those of Florissant, Colorado." *Proc. Amer. Philos. Soc.*, Vol. XXXII, 1894, pp. 163-245. Abstracts: *Amer. Nat.*, Vol. XXVIII, 1894, pp. 951-954; *Amer. Journ. Sci.*, Vol. XLVII, 1894, p. 481.
- \* \* \* \* \* "American fossil cockroaches." *Bull. U. S. Geol. Sur.*, No. 124, 1895.
- \* \* \* \* \* "Adephagus and clavicorn Coleoptera from the Tertiary deposits at Florissant, Colorado." *Mon. U. S. Geol. Sur.*, Vol. XL, 1900.
- WARDER, R. B. "The silicified stumps of Colorado." *Proc. 31st Ann. Meet.*

*Amer. Assn. Adv. Sci.*, 1883, pp. 398-399. Discusses the *Sequoia* stumps and associated leaf impressions at Florissant, particularly the extremes of annual growth rings, and suggests the possibility of hot silicious waters from volcanic springs.

WILLISTON, S. W. "Some interesting new Diptera." *Trans. Conn. Acad. Arts and Sci.*, New Haven, Conn., Vol. IV, 1880, pp. 243-246. Discusses some Florissant species.

\* \* \* \* \* "Synopsis of North American Syrphidae." *Bull. U. S. Nat. Mus.*, No. 31, 1886. Contains a brief section on geological distribution, including Florissant species, but incorrectly cites the U. S. Geol. Sur. instead of Hayden Survey or U. S. Geol. and Geog. Sur. of the Terr., the two surveys and their publications being distinct and each having published bulletins, etc., bearing the same numbers.

VON ZITTEL, KARL A. *Text-book of paleontology*. American edition, 1900, Vol. I, pp. 682-691. Figures some Florissant species to illustrate genera.

## THE FOSSIL FAUNA AND FLORA OF THE FLORISSANT (COLORADO) SHALES

BY T. D. A. COCKERELL

The Tertiary lake basin of Florissant, Colo., is one of the most famous localities for fossils in the world. The plants and insects of a past age are wonderfully preserved in fine volcanic sand or ash, deposited in layers which readily split apart, revealing the specimens, just as they fell, in prodigious numbers. Green leaves and even branchlets were torn from the trees, and insects perished wholesale, in a catastrophe which must have equaled that of Martinique. There were, in fact, several successive eruptions, as about a dozen different horizons are found to be fossiliferous. While some of these may represent a single period of volcanic activity, it is not to be doubted that considerable periods elapsed between some of the deposits. Perhaps the non-fossiliferous shales were deposited so soon after the fossiliferous ones that no living creatures remained to be entombed, all having been destroyed or driven away; in this case the next fossil-bearing layer will indicate a new eruption, following after a greater or less lapse of time.

In all eleven vertebrates, one mollusc, 610 insects, 30 spiders, and about 145 recognizable plants have been described from these beds. The insects were all described by Mr. S. H. Scudder, except a few plant-lice named by Mr. Buckton from drawings supplied by Mr. Scudder, and some hymenoptera recently examined by the present writer. The Scudder collection, at the Museum of Comparative Zoölogy, Cambridge, Mass., contains probably at least another 400 species of insects. These were to have been described by Mr. Scudder, but he is no longer able to work upon them, and others will be obliged to do the best they can in the absence of the master hand. Mr. Samuel Henshaw, curator of the Museum of Comparative Zoölogy, has very kindly transmitted to me the bees and wasps for study, and the work on them is already completed.

The plants were catalogued in 1898 (*Trans. St. Louis Acad.*) by Mr. W. C. G. Kirchner, who contrived to enumerate as many as 213 species. He included, however, all the indeterminate things, many obsolete identifications, and some duplicates; with a more careful examination, even with the addition of some new species discovered by Judge Henderson and Dr. Ramaley, I cannot find more than about 145 really recognizable species.

A paper on the new species of plants has been sent for publication elsewhere; in addition, several new names have been proposed to replace homonyms, and these will be recorded in the same paper. Should circumstances permit, it is hoped to work up the Florissant beds in detail, with the idea of presenting as perfect a picture as possible of the life of the period they represent. There is, perhaps, no locality in the world where so many terrestrial species of one time are preserved; and if every advantage is taken of the splendid opportunity afforded, the result should be of great value to biological and geological science. The work should, of course, employ many hands; it is far too great for any single individual, though such an individual may have a general oversight of the entire field, and piece together the contributions of specialists. It is much regretted that the splendid publications of Scudder and Lesquereux have not attracted more critical attention, as the advice of specialists on many points is greatly needed. Fortunately, the ants are to be studied by Dr. W. M. Wheeler, and his researches are sure to be of extreme interest.

There is one aspect of the Florissant insect fauna which is of the greatest importance to the student of evolution; namely that explained by Mr. Scudder in the following words:

In my recent work on our Tertiary insects, I called attention to some remarkable features in the fossil plant-lice of our Tertiaries, especially the great length and slenderness of the stigmatic cell—a feature which affects the whole topography of the wing, and is found also in the only Mesozoic plant-louse known, but which, nevertheless, cannot be regarded as of significant taxonomic importance since it occurs equally in both Aphidinae and Schizoneurinae, the two principal subfamilies of that group, both today and formerly. So, too, in treating in the same place the Pentatomidæ, I pointed out that the scutellum was universally shorter in all our Tertiary forms, whether belonging to the subfamily of Cydninae or Pentatom-

inæ. I may further add the unpublished fact that it is a peculiarity of the Tertiary Staphylinidæ of this country that the antennæ and legs are measurably shorter than in modern types; this is most marked in cases where the living and extinct species of the same genera are compared.—*Tertiary Rhynchophorous Coleoptera*, 1893, p. 2.

Thus we find, among the insects, indications of common trends of variation similar to those observed by H. F. Osborn and others among the vertebrates. Professor Osborn wrote in 1897:

My study of teeth in a great many phyla of Mammalia in past times has convinced me that there are fundamental predispositions to vary in certain directions; that the evolution of the teeth is marked out beforehand by hereditary influences which extend back hundreds of thousands of years.—*Science*, Oct. 15, 1897.

The subject is further elaborated by the same author in the *American Naturalist*, April, 1902, and I have offered some theoretical considerations in *Nature*, Dec. 28, 1905, p. 197.

It remains to offer some remarks on the probable age of the Florissant shales. I am informed that geology affords little help in this matter, and for the present, we must rely wholly, or almost wholly, on the evidence afforded by the fossils. The total absence, so far, of mammals, reptiles, batrachians or land shells is much to be regretted; it can hardly be doubted that further search will reveal some members of one or other of these groups. In the meanwhile, it ought to be possible to reach some conclusions from the very large series of organisms already discovered.

In the first place, it seems to me evident that we must cease to refer to the Florissant shales as belonging to the "Green River Group," unless that term is so extended as to be nearly meaningless. Mr. Scudder wrote in 1893:

The detailed study of the fossil Rhynchophora has made very clear and specific one point which impressed me in general while working in the field, and that is the wide difference between the character of the fossils obtained at Florissant and those obtained at any of the other localities (perhaps excepting Elko, Nevada, of which little is known) in the Rocky Mountain region. He goes on to specify the differences in detail, and remarks that when we come to examine the species of Rhynchophora, we shall find that while the three localities in western Colorado and Wyoming share a number of forms in common not a single species found at Florissant occurs in either of the others.

Mr. Scudder designates the Florissant fauna as the *Lacustrine Fauna*, and the other (including the Green River beds) as the *Gosiute Fauna*, and then proceeds:

The difference between the Gosiute and Lacustrine faunas is shown to be much more remarkable when we examine the larger groups. Thus, of the 66 genera found at Florissant, only 18 occur also in the Gosiute fauna, which contains, besides, 31 genera not found at Florissant, and there are even a number of tribes which, as far as we yet know, are entirely confined to one or the other fauna.

Mr. Scudder does not attempt to decide which is the older.

Turning now to the fishes, the Perciform fishes have five genera, with 18 species, in the Green River beds, but one genus at Florissant, different from all the Green River ones. The Cyprinids have a genus with several species at Florissant, but no member at all in the Green River. The Isospondyli are not at Florissant, but have three Green River genera, one allied to *Clupea*. There is even a ray (*Dasyatis*) in the Green River beds. While the Florissant fish-fauna is so small and localized that the absence of particular types cannot be considered very important, the *presence* of types not known in the Green River beds is certainly significant. The evidence from the plants is not so clear, but there is no very close similarity. The presence of an undoubted palm and of a *Cinnamomum* in the Green River beds suggest a warmer climate than that of the Florissant flora.

So far as we may judge from the trend of the evidence, and the opinions of Lesquereux and Cope the Florissant beds are *later*, not earlier, than those of Green River. Scudder (1890), after carefully reviewing the subject, concluded that they belonged "in or near the Oligocene." More recent writers have been inclined to reject the Oligocene as a division of our Tertiary, and have referred the Florissant beds to the Upper Eocene. My own feeling is, that Lesquereux's early conclusion was correct, and that they are surely Miocene. Many of the plants are similar to, or even apparently identical with, those well-known to belong to the Miocene period; and that they do not show more resemblance to those of the Pacific region Miocene may be explained as the result of geographical remoteness and a mountain habitat. On the other hand, the resemblances to the plants of older

periods are generally such as run through the entire Tertiary series, or, in certain cases, due to mere mistakes. Lesquereux, being most familiar with fossil floras, made comparison with them, but the more one works upon the plants, the more one is impressed with their modern *facies*, and in many instances with the extremely close resemblance to types still living in the Rocky Mountains.

That the deposits are not *later* than Miocene, will be generally admitted; for in spite of all resemblances to recent forms, there are plenty of proofs that a long time has elapsed since the deposits were formed. Indeed, argument from this side of the case would be superfluous. With regard to the climate prevailing when the Florissant biota lived, it may be said that it was undoubtedly moister and warmer than that of the present day. As has been several times remarked, it seems to have resembled that of our southern states; but not, I think, the most southern ones. We do not know what elevation of the range may have taken place since the Florissant epoch; but it may be doubted whether the warmer climate was wholly or primarily due to a lower altitude, for it is well known that the whole continent enjoyed mild or warm temperatures during the Miocene, even far north.<sup>1</sup> Having in view the known Miocene flora of the lowlands in this latitude, it certainly appears that that of Florissant was semialpine or boreal in character; especially since a critical examination of the material and literature indicates that several of the apparently subtropical species are wrongly credited to it, or are very doubtfully of the genera to which they have been assigned. Even some of the apparent exceptions confirm the view just stated. Thus *Weinmannia*, today a neotropical genus, is represented by excellent material at Florissant; but on turning to Grisebach's *Flora of the British West Indian Islands*, I find that *Weinmannia* in Jamaica is "common on the summits of the Blue Mountains," one of the specific names applied to it being *alpestris*. It is, therefore, a mountain genus, which once lived in the Rocky Mountains, and may even have survived there until destroyed by the cold of the glacial epoch.

If the above arguments are justified, it is easy to understand why so many of the Florissant plants, notwithstanding their antiquity,

<sup>1</sup>For a general discussion of this matter, see A. R. WALLACE'S *Island Life*.

resemble those of the present day. During the Miocene, the lowlands were occupied largely by a flora which has not been able to survive the later cold, and has either been exterminated or driven into Central America. But in the mountains, the temperate region flora must have maintained itself, restricted in area, but ready in a later day to spread widely over the country. Hence assuming the Florissant beds to be Miocene, their plants might show more similarity in many respects to those of today, than to the strictly contemporaneous flora of the lowlands in the same latitude.

It is true that Scudder refers a number of times to subtropical affinities exhibited by the Florissant insects, but on the *whole* the insect fauna is that of a warm temperate region; and certainly the bees, which I have studied, are by no means of tropical groups. The prevalence of Aphides indicates a temperate region, while many of the genera in other groups are such as exist in the United States today. The appearance of a small number of species having a really tropical *facies* is explained by the ready migration of insects; and, in truth, such forms exist in the Colorado fauna today, some as permanent residents, others as casual visitors.

It is much to be regretted, that in all the collecting which has been done at Florissant, no record has been kept of the exact horizons from which the specimens came. It may well be that the plants and animals are not the same in all, and that much time elapsed between the formation of some of them. This seems the more probable, from the large number of closely-allied species of certain groups of insects and plants; too many, it would seem, to have existed at the same time and in the same immediate locality. If these could be ascertained to come from different horizons, the difficulty would be explained. There is also reason to hope that by carefully noting the horizons we might determine the *time of year* of the eruptions. Lesquereux has already made some suggestions bearing upon this matter; and it is to be remarked that large numbers of Bibionid flies and winged Termites have been found, indicating by their presence early spring. If we could thus ascertain the time of year of any particular layer, we should know something about the time of flight of the insects entombed

in it, in addition to those which we could safely assume to be vernal or otherwise. This information would not only be of interest from an entomological standpoint, but would perhaps help to explain the differences between the contents of closely adjacent beds, which might have been deposited at different seasons of the year.

Many specimens have been obtained at Florissant by persons who have no expectation of using them for scientific purposes; or are deposited in collections unworked. The University of Colorado will be very glad to obtain the loan of any such material for study, and will return it carefully; but it is hoped that if any new species are found in private collections, they will be ultimately deposited in some museum where they can be permanently cared for and made accessible to students.

#### SUMMARY OF THE FAUNA AND FLORA OF THE FLORISSANT SHALES

##### BIRDS (2 species)

###### Order PASSERES

*Palæospiza bella* J. A. Allen, is a passerine bird of uncertain affinities, but regarded as the type of an extinct genus. "The absence of the bill renders it impossible to assign the species to any particular family, but the fossil on the whole gives the impression of Fringilline affinities." (Allen.)

###### Order LIMICOLAE

*Charadrius sheppardianus* Cope, is a plover which Cope could not distinguish from the modern genus *Charadrius*. It was discovered by Dr. G. Hambach.

##### FISHES (9 species)

###### Order HOLOSTEI

*Amia dictyocephala* Cope, and *A. scutata* Cope, represent a genus which has one living species (*A. calva*, Linné, the Bow-fin) in North America, but is common (six species) in the Bridger Eocene of Wyoming. It appears to represent a waning type.

###### Order NEMOGNATHI

*Rhineastes pectinatus* Cope, is a catfish belonging to a genus otherwise known (five species) from the Bridger Eocene of Wyoming.

###### Order EVENTOGNATHI (PLECTOSPONDYLI)

*Amyzon* Cope, is a genus of Catostomidæ, or suckers, well represented at Florissant. Three or four species occur, and have been described by Cope.

###### Order PERCOMORPHI

*Trichophanes* Cope, a genus of perciform fishes of the family Aphredoderidæ, is represented by *T. foliarum* Cope, and *T. copei* Osborn, Scott and Speir.

The family has three other genera in the Green River beds of Wyoming, but our genus is not present in those beds, so far as known.

#### MOLLUSCA (1 recognizable species)

A few freshwater Mollusca have been found, not differing in any striking characters from those inhabiting Colorado today. *Planorbis florissantensis* Ckll. has recently been described; the other forms have not yet been met with in a condition for description. It is much regretted that no land shells have yet been discovered.

#### INSECTS

##### COLEOPTERA (213 species described, of over 400 found)

*Carabidæ*. Scudder reports 25 species.

*Dytiscidæ*, etc. (water-beetles). Five species.

*Staphylinidæ*. Thirty-five species.

*Nitidulidæ*. Three species.

*Byrrhidæ*. Represented by a remarkable extinct genus, *Nosotetocus* Scudd., with three species, and by four referred to modern genera.

*Silphidæ*, *Histeridæ*, *Plinidæ*, *Coccinellidæ*. "From 2 to 10 species each." *Cleridæ*, *Parnidæ* and *Dermestidæ*, each one species.

*Telephoridæ*. One species (*Chauliognathus pristinus* Scudd.), referred to a modern genus.

*Scarabæidæ*. Nearly 30 species.

*Cucujidæ*, two.

*Buprestidæ*. "Nearly as many" as in the *Scarabæidæ*. One (*Chrysobothris haydeni* Scudd.) has been described, and is placed in a living genus.

*Elateridæ*. "Over forty [species] have been separated."

*Meloidæ*, *Mordellidæ*, *Malacodermidæ*. "About forty species," i. e., of these groups together.

*Rhipiphoridæ*. *Rhipiphorus geikiei* Scudd.; the genus modern.

*Cerambycidæ*. "Thirty or more specimens, representing more than half as many species. *Parolamia rudis* Scudd., belonging to an extinct genus, has been described.

*Chrysomelidæ*. "About two dozen species." One referred to an extinct genus, *Oryctoscirtetes* Scudder.

*Tenebrionidæ*. "Nearly 20 species."

*Bruchidæ*. "A dozen or more species." The only one described is placed in the modern genus *Spermophagus*.

*Rhynchophora*. The species of this great group, commonly known as weevils, have been worked up by Mr. Scudder, with the following results:

*Rhynchitidæ.*

Subfam. *Rhynchitinæ.* 4 species, belonging to 3 genera, of which one is extinct.

Subfam. *Isotheinæ.* 11 species, referred to 6 genera, all extinct, the subfamily itself being extinct. One of the genera also occurs in the strata at Roan Mts., Colo., and another genus has been found at Green River, Wyo., the species in each case being distinct from those of Florissant.

*Otiiorhynchidæ.* 14 species, referred to 10 genera, of which six are extinct, but one of these is merely a blanket genus to cover miscellaneous members of this group, the affinities of which are uncertain.

*Curculionidæ.* 75 species, belonging to 36 genera, of which 9 are said to be extinct. One of the extinct genera, *Geralophus* Scudd., has 9 species, and is the most abundant type of Rhynchophora at Florissant.

*Calandridæ.* 6 species, representing 5 genera, of which 3 are extinct.

*Scolytidæ.* 1 species, of the modern genus *Hylesinus*.

*Anthribidæ.* 5 species, of as many genera, of which two are extinct.

HYMENOPTERA (33 species described,<sup>1</sup> of over 230 found)

*Apoidea* (bees). 14 species, of 9 genera, of which two are extinct, while one is represented by an extinct subgenus (? genus) placed under *Parandrena*. The modern genera are *Halictus* (2 species), *Andrena* (2), *Dianthidium* (1), *Anthidium* (2), *Ceratina* (1) and *Heriades* (3). The details will shortly be published elsewhere.

*Fossores*, etc. "About 30 species." I have described 12 wasps, belonging to 10 genera, of which 5 are extinct. The recent genera are *Passalæcus*, *Hemipogonius*, *Tracheliodes*, *Hoplisus* and *Ammophila*. There are two extinct genera of *Tiphidæ*. I have also described an extinct genus of *Vespidæ*, with 3 species, and two species of *Eumenidæ*, referred to the modern genus *Odynerus*.

*Formicoidea* (ants). "Perhaps fifty species." They will be studied by Dr. W. M. Wheeler. One species (*Ponera hendersoni* Ckll.) has recently been described.

*Ichneumonidæ* "perhaps 80" species.

*Stephanidæ.* I have described one, belonging to a new genus.

*Braconidæ*, *Chalcididæ*, *Cynipidæ*, *Chrysididæ.* "Probably 50 species" between them.

*Tenthredinoidea.* "14 or 15 species. One, *Atocus defessus* Scudd., has been published; it represents an extinct genus belonging to the *Lydidæ*.

*Siricidæ.* One.

LEPIDOPTERA (9 published, of perhaps 16 found)

*Rhopalocera* (butterflies)

<sup>1</sup> Of these, 31 await publication. The large one referred to by Scudder as apparently a *Bombus* is not sufficiently well presented for identification, but it is not a bee, and probably belongs to the Coleoptera.

Fam. *Nymphalidæ*.

Subf. *Nymphalinæ*. 5 species, of as many genera, all extinct.

Subf. *Libytheinæ*. 2 species, of two genera, both extinct.

*Papilionidæ*, s. f. *Pierinæ*. 1 species, of an extinct genus.

*Heterocera* (moths). "Perhaps 8 species;" one has been described by Scudder, and is referred, with doubt, to the modern genus *Psecadia*. I have examined a small species, probably one of the *Elachistidæ*, collected by Scudder.

## DIPTERA (54 described; many more found)

*Culicidæ*, *Chironomidæ*. "Abundant."

*Tipulidæ*. 51 species described by Scudder; they belong to 15 genera, of which 8 are extinct. No less than 15 species are referred to the modern genus *Tipula*.

*Mycetophilidæ*. "Probably 20 or 30 species." One has been published, typical of an extinct genus, *Mycetophætus*, Scudder.

*Bibionidæ*. Very abundant in individuals, but apparently few species.

*Stratiomyidæ*. "2 or 3 species."

*Hirmonneuridæ*. One has been described, representing an extinct genus, *Palem-bolus* Scudd. Others belong here or to *Mydasidæ*.

*Asilidæ*, *Therevidæ*. Quite numerous.

*Bombyliidæ*. "Certainly 6 or 8 species."

*Syrphidæ*. Numerous. Discussed by Dr. Williston.

*Empidæ*. Numerous.

*Ortalidæ*. 3 or 4 species.

*Estridæ*. One species described, belonging to an extinct genus, *Paloestrus* Scud.

*Muscidæ* and allies. Very many.

## ORTHOPTERA (24 species)

*Blattidæ*. 2 species, referred to living genera.

*Forficulidæ*. 10 species, belonging to a single extinct genus, *Labiduromma* Scudd.

*Phasmidæ*. One species, of an existing genus.

*Acridiidæ*.

Subf. *Ædipodinæ*. 3 species, including two extinct genera, and the modern genus *Ædipoda*, here only used in the old and general sense.

Subf. *Truxalinæ*. 3 species, two of them belonging to an extinct genus, the third referred quite provisionally to a modern genus. *Tyrbula multi-spinosa* Scudd., described from Green River, Wyoming, is recorded from Florissant on the strength of a fragmentary specimen. As the insects of the Green River deposits are in general quite distinct from those of Florissant, the identity must be considered very doubtful.

*Locustidæ*. 5 species, all of different genera, and including four subfamilies. One genus is extinct; two others are quite provisionally placed in modern genera.

## HOMOPTERA (80 species)

*Coccidæ*. One, considered to be a male of the still existing genus *Palæococcus*.

*Aphididæ*. All the genera extinct.

Subf. *Aphidinae*. 24 species, placed in 11 genera.

Subf. *Schizoneurinae*. 6 species, referred to 4 genera.

*Psyllidæ*. 2 species, belonging to two extinct genera.

*Fulgoridæ* (sens. latiss.) 13 species, of 7 genera, of which three are extinct, and three others are only provisionally employed.

*Cicadidæ*. One species, placed in the modern genus *Cicada*.

*Jassidæ* (sens. lat.). 11 species, of 8 genera. Two genera are described as extinct; 3 modern genera are only provisionally or doubtfully recognized.

*Cercopidæ*. 22 species, placed in 9 genera, of which six (including the most abundant and characteristic species) are extinct. One of the modern genera is only provisionally employed. The extinct genus *Petrolystra* includes a couple of very large species, having the tegmina  $29\frac{1}{2}$  and  $28\frac{1}{4}$  mm. long respectively.

## HETEROPTERA (140 species)

*Corixidæ*. 3 species, of 2 genera, one extinct.

*Notonectidæ*. 1 species of the modern genus *Notonecta*.

*Veliidæ*. 2 species, of 2 genera, both extinct.

*Hydrobatidæ*. 1 species, of an existing genus.

*Reduviidæ*. 2 species, representing 2 genera, both extinct.

*Tingididæ*. 3 species, of 3 genera, one of them extinct.

*Capsidæ*. 13 species, of 7 genera, only one described as extinct.

*Lygæidæ*. 49 species, placed in 24 genera, of which 16 are extinct. Two of the species are Pyrrhocorids, referred to the modern genus *Dysdercus*. From the figures, it seemed to me that *Necrochromus cockerelli* Scudd., might belong to the Phymatidæ, but Prof. Herbert Osborn, whom I consulted about the matter, thinks it is probably a true Lygæid.

*Coreidæ*. 33 species, referred to 14 genera, 10 extinct.

*Pentatomidæ*. 33 species, of 14 genera, 13 extinct.

## EPHEMEROPTERA (six nominal species)

*Ephemeridæ*. One species described from a poorly preserved adult, and five from nymphs; all referred, in a general sense, to *Ephemera*. The nymphs have characters of various genera; *E. immobilis* suggests *Bactis*; *E. tabifica* has some resemblance to *Potamanthus*; *E. macilenta* recalls *Hexagenia*; *E. pumicosa* and *interempta* may be related to *Ephemerella*.

## NEUROPTERA (12 species)

*Chrysopidæ*. 4 species, belonging to 2 extinct genera.

*Hemerobiidæ*. 1 species, of the existing genus *Osmylus*.

*Panorpidæ*. 2 species, of different genera, one of which is extinct.

*Raphidiidæ*. 5 species, referred to the only two existing genera.

ODONATA (9 species)

*Æschnidæ*. 3 species, referred to *Æschna*; one is a nymph. *Æ. separata* is said to belong to the subgenus *Basiæschna*; this group is now recognized as a genus, so the species will be *Basiæschna separata*.

*Agrionidæ*. 6 species, one a nymph. Three genera are recognized, of which one is extinct.

PLATYPTERA (6 species)

*Termitidæ*. 6 species, in 3 genera, one extinct.

TRICHOPTERA (22 species)

*Hydropsychidæ*. 16 species, in 7 genera, of which 5 (one of them containing 7 species) are extinct.

*Leptoceridæ*. 2 species, provisionally placed in the modern genus *Setodes*.

*Limnophilidæ*. One species, provisionally referred to the existing genus *Limnophilus*.

*Phryganidæ*. 3 species, of as many genera, one of which is extinct.

THYSANURA (1 species)

*Lepismatidæ*. One species, of the recent genus *Lepisma*.

BALLOSTOMA (1 species)

*Planocephalidæ*. Including *Planocephalus aselloides* Scudder, a problematical animal of uncertain affinities. Scudder makes the Ballostoma a suborder of Thysanura.

ARACHNIDA

ARANEÆ (spiders) (30 species)

In the nature of things, it is difficult to classify fossil spiders. Many years ago, Mr. R. I. Pocock expressed to me his dissent from some of the references to genera, etc., made by Scudder; but not being at that time especially interested in the Florissant fossils, I did not learn what changes he would make.

*Agalenidæ*. Two species, referred to a modern genus.

*Attidæ*. 3 species, placed in the extinct genus *Parattus* Scudd.

*Drassidæ*. 5 species, placed in two modern genera.

*Dysderidæ*. 1 species, of a modern genus (*Segestria*).

*Epeiridæ*. 12 species, in 4 genera, one genus (with 4 species) being extinct.

There is one species of *Nephila*.

*Theridiidæ*. 3 species, and egg-cases referred to a fourth. No extinct genera.

*Thomisidæ*. 3 species, referred to *Thomisus* in a broad sense.

## SPERMATOPHYTA

## DICOTYLEDONES (about 125 species)

*Compositæ* (1 species)

A thistle, *Carduus florissantensis* Ckll., has been described from a specimen collected by Judge Henderson and Dr. Ramaley.

*Convolvulacæ* (2 species?)

Two "scariose calyces" are described by Lesquereux as belonging to the genus *Porana*, which has several species in the European Miocene, and one in the John Day Miocene of Oregon.

*Apocynacæ* (1 species?)

*Apocynophyllum scudleri* Lx., was described from the Green River beds of Wyoming; but Kirchner lists it from Florissant, on the strength of a specimen in the collection of Dr. Hambach. No particulars are given, and I think the occurrence of the species at Florissant needs confirmation.

*Oleacæ* (8 species)

No less than seven species of *Fraxinus* are described by Lesquereux; but of one it is said that it may be a *Myrica*. Two are unfigured. The leaves described as *Fraxinus libbeyi* are curiously similar to those of *Ulmus braunii*. In addition to the new species, *F. prædicta* Heer is reported, but on the basis of a very unsatisfactory fragment. This species is also said to occur in the Denver beds at Golden. *Osmanthus præmissa* (*Olea præmissa* Lx.) is represented by a beautiful specimen, showing leaves and flowers.

*Ebenacæ* (2 or more species?)

Two species represented by leaves, and referred to *Diosypros brachysepala* Al. Br. (originally described from Europe) and *D. copeana* Lx. The first of these appears to be more especially a Laramie species, while the second originally came from the Green River beds in Nevada, and is not cited by Knowlton from any other place. The recognition of these species in the Florissant flora must doubtless be considered wholly provisional. Two other species, *Diospyros cuspidata* Kirchner, and *Macreightia crassa* Lx., are based on calyces. Their value as evidence is clearly very slight, and they possibly represent different interpretations of the same thing.

*Sapotacæ* (1 species)

*Bumelia florissanti* Lx., is described.

*Myrsinacæ* (1 species)

*Myrsine latifolia* Lx., is based on a fragmentary leaf.

*Ericacæ* (1 or 2 species)

*Andromeda rhomboidalis* Lx. is described but not figured. Another leaf is referred, quite hypothetically, to *Vaccinium reticulatum* Al. Br.

*Araliaceæ* (2 species)

*Aralia dissecta* Lx. is based on a very large leaf, not at all resembling the ordinary species of the genus. *Hedera marginata* Lx. is a species of somewhat doubtful generic position.

*Malvaceæ* (1 species)

*Malvastrum exhumatum* Ckll. has been based on a specimen in the collection of the University of Colorado. It resembles a species living in New Mexico.

*Sterculiaceæ* (1 or 2 species)

*Sterculia rigida* Lx. and *S. engleri* Kirchner have been described. They do not appear to differ materially.

*Tiliaceæ* (1 species)

*Tilia populifolia* Lx. is a species with fine large leaves.

*Rhamnaceæ* (5 or 6 species)

Six species are described, as *Paliurus florissanti* Lx., *P. orbiculatus* Saporta, *Rhamnus kirchneri* Ckll.,<sup>1</sup> *R. notatus* Saporta (?), *R. oleajolius* Lx., and *Zizyphus obtusa* Kirchner.

The species of Saporta were originally described from Europe, and their recognition at Florissant is provisional.

*Sapindaceæ* (5 or 6 species)

Lesquereux has described five species of *Sapindus*; and a fruit is referred with doubt to *Dodonæa*.

*Aceraceæ* (1 or 2 species)

Kirchner describes *Acer florissanti* from an excellently preserved leaf, and *A. mysticum* from a fruit. They may very well belong to the same species, of course. A leaf of *A. florissanti* was found southwest of Florissant by Messrs. Henderson and Ramaley.

*Staphyleaceæ* (1 species)

Represented by *Staphylea acuminata* Lx.

*Ilicaceæ* (6 species)

Lesquereux has described six species of *Ilex*; Kirchner adds a seventh, *I. rigida*, but it appears to me to be a synonym of *I. knightiæfolia* Lx. *Ilex quercifolia* Lx., 1883, not of Meerburgh, 1798, may be called *I. leonis*.

*Celastraceæ* (4 species)

Lesquereux describes *Celastrus jaxiniifolius* and *C. lacoci*, and records *C. greithianus* Heer, a European species. Another form is named *Celastrinites elegans* Lx.

*Anacardiaceæ* (11 species)

Ten species of *Rhus* were described by Lesquereux, and Kirchner adds another, *R. rotundifolia*. These include typical *Rhus* (*R. coriarioides*), *Schmaltzia* (*S. vexans*) and *Cotinus* (*C. fraterna*).

<sup>1</sup> *Rhamnus kirchneri* Ckll. = *R. ellipticus* Kirchner, 1898, not *R. elliptica* Swartz, 1788.

*Rutaceæ* (1 species)

*Zanthoxylum spireæfolium* Lx., does not look, from the figure, as if it belonged here, but it may do so. It is said to be closely allied to certain fossil species described by Heer from Europe.

*Leguminosæ* (7 species)

Lesquereux described seven species, referred to the genera *Acacia*, *Cercis*, *Cytisus*, *Leguminosites*, *Mimosites* and *Podogonium*; while he recognized species of *Dalbergia* and *Cassia* described by Heer. *Podogonium americanum* Lx., is listed by Kirchner, but apparently in error; it is a species of the Laramie and Montana formations in Wyoming. *Cercis parvijolia* Lx., was found by Messrs. Henderson and Ramaley in the railroad cut east of Florissant station. The Florissant *Dalbergia* resembles the living *D. melanoxyton* G. and P. which I have received from Ceylon, through the kindness of Mr. E. E. Green. *Mimosites linearis* (Lx.) Knowlton, has a curiously strong superficial resemblance to *Dalbergia purpurea*, but the type of leaf is a common one.

*Rosaceæ* (6 species)

*Rosa hillia* Lx., is a very interesting trifoliate species. The genus *Amelanchier* is represented by *A. typica* Lx. and *A. scudderi* Ckll. *Amygdalus* is represented by *A. gracilis* Lx., reported also from the Green River beds of Wyoming; but Lesquereux figures leaves from both localities, and they do not appear to me to belong to the same species. *Cratægus* has two species, *C. lesquereuxi* Ckll.,<sup>1</sup> and *C. flavescens* Newberry. The latter is also reported from the John Day Valley, Oregon.

*Altingiaceæ*

*Liquidambar europæum* Al. Br., a common Miocene plant of Europe, is listed by Knowlton and Kirchner from Florissant, and is also reported from the John Day Miocene. There is apparently some mistake, however, as Lesquereux cites it from Wyoming, not from Florissant, and Knowlton omits this locality, while giving no other source of information.

*Cunoniaceæ* (3 species?)

Lesquereux describes three species of *Weinmannia*. They certainly look different; but the common neotropical species of today, *W. pinnata*, must be very variable as it has received seven specific and three varietal names.

*Magnoliaceæ*

Kirchner refers here certain fruits described by Lesquereux, but there is no real evidence that the family was represented at Florissant. *Carpites milioides* Lx., looks like a *Lepidium*.

<sup>1</sup> *Cratægus lesquereuxi* Ckll. = *C. acerifolia* Lx., 1883, not of Moench, 1785.

*Polygonaceæ* (1 species)

Dr. Small has described a species as *Polygonum tertiarium*. I saw the type at the New York Botanical Garden.

*Pimeleaceæ* (1 species)

*Pimelea delicatula* Lx., is described.

*Proteaceæ* (8 species)

Certain seeds are described as *Banksites lineatus* Lx., while Lesquereux describes seven species ascribed to *Lomatia*, some of them looking very like Hydrophyllaceæ of the *Phacelia* type;—thus, compare *L. terminalis* and *L. tripartita* with *Phacelia bipinnatifida*, *L. acutiloba* with *P. franklinii*, or *L. spinosa* with *P. fimbriata*.

*Santalaceæ* (1 doubtful species)

*Santalum americanum* Lx. is a leaf with little character; it might just as well be a *Lepargyræa*.

*Moraceæ*

Kirchner cites two species of *Ficus*, but one of them (*F. haydenii* Lx.) is a Laramie species, while the other, also a Laramie species, was reported from Florissant only on the strength of a fragment collected by Professor Cope; which, from the figure, does not seem to be identical with the Laramie plant, though it looks like a *Ficus*. Kirchner has figured a leaf from Florissant, which he refers to *Ficus haydenii*, but it cannot possibly have anything to do with that species. Messrs. Henderson and Ramaley found a leaf which has the appearance of *Cinnamomum*. It is not "*C. scheuchzeri*" (Lx., Cret. and Tert. Fl., pl. xxxviii. f. 6), but I cannot separate it from certain leaves attributed to *C. affine* by Lesquereux. Knowlton, however, divides *C. affine* into two species, and by the characters he assigns, the Florissant leaf would belong to *Ficus trinervis* Knowlton.

*Ulmaceæ* (6 species)

*Planera longifolia* Lx. and its variety *myricæfolia* are very abundant; Lesquereux examined over 2,000 specimens. A *Celtis* has been named *C. McCoshii* Lx.; it is said also to occur in Uinta County, Wyoming. Of *Ulmus* there are supposed to be four species; one is considered to be *U. braunii* Heer, a common species of the European Miocene; the others were described as new. *U. brownellii* looks to me too much like *U. hillii*, but Lesquereux points out differences.

*Betulaceæ* (about 3 species)

*Alnus cordata* Lx. is described but not figured. A fragment from Florissant is referred to *A. kefersteinii* (Goep.) Ung. *Betula* is represented by two species.

*Salicaceæ* (6 species)

*Populus* has several species. A narrow-leaved cottonwood is *P. lesquereuxi* Kkll. (*heerii* Lx., not Saporta); the specimens are beautifully preserved. *P. scud-*

*deri* (*P. balsamoides* (?) *latifolia* Lx.<sup>1</sup>) has very large broad leaves; of the same general type, but smaller, more obtuse, and with different veining, is *P. arctica* Heer, which Kirchner lists from Florissant, but probably in error. Knowlton, however, says it is abundant from the Laramie to the Miocene; no doubt the name has been used to designate leaves of this type, which may or may not be conspecific. *P. pyrifolia* Kirchner, and *P. oxyphylla* Sap., Lx., probably represent large and small leaves of the same species. In view of the general improbability of our species being identical with that of Saporta, I should prefer to use Kirchner's name. Still another species, represented by leaves not unlike the smaller and shorter ones of *P. lesquereuxi*, is referred to *P. zaddachi* Heer, but is said not to be typical.

Of *Salix*, Lesquereux has described *S. libbeyi* and *S. amygdalæfolia*, the latter also said to occur in the John Day Miocene. Kirchner lists four others, but they represent obsolete or dubious identifications. A fine leaf of an apparently new species was found by Messrs. Henderson and Ramaley.

#### *Myricaceæ* (about 10 species)

*Comptonia* is represented by *C. insignis* (*Myrica insignis* Lx.) and *C. acutiloba* (*Myrica latiloba acutiloba* Lx.); the latter I should think merely a small leaf of the former, except that the veining does not seem quite the same. Two species, described as *Myrica*, can be segregated under *Morella*, following Dr. Small. These are *Morella hendersoni* (Ckl.), based on an excellent specimen secured by Messrs. Henderson and Ramaley, and *M. bolanderi* (*Myrica bolanderi* Lx., 1878; *Ilex undulata* Lx., 1874, not of Heer, 1859). The locality of the latter is not entirely without doubt.

There remain, still in *Myrica*, six species described by Lesquereux, and four others recognized as pertaining to species described from Europe by Unger, Saporta and Schimper. Judging from the figures, I should think that *M. jallax* Lx., *M. obscura* Lx., and *M. rigida* Lx., might very well represent variations of *M. drymeja* (Lx.) Knowlton; Lesquereux suggests this possibility in regard to *jallax*. *M. scottii* Lx., is very like the narrower *Planera* leaves, but the venation differs. *M. amygdalina* Sap., Lx., is perhaps too near *M. acuminata* Ung., Lx., *M. polymorpha* Schimp., Lx., exceedingly like *M. scottii*. *M. zachariensis* Sap., is figured both from Florissant and Alkali Station, Wyo., but the figures seem to me to represent different things.

#### *Juglandaceæ* (4 or 5 species)

An involucre, not figured, is referred to *Engelhardtia oxyptera* Saporta. *Hicoria juglandiformis* (Sternb.) Knowlton, a species described from Europe, is recognized from good specimens of the leaves; it is also reported from the Miocene of California. Two others European species are hypothetically recognized from nuts. Of *Juglans* we have *J. affinis* Kirchner, *J. florissanti* Lx. (not figured)

<sup>1</sup> The name *latifolia* was earlier (1794) employed in this genus by Moench, for a tree now considered a variety of *P. balsamifera*.

and a form which is referred to the European *J. costata* Ung. In addition, Kirchner lists *J. thermalis* Lx., and *J. crossii* Knowlton. Of these, the former belongs to the Denver beds (Golden etc.), and has apparently never been found at Florissant; while the latter, heretofore reported from Wyoming and Montana, is recognized in a Florissant specimen which is figured, and certainly looks like *crossii*. It is to be remarked that *J. crossii* is a substitute name for *J. denticulata* Heer, preoccupied; hence it belongs to the European plant, not to the American, should the two be really distinct.

*Pterocarya americana* Lx., seems doubtful as to locality, and Lesquereux himself says "it would be more advisable to consider the fragment as that of a leaflet of *Carya* or of *Juglans*."

#### *Cupuliferæ* (about 10 species)

Of *Carpinus* we have *C. fraterna* Lx. and *C. attenuata* Lx. A greatly elongated leaf of *C. fraterna* was found by Messrs. Henderson and Ramaley; the allied modern *C. americana* exhibits a similar variation. In addition, *C. grandis* Ung., is reported; but the figures appear to indicate that the Florissant leaves so-called are *fraterna*, and are quite distinct from the plant from Elko Station, Nevada, referred to *C. grandis*, or probably more correctly called *C. elkoana* (*Quercus elkoana* Lx.)

*Castanea intermedia* Lx., is listed by Kirchner from Florissant; Lesquereux and Knowlton say Middle Park. *Ostrya betuloides* Lx. is described, but not figured.

Of *Quercus* we have *Q. ramaleyi* Ckll., allied to a recent species of New Mexico; *Q. pyrifolia* Lx.; *Q. osbornii* Lx., having a curiously close resemblance to *Rhus acuminata*; and *Q. elanoides* Lx., also occurring in the Miocene of California. The last is, I suppose, the plant reported in 1883 as *Q. elana* Ung. The following European species are also recognized, but the first two, at any rate, are doubtful: *Q. neriifolia*, Al. Br., *Q. drymeja* Ung., *Q. mediterranea* Ung., and *Q. serra* Ung.

#### MONOCOTYLEDONES (about 5 species)

##### *Palme*

An object something like a hazel nut is described as *Palmocarpon* (?) *globosum* Lx., its connection with the palms is quite hypothetical. *Flabellaria florissanti* Lx., a genuine palm, is not from Florissant, notwithstanding its name. It is from the Green River beds of Wyoming, and suggests that the Green River period had a warmer climate than that of Florissant.

##### *Lemnaceæ* (1 species)

*Lemna penicillata* Lx. = *Spirodela penicillata*.

##### *Araceæ* (1 species)

*Acorus affinis* Lx., afterwards referred to *A. brachystachys* Heer, is a rather dubious plant.

*Typhaceæ* (1 species)

A *Typha* is very common at Florissant, and is described and figured by Lesquereux (Cret. and Tertiary Floras, p. 141, pl. XXIII) as *T. latissima* Al. Br., of Europe. It is admitted, however, that it does not exactly agree with the European plant, the "veinlets which separate the primary nerves" being twice as numerous. It is preferable, I think, to distinguish the Florissant plant by another name, and *Typha lesquereuxi* is proposed. Lesquereux cites Florissant and the Green River beds of Wyoming (under the name of "Randolph County"); the former should be considered the type locality.

*Naiadaceæ*. (1 or 2 species?)

The objects called *Najadopsis rugulosa* Lx., *Potamogeton* (?) *verticillatus* Lx., and *P. geniculatus* Al. Br. are of a problematical character. The last, not figured from Florissant, seems to have the best standing.

## GYMNOSPERMÆ (4 species)

*Pinus florissanti* Lx.

From Fossil Stump Hill (Henderson and Ramaley) are excellent specimens of the leaves, not massed together, but separately in bundles of three. These evidently belong to *Pinus hambachi* Kirchner; but since they are exactly the leaves which ought to belong to *P. florissanti*, a species allied to *P. ponderosa*, and known only by the cone, I treat *hambachi* as a synonym. This, the one clearly-known Florissant pine, is allied to the tree still growing in the same region. "*P. palæostrobus*(?)" must be considered doubtful.

*Sequoia affinis* Lx.

This is the well-known Florissant species, to which the fossil stumps may doubtless be assigned. The specimens referred to *S. langsdorfii*, with doubt, are supposed to be the same. Much of what has been called *Sequoia* appears to be *Glyptostrobus*.

*Taxodium* is listed by Kirchner, but apparently does not occur at Florissant *Podocarpus eocenica* Ung. is doubtful in the extreme.

*Widdringtonia linguæfolia* Lx., is common and well-known; what was formerly called *Thuites callitrina* Ung., becomes *W. linguæfolia gracilis* Lx. The reference of this plant to *Widdringtonia* seems unnecessary, as the material agrees well with the American genus *Sabina*, and should I think be referred to as *Sabina linguæfolia*. The mode of branching suggests *Sabina* rather than *Chamæcypris*. *Widdringtonia* is an old-world genus. *Glyptostrobus ungeri* Heer (?) is also well-known, and is especially interesting as representing a boreal genus, now surviving in China, and most nearly represented in the modern American flora by *Taxodium*. There is some question about the identity of the Florissant plant; Knowlton refers it to *G. europæus*, of which he considers *ungeri* a variety. It ranges, hypothetically, from the Fort Union beds to the Miocene.

## PTERIDOPHYTA

*Isoetaceæ* (1 species)

*Isoetes brevifolius* Lx. is described but not figured. It is said to resemble *I. braunii* Heer.<sup>1</sup>

*Filices* (2 species)

Two ferns have been found; *Sphenopteris guyottii* Lx., which is common, and *Adiantites gracillimus* Lx. The *Sphenopteris* has the aspect of *Asplenium filix-joemina* (L.) Bernh. *Asplenium crossii* Knowlton, has been listed from Florissant in error.

There have also been described a doubtful *Chara*; two supposed species of *Salvinia*, one considered wholly doubtful, the other referred by Hollick to *Tmesipteris*; three problematical mosses, ascribed to *Hypnum* and *Fontinalis*; and some flowers, fruits, etc., of uncertain relationships.

## EXPLANATION OF PLATE

The plants figured were all collected by Judge Junius Henderson and Professor Francis Ramaley, and are in the University of Colorado Museum. Descriptions of the new species are included in a paper in *Bull. Torrey Botanical Club*, 1906.

(1) *Quercus ramaleyi*, n. sp., a species of oak closely allied to *Q. fendleri*, still living in New Mexico, of which a leaf is also shown. The leaf of *Q. fendleri* is from Las Vegas Hot Springs, N. M., alt. 7,000 ft.

(2) *Carpinus fraterna* Lx., a species of hornbeam, very closely allied to *C. caroliniana*, living today from Nova Scotia to Texas, in moist localities. The leaf shown is very much more elongate than Lesquereux's type, but the living species varies in a similar manner.

(3) *Amelanchier scudderi*, n. sp., a june-berry or service berry, allied to *A. alnifolia*, living today over a great part of North America. The leaf also resembles the genus *Malus* (apple), and it is impossible to be absolutely sure that it does not belong there, in the absence of other parts; but it is so like *A. alnifolia* that it is almost certainly a close relative.

(4) *Rhus coriarioides* Lx., a sumac scarcely differing from the common living *R. hirta*.

(5) *Malvastrum exhumatum*, n. sp., a star-mallow closely allied to a species found today in New Mexico.

(6) *Carduus florissantensis*, n. sp., a thistle which greatly resembles the scarlet oak, *Quercus coccinea*, but is distinguished by the venation. It is perhaps somewhat allied to the living *C. ochrocentrus* of Colorado, but that has the leaf-surface much more reduced, and the prickles much more developed, as might be expected from the present much greater aridity of the climate.

(7) *Myrica* (or *Morella*) *hendersoni*, n. sp., a wax-myrtle closely allied to the living *M. cerifera*, which occurs in damp places from Maryland to Texas.

<sup>1</sup> *I. braunii* Durieu, 1864, is later, and should be renamed.

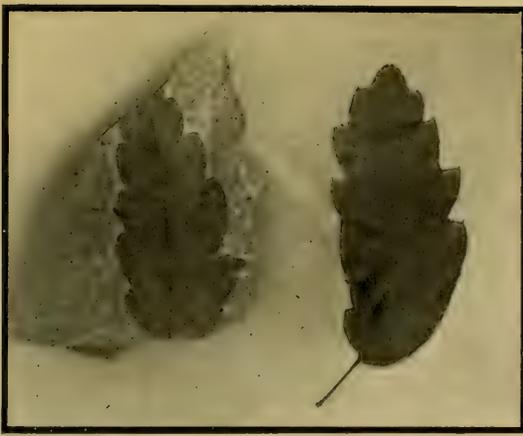


FIG. 1



FIG. 2



FIG. 3



FIG. 4

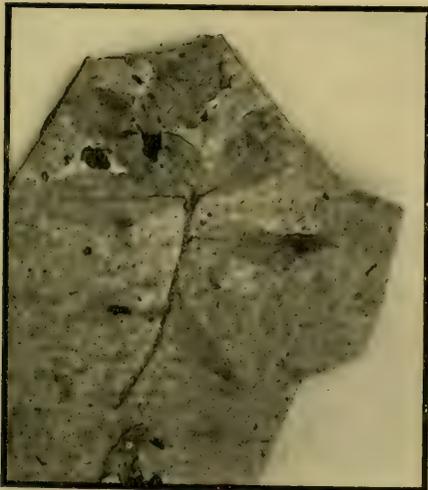


FIG. 7



FIG. 6



FIG. 5



## PLANTS OF THE FLORISSANT REGION IN COLORADO <sup>1</sup>

BY FRANCIS RAMALEY

The vicinity of Florissant, Colo., is a region of considerable botanical interest. It offers a good example of a xerophytic<sup>2</sup> flora at high altitude. To those who live in Colorado, or in other Rocky Mountain states, the plants in general would be familiar, yet there are some plants of striking appearance which do not extend even to northern Colorado.

The present paper is not intended as a contribution to knowledge, but is merely an attempt to describe the general aspect of the region as affected by the plant life. Whoever stops to think of the scenery of any country will probably think first of mountains and seas. Yet for the scenery of everyday life the plant population is very important. A region green with abundant carpet of grasses and herbs has a very different aspect from one which is timber-clad or one which is gray with sage-brush. A person who tramps over the hills or along the stream-banks will find the landscape ever changing with the different plants which he encounters.

In the following pages are described some of the more salient features which give botanical interest to the Florissant region. The half-tone reproductions are all made from the author's negatives, selected to show the larger landscape features, and also a few of the more interesting species in greater detail. As the writer's visit was made in late July and early August, the account will refer to plants seen at that time.

The town of Florissant is situated at an altitude of about 8,000 feet above sea-level in the basin of a Tertiary lake. It is about forty miles west of Colorado Springs and is reached by the Colorado Midland railway. A creek flows westward through the town, receiving

<sup>1</sup> It is intended that this popular account of the plants in the Florissant region will be supplemented later with a more detailed description.

<sup>2</sup> ξηρος, "dry;" φυτόν, "plant."

tributaries from the north and south. It carries the waters to the South Platte River about five miles to the west. In the summer there is very little water in the streams. Eastward, above the town, is Florissant canyon, through which the main creek flows.

In following up any of the tributaries of Florissant Creek<sup>1</sup> there will be found places with a considerable accumulation of humus soil and a plant covering of mesophytic<sup>2</sup> character. Here and there are stretches of boggy ground where hydrophytes<sup>3</sup> find a suitable substratum. But if we take it all in all, we find a dry-country vegetation throughout the Florissant district.

A botanist does not need to be told that the town of Florissant has been in existence for some years. The weeds along the railroad track and in the roadways and through the pastures tell the story. A considerable number of these weeds have been introduced from lower altitudes since the settling of the country by man. Various plants of the aster, mustard, spurge, smart-weed, and grass families are especially conspicuous as roadside weeds.

An examination of the plant population of the Florissant region shows a great number of plants of the aster or composite family. In fact, during midsummer the prevailing color of the landscape is greenish yellow, due to the many coarse composites which are coming into blossom at that time.<sup>4</sup> A great preponderance of composites is to be noted throughout Colorado, but especially in the south.

<sup>1</sup> Otherwise known as Twin Creek.

<sup>2</sup> μέσος, "middle;" φυτόν, "plant;" i. e., plants growing in conditions of medium dryness.

<sup>3</sup> ὕδωρ, "water;" φυτόν, "plant."

<sup>4</sup> The following plants of the composite family were collected. Determinations were made by Professor Aven Nelson.

*Achillaea lanulosa* Nutt.

*Antennaria parvifolia* Nutt.

*Artemisia borealis* Pall.

*Artemisia canadensis* Michx.

*Artemisia frigida* Willd.

*Carduus aculeolens* (A. Gray) Rydb.

*Carduus ochrocentrus* (A. Gray) Greene.

*Chaenactis douglassii* (Hook.) H. & A.

*Chrysopsis resinolens* Aven Nelson.

*Chrysothamnus* sp.

*Crepis runcinata* (James) T. & G.

*Erigeron canus* A. Gray

*Erigeron* sp.

*Helianthella parryi* A. Gray

*Helianthus petiolaris* Nutt.

*Lygodesmia juncea* (Pursh) D. Don.

*Machaeranthera varians* Greene

*Picradenia floribunda utilis* Ckll.

*Picradenia ligulaeflora* Aven Nelson

*Rudbeckia flava* Moore

*Senecio bigelovii* A. Gray

*Senecio eremophilus* Richards.

*Senecio spartioides* T. & G.

*Solidago decumbens* Greene

*Solidago missouriensis* Nutt.

Florissant has a drier and warmer climate than have the parks of northern Colorado, so we find there a number of plants which, in the northern part of the state, do not reach such an altitude. It is interesting to make comparison of Estes Park, in northern Colorado, with Florissant. The two places have somewhat similar topography, are about the same altitude, and yet show many differences in their plants. One of the striking plants about Florissant is the Rocky Mountain bee plant.<sup>1</sup> Some fine specimens of this species may be seen along roadsides and in old fields.<sup>2</sup> In the Estes Park region this plant does not reach the high altitudes, though it is very abundant at Lyons, only twenty miles from the park.

\*   \*   \*   \*   \*   \*   \*   \*

As has been said, the great mass of the vegetation is of the arid type. All the lower-lying territory in the lake basin, except along stream-banks, bears dry-country plants. On many a hillside or gentle slope the plants are seen widely scattered, since the dryness of the soil does not permit close massing. So, while in moister places the "struggle for existence" is between plant and plant, here the struggle is between the plant and its lifeless environment.

In the flat, open country nearly all the larger and conspicuous plants are low, shrubby composites. Perhaps the visitor who is not a botanist would hardly think of them as "shrubby," but the lower parts of these plants live from year to year, and the general habit of the plant is that of a shrub rather than an herb. Here are various kinds of sage-brush.<sup>3</sup> In places where cattle and horses have not trampled the vegetation, or on old wagon tracks, these grayish plants form a striking element of the landscape. None of the large, bushy sage-brushes occur in the Florissant region. An abundance of the smaller ones, however, tells us of the dryness of the soil, which the people of the west associate in their minds with these plants.

The Colorado rubber plant<sup>4</sup> is abundant with other plants of the same general appearance. From the latex, or juice, of this plant

<sup>1</sup> *Cleome serrulata*.

<sup>2</sup> Shown in the lower right-hand figure in the plate at the end of this article.

<sup>3</sup> *Artemisia* spp.

<sup>4</sup> *Picradenia floribunda utilis*.

rubber can be made. Whether the plant will be of economic value needs to be determined. The plant grows to a height of from eight inches to two feet, branching abundantly from the root. A non-botanist might think of it as a very poor sort of golden-rod. It produces a number of flower heads, but they are rather small. Most of the other plants growing with this one are also of the composite family. Probably different kinds of *Chrysothamnus* and *Picradenia* are most abundant. But throughout the drier parts of the region the number of different species is few. If one looks around him in this dry region, he will see, within a radius of a hundred feet, perhaps thousands of plants, and yet there may be no more than a dozen different species. This is always the case where environment is austere; only a few forms will be well adapted to withstand the unfavorable conditions.

In our account of these dry-country plants we should not omit the shrubby pepper-grass,<sup>1</sup> a plant of the mustard family. Everyone knows the ordinary pepper-grass of door-yards and roadsides, with its short stems and abundance of small white or greenish flowers, followed by the flat, peppery fruits about an eighth of an inch across. The sweet alyssum of the greenhouses and flower beds is familiar, too. The pepper-grass at Florissant shows similarities to these two plants. It has an abundance of small white flowers and the usual peppery fruits. The plants grow so large that when in full bloom they make a fine appearance. Along old roads and in waste places they are frequently massed in large patches, or they form broad bands flanking the roadway. In fact, they are such a striking part of the landscape in midsummer that the Florissant region without the shrubby pepper-grass would be a very different looking place.

\* \* \* \* \*

Next in amount after the flat, open country will come the dry hillsides. Here are scattered pines and spruces, interspersed with small groves of white-barked aspen.<sup>2</sup> There is a greater variety of herbaceous plants than in the more open country. This is because there is a greater range of conditions for plant life. Hillsides may slope to east or west or north or south, and they may be cut up by gullies, expos-

<sup>1</sup> *Lepidium jonesii* Rydb.

<sup>2</sup> *Populus tremuloides* Michx.

ing different kinds of soil. So, with less sameness in the environment, will come less sameness in the flora.

In the spring these hills bear larkspurs and vetches; and there are the delicate flowers of the bear-berry, or "kinnikinnik,"<sup>1</sup> as it is called in Colorado. Later come the lungwort<sup>2</sup> or "bluebell," and lupines and loco-weeds.<sup>3</sup> Throughout the summer may be found various kinds of beard-tongue,<sup>4</sup> and on dry, gravelly slopes certain "stemless" forms of evening primroses. Some of these have flowers two inches across. The wild geranium<sup>5</sup> blooms through spring and summer among fallen logs and in the partial shade of pine and spruce trees. This plant closely resembles the crane's-bill of our eastern states. The columbo is a tall, straight plant of the gentian family,<sup>6</sup> but with greenish flowers. It has much the form of common mullein. At the heads of gullies the tall, pink *Gilia*<sup>7</sup> can almost always be found. It seldom occurs elsewhere. Different species of golden-rod grow sparingly among pine trees and aspens on the hillsides.

Although most of the plants of the hillsides are herbaceous, rather than woody, still there are representatives of some woody species here and there. Wherever large rocks are found, with frost cracks, one may expect to find a few shrubs. The thimble berry<sup>8</sup> is fairly common. In early spring this bears a mass of large, white, rose-like flowers. At that season the plant is very attractive. However, the berries which come later are so insipid and so full of seeds that one may well wonder at the taste of the botanist who gave the plant its specific name "deliciosus." Some wild raspberries of good flavor may be found now and then, but they are nowhere abundant. A few of our western choke cherries,<sup>9</sup> and some wild gooseberries and currants, grow on the higher hills and in rocky or shaded places.

A shrub known as mountain mahogany<sup>10</sup> is fairly common on drier parts of the hills. The wood of this species is extremely hard; even in collecting small specimens of the plant for the herbarium a pocket

<sup>1</sup> *Arctostaphylos uva-ursi*.

<sup>2</sup> *Mertensia*.

<sup>3</sup> *Geranium fremontii*. A photograph of some of these plants is reproduced in the plate at the end of this article.

<sup>4</sup> *Frasera speciosa* Dougl.

<sup>5</sup> *Rubus deliciosus* James, *Oreobatus deliciosus* (James) Rydb.

<sup>6</sup> *Prunus demissa melanocarpa*.

<sup>7</sup> Species of *Astragalus* and *Aragallus*.

<sup>8</sup> *Pentstemon* spp.

<sup>9</sup> *Gilia aggregata*.

<sup>10</sup> *Cercocarpus parvifolius*.

knife is hardly strong enough to cut the twigs. On dry slopes, exposed to wind, this plant puts forth great numbers of small, short branches, thus producing a dense, scrubby growth. Although the flowers of the mountain mahogany are small and inconspicuous, the fruits are interesting because of the long tail-like style which grows to a length of two or three inches.

The nine-bark<sup>1</sup> and wax-flower<sup>2</sup> are shrubs which produce conspicuous flowers. It is mostly in rocky-places that these are to be found—seldom on open slopes. Lower down in the foothills these plants occur only in the more shaded situations, as along canyon-walls and in deep gulches. Although the rainfall at Florissant is not much greater than at lower altitudes, yet the smaller amount of evaporation permits plants to grow in more open situations.

Trees are nowhere abundant in the lake basin at Florissant, but there are some good stands of spruce in the higher hills a few miles away. All the lower ridges have a few trees. Most of these are pines<sup>3</sup> and spruces, with here and there a cedar. Low mats of juniper are scattered about, chiefly on the steeper slopes. Aspens may be found in soil somewhat more moist than that which supports the cone-bearing trees. A number of dead aspens of some size are to be seen, but none of the living specimens are at all large. A few years ago there was an invasion of caterpillars. It is stated that the aspen trees, during that year, were again and again stripped of leaves. This caused the death of the trees.<sup>4</sup>

In the aspen groves may usually be found certain species of herbaecious plants not so abundant among the pines and spruces. This

<sup>1</sup> *Opulaster*.

<sup>2</sup> *Edwinia*, or *Jamesia*.

<sup>3</sup> Shown in the photographs reproduced in the plate at the end of this article.

<sup>4</sup> Following is a list of woody plants obtained by the writer. On account of the short time which he was able to give to the collection of plant specimens at the time of his visit to Florissant, the list is by no means complete. However it will give an idea of the more common or striking species.

*Arctostaphylos uva-ursi* (Linn.) Spreng.

*Pinus scopulorum* (Englem.) Lemmon

*Betula fontinalis* Sarg.

*Populus tremuloides* Michx.

*Cercocarpus parvifolius* Nutt.

*Prunus demissa melanocarpa* Aven Nelson

*Dasiphora fruticosa* (Linn.) Rydb.

*Pseudotsuga taxifolia* (Poir) Britt.

*Edwinia americana* (T. & G.) Heller

*Ribes cereum* Dougl.

*Juniperus sibirica* Burgsdorff

*Rubus deliciosus* James

*Opulaster intermedius* Rydb.

*Salix stricta* (And.) Rydb.

*Pinus murrayana* "Oreg. Com."

These determinations were all made by Professor Aven Nelson.

is to be expected because the aspens occur in the richer and more moist soil, and they furnish shade which is suitable for certain plants. Violets, *Arnica*, the columbine, larkspurs, the false Solomon's seal, and other shade-plants occur here.

\* \* \* \* \*

Even a short account of the Florissant region should contain some mention of the grasses found there. Of these there are many species, but few individuals of any one kind. Nowhere is there a grass carpet of any size, and the grasses occur almost always in small clumps widely scattered on hillsides and stream banks. As is usual in Colorado, the wheat grasses, wild barley, fescue, grama grass, and bromes are the kinds most abundant, rather than such forms as panic grass and blue grass, which are so widely distributed and so abundant in the eastern United States.<sup>1</sup>

\* \* \* \* \*

In the Florissant region, as elsewhere in the mountain districts of Colorado, the plant population is of a mixed character. The brilliant sunshine, long continued through the growing season, permits the growth of southern forms and plants of the plains region. At the same time, in shady situations among rocks and on north slopes, it is likely to be cool even in the warmest part of the summer. Thus, northern plants are able to obtain a foothold. On the whole, however, the affinities of the flora are with the South rather than with the North. The flat, open parts of the lake basin furnish conditions suited only to a few species of xerophytic plants, but these are represented by many individuals. Many more species are found on the dry hillsides; but it is only along moist canyon-sides and stream-banks that

<sup>1</sup> Seventeen species of grasses were collected. They have been determined by Professor Aven Nelson. Following is the list:

<i>Agropyron caninum</i> (Linn.) Beauv.	<i>Bromus porteri lanalipes</i> Shear
<i>Agropyron dasystachyum subvillosum</i> (Hook.) S. & S.	<i>Bromus pumbellianus</i> Scribn.
<i>Agropyron occidentale</i> (Vasey) Shear	<i>Danthonia parryi</i> Scribn.
<i>Agropyron pseudorepens</i> S. & S.	<i>Festuca ovina</i> Linn.
<i>Agropyron tenerum</i> Vasey	<i>Hordeum nodosum</i> Linn.
<i>Agropyron</i> spp.	<i>Koeleria cristata</i> (Linn.) Pers.
<i>Bouteloua oligostachya</i> (Nutt.) Torr.	<i>Sitanion longijolius</i> J. G. Smith.
<i>Bromus porteri</i> (Coul.) Nash	<i>Stipa vaseyi</i> Scribn.

mesophytic conditions are reached. Here only are there plant associations which resemble those of the northeastern United States.

Along the streams, especially the swifter parts of their courses, grow birches<sup>1</sup> and willows. If the word "birch" brings to the mind of the reader thoughts of the paper birch of our eastern and central states, then he will have an erroneous idea of the trees at Florissant. The birches and willows are low trees or shrubs, and they form small thickets. In these thickets grow gentians and various orchids, though never in great numbers. Around the margins of the thickets grow the single-flowered harebell<sup>2</sup> and the star-flowered false Soloman's seal.<sup>3</sup> In this same moist soil are other northern plants, such as the shrubby cinquefoil<sup>4</sup> and western mint,<sup>5</sup> and different species of the sedge and crowfoot families. In the places more open, but still moist, there is a curious wide-spreading thistle.<sup>6</sup> The leaves form a dense rosette on the ground with a spread of two feet or more. No upright stem occurs, and the small flower-heads are partly concealed by the incurved leaves.

To get a proper understanding of the plant population of any region, it is often as useful to know what plants are lacking as it is to know what plants are present. If we compare the Florissant region with the mountain districts of New England or the middle Atlantic states, we shall find many differences. In the Florissant region, and for that matter everywhere in Colorado, there are few trees except cone-bearers. There are no nut-bearing trees. Walnuts, butternuts, hickories, chestnuts, and beeches do not extend into Colorado. Hard maple, elm, and ash are absent, as well as other familiar forest trees of the eastern United States. There are no laurels and rhododendrons in the Colorado mountains. In fact, it is only in flowering herbs that our mountains excel. But these make up for all deficiencies. Brilliancy and abundance of color make the hillsides and canyon-slopes beautiful all summer.

<sup>1</sup> *Betula fontinalis*.

<sup>2</sup> *Campanula uniflora*.

<sup>3</sup> *Mentha canadensis rubellus* Aven Nelson.

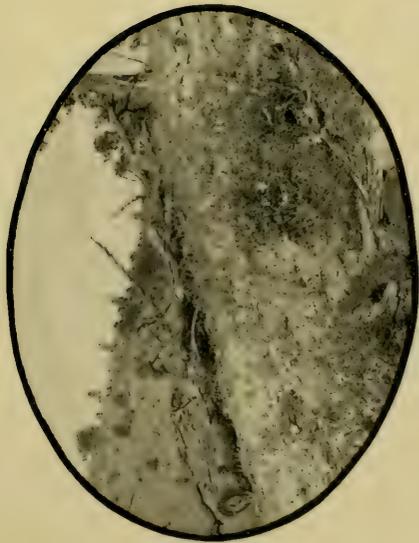
<sup>4</sup> *Carduus aculeatus*. A photograph is reproduced in the accompanying plate.

<sup>5</sup> *Vagnera stellata*.

<sup>6</sup> *Dasiphora fruticosa*.

The hardihood of the plants which grow in dry soil exposed to hot sun is something to interest the casual visitor as well as the botanist. The structural characters developed to adapt the plants to the different conditions of climate and soil in these mountains are well worth studying. Everywhere in the Colorado mountains a useful study can be made of plant distribution as affected by soil, moisture, and exposure to sun. Nowhere has the writer seen better opportunity for such study than in the region of Florissant.





Wild geraniums growing on a hillside



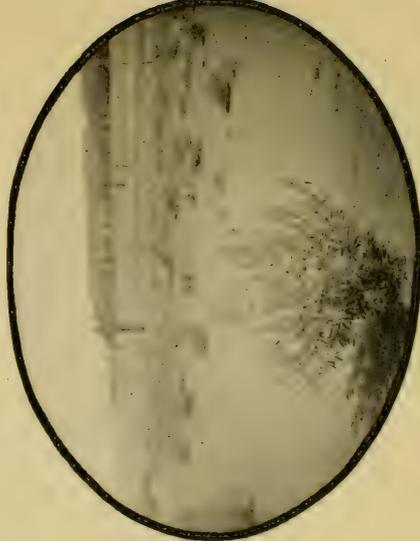
The Colomho (tail-spoke-like plants) on a hillside



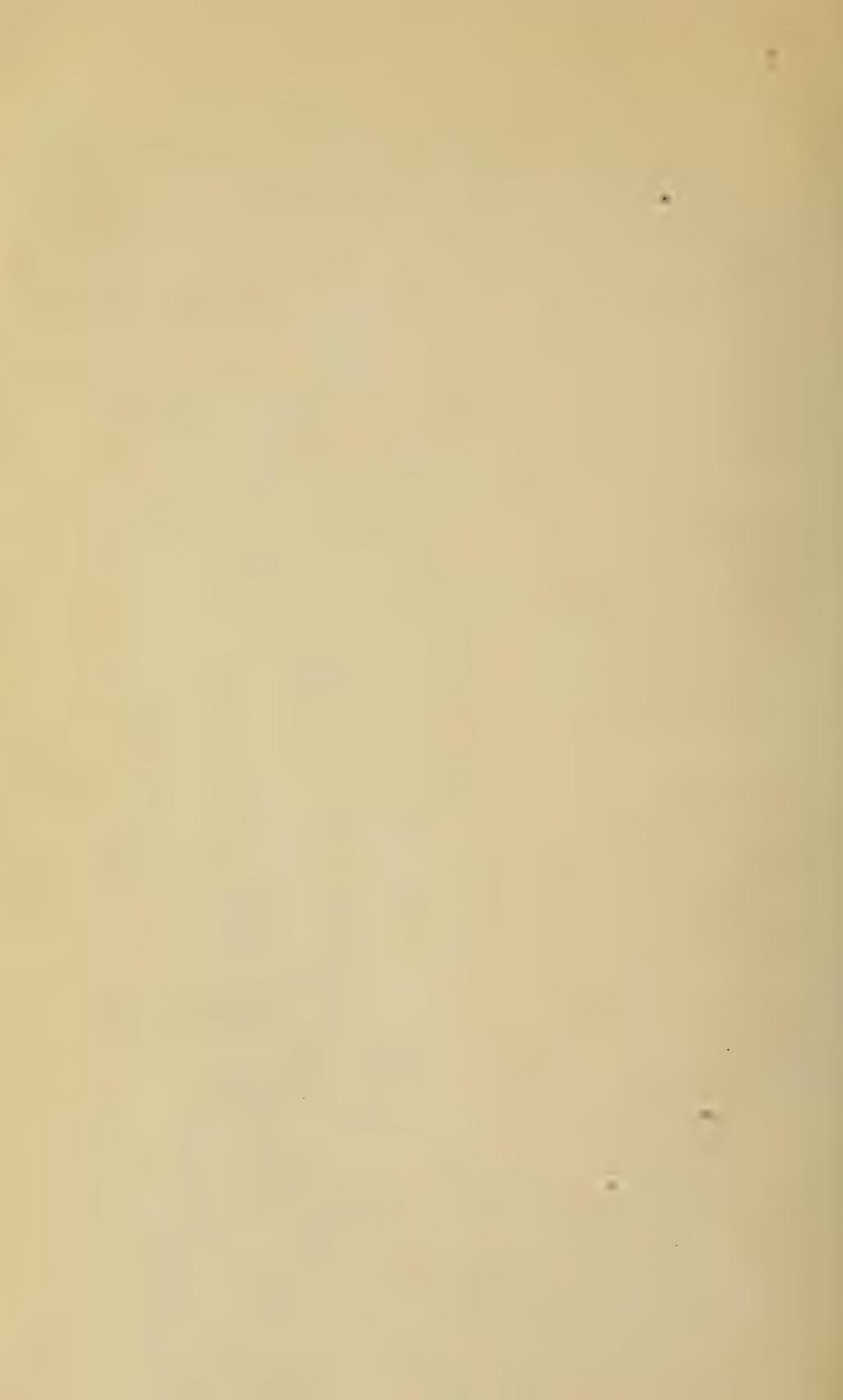
General view of the lake basin



Low "stemless" thistles (*Carduus aculeatus*)



Bee plant in foreground, shrubby pepper-grass farther back



VOLUME III

NUMBER 4

THE  
UNIVERSITY OF COLORADO  
STUDIES



FRANCIS RAMALEY  
EDITOR

PUBLISHED BY THE  
UNIVERSITY OF COLORADO  
BOULDER, COLO.

AUGUST, 1906

*Price, 50 Cents*



VOLUME III

NUMBER 4

THE  
UNIVERSITY OF COLORADO  
STUDIES



FRANCIS RAMALEY  
EDITOR

PUBLISHED BY THE  
UNIVERSITY OF COLORADO  
BOULDER, COLO.

AUGUST, 1906

*Price, 50 Cents*

PRINTED AT  
THE UNIVERSITY OF CHICAGO PRESS  
CHICAGO, ILLINOIS

## CONTENTS

	PAGE
1. SOCIAL AND INDUSTRIAL EFFECTS OF RAILROAD RATE-MAKING . . . . .	187
JOHN B. PHILLIPS, PH.D., Professor of Economics and Sociology	
2. THE COUNTY BOUNDARIES OF COLORADO . . . . .	197
FREDERIC L. PAXSON, PH.D., Professor of History	
3. LUCRETIVS AND HAECKEL BEFORE THE RIDDLES OF THE UNIVERSE, PART II. . . . .	217
FRED B. R. HELLEMS, PH.D., Professor of Latin	
4. SHAKESPEARE AND PSYCHOGNOSIS. ESSAY II. MAJOR CHARACTERS OF "THE TEMPEST" . . . . .	229
MELANCHTHON F. LIBBY, PH.D., Professor of Philosophy	
5. TENDENCIES IN MODERN MUSICAL COMPOSITION . . . . .	249
GEORGE M. CHADWICK, Instructor in Music	
6. A DEFINITION OF QUATERNIONS BY INDEPENDENT POSTULATES . . . . .	257
RUBY L. CARSTENS, M.A. Assistant in Mathematics.	
7. AREAL GEOLOGY OF LOWER CLEAR CREEK (COLORADO). . . . .	263
JAMES UNDERHILL, M.A.	



## SOCIAL AND INDUSTRIAL EFFECTS OF RAILROAD RATE-MAKING<sup>1</sup>

BY JOHN BURTON PHILLIPS

Any intelligent study of the railroad-rate question involves a consideration of the social and industrial effects of freight rates. The rates at which freight is carried to and from various places in the United States are great factors in determining their prosperity. Unless this effect of freight rates is understood, no intelligent discussion of the proposal to take the rate-making power out of the hands of the railroads will be possible. In this paper some attention will be given to the effects of the freight rate on Atlantic ports, building parallel railroads, concentrating population in cities, and distributing industries.

At the present time the railroads are maintaining what is called a differential in the rates that prevail for the shipment of freight from the West to the ports on the Atlantic seaboard. It seems that the most accessible outlet for the grain that is grown in the Northwest was for many years the port of New York City. The New York Central and Hudson River Railroad secured the larger amount of freight if the grain was carried to the seaboard by the most inexpensive route. Other men had invested their capital in railroads, and these men wished that their capital so invested should yield a good profit. It was found that the Baltimore and Ohio, Chesapeake and Ohio, and the Pennsylvania could not compete at the usual freight rate for grain with the New York Central, and were being worsted in the competition that was then on. They therefore decided to engage in a rate war for the purpose of compelling the New York Central to come to terms with them and maintain a rate that would give to them a larger share of the grain destined for the seaboard. The war was begun and waged with remarkable fierceness, until finally in 1877 an agreement was reached by which the New York Central pledged itself to raise the rate on grain destined for export through the port of New York, so that that city would not be a serious competitor with the cities

<sup>1</sup> *Vide The Iron Trail*, March, 1905.

on the Atlantic seaboard farther south. The rate was made about two cents higher for New York than for Philadelphia, and three cents higher than for Baltimore and Newport News.

The result of this agreement whereby the natural routes of transportation were changed to help railroads that could not compete with the New York Central, was soon seen in its effect on the growth of the city of New York. That city began to lose in relative importance as a port of international trade. Its exports and imports, which had been increasing at an enormous rate, while continuing to increase, yet showed a great diminution in their rate as compared with that of other ports favored by the differential. The merchants of New York besought the New York Central to remove the differential. The New York Central agreed to do so if the other roads would permit it. The roads interested were consulted, and they announced that in case the differential was removed a rate war would immediately be instituted. The differential was not removed. The merchants of New York, unable to obtain satisfaction from the railroads, thought of the Erie Canal. They appealed to the legislature, and the result was the adoption of a constitutional amendment providing for the expenditure of \$101,000,000 for the purpose of deepening, widening, and straightening the Erie Canal so that a 1,000 ton barge can navigate it. The canal is owned by the state, and no tolls are charged for its navigation. In this way it is expected that the problem of the differential will be in part eliminated. The sum of \$101,000,000 is therefore a part of what it will cost the people of New York to allow the railway managers to maintain such a freight rate as will enable export grain to be carried to other cities than to that port which is its most accessible outlet.

The Erie Canal is the most expensive waterway in the world, and would long ago have been abandoned if it had not been that it is useful as a restraint upon the railway managers in the matter of adjusting rates. It has cost the state about three quarters of a million dollars a year for many years, and this needless expense will have to be paid till the business of making rates for railroads is put on a different basis. Aside from this annual expense for the maintenance of the canal, and the \$101,000,000 appropriation of 1903, and the \$9,000,000 of 1896, there is the annual loss to the entire country in the excessive freight rate that is maintained for

the purpose of making inferior places equal to the principal export city. How much this is cannot be estimated with any degree of accuracy. It is certainly enormous.

It is true that the constitution guarantees that the government of the United States shall not do anything that will give one port an advantage over another. The purpose of this clause in our constitution is to provide that property shall be protected in those places which nature has fitted to be the chief seaports of the country. It was the aim of the constitution-makers that there should be no discriminating duties levied against any port and in favor of any other port. The constitution strives in this way to assure the equality of competition upon which theory our government rests. In thus attempting to guarantee that there shall be no discrimination against one port as compared with another, it was hoped that only the forces of nature which are over and above human control were to be allowed to have free play, and those ports that were most favored by nature would become the greatest places of export.

The fathers sought therefore to keep from the new government they were making the power to interfere with the natural growth of the various ports. It is unreasonable to assume that they thought Congress should not have the power to prevent individuals from destroying this very clause which they in their wisdom thought fit to insert in the fundamental law of the new government. Nor is it to be thought that in making this clause they believed that the natural advantages which any one port might possess should be destroyed by a company of individuals. When the differential rate on freight from the West to the seaboard is maintained in such a way as to prevent the trade going to the principal port of entry, it is an interference with the conditions established by nature and favoring the growth of seaports. Such a differential can make new seaport cities. In 1890 the population of Newport News, the terminal of the Chesapeake and Ohio, was 4,449; in 1900 it was 19,635—an increase of over 450 per cent.

The least expensive way for the United States to get its grain to the ships was formerly to take it to the harbor of New York. But the differential has changed this. By raising the price paid for hauling, it is now as easy to take the grain to various other seaports. That is, the people of

the United States have been obliged to pay more for the sake of having their grain hauled to other and less advantageous seaports than New York. In other words, the entire people have been taxed for the purpose of benefiting the men who have put their capital into railroads which could not compete with those on the main route to the seaboard without some kind of an arrangement that would keep the price of hauling higher than would otherwise be the case.

The power of the government to fix rates is sufficient to stop the building of one railroad parallel to another. It is well known that there have been several instances in the United States where one railroad has been built parallel to another, not for the purpose of carrying freight and passengers, but solely for the sake of compelling the established road to buy it out or to divide the profits with it. When a railroad has become a great dividend-earner and its stock is at a high price, it will occur to certain unscrupulous persons that by building another road alongside of it they can compel it to buy the new road or divide the profits with them. It is a species of blackmail. The most conspicuous example of this is the West Shore railroad that was built from New York City to Buffalo. It parallels the New York Central nearly all the way. This road was built for the purpose of selling out to the Central, and after a rate war this wished-for consummation was brought about. The Nickel Plate is another example of the same thing. In these cases it is necessary for the older road to buy out the new one or its business is ruined. There is no one to control the freight rates that the bandit railroad can make, and as it is in the business for the purpose of selling out, it will make these rates so low that it will get all the trade away from the older road unless that road meets its rates, and it will continue this practice till the old road is obliged to buy the bandit road to save itself from destruction. Then, when the war is over and the bandit road has passed into the hands of the older road, the public is made to pay for the costs of war and the building of the robber railroad in the increased rates that must be made in order to recoup the older road for the deficit caused by the attack of the railroad banditti. It has even been suggested that this is one of the reasons why the government should not attempt to fix rates, because the railroads would not then have the opportunity of recouping themselves by increas-

ing their rates after such an attack as has been described above. This appears to be a short-sighted argument. If the government could control the making of rates it could prevent a rate war. Government regulation of railway rates means that the low rate which a railroad desires to put in force would have to be approved by the Interstate Commerce Commission. How, then, could a railroad built parallel to another with the idea of waging a rate war till it was bought out at a fancy price, injure established dividend-paying property? If the government prevented the fixing of a low rate, the railroad banditti would be robbed of one of their most effective weapons. Forbidden to fix their rates at ruinous figures so as to get their business away from the old road, they would not desire to build a competing line for the purpose of selling out. Therefore, the capital which now goes into such worse than useless enterprises would find employment in legitimate fields.

The United States Industrial Commission recommended in its report in 1902 that the Interstate Commerce Commission be given the power to prevent the paralleling of railroads. It seems clear from the above observations that the power to make rates is all that is needed in order to stop paralleling. This prevention of parallel railroad-building will act as a guarantee to the railroads that they will not be molested by unscrupulous speculators. Therefore, government rate-making, whatever its dangers in other respects, will be very likely to protect the railroads from the depredations of certain marauders to which they are now exposed.

The effect of freight rates upon the concentration of our population in cities has never been fully pointed out. It is well known that one of our most serious problems is to induce people to remain in the smaller towns or in the rural districts. There are many causes operating to congest population in cities. Among these is the rate fixed by the railroads for carrying commodities.

A study of the growth of cities in the United States shows that those cities have grown most where there are several railroads. At these points the railroads have found it necessary to fix rates to compete with other roads and in some cases with steamships. Places thus favored by competitive rates are the places where manufacturers and jobbers are most likely to locate. When a town has but one railroad, and that

has a monopoly of its traffic, there is no overwhelming reason, from the manager's point of view, why the road should give this place as favorable a freight rate as it is obliged to give other places on its lines located at points with more than one railroad. The population of the small town therefore remains stationary, or even declines, owing to the fact that manufacturers, having located there in an early day, and having discovered the disadvantages they are under in the matter of transportation, decide to move their plants to the larger town where competitive rates prevail. Other lines of business are also crippled. Real estate in the town is affected, and its value declines. Farm land in the vicinity of the small town suffers and its value also declines. All things considered, a town from which goods must be transported at a higher rate than from other places on the same railroad is a good place to emigrate from. The same causes that make this a good town to leave make the place where lower rates prevail a good place to settle, and this is one of the reasons why the larger places are growing so rapidly. Railroad freight rates, as at present fixed, are tending to give a forced growth to our cities.

Freight rates are so adjusted that the distribution of industries is prevented. Why should the western part of the United States be supplied with great numbers of articles made in New York, when the same articles can be made in St. Louis? Why this enormous haulage? Manufactures have developed slowly in the western states, and these states are offering various inducements to encourage manufacturing industry within their borders. Many of these states are offering bounties, and others are exempting new manufacturers from taxation. One of the reasons for this lack of manufacturing development in the West is the freight rate from eastern cities. The rates are made low enough to enable the eastern manufacturer to invade successfully the local western market and deliver the goods there at a lower price than the local producer. This has tended to prevent capital from coming into the western territory to establish manufacturing industries. A conspicuous illustration of the attitude of the railways toward the movement of manufactures to the western states appears in the testimony of Professor Ripley before the United States Industrial Commission. A number of men had planned

to build a pulp- and paper-mill in Denver and use the raw materials of that section to manufacture paper for the newspapers that circulate in that region. In this way the great expense of shipping this commodity a thousand miles might be avoided. Plans were under way when the attention of one of the railroads was called to the matter, and the officials of the road informed the promoters that if a paper-mill was built in Denver, and thereby the shipment of paper from Wisconsin interfered with, the railroads would kill the enterprise at any cost to themselves. This they could do by lowering the freight rate on paper from the East. The promoters were greatly discouraged, but, as the freight rate was so high, they decided to build the mill. Plenty of timber was available in the near-by mountains. Coal mines were in active operation within twenty miles of Denver. There was every reason why the mill should succeed and the great expense of hauling paper 1,000 miles from Wisconsin be saved. The rate on incoming paper had been \$1.55 a hundred, and the complaints about the high rate had been one of the leading causes that had led to the erection of the mill. As soon as the mill went into operation, the railroads reduced the rate on incoming paper to \$0.25 a hundred. It is not surprising that the mill went into bankruptcy.<sup>1</sup>

The following table of rates from eastern points to Denver, and also from eastern points to the Pacific coast, shows very clearly how the development of a city as a manufacturing and jobbing center may be checked by the adjustment of freight rates. This table is compiled from testimony given by witnesses before the Industrial Commission in 1901, and represents the rates in force at that time. Though there have been changes since, the figures are still valuable as showing the influence of freight rates on the industrial growth of Denver. The most striking feature of this table is the great discrimination against Denver and in favor of San Francisco. It is hard to understand why the freight rate for hauling boots and shoes from Chicago to San Francisco should be less than the charge for hauling them to Denver, 1,200 miles nearer. Why the rate from Denver to San Francisco should be more than the rate from Chicago to San Francisco is still more incomprehensible! This is an open violation of the long-and-short-haul clause

<sup>1</sup> *Report of the Industrial Commission*, Vol. IV, p. 264; *ibid.* Vol. IX, p. 287.

## FREIGHT RATE DISCRIMINATION AGAINST DENVER

Commodity	Whence shipped	Rate to Denver	Rate to San Francisco
Boots and shoes.....	Chicago	\$2.05	\$1.50
Boots and shoes.....	Denver	....	3.00
Books.....	Chicago	2.05	1.75
Books.....	Denver	....	3.00
Oil.....	Chicago	....	0.78½
Oil.....	Denver	....	0.80
Crockery.....	Trenton	1.53	0.95
Oil cloth }.....	Missouri River	0.80	0.75
Linoleum }			

of the interstate commerce law. In the evidence before the commission mention is made of a man who desired to start a publishing house in Denver and print books to sell on the Pacific slope. As soon as he found the freight rate on books to be \$1.75 from Chicago to San Francisco and \$3 from Denver to San Francisco, he decided to manufacture books in Chicago. The table shows that the same considerations would prevail with other manufacturers and jobbers. A jobber in boots and shoes could not live in Denver if he had to pay \$2.05 freight from Chicago to Denver and \$3 from Denver to San Francisco, a total of \$5.05 in freight from Chicago, when the jobber in Chicago could lay down the same goods in San Francisco for \$1.50. This explains what was pointed out by witnesses before the commission, namely, that various jobbers had withdrawn from Denver to Missouri River points and Chicago. It was stated to the commission that, owing to the difference in rates on oil, that commodity had been shipped from the East to San Francisco and back to Denver at a profit to the Denver dealer.<sup>1</sup>

The population of Denver increased from 106,713 in 1890 to 133,879 in 1900—an increase of 25.4 per cent. At first thought this would seem to be an indication of great industrial prosperity. Such, however, is not the case. It must not be forgotten that among the various attractions of the city of Denver, one of the most conspicuous is the favorable effect of its climate upon those persons afflicted with tubercular disease, and a large part of this increase in population is represented by persons that have sought Denver as a place of residence while in quest of health.

<sup>1</sup> *Report of the United States Industrial Commission, Vol. IV, p. 68.*

The best index of the industrial growth of Denver during the above period is the census of manufactures. While the census figures for 1900 show an increase of 41 per cent. in the value of Denver manufactures over the manufactures of 1890, these figures are entirely illusory. The increase is only apparent, as the figures for 1900 include the products of smelting and refining ores, and these products were not included in the census figures for manufactures in 1890. In that census these industries are classed as mining. Excluding the products of these industries, the value of Denver manufactures in 1900, as compared with their value in 1890, shows a decline of 5.6 per cent.<sup>1</sup>

The growth of the city, therefore, was not due to the increase in general manufactures. With the development of mining, however, there has been a great development along certain lines of manufacture, such as that of mining machinery. The growth of the smelting and refining industry has also had much to do with the present prosperity of the city. While Denver is now a flourishing city, it is greatly to be regretted that its development as a manufacturing and distributing center for the Rocky Mountain region has been so greatly interfered with by discriminating freight rates.

In this way the railroads prevent the distribution of industries in this country. They are in the hauling business, and therefore opposed to the self-sufficiency of the different sections of the United States. The logical result of such a policy is to keep the East a manufacturing section with great industrial cities, crowded tenement-house populations, sweat-shop industries, contagious diseases, and high mortality, while the West is obliged to engage largely in industries which produce raw material.

Such are some of the social and industrial possibilities of the rate-making power. Whether or not the American people will decide to take this power from the railroads and vest it in a public supervisory tribunal, or whether they will prefer to hope for the development of an enlightened public spirit on the part of the railroad managers, is a question whose answer will be awaited with much interest by all thoughtful persons.

<sup>1</sup> *Twelfth Census, Manufactures, Part II, p. 65.*



## THE COUNTY BOUNDARIES OF COLORADO

BY FREDERIC L. PAXSON

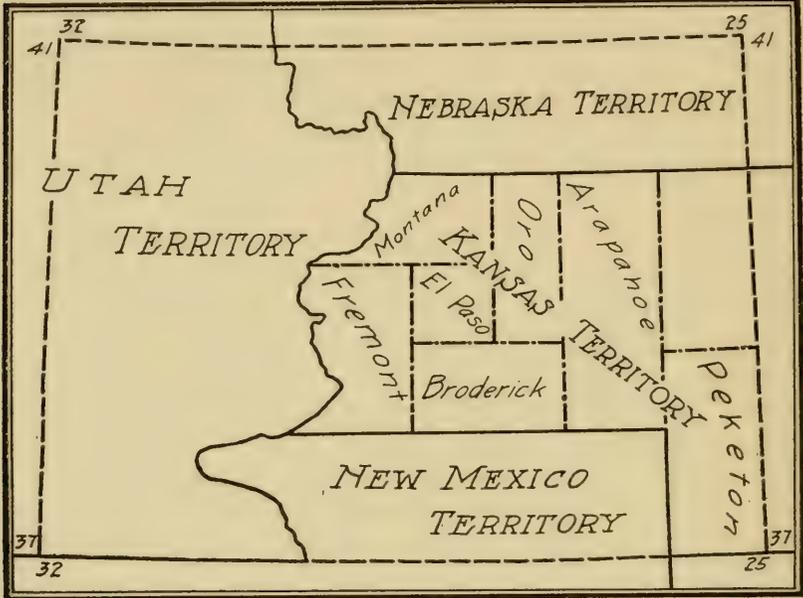
The early history of the state of Colorado is of necessity closely connected with that of the territories from which lands were taken to endow the new commonwealth. Kansas, Nebraska, Utah, and New Mexico were all levied upon, and out of the lands thus provided was erected, under the stimulus of the discovery of gold near Pike's Peak in 1858, the new territory bearing the name of Colorado, by the act of February 28, 1861.<sup>1</sup>

The territorial history of the Colorado lands in connection with Nebraska, Utah, and New Mexico has not yet been made accessible. Kansas three times passed laws which are of interest in the history of the new territory.<sup>2</sup> In the year 1855 she created the county of Arapahoe, embracing all of her territory west of the one hundred and third meridian, while the county of Washington, south of thirty-eight degrees and thirty minutes, included the southeast corner of Colorado. Neither of these counties was ever organized, Arapahoe being attached to Marshall, as was Washington to Allen, for purposes of government, and both of them being reshaped before their local settlement justified any formal organization. The discovery of gold in Arapahoe county in 1858 brought about the repeal of the act of 1855, and the substitution for the two counties of Arapahoe and Washington, within Colorado limits, of the counties of Oro, Broderick, Montana, Arapahoe, El Paso, and Fremont, all lying west of the one hundred and third meridian. The southern end of the single degree east of this meridian, losing even its nominal Washington county in 1859, became in the following year a part of the county of Peketon. And in this condition all of Kansas west of the twenty-fifth meridian from Washington (approximately the one hundred and second from Greenwich) was cast adrift when Kansas was admitted into the union on January 29, 1861.

<sup>1</sup> F. L. PAXSON, "The Boundaries of Colorado," in *University of Colorado Studies*, Vol. II, pp. 87-94.

<sup>2</sup> H. G. GILL, "The Establishment of Counties in Kansas," in *Kansas Historical Society Collections* Vol. VIII, pp. 1-23, with sixteen outline maps.

The first legislative assembly of the territory of Colorado met in Denver in the autumn of 1861 to pass, among others, a law dividing the whole territory into seventeen counties.<sup>1</sup> Of these original counties, six embraced large areas of plains lands of the eastern slope—Weld, Arapahoe, Douglas, El Paso, Pueblo, and Huerfano. Three covered the whole



MAP I.—1861—Before Admission of Kansas.

unoccupied western slope—Summit, Lake, and Conejos.<sup>2</sup> Two, Fremont and Costilla, divided the eastern and western slopes at the south while six mountain counties in the center of the state—Larimer, Boulder, Gilpin, Clear Creek, Jefferson, and Park—have until this day remained in their original limits as witnesses to the wisdom of the legislature which brought them into existence.<sup>3</sup>

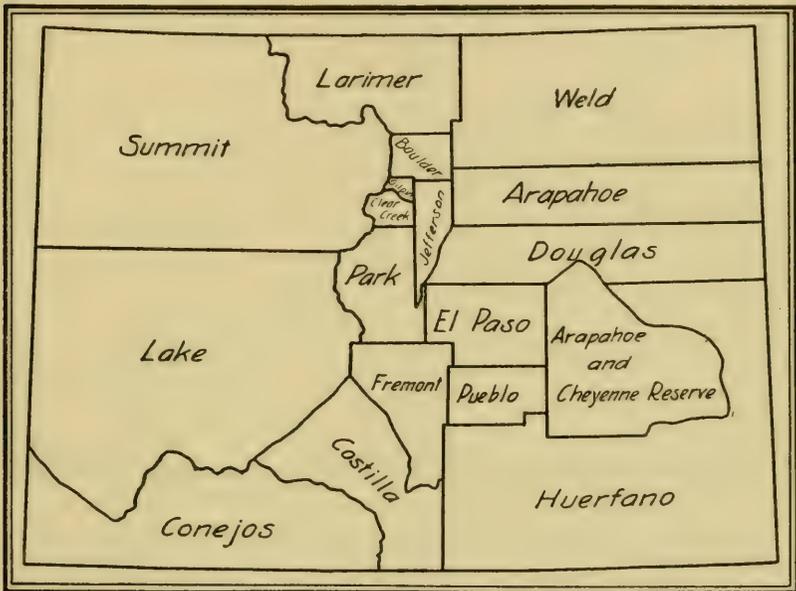
In defining the boundaries for these first counties the legislature made large use of the lines of the United States survey, which had begun in the

<sup>1</sup> Act of November 1, 1861 (First Legislative Assembly, *Session Laws*, pp. 52-57).

<sup>2</sup> The act of November 1, 1861, created a county of Guadalupe, whose name was changed by the act of November 7, 1861, to Conejos (*Sess. Laws*, 1861, p. 143).

<sup>3</sup> These central counties contained most of the population of the territory, for here were the great mining camps.

territory a few months before the act was passed. The eighth guide meridian, passing through the town of Pueblo, gives the location to ranges in the whole state, save the southwest corner. And the base line of the fortieth parallel is used over the same area. In the southwest, and in later years, the New Mexico principal meridian replaces the eighth guide of the eastern slope. The six eastern counties were all defined with reference to these base and range lines, in existence or projected.

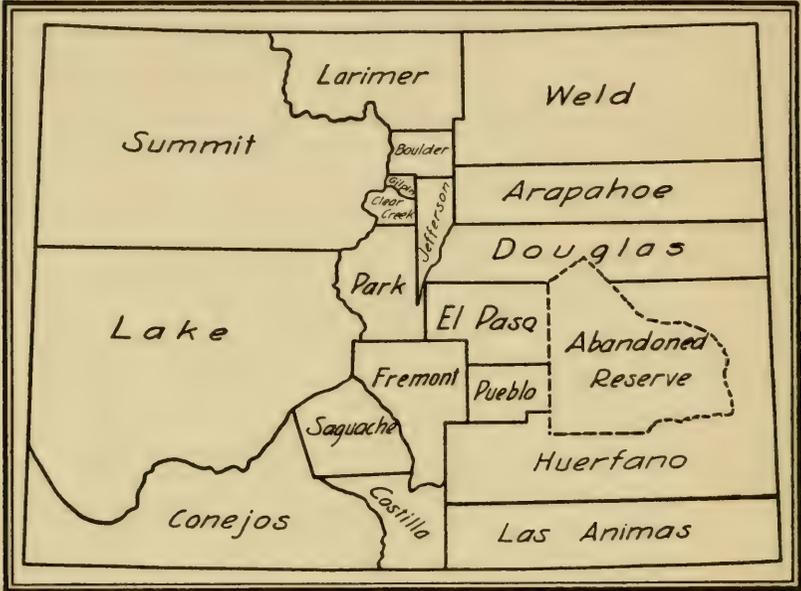


MAP II.—1861—First Legislative Assembly.

The central counties made much use of the Snowy Range, which the courts later determined to mean the continental divide when not further qualified by a local name, as Mosquito or Sangre de Christo or La Plata range.<sup>1</sup> The western counties, beyond the region of accurate survey or actual settlement, were open to confusion in the case of the Lake-

<sup>1</sup> This ruling was made in a suit in which Grand county endeavored to establish the Medicine Bow range as its eastern boundary, which was by definition the "Snowy Range" (*Grand County v. Larimer Co. Colorado Supreme Court Reports*, Vol. IX, p. 268, April term, 1886). In the following year the legislature provided that disputed county boundaries should be determined and surveyed by the state engineer (Act of April 4, 1887, *Sess. Laws*, 1887, p. 288).

Conejos line which was defined as running along a range, the La Plata, which was misplaced in the maps used by the legislature; but this mistake was corrected before the opening of the San Juan country made it a matter of importance.<sup>1</sup> It is worthy of note that four of the eastern



MAP III.—1866—Second to Sixth Assemblies.

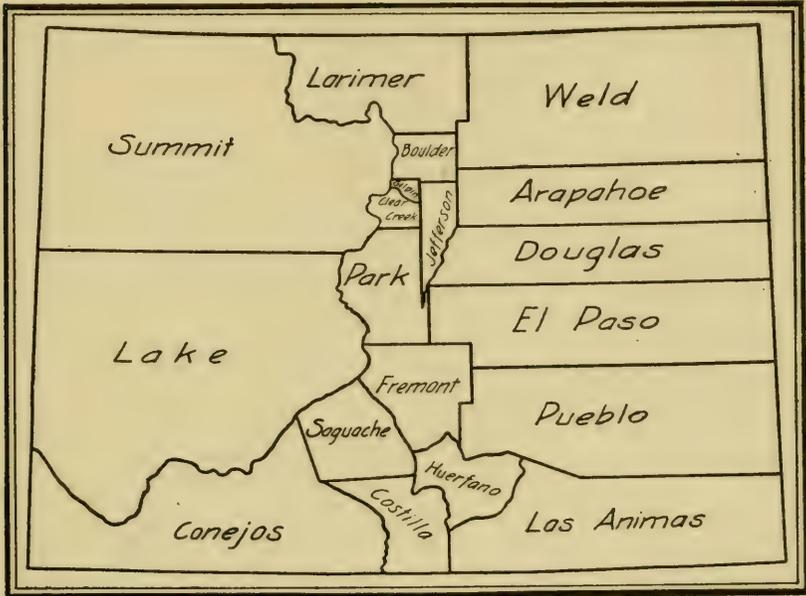
counties were bounded in part by the Cheyenne and Arapahoe reservation, established by treaty of February 18, 1861, and lasting until after the treaty of Little Arkansas, of October 14, 1865, which followed the serious plains war of 1864.<sup>2</sup> In no other instance did Colorado allow a reservation to interfere with the extension of county boundaries over its area. The Ute reservations in the west were always covered by these lines.

From 1864 until the arrival of the railways in 1870 Colorado failed to continue in the rapid growth which had been hoped for in the early sixties.

<sup>1</sup> There is a range indicated as "La Plata" in the position evidently contemplated in 1861, in "Map No. 4: From the Coo-che-to-pa Pass to the Wahsatch Mountains," in *Reports of Explorations . . . for a Railroad from the Mississippi River to the Pacific Ocean* (Washington, 1861), Vol. XI. This range separates the rivers San Juan and Dolores, along which divide the line is drawn in the maps accompanying this article.

<sup>2</sup> C. C. ROYCE, "Indian Land Cessions in the United States," in *Bureau of American Ethnology*, Eighteenth Report, 1896-97, Part 2, pp. 824, 838, and maps.

Her mines were in a measure discredited, statehood failed in spite of the exigencies of the Republican party in Congress, and population seems actually to have fallen away during these years. The county process indicates this stagnation in its own leisurely development.



MAP IV.—1868—Seventh Assembly.

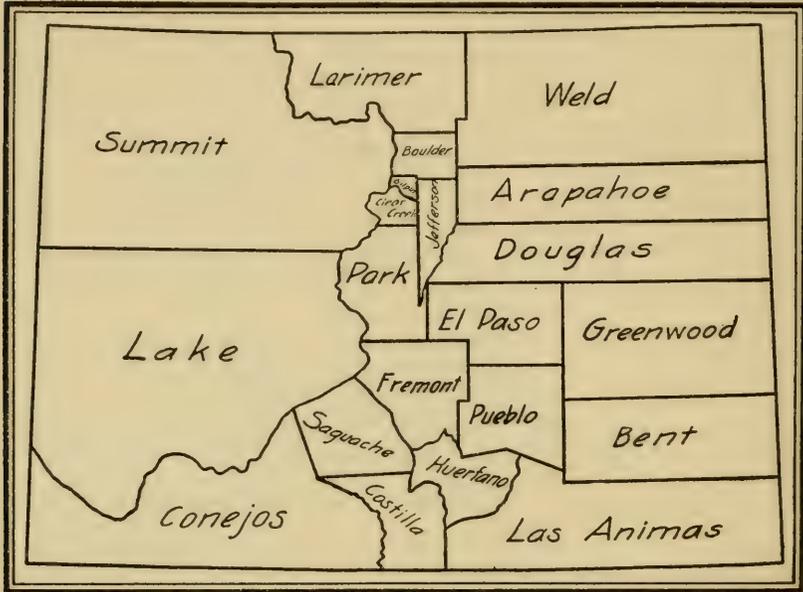
With the exception of Saguache, formed out of that part of Costilla north of La Loma del Norte and Moscow Creek,<sup>1</sup> no new county was created on the western slope during these years. Saguache was the work of the sixth legislative assembly sitting at Golden in 1866-67. Its north-west boundary was not the original Costilla-Lake line of 1861, but a new line erected for Costilla-Conejos by the third legislature in 1864, and extending from the top of Cochetopa Pass to "the mouth of the canon of the Snowy Range from whence flows the Rio Grande del Norte,"<sup>2</sup> the southern point being later determined by the state engineer as the town of Del Norte, situated in La Loma del Norte.<sup>3</sup>

<sup>1</sup> *Sess. Laws, 1866-67*, p. 54, act of December 29, 1866.

<sup>2</sup> *Sess. Laws, 1864*, p. 68; February 24, 1864.

<sup>3</sup> Cochetopa Pass was in 1892 defined by the state engineer as situated in S. W. Cor., Twp. 46 N., Range No. 4, East, of New Mexico Principal Meridian (*Colorado State Engineer, Sixth Biennial Report*, p. 49). The 'mouth' of the canon was located in this same report (p. 44).

On the eastern slope the corners of Fremont county were straightened out by the fifth and seventh assemblies of 1866 and 1868,<sup>1</sup> while the county of Las Animas made its appearance in the former year, formed from that part of Huerfano county south of thirty-seven degrees and thirty minutes.<sup>2</sup>



MAP V.—1870—Eighth Assembly.

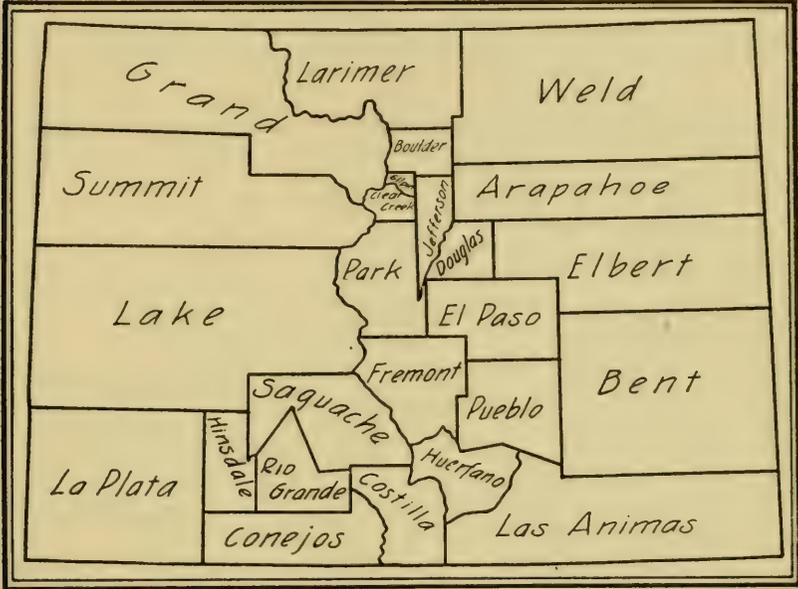
The disappearance of the Cheyenne and Arapahoe reservation, and the removal of the Indians, forced a revision of these southeastern lines in 1868, with the result that the seventh legislature restricted Huerfano county to its modern irregular bounds and divided its old territory between Pueblo and Las Animas, its neighbors on the northeast and southeast.<sup>3</sup>

<sup>1</sup> An act of March 11, 1864 (*Sess. Laws*, 1864, p. 69), had given a conditional modification to Fremont, depending upon a certain Beaver Creek. This act was repealed by the act of February 6, 1866 (*Sess. Laws*, 1866, p. 47). The later act of January 6, 1868 (*Revised Statutes*, 1868, p. 163), substituted the range of mountains east of the Arkansas River for the original northwestern line, the new line crossing the Arkansas three miles below the mouth of the South Arkansas in order to connect with the range mentioned.

<sup>2</sup> February 9, 1866 (*Sess. Laws*, 1866, p. 49).

<sup>3</sup> Act of January 9, 1868 (*Revised Statutes*, 1868, p. 164). These *Revised Statutes* were authorized by the seventh assembly and form the first revision of Colorado laws.

The advent of the railway in Colorado left its necessary imprint upon county organization. The Denver Pacific, connecting Denver and Cheyenne, and the Kansas Pacific, otherwise known as the Eastern Division of the Union Pacific, reaching the territorial capital from the east, both came into operation in the summer of 1870. Greenwood and Bent counties



MAP VI.—1874—Ninth and Tenth Assemblies.

had preceded the Kansas Pacific by some months,<sup>1</sup> while the activity around the county seat of the former, Kit Carson, caused by the heavy Santa Fé trade springing from the railway at that point,<sup>2</sup> gave a considerable activity to speculation in territorial lands. The county of Elbert, south of Arapahoe, came with the tenth legislature in 1874 at the expense of Douglas and Greenwood,<sup>3</sup> while the latter gave to Bent what Elbert did not need and itself disappeared from the map.<sup>4</sup> In this condition,

<sup>1</sup> Act of February 11, 1870 (*Sess. Laws*, 1870, p. 53).

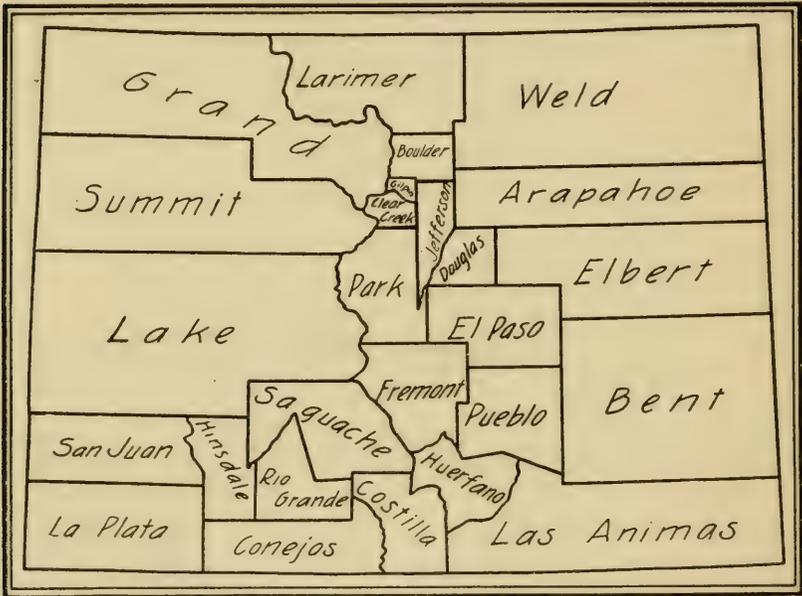
<sup>2</sup> The Arkansas Valley Railroad was constructed by Kansas Pacific interests to connect Kit Carson and Pueblo. It was built as far as La Junta, further extension being unnecessary since the Santa Fé had already reached Pueblo by La Junta. The Arkansas Valley was never a success, closed down in 1877, was sold under foreclosure in 1878, and is today abandoned. (Poore, *Railway Manual*, 1878, p. 894.)

<sup>3</sup> Act of February 2, 1874 (*Sess. Laws*, 1874, p. 69).

<sup>4</sup> Act of February 6, 1874 (*Sess. Laws*, 1874, p. 61). The *Ninth Census*, 1870, had given to Greenwood a population of 510 (Vol. I, *Population*, p. 16).

save for the county of Custer, made in 1877,<sup>1</sup> the eastern slope remained through the rest of the seventies and through the eighties to 1887.

On the western slope of Colorado the seventies show a greater county activity than on the eastern. The early counties beyond the range had lost much of their importance from the fact that the Ute reservation covered most of the useful lands. But the Indians receded before the prospector during this decade,<sup>2</sup> allowing the creation of many new counties in place of the original three—Summit, Lake, and Conejos.



MAP VII—1876—Eleventh Territorial Assembly.

Saguache county was the first to change in the early seventies, receiving in 1872 a new northern line in the latitude of Poncha Pass, and a new

<sup>1</sup> Act of March 9, 1877 (*General Laws*, 1877, p. 211). The first general assembly of the new state of Colorado published no *Session Laws*, but embodied the statutes of 1877 in a code of *General Laws*.

<sup>2</sup> The original reserve, west of 107° and south of fifteen miles north of 40°, was based on a treaty March 2, 1868. The Utes ceded the San Juan rectangle out of this by a treaty of September, 13, 1873, and the remaining portion, save for the fifteen mile strip of the Southern Ute reserve, by an agreement of March 6, 1880. (ROYCE, *Indian Land Cessions*, pp. 848, 864, 874, 899, 904, 908; *House Executive Document* 66, *Forty-fifth Congress, Second Session*.)

western line along the Ute reserve in one hundred and seven degrees.<sup>1</sup> The next legislature, the tenth in 1874, was able to take advantage of the cession by the Utes of their San Juan lands, and to create three southwestern counties at the expense of Conejos and Lake. The large county of La Plata received on the east a meridian six miles west of the mouth of Lost Trail Creek on the Rio Grande, and on the north a parallel ten miles north of the thirty-eighth parallel,<sup>2</sup> both of which boundaries were shortly to give way to more reasonable lines along the obvious summits. Conejos was in the same year forced back of the ninth correction line and the first guide meridian east of the New Mexico principal meridian, while the lands thus surrendered were divided by the New Mexico meridian itself into Hinsdale and Rio Grande. The county of Grand was erected by the same tenth assembly out of that part of the huge Summit north of the Ute reserve and the line between townships Nos. 1 and 2 south.<sup>3</sup>

The eleventh legislature, 1876, the last of the territorial series, added San Juan to the southwestern group, taking from La Plata for the purpose its lands north of nine miles south of the tenth correction line, and erecting a mountain line for most of San Juan's eastern boundary.<sup>4</sup> The impossibility of the 1861 Conejos-Lake line was by this time clearly seen in that the La Plata range not only did not cross the western boundary of the territory, but did not even connect with the continental divide at the source of the Rio Grande, which the statute called upon it to do. With this legislature the territorial period ended, twenty-six of the counties of Colorado being in existence.<sup>5</sup>

<sup>1</sup> Act of February 9, 1872 (*Sess. Laws*, 1872, p. 81). The state engineer, under act of April 4, 1887, has determined the summit of Poncha Pass to be "Intersection Peak" as indicated on Sheet VII of F. V. HAYDEN, *Atlas of Colorado* (Washington, 1881). (*Colorado State Engineer, Fourth Biennial Report*, Part I, p. 116.) The court of appeals sustained his ruling in September, 1892 (*Gunnison Co. v. Saguache Co. Colorado Court of Appeals Reports*, Vol. II, p. 412).

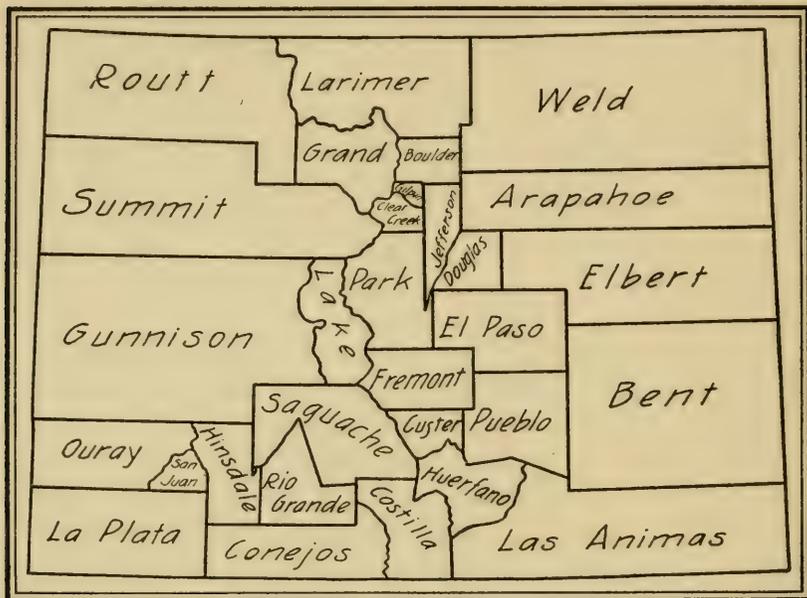
<sup>2</sup> Act of February 10, 1874 (*Sess. Laws*, 1874, p. 66). A single act defined the boundaries of the three counties, and in a later section (No. 13) established the tenth correction line as a new boundary between Costilla and Saguache.

<sup>3</sup> Act of February 2, 1874, (*Sess. Laws* 1874, p. 71). The mountain boundary of the new Grand left the Snowy Range where it throws off a spur between the Williams' Fork and Blue Rivers, on the west boundary of Clear Creek, and follows the spur range to the township line mentioned.

<sup>4</sup> Act of January 31, 1876 (*Sess. Laws*, 1876, p. 58).

<sup>5</sup> The writer is indebted to one of his graduate students, Mr. Frederick Eugene Hagen, for assistance in the preliminary survey of the territorial period. He has, however, based all his conclusions upon a personal examination of the statutes involved.

The first general assembly of the new state, meeting in 1877, took up the process of subdividing the west so vigorously that three new counties made their appearance in this year. San Juan, which had come into existence only the year before, was cut down until it reached its present location and boundary, while so much of the original territory as lay west



MAP VIII.—1877—First General Assembly.

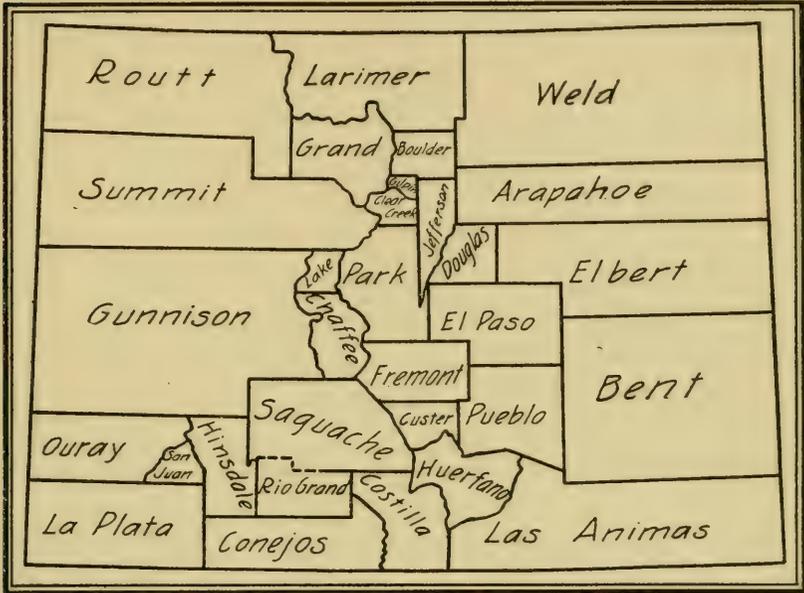
of an irregular mountain line became the new county of Ouray.<sup>1</sup> Lake county was confined to the east of the continental divide or Snowy Range, while its discarded portion received the name of Gunnison.<sup>2</sup> Routt county was cut off from Grand with an eastern boundary that was at a later day to cause litigation with both its mother-county and Larimer.<sup>3</sup>

<sup>1</sup> Act of January 18, 1877 (*General Laws, 1877, p. 207*).

<sup>2</sup> Act of March 9, 1877 (*General Laws, 1877, p. 213*).

<sup>3</sup> The western boundary of Larimer was determined by the supreme court in *Grand Co. v. Larimer Co.* (IX *Colorado, p. 268*). Routt county received a somewhat uncertain boundary in the act of January 29, 1877 (*General Laws, 1877, p. 209*). In one section it was to include that part of Grand lying west of a defined line, while the defined line, starting from the intersection of south line of Grand and the Gore Range, and running north to the Wyoming territorial line, ran, through half its length, through North Park and Larimer county. Thus a technical contention based upon the more definite boundary statement might have included in Routt a part of Larimer. The identity of Gore Range caused litigation between Routt and Grand over a twelve-mile strip. The state engineer, J. S. Green, identified the point of intersection at Yarmany Peak, his ruling

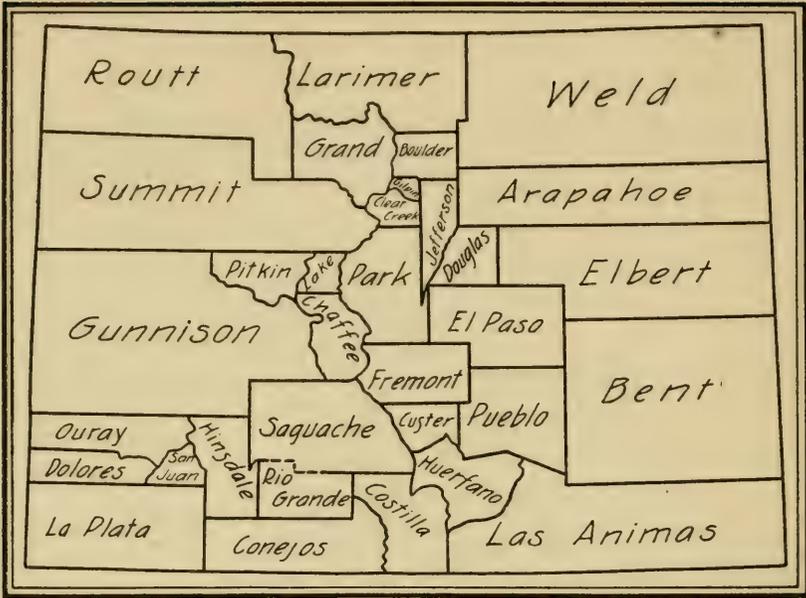
In 1879 the second state assembly gave to Saguache, already a much-bounded county, a new line on its south, and at the same time a ground for future litigation.<sup>2</sup> To the adjoining county of Lake, between Snowy



MAP IX.—1879—Second General Assembly.

being overthrown and the point being placed twelve miles farther west by the district court of Grand upon appeal of Grand. The court of Appeals, in 1894, reversed the decision of the court below, and remanded the case (IV *Colorado Court of Appeals*, p. 306). Subsequently the county attorneys of Grand and Routt agreed to run the line from the southwest corner of township No. 1, range 82, west.

<sup>2</sup> An adjudication of the common boundaries of Saguache, Hinsdale, and Rio Grande occurred after the beginning of the mining boom at Creede and before the creation of Mineral county in 1893. In order to determine the location of certain of the new camps, appeal was jointly made by the counties to the state engineer, J. B. Maxwell, under the act of 1887. Maxwell sat at Creede in March, 1892, and handed down a decision defining the southern boundary of Saguache as running from the intersection of the tenth correction line north with the first guide meridian east of the New Mexico principal meridian, west to an intersection with a line running northwesterly from Del Norte to Cochetopa Pass, and northwesterly to said pass; thence southwesterly along the continental divide to the one hundred and seventh meridian. (*Colorado State Engineer, Sixth Biennial Report*, pp. 42-50.) This decision of the state engineer was later contested by Mineral county, and the district court of Chaffee reversed the decision on the ground that the procedure of the state engineer was illegal, his duty being to survey a line, not merely to adjudicate it. The court also took evidence and established the Rio Grande River, west of the New Mexico meridian, as the southern line of Saguache, in place of the continental divide. Upon the appeal of Hinsdale, this decision was reversed by the court of appeals at its April term, 1897 (*Colorado Court of Appeals Reports*, Vol. IX, p. 368). A year later, the court of appeals was itself reversed by the supreme court, upon the appeal of Mineral (*Colorado Supreme Court Reports*, Vol. XXV, p. 95). In the light of these decisions, the Saguache-Hinsdale line must be inter-



MAP X.—1881—Third General Assembly.

and Mosquito Ranges, its attention was called by the discovery of great silver lodes near the old town of Oro. At first it divided the county, giving its north end, north of five miles south of the first correction line, the descriptive name of Carbonate.<sup>1</sup> But before the session ended, Car-

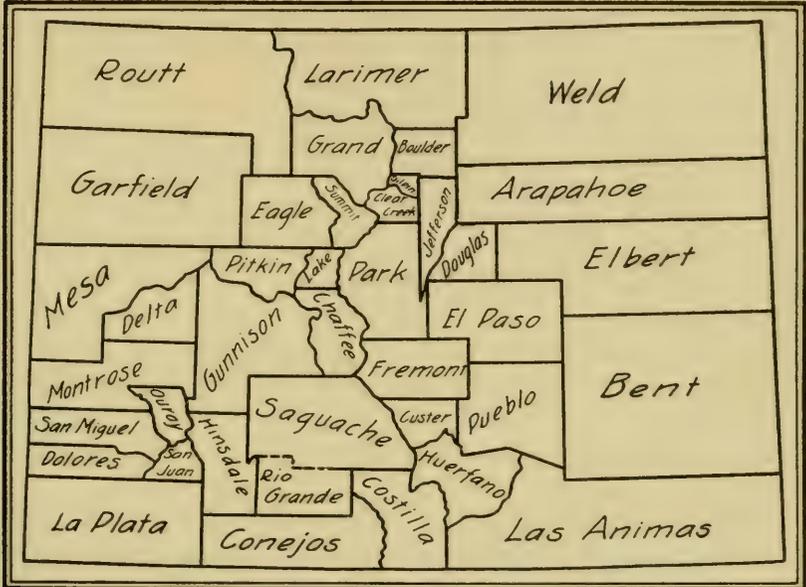
preted as running in part along the Rio Grande, although the writer has been unable to find any statutory authority for the ruling of the Chaffee county court, and inclines to the opinion that a better interpretation of the statute would have been reached had the court been able to pass the matter back to the state engineer for lawful action, rather than to decide the location of the line itself.

The Saguache-Rio Grande line is likewise in some doubt. When Rio Grande was erected in 1874 its northern line was the old southern line of Saguache, passing through Del Norte and Cochetopa Pass. In an act of February 8, 1879, Rio Grande was increased by all of Saguache lying south of the tenth correction line, from its intersection with the first guide meridian east, west thirty miles, north six miles, and west to the Hinsdale line (*Sess. Laws, 1879, p. 48*). It has been commonly held that this act transferred to Saguache all of Rio Grande lying north of the described line, and in this spirit the best maps are commonly drawn. But the text of the act contains no reference whatever to an increase of Saguache. The maps here presented accept the current assumption that such was the intent of the legislature of 1879, and that the statute was merely defective in phrase. But there is much reason to believe that a technical interpretation of the law would restore to Rio Grande its Cochetopa triangle. Such was the opinion of Maxwell in 1892, and the writer accepts his argument as conclusive. The Chaffee county court threw out his ruling because of the manner in which it had been made, not on any avowed ground of an incorrect interpretation of law (*Sixth Biennial Report, p. 47*).

<sup>1</sup> Act of February 8, 1879 (*Sess. Laws, 1879, p. 47*). The "Camp of the Carbonates," as Leadville was popularly known, brought Colorado into the public eye in 1878 and 1879. Some of the contemporary bibliography may be found in F. L. PAXSON, "Preliminary Bibliography of Colorado History," in *University of Colorado Studies*, Vol. III, pp. 19-24

bonate had been discarded for the old name of Lake, while the southern end received the new name of Chaffee.<sup>1</sup>

Two years after the Leadville boom of 1879, the third assembly divided the county of Ouray, to erect that of Dolores, and cut off the northeastern corner of Gunnison to receive the name of Governor Pitkin.<sup>2</sup> But it was not until the time of the fourth assembly, in 1883, that the final



MAP XI.—1883—Fourth General Assembly.

removal of the last of the Uncompahgre Utes made it possible to reduce the counties of the west to reasonable dimensions. In this year, 1883, Summit was restricted to its present limits, while out of its western end were erected Eagle and Garfield.<sup>3</sup> Gunnison was likewise reduced to its

<sup>1</sup> Act of February 10, 1879 (*Sess. Laws*, 1879, p. 48).

<sup>2</sup> Dolores was erected by act of February 10, 1881, and Pitkin by act of February 23 (*Sess. Laws*, 1881, pp. 92, 89). The joint line of Garfield, Pitkin, and Mesa was run by the state engineer in 1890 (*Fifth Biennial Report*, Part I, p. 14.).

<sup>3</sup> Garfield, February 10; Eagle, February 11; (*Sess. Laws*, 1883, pp. 130, 127). The Eagle-Summit boundary was defined, in its northern end, as the divide between the Piney and Blue Rivers. A later and better geographical knowledge showed that two divides exist between these rivers, being themselves separated by the Sheephorn Creek and valley. The state engineer, John E. Field, surveyed the line in 1897 and accepted the eastern divide as the statutory line, throwing the Sheephorn valley into Eagle county (*Ninth Biennial Report*, p. 30). The line between Garfield and Eagle had been run by the same official in 1893 (*Seventh Biennial Report*, p. 221).

present dimensions, Mesa, Delta, and Montrose being created wholly, and Uncompahgre in part, at its expense.<sup>1</sup> The meridian of one hundred and seven degrees, thirty minutes, became the western line of the reduced county, while the Delta-Mesa line followed the edge of the Grand Mesa in part. A new county of Uncompahgre was created by this assembly, comprising all of the valley of the Uncompahgre River and its tributaries south of thirty-eight degrees and twenty minutes, and north of the San Juan county line. Before the session ended the name of San Miguel had been applied to the old county of Ouray, while the name Ouray had been transferred to the new county of Uncompahgre.<sup>2</sup>

The history of the western slope since 1883 is quickly told. Archuleta came with the fifth assembly in 1885, to reduce Conejos to its present limits west of the continental divide.<sup>3</sup> In 1889 the seventh assembly divided La Plata along the mountain range of the same name, and gave the name Montezuma to its western end, in honor, perhaps, of its prehistoric ruins.<sup>4</sup> It ran also an irregular line along the lines of the United States survey in creating Rio Blanco in the northern part of Garfield.<sup>5</sup> The ninth assembly, four years later, separated Rio Grande and Hinsdale counties by the new county of Mineral, four ranges wide and running from the ninth correction line to the continental divide.<sup>6</sup>

During the eighties Colorado developed as an agricultural state more rapidly than before. Irrigation had ceased to be an experiment; while the assertion by the state of its rights to control its waters, together with the supervision of the state engineer over hydraulic conditions, founded

<sup>1</sup> Mesa, February 14; Delta, February 11; Montrose, February 11; Uncompahgre, February 27 (*Sess. Laws*, 1883, pp. 133, 124, 136, 139).

<sup>2</sup> Uncompahgre was created by act of February 27, 1883, and had its name changed to Ouray, March 2, 1883 (*Sess. Laws*, 1883, p. 139). The dividing line between the new Ouray and San Juan had been defined by act of January 18, 1877 (*General Laws*, 1877, p. 207). It depends upon the location of a certain Mineral Creek which empties into the Uncompahgre River, and is of great importance because it traverses a rich mineral district. The line is now (1906) in the hands of the state engineer, whose chief difficulty is to identify Mineral Creek. The northern line of 38° 20', calling for an astronomical location, is also in the hands of the state engineer.

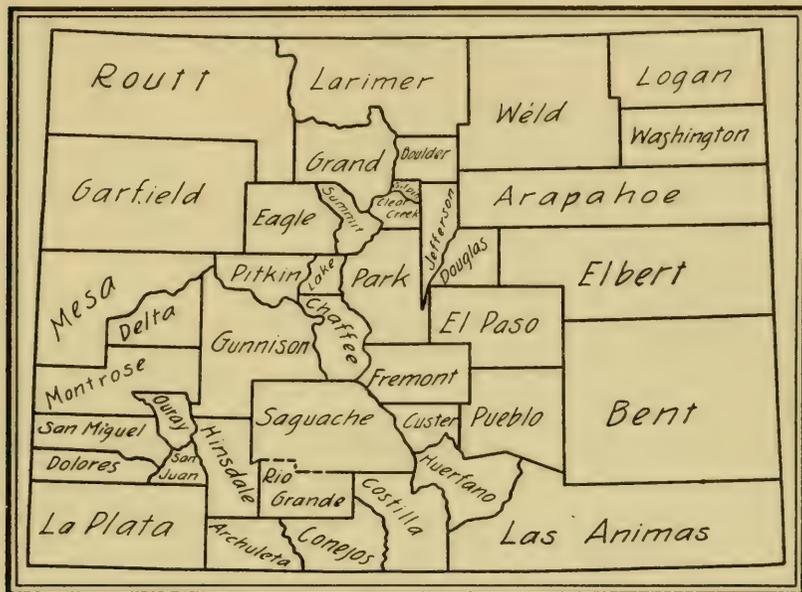
<sup>3</sup> Act of April 14, 1885 (*Sess. Laws*, 1885, p. 40).

<sup>4</sup> Act of April 16, 1889 (*Sess. Laws*, 1889, p. 262).

<sup>5</sup> Act of March 15, 1889 (*Sess. Laws*, 1889, p. 325). The act is carelessly worded in its definition of the survey lines, but its intent can be easily seen.

<sup>6</sup> Act of March 27, 1893 (*Sess. Laws*, 1893, p. 94). This act was carelessly phrased. A later act of April 24, 1895, was necessary to bring its wording into harmony with its intent (*Sess. Laws*, 1895, p. 205).

irrigation rights upon bases more equitable than had been known before.<sup>1</sup> The resulting expansion in the Platte and Arkansas valleys started anew the county growth on the east slope that had paused after the erection of Custer in 1877.

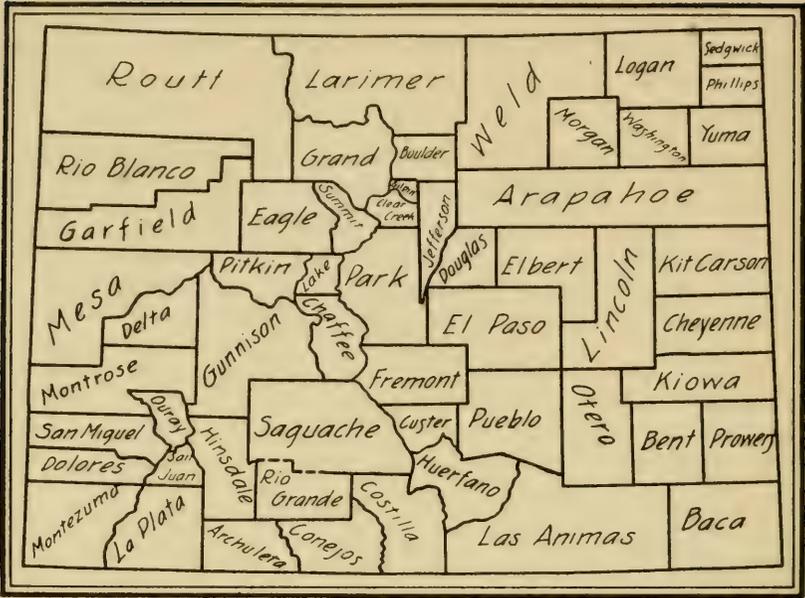


MAP XII.—1887—Fifth and Sixth Assemblies.

The county of Weld, one of the original seventeen of 1861, had complete control of the waters of the lower Platte until 1887. An attempt to create a county of Platte out of its eastern end had been made in 1872, but had failed to secure the required approval at the polls.<sup>2</sup> And thus Weld remained unbroken until the sixth assembly of 1887

<sup>1</sup> The act of February 19, 1879, inaugurated the policy of control of irrigable streams by the state, by erecting ten irrigation districts with a water commissioner for each. Two years later, March 5, 1881, the administration of the system was centralized by the establishment of the office of state engineer to supervise the work of the local commissioners. Twelve *Biennial Reports* have been published by the state engineer, the last being for 1904. Since the act of April 4, 1887, this official has had the duty of adjudicating and surveying disputed boundaries (*Sess. Laws*, 1879, p. 94; 1881, p. 119; 1887, p. 288).

<sup>2</sup> The erection of Platte county was authorized, subject to popular vote, February 9, 1872 (*Sess. Laws*, 1872, p. 80). This statute was repealed February 9, 1874 (*Sess. Laws*, 1874, p. 82). The courts have decided that such a popular vote is not a constitutional prerequisite to the formation of a new county, although it is necessary in cases of transfer of land from one existing county to another (*Frost v. Pfeiffer*, XXVI Colorado 338). There is a general statute of April 4, 1887, for alteration of county lines in certain cases by mutual consent of adjacent counties (*Sess. Laws*, 1887, p. 71.)



MAP XIII.—1889—Seventh General Assembly.

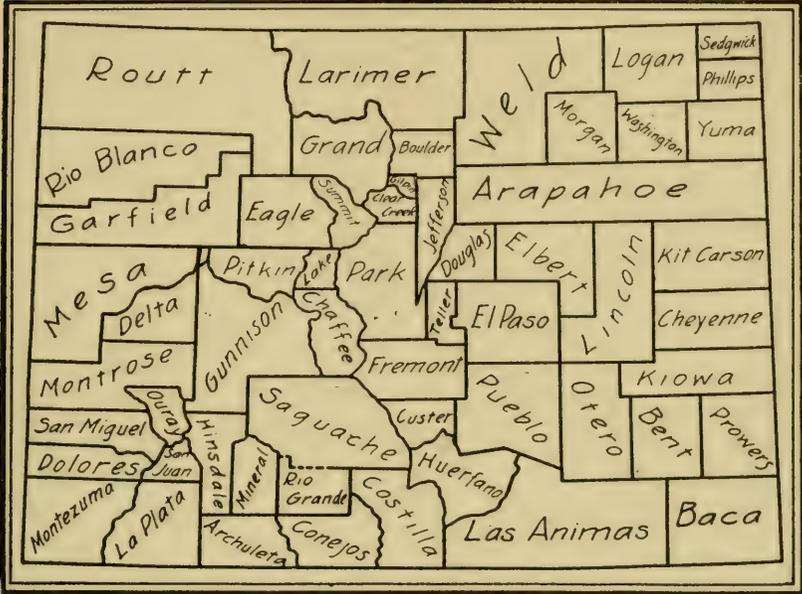
erected two counties of Logan and Washington, and began the process of the final subdivision of the east.<sup>1</sup>

The seventh assembly, in 1889, created eleven counties on the eastern border of the state.<sup>2</sup> Logan parted with its eastern end to endow Sedgwick and Phillips; Yuma was erected in the eastern end of Washington; while Weld gave up, as its last contribution, the area of Morgan. South of Arapahoe, which came through the assembly untouched, perhaps because its eastern end contained no railways to develop the country or to pay taxes for new counties, Elbert and Bent suffered most in the division. From Elbert came Kit Carson and a part of Cheyenne on the Kansas line, with the greater part of Lincoln; while

<sup>1</sup> Washington, February 9; Logan, February 25, 1887 (*Sess. Laws*, 1887, pp. 251, 247).

<sup>2</sup> A study of this county expansion in connection with the railway development of the eighties shows the intimate relation existing between railway transportation and frontier development. A state commissioner of railroads was created in 1885 (*Sess. Laws*, 1885, p. 307). Two reports were published by this official in 1885 and 1892, and finally the office was abolished over the veto of Governor Waite in 1893 (*Sess. Laws*, 1893, p. 405; DAVIS H. WAITE, *Biennial Message . . . to the Tenth General Assembly* [Denver, 1895], p. 43). The *Eleventh Census. Report on Transportation Business*, Part I, pp. 4, 43, states that railroad mileage in Colorado increased from 1,385 in 1880 to 4,176 in 1890.

Bent not only contributed to complete Lincoln and Cheyenne, but parted with three complete counties in Kiowa, Prowers, and Otero. Las Animas lost Baca in this same destruction, giving up the one county of the eastern border with no railway in its endowment.<sup>1</sup>



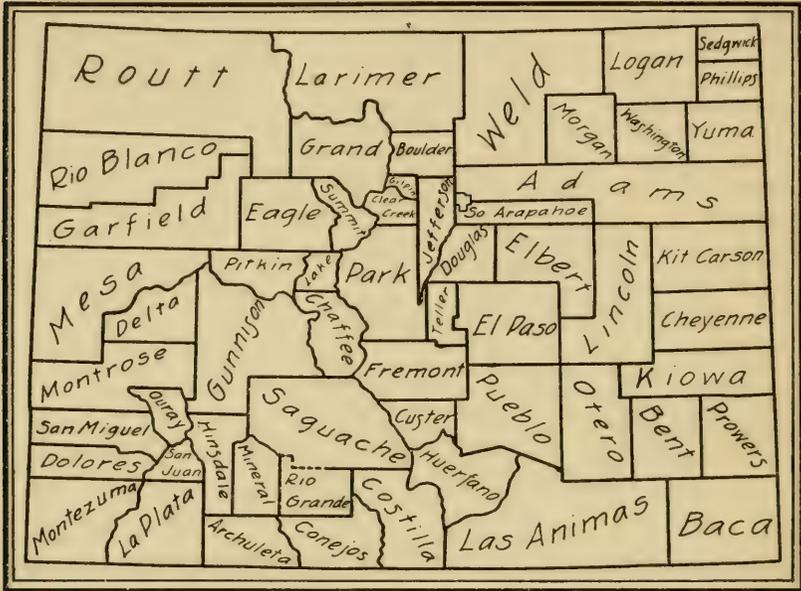
MAP XIV.—1890—Eighth to Twelfth Assemblies.

There was little left to be done on the eastern slope after the comprehensive accomplishments of the seventh assembly. Ten years later, in 1890, the twelfth assembly took the next step in response to the demands of the new Cripple Creek camp, creating Teller county at the expense of El Paso and Fremont.<sup>2</sup>

<sup>1</sup> Morgan, February 19, 1889 (*Sess. Laws, 1889, p. 267*); Yuma, March 15 (p. 476); Cheyenne, March 25 (p. 56); Otero, March 25 (p. 281); Phillips, March 27 (p. 288); Sedgwick, April 9, (p. 340); Prowers, April 11 (p. 294); Kiowa, April 11 (p. 222); Kit Carson, April 11 (p. 225); Lincoln, April 11 (p. 234); Baca, April 16 (p. 26).

<sup>2</sup> Act of March 23, 1890 (*Sess. Laws, 1890, p. 359*). The difficulties in administering a county containing, as in the case of El Paso, two large centers of population, Colorado Springs and Cripple Creek, were made clear during the great strike of 1893-94 (B. M. RASTAL, "The Cripple Creek Strike of 1893," in *Colorado College Studies, Vol. II, pp. 1-48*). The case of *Frost v. Pfeiffer*, cited above, was decided in connection with the creation of this county (XXVI Colorado, 338). The western line of Teller had been run, on appeal of El Paso and Park, in 1893 (*Colorado State Engineer, Seventh Biennial Report, p. 221*).

The thirteenth assembly was induced by the needs of the city of Denver to prepare a constitutional amendment providing a special type of government for counties of more than seventy thousand inhabitants, and a statute erecting the city and county of Denver as coterminous



MAP XV.—1901—Thirteenth Assembly.

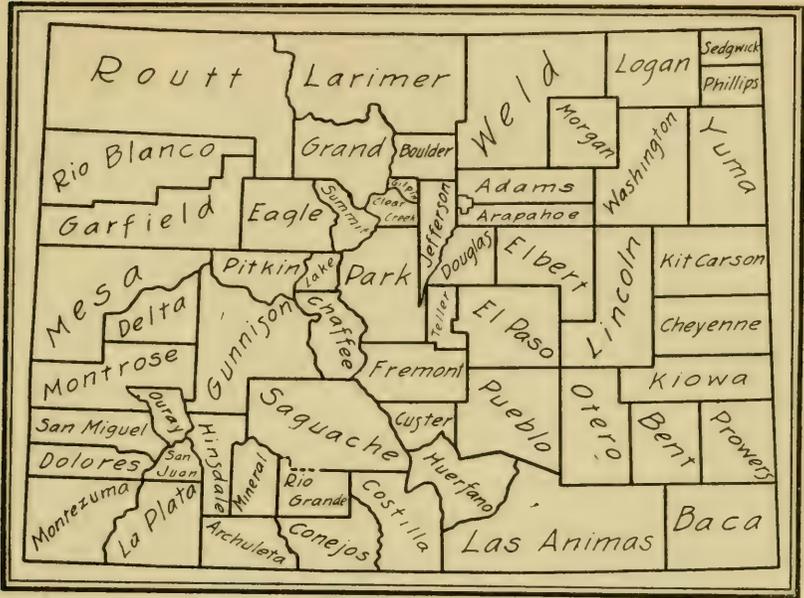
divisions.<sup>1</sup> It provided also that upon the acceptance of this amendment on November 4, 1902, the remainder of Arapahoe county should become Adams and South Arapahoe.<sup>2</sup> Two years later the fourteenth assembly cut away from the cumbersome Adams county, and gave vigor to the notion of the necessity of the railroad to county life by adding portions of the discarded Adams to Washington and Yuma.<sup>3</sup>

<sup>1</sup> Act of March 18, 1901 (*Sess. Laws, 1901*, p. 97; DAVID A. MILLS, *Legislative Manual, State of Colorado, 1903*, p. 267).

<sup>2</sup> Acts of April 15, 1901 (*Sess. Laws, 1901*, pp. 133, 138).

<sup>3</sup> Acts of April 10, 1903 (*Sess. Laws, 1903*, pp. 169, 173).

The fifteenth assembly, in 1905, made no territorial changes, ignoring some demand for a new county in North Park at the expense of Larimer, and devoting itself to the administrative problems arising from the strikes of the preceding year.



MAP XVI.—1903—Fourteenth Assembly.



# LUCRETIUS AND HAECKEL BEFORE THE RIDDLES OF THE UNIVERSE

BY FRED B. R. HELLEMS

## PART II<sup>1</sup>

(1) The Existence of God. (2) The Freedom of the Will. (3) The Nature of Matter and the Origin of Motion. (4) The Origin of Life. (5) The (Apparently Preordained) Orderly Arrangement of Nature. (6) The Origin of Simple Sensation and Consciousness. (7) Rational Thought and the Origin of the Cognate Faculty, Speech.

In our approach to the remaining riddles we ought to be on our guard against expecting such practically complete agreement as we have found in examining the central problem; but we shall find no lack of close and suggestive similarity.

### I. THE EXISTENCE OF GOD

The idea of a "ruling, creating, sustaining God" is opposed by Haeckel and Lucretius with the same ardor, but with a different attitude. Haeckel treats all theism as "mystic dualistic dogma, a mere anthropistic ideal," and dismisses it as a vanished fabric of a dream.<sup>2</sup> He naturally turns to pantheism as the world-system of the modern scientist.

That Lucretius had, "in the same or an analogous sense, a profound conception of the unity of nature and God" has been pointed out by Haeckel himself, and the fact need not be enlarged upon. It is worth recalling, however, that Lucretius nowhere absolutely denies the existence of the gods, and, indeed, speaks of their existence and even of "their revealing themselves to the mind of man."<sup>3</sup> He rationalizes about them and allows them a lotos-eating sort of existence, for all that is necessary for his purpose is the elimination of their interference in the affairs of the universe; and a brilliant critic has most felicitously compared his treatment of the gods to the treatment of rebel potentates in the East, where the kings are left to the people after being ceremonial-

<sup>1</sup> Part I, "The Immortality of the Soul," appeared in the preceding number of the *Studies*.

<sup>2</sup> *WR.*, 275 seq.

<sup>3</sup> See a concise and lucid account in SELLAR, *Roman Poets of the Republic*, 364 seq.

ized into harmlessness. That Lucretius really believed in even this dreamy existence of the gods I am strongly inclined to doubt; but even if he did, it is hardly necessary to point out that gods who are rationalized into distant, graceful, non-interfering spectators of the march of the universe are for all practical purposes the same as no gods at all. The attitude of such a rationalist may even be more atheistic in effect than atheism itself.<sup>1</sup>

## 2. THE FREEDOM OF THE WILL<sup>2</sup>

In theory Haeckel is an unconditional determinist, because he is an unconditional scientist.<sup>3</sup> His conclusion runs: "The great struggle between the determinist and the indeterminist, between the opponent and the sustainer of the freedom of the will, has ended today, after more than two thousand years, completely in favor of the determinist. The human will has no more freedom than that of the higher animals, from which it differs only in degree, not in kind. In the last century the dogma of liberty was fought with general philosophic and cosmological arguments. The nineteenth century has given us very different weapons for its definitive destruction—the powerful weapons which we find in the arsenal of comparative physiology and evolution. We now know that each act of the will is as fatally determined by the organization of the individual and as dependent on the momentary condition of his environment as every other psychic activity. The character of the inclination was determined long ago by *heredity* from parents and ancestors; the determination to each particular act is an instance of *adaptation* to the circumstances of the moment wherein the strongest motive prevails, according to the laws which govern the statics of emotion. Ontogeny teaches us to understand the evolution of the will in the individual child. Phylogeny reveals to us the historical development of the will within the ranks of our vertebrate ancestors."

With this Lucretius, for all his thoroughgoing atomism, could not

<sup>1</sup> Compare Mr. Gladstone's vigorous presentation and condemnation of the Lucretian attitude in modern life. He quoted the six "plangent" lines (II, 646-651) with tremendous effect in a speech that both Mr. Bryce and Mr. Morley select as one of the most impressive of his later efforts. Vide MORLEY, *Life of Gladstone*, III 18-20; and *The Quarterly Review*, September, 1903.

<sup>2</sup> For the current interest about this question in scientific circles, and an attempt at a combination of monism with this postulate of practical reason, see W. H. MALLOCK, "The Reconstruction of Religious Belief" (Harper's, 1905), particularly pp. 354 *seq.*

<sup>3</sup> *WR.*, 129-131.

quite agree. An English writer has pointed out that Lucretius, having escaped from the arbitrary dominion of the gods and found himself confronted by the yet more terrible phantasm of necessity transforming man into a slave, a mere machine of fate, resorted to a bold and simple expedient: "I cannot account for the free-will appearing in human beings unless it were there from the first. If men have free-will, then the atoms from which they come must have free-will too, since nothing comes from nothing." This embryonic free-will is seen in the swerving of the atoms. After insisting on the necessity of assuming that the atoms have power to swerve the least tiny bit, *nec plus quam minimum*, he proceeds:<sup>1</sup> "Again if all motion is ever linked together and a new motion ever springs from another in a fixed order and first beginnings do not by swerving make some commencement of motion to break through the decrees of fate, that cause follow not cause from everlasting, whence have all living creatures here on earth, whence, I ask, has been wrested from the fates the power by which we go forward whither the will leads each, by which likewise we change the direction of our motions neither at a fixed time nor a fixed place, but when and where the mind itself has prompted? For beyond a doubt in these things his own will makes for each a beginning and from this beginning motions are welled through the limbs. . . . Wherefore in seeds [i. e., atoms] too you must admit the same, admit that besides blows and weights there is another cause of motion, from which this power of free action has been begotten in us, since we see that nothing can come from nothing. For weight forbids that all things be done by blows, through, as it were, an outward force; but that the mind itself does not feel an internal necessity in all its actions and is not, as it were, overmastered and compelled to bear and put up with this, is caused by a minute swerving of first-beginnings at no fixed part of space and no fixed time."<sup>2</sup> In this connection Lucretius admits fully the power of heredity: "However much teaching renders some equally refined, it yet leaves behind those earliest traces of the nature of each mind;" but he insists on the power of reason to modify the natural disposition. "Traces of the different natures left behind, which reason is unable to expel from us, are so exceedingly slight that there is nothing to hinder us from living a life

<sup>1</sup> *De R. N.*, II, 243-250.

<sup>2</sup> *Ibid.*, II, 251-293.

worthy of the gods."<sup>1</sup> To this Haeckel would rejoin that our very reason is a product of our heredity and environment.<sup>2</sup>

### 3. THE NATURE OF MATTER AND THE ORIGIN OF MOTION

We may now return to the order of the riddles originally given above taking up together the first, as to the nature of matter, and the second, as to the origin of motion.

Under the "Law of Substance"<sup>3</sup> Haeckel embraces the chemical law of the conservation of matter and the physical law of the conservation of energy. The former we have in Lucretius as his fundamental tenet: "Nothing can come from nothing and nothing returns to nothing;"<sup>4</sup> the latter is, of course, purely modern. Haeckel comes, then, to two fundamental forms of substance, ponderable matter and ether, whereas Lucretius has matter and void. As to the nature of the ultimate particles of substance, Haeckel inclines to the theory put forth by J. C. Vogt, and we may let him state it in his own words:<sup>5</sup>

Vogt assumes the primitive force of the world, the universal *prodynamis*, to be, not the vibration or oscillation of particles in empty space, but the condensation of a simple primitive substance, which fills infinity of space in an unbroken continuity. Its sole inherent mechanical form of activity consists in a tendency to condensation or contraction, which produces infinitesimal centers of condensation; these may change their degree of thickness, and, therefore, their volume, but are constant as such. These minute parts of the universal substance, the centers of condensation, which might be called *pyknotoms*, correspond in general to the ultimate separate atoms of the kinetic theory; they differ, however, very considerably in that they are credited with sensation and inclination (or will-movement of the simplest form), *with souls*, in a certain sense—in harmony with the old theory of Empedocles of the "love and hatred of the elements." Moreover, these "atoms with souls" do not float in empty space, but in the continuous, extremely attenuated, intermediate substance, which represents the uncondensed portion of the primitive matter. By means of certain "constellations, centers of perturbation, or systems of deformation," great masses of centers of condensation quickly unite in immense proportions, and so obtain a preponderance over the surrounding masses. By that process the primi-

<sup>1</sup> *De R. N.*, III, 307-322.

<sup>2</sup> With regard to Haeckel's statement that higher animals have as much claim to possess freedom of the will as have human beings, it should be noted that Lucretius holds the same view; he allows a certain freedom to both, Haeckel to neither. *De R. N.*, II, 263 *seq.*, in connection with the context; *WR.*, 131.

<sup>3</sup> *WR.*, 211 *seq.*

<sup>4</sup> *De R. N.*, I, 149, 150, *et passim.*

<sup>5</sup> *WR.*, 218-219.

tive substance, which in its original state of quiescence had the same mean consistency throughout, divides or differentiates into two kinds. The centers of disturbance, which *positively* exceed the mean consistency in virtue of the *pyknosis* or condensation, form the ponderable matter of bodies; the finer, intermediate substance, which occupies the space between them, and *negatively* falls below the mean consistency, forms the ether, or imponderable matter. As a consequence of this division into mass and ether there ensues a ceaseless struggle between the two antagonistic elements, and this struggle is the source of all physical processes. The positive ponderable matter, the element with the feeling of like or desire, is continually striving to complete the process of condensation, and thus collecting an enormous amount of potential energy; the negative, imponderable matter, on the other hand, offers a perpetual and equal resistance to the further increase of its strain and of the feeling of dislike connected therewith, and thus gathers the utmost amount of *actual* energy.

The primal atoms of Lucretius are known well enough. They are indestructible, eternal, indivisible—except metaphysically into *minimas partes*—of various shapes, infinite in number, moving continuously in infinite space. The various qualities of material things are the results of accidental combinations of the atoms, and we have seen that even the human mind and soul are included in this reckoning. In view of the importance of the atomic motion just mentioned, we may quote the following:

If you think that first-beginnings of things can lag and by lagging give birth to new motions of things, you wander far astray from the path of true reason: since they travel about through void, the first-beginnings of things must all move on either by their own weight or haply by the stroke of another. For when during motion they have, as often happens, met and clashed, the result is a sudden rebounding in an opposite direction; and no wonder, since they are most hard and of weight proportioned to their solidity and nothing behind gets in their way. And that you may more clearly see that all bodies of matter are in restless movement, remember that there is no lowest point in the sum of the universe, and that first bodies have not where to take their stand, since space is without end and limit and extends immeasurably in all directions round, as I have shewn in many words and as has been proved by sure reason. Since, then, this is a certain truth, sure enough no rest is given to first bodies throughout the unfathomable void, but driven on rather in ceaseless and varied motion they partly, after they have pressed together, rebound, leaving great spaces between them, while in part they are so dashed away after the stroke as to leave but small spaces between. And all that form a denser aggregation when brought together and rebound leaving trifling spaces between, held fast by their own close-tangled shapes, these form enduring bases of stone and unyielding bodies of iron and the rest

of their class, few in number, which travel onward along the great void. All the others spring far off and rebound far leaving great spaces between: these furnish us with thin air and bright sunlight. And many more travel along the great void, which have been thrown off from the unions of things or, though admitted, have yet in no case been able likewise to assimilate their motions. Of this truth, which I am telling, we have a representation and picture always going on before our eyes and present to us: observe whenever the rays are let in and pour the sunlight through the dark chambers of houses: you will see many minute bodies in many ways through the apparent void mingle in the midst of the light of the rays, and as in never-ending conflict skirmish and give battle, combating in troops and never halting, driven about in frequent meetings and partings; so that you may guess from this, what it is for first-beginnings of things to be ever tossing about in the great void. So far as it goes, a small thing may give an illustration of great things and put you on the track of knowledge. And for this reason too it is meet that you should give greater heed to these bodies which are seen to tumble in the sun's rays, because such tumbblings imply that motions also of matter latent and unseen are at the bottoms. For you will observe many things there impelled by unseen blows to change their course, and driven back, to return the way they came, now this way and now that way in all directions round. All you are to know derive this restlessness from the first-beginnings. For the first-beginnings of things move first of themselves, next those bodies which form a small aggregate and come nearest, so to say, to the powers of the first-beginnings, are impelled and set in movement by the unseen strokes of those first bodies, and they next in turn stir up bodies which are a little larger. Thus motion mounts up from the first-beginnings and step by step issues forth to our senses, so that those bodies also move, which we can discern in the sunlight, though it is not clearly seen by what blows they so act.<sup>1</sup>

As to the "Origin of Motion," then, the theory of either scientist is simply a part of his conception of matter, as has doubtless been noticed in reading the preceding paragraphs. Lucretius merely posits motion as a property of his ultimate particles, and Haeckel practically does the same when he insists on the "tendency to condensation or contraction" in Vogt's primitive substance.<sup>2</sup>

In connection with the nature of matter it would seem desirable to discuss briefly one point, the character of the atom as related to the problem of consciousness. Both Haeckel and Lucretius state that consciousness has a material, and therefore an atomic, basis;<sup>3</sup> but the former has

<sup>1</sup> *De R. N.*, II, 80-141.

<sup>2</sup> Cf. *WR.*, 241: "In our opinion this second world-enigma is solved by the recognition that movement is as innate and original a property of substance as is sensation."

<sup>3</sup> See p. — of this article.

always denied any individual consciousness to the atom, and the latter refuses to attribute thereto any sensation whatever.<sup>1</sup> But here is our old crux as to *ex nihilo nihil fit*, and Haeckel, as we have seen, does attach "the elementary qualities of sensation and will" to his first-beginnings. Apparently, then, Haeckel is a consistent monist and Lucretius a benighted materialist; but in reality this "unconscious possession of sensation and will," manifested so early in matter as tropisms, and the power to swerve possessed by the Lucretian atoms, making a break in the endless chain of causation, may eventually appear to metaphysical examination much closer together than they seem at first sight.

#### 4. THE ORIGIN OF LIFE

The question of the origin of life is still approached with no little diffidence by many advanced scientists; but for Haeckel and Lucretius there is no doubt nor shadow of turning.<sup>2</sup> In the tender age of the world, when there were conditions of heat and moisture scarcely conceivable by us, life was generated spontaneously by the earth, which has "rightly gotten the name of mother." Some combination of particles under just the proper condition was the origin of organic life. These two sentences would be a fair statement of the fundamental position of either writer; but the orderly development of organisms through the crudest protoplasmic forms is of course a purely modern conception.<sup>3</sup> Lucretius can guess that nature essayed the creation of all sorts of living creatures which died out because they were unable to beget and continue their breed, and in one sense this is a theory of the survival of the fittest; but it should not be confused with the elaborately supported modern hypothesis. It is very strange, however, almost incredible, indeed, that with the suggestions of Lucretius available for modern science the formulation of this all important hypothesis came so late.

#### 5. THE ORDERLY ARRANGEMENT OF NATURE

When we come to the (apparently preordained) orderly arrangement of nature, we naturally find both writers immediately rejecting any "divine,

<sup>1</sup> *De R. N.*, II, 865 *seq.*

<sup>2</sup> In the *WR.* see the first part of "The Unity of Nature" (chap. xiv) and the latter part of "The Evolution of the World" (chap. xiii); in the *De R. N.* see Book V, particularly vss. 416-924.

<sup>3</sup> Particularly significant of the difference in the method of approach of our two writers and of the data available for their use is the statement of the carbon theory of abiogenesis or archigony in *WR.*, 256 *seq.*

supernatural, telic force." "All things are done without the hands of the Gods."<sup>1</sup> Indeed, as we have already seen, the *De Rerum Natura* and the *Welträthsel* were put forth to deny the operation of any external ruler, so that an adequate treatment of this fourth enigma would demand an exhaustive exposition of both books, and there is something appurtenant to this section in every topic we have touched upon. Accordingly, we shall have to pass over the more general phases; but the argument from disharmonies, to borrow a word from Metchnikoff, demands some notice, inasmuch as both men make it especially significant.

"But if I did not know what first-beginnings of things are, yet judging by the very arrangements of heaven I would venture to affirm, and led by many other facts to maintain, that the nature of things has by no means been made for us by divine power; so great are the defects with which it is encumbered." Thus Lucretius writes,<sup>2</sup> and then enumerates a few of the defects: the comparatively small part of the world profitably habitable by man, the difficulty of tillage, the tendency of food-producing plants to degenerate, disease, untimely death—the great disharmony—the helplessness of the human offspring as contrasted with the young of beasts. "Throughout the whole of astronomy, geology, physics, and chemistry there is no question today of a 'moral order,' or 'a personal God whose hand hath disposed all things in wisdom and understanding,'" says Haeckel, and then turns with the same spirit to the history of peoples and of humanity and to the fate of individual human beings, the catastrophes and accidents of modern daily life. "And among these hundreds of thousands of animal victims of modern civilization, strong, industrious, courageous workers predominate. Yet the talk of a 'moral order' goes on."<sup>3</sup> Haeckel, of course, can give all the arguments of Lucretius and add thereto all the significant instances of dysteleology in modern biology. "All the higher animals and plants, or, in general, all organizations which are not entirely simple in structure, but are made up of a number of organs in orderly co-operation, are found, on close examination, to possess a number of useless or inoperative members, sometimes, indeed, hurtful and danger-

<sup>1</sup> *De R. N.*, I, 158, *et passim*; *WR.*, 258 *seq.*, *et passim*.

<sup>2</sup> *De R. N.*, V, 195-199; *cf.* 177-181.

<sup>3</sup> *WR.*, 273.

ous;" and the now ubiquitous appendix is honorably prominent at the end of the enumerated instances.

#### 6. THE ORIGIN OF SIMPLE SENSATION AND CONSCIOUSNESS

Upon the origin of simple sensation and consciousness, the fifth enigma, we have already touched so that we may make our treatment very brief. Lucretius,<sup>1</sup> posits an atom without sensation, *insensile*, and states that from these insensible primordia arise all things capable of sensation. Atoms of the same sort in different arrangements give us inert logs and leaping flames and vital parts that can feel. He adduces in evidence the childish belief that worms may arise from heaps of inanimate filth, and the change in the nature of material when grass becomes part of the bodies of animals and these in turn part of our frame, or we a part of theirs. That is, he argues that nature has a power of turning inanimate matter into living substance capable of sensation, or, to advance a couple of thousand years for a word, into protoplasm. He asks how eggs can be changed into birds unless sensible things can arise from insensible.<sup>2</sup> Sensation in the human frame, he goes on, disappears when the arrangement of the atoms is disturbed by a powerful blow, so it must be due merely to that arrangement. Again, if the blow was not strong enough to cause death, the original arrangement of the atoms in the frame is gradually brought about again and sensation returns. "So that you may know that it is of great import with what first-beginnings the same first-beginnings are combined and in what arrangement, and what motions they mutually give and receive."<sup>3</sup>

For Haeckel the answer to the present riddle is found in the nature of his ultimate substance. The pyknotoms are credited with a certain sensation and inclination, so that he finds no difficulty in the development of

<sup>1</sup> *De R. N.*, II, 865-1022.

<sup>2</sup> Cf. Huxley in *Science and Christian Tradition*: "Granted a fowl feels; that the chick just hatched feels, that the chick when it chirps within the egg may possibly feel; what is to be said of it on the first day, when it is nothing but a flat cellular disk? I certainly cannot bring myself to believe that this disk feels. Yet if it does not there must be some time in the three weeks between the first day and the day of hatching, when as a concomitant, or a consequence of the attainment by the brain of the chick of a certain stage of structural evolution, consciousness follows."

<sup>3</sup> It will be noticed that Lucretius does not use the power of swerving in the atom as a starting-point for sensation and consciousness; the explanation probably is that he did not feel it necessary in this connection, whereas for his doctrine of the freedom of the will it is indispensable.

less simple sensation. All sensibility is connected with material changes in the protoplasm.<sup>1</sup> In the lowest animals and in plants the psychoplasm, the indispensable substratum of any psychic activity, has not reached an independent differentiation. He then gives five chief stages of sensibility from the point at which the whole psychoplasm is sensitive to the point at which "*conscious perception* is developed by the mirroring of the sensations in a central part of the nervous system, as we find in man and the higher vertebrates, and probably in some of the higher invertebrates, notably the articulata."

Both writers, then, hold that the origin of simple sensation and consciousness is connected with the arrangement of the ultimate particles of substance. Lucretius maintains that sensibility may arise from insensible atoms; whereas Haeckel attributes to his atoms the simplest form of sensation. Both, of course, deny any divine interposition at the point where it is so often demanded, the origin of consciousness.<sup>2</sup>

#### 7. RATIONAL THOUGHT AND THE ORIGIN OF THE COGNATE FACULTY, SPEECH

Recalling our treatment of the preceding topic and of the immortality of the soul, it is hardly necessary to state that for both Haeckel and Lucretius rational thought is simply the culmination of our psychic gradations.

As to the origin of language Haeckel<sup>3</sup> is contented to point out that "here also we have to recognize a long chain of evolution which stretches unbroken from the lowest to the highest stages. Speech is no more an exclusive prerogative of man than reason. In the wider sense it is a common feature of all the higher gregarious animals, at least of all the articulata and the vertebrates, which live in communities or herds. This is effected either by touch or by signs, or by sounds having a definite meaning. The song of the bird or of the anthropoid ape (*Hylobates*), the barking of the dog, the neigh of the horse, the chirp of the cricket, the cry of the cicada, are all specimens of animal speech. Only in man, however, has that articulate conceptual speech developed which has enabled

<sup>1</sup> *WR.*, 108 *seq.*

<sup>2</sup> Their views as to consciousness in its higher forms have been compared in Part I of the paper in the preceding number of the *Studies*.

<sup>3</sup> *WR.*, 126.

his reason to attain such high developments." Others have worked out the theory of linguistic evolution in such detail that he has only to summarize their results. Lucretius, however, was not so fortunate, and he writes at greater length as follows:

But nature impelled them to utter the various sounds of the tongue and use struck out the names of things, much in the same way as the inability to speak is seen in its turn to drive children to the use of gestures, when it forces them to point with the finger at the things which are before them. For everyone feels how far he can make use of his peculiar powers. Ere the horns of a calf are formed and project from his forehead, he butts with it when angry and pushes out in his rage. Then whelps of panthers and cubs of lions fight with claws and feet and teeth at a time when teeth and claws are hardly yet formed. Again we see every kind of fowl trust to wings and seek from pinions a fluttering succour. Therefore, to suppose that some one man at that time apportioned names to things, and that men from him learnt their first words, is sheer folly. For why should this particular man be able to denote all things by words and to utter the various sounds of the tongue, and yet at the same time others be supposed not to have been able to do so? Again if others as well as he had not made use of words among themselves, whence was implanted in this man the previous conception of its use and whence given to him the original faculty to know and perceive in mind what he wanted to do? Again one man could not constrain and subdue and force many to choose to learn the names of things. It is no easy thing in any way to teach and convince the deaf of what is needful to be done; for they never would suffer nor in any way endure sounds of voice hitherto unheard to continue to be dinned fruitlessly into their ears. Lastly, what is there so passing strange in this circumstance, that the race of men, whose voice and tongue were in full force, should denote things by different words as different feelings prompted? Since dumb brutes, yes, and the races of wild beasts are accustomed to give forth distinct and varied sounds when they have fear or pain and when joys are rife. This you may learn from facts plain to sense; when the large, spongy, open lips of Molossian dogs begin to growl enraged and bare their hard teeth, thus drawn back in rage they threaten in a tone far different from that in which they bark outright and fill with sounds all the places round. Again when they essay fondly to lick their whelps with their tongue, or when they toss them with their feet and snapping at them make a feint with lightly closing teeth of swallowing though with gentle forbearance, they caress them with a yelping sound of a sort greatly differing from that which they utter when, left alone in a house, they bay or when they slink away howling from blows with a crouching body. Again is not the neigh, too, seen to differ, when a young stallion in the flower of age rages among the mares smitten by the goads of winged love, and when with wide-stretched nostrils he snorts out the signal to arms, and when as it chances on any other occasion he neighs with limbs all shaking? Lastly, the race of fowls

and various birds, hawks and osprays and gulls seeking their living in the salt water mid the waves of the sea utter at a different time noises widely different from those they make when they are fighting for food and struggling with their prey. And some of them change together with the weather their harsh croakings as the long-lived races of crows and flocks of rooks when they are said to be calling for water and rain, and sometimes to be summoning winds and gales. Therefore, if different sensations compel creatures, dumb though they be, to utter different sounds, how much more natural it is that mortal men in those times should have been able to denote dissimilar things by many different words!<sup>1</sup>

In running over these lines one readily notes that Lucretius agrees with modern views in assigning language to both beasts and birds; that he insists upon a *pari passu* development of a number of primitive ancestors; and that he thinks of the evolution of language as absolutely simple and natural.

In conclusion, I may answer the question of a friend as to what ends the foregoing paper, including the sections on "The Immortality of the Soul," was intended to serve. To begin with, we stand at the parting of the ways.—The human race, however, always does stand at a parting of the ways, and, I suppose, always will.—Monism and dualism are distinct paths claiming to lead us onward and upward to the highest planes of moral life and intellectual thought, and one of these paths every thinking man must follow. At such a time it might seem worth while to consider monism at two significant points in its historical development, in the hope of gaining some little knowledge, at any rate, as to the line as well as the extent of its advance. That Haeckel and Lucretius conveniently represent two such points is obvious. Again, I take it to be true that a comparison of the views of two master-minds on a series of momentous questions is never without some profit. Furthermore, the hard-working teachers of science and of classics often wish to bring together the two stages of thought represented by our authors, and for them I have tried to make such a comparison easily available. That the method of quoting so extensively is open to criticism I am well aware; but I have preferred to stand aside and let the recorded words speak for themselves. From a man's own words one may learn his thoughts, whereas an interpreter is often misleading, if not misled.

<sup>1</sup> *De R. N.*, V 1028-1090.

# SHAKESPEARE AND PSYCHOGNOSIS

## ESSAY II. MAJOR CHARACTERS OF "THE TEMPEST"<sup>1</sup>

BY MELANCHTHON F. LIBBY

### ARIEL: IDEAL TYPE

As Ariel is called "An Airy Spirit," it might be supposed that his character would defy the inductive method of criticism. But in reality he appears in six of the nine scenes, and many plain but significant facts can be stated concerning his words, actions, and relations to others. He appears in the second, third, sixth, seventh, eighth, and ninth scenes. The thunder and lightning of the first scene are the work of Ariel; or, if one judge by his words to Prospero in scene ii, he is, rather than makes, the lightning. In the second scene we learn that he is Prospero's servant; that he comes to him at his master's wish and command. Without further message, he respects the authority of the grave and learned Prospero. He has remarkable powers over nature, being able to fly, swim, dive into fire, ride on clouds. He has "performed to point" a tempest with terrible accompaniments of lightning, thunder, wind, and wave. Through these dramatic means he has moved men to tricks of desperation. He has dispersed the shipwrecked men in troops about the island. He speaks with vivid powers of narration, and of his own initiative mimics the attitude of the despairing Ferdinand. He has dispersed a fleet.<sup>2</sup>

At the mention of more toil he becomes moody. He demands his liberty, desiring to follow the play-instinct, and not to serve the ends of his moral and intellectual master. He speaks boldly of the worth to Prospero of his service, which he describes as truthful, free from mistakings, and free from grumblings.

Prospero, with habitual severity, says nothing in reply to this claim. He proceeds to read Ariel a lesson of gratitude, in the course of which we learn something of the spirit's history.

Prospero gives us more facts about Ariel: he can walk the bed of the ocean, face the cold of the north, penetrate the veins of the frozen earth. Ariel was the servant of Sycorax before he was the servant of Prospero. This extraordinary fact is fully emphasized. But the gross nature of the ancient rites of Sycorax roused deep revolt in Ariel. For his rebellion he was horribly punished, being imprisoned in a cloven pine, for a dozen years. Sycorax died. Then came an interval during

<sup>1</sup> Essay I, "The Minor Characters of the Tempest," appeared in No. 2 of this volume of *University of Colorado Studies*, p. 63.

<sup>2</sup> This figure may have been suggested by the popular idea of the time concerning the protection of England from the Armada.

which the freckled hag-born whelp, Caliban, was the only human being on the island. Ariel showed himself capable of feeling pain by his groans. His groan moved wolves to howl, a strong comparison as Shakespeare uses words: "It was a torment to lay upon the damned."<sup>1</sup>

It was Prospero's art, gained by the bettering of his mind by study, that enabled him to free Ariel from between the forks of the tree. If the freed spirit now declines to assist his learned master in his labors, the master will peg him in the knotty entrails of an oak for twelve years more. Prospero does not deny Ariel's right to liberty. He denies that Ariel should yet assert that right. Ariel acquiesces and begs his master's pardon.

Ariel's name in the *Dramatis Personae* is entered after Miranda's, not among the male characters. In the play he is only *once* referred to by a masculine word.<sup>2</sup> Prospero commands him to assume the form of a nymph, and to render himself invisible to all but his master. These two powers, of assuming any desired form and of being invisible, are accepted and used by Shakespeare as facts suitable to the conception of a spirit.

When Ariel reappears like a water-nymph, Prospero gives the spirit a command. It is not clear why the form of a water-nymph was required, for when Ariel enters, followed by Ferdinand, he is heard singing, but not seen. Perhaps, as he is to sing like a water-nymph, he must assume that part in its entirety. The first song is an expression of the free play-instinct; with lyrics of the moral and intellectual realm it has no relation; it expresses no interest in anything except the interest of pure, disinterested love of the beautiful. It is unique in its freedom from thought or purpose. It has the suggestion of the passing of night and the coming of dawn, which should enhance its beauty to those who might find its clear, dim, peaceful pictures and far away beautiful sounds insipid.

The second song is also mystical and unearthly. The light, emotionless treatment of death, so remote from commonplace dirges, suggests that to the spirit this world is but a passing show and death no more than the dropping of the curtain between acts. It has the note of infinity in a remarkable degree. There is no human pathos in the line, "those are pearls that were his eyes," yet it is not coarse or harsh. Ariel is speaking of human vicissitude under the forms of the eternal. Only from such a point of view is it true that whatever is, is right, and from a station above passion and sympathy it is sufficient to say to Ferdinand mourning for his father,

"Nothing of him that doth fade,  
But doth suffer a sea-change  
Into something rich and strange."

Ferdinand's comment on the poem is the best criticism. "This is no mortal busi-

<sup>1</sup>Hartmann's conception of a suffering god.

<sup>2</sup>In Renan's *Caliban* Ariel is female.

ness, nor no sound that the earth owes: I hear it now above me." It is precisely at this point that Prospero says,

"The fringed curtains of thine eye advance,  
And say what thou seest yond."

At this moment Miranda and Ferdinand fall in love, and thus the mortal is linked to the spiritual in the very center of the plot. Ariel has roused in Ferdinand a profound spiritual craving, and, as his eyes fall upon Miranda, he exclaims: "Most sure the goddess on whom these airs attend!" It is in this that natural magic is seen to be seated.<sup>1</sup> Prospero thanks Ariel for his service in bringing Ferdinand in this way: Prospero here controls human life at its fountain:

"Spirit, fine spirit, I'll free thee  
Within two days for this."

Prospero attaches very serious importance to the high romantic art of the fantastical spirit, and its influence upon this pair of children. "Miranda is fifteen, and Ferdinand presumably not much older." He afterwards exclaims again: "Delicate Ariel, I'll set thee free for this." As if in some mysterious way the freeing of the spirit depended upon the success of true love, and true love depended upon the labors of the spirit.<sup>2</sup>

At the close of the scene Ariel receives a new command, which he promises to obey to the syllable.

It appears from the scene that, though Ariel is a spirit, his character is firmly outlined by words, actions, and descriptive narration. He possesses powers over the elements of physical nature far transcending those of science as known to Shakespeare, or even as known today. He exercises these powers, as far as can be learned, immediately, not mediately. This is his peculiar gift as a spirit. He prefers play to labor, and has no initiative in useful effort, but in mimicry or play he shows pleasurable activity; restraint makes him moody and low-spirited. What he agrees to do he does satisfactorily in every respect; but it seems he would do anything else with equal exactness, if Prospero commanded it. Uncontrolled, he would play, like Puck. As far as his story extends, he has been a servant or a prisoner. When the service was too distasteful, he rebelled, to his cost. It was through learning that he became comparatively free. He therefore owes it to learning to lend his powers to its further needs. There is danger of a worse fate if he refuses, which is a course within his choice.

His power extends to his own form, which he can change or render invisible.

His songs are marked by two distinct characteristics—the pure love of mere beauty—as music, dancing, landscape, joyous playfulness; and the note of remote-

<sup>1</sup> Cf. Kipling's "To the true Romance."

<sup>2</sup> The pedagogy that aims at modifying environment leaves the raw material of education to chance. The control of selection by science, however impossible at present, can alone bring the evolution of man within the control of knowledge.

ness from mortal sympathies and purposes. This note of infinity is the most characteristic fact about Ariel. His cool, beautiful explanation of death, the deepest of human terrors, as a phenomenon of progress, is not inhuman but superhuman. This superhuman point of view makes his lack of human feeling assume a new and different aspect. Prospero treats him as if he had absolute respect for his power, genius, purity, but as if he felt the need of using and directing his power because of Ariel's freedom from the sense of duty. Ariel treats Prospero as if he respected his gravity, learning, purpose; but as if his austere control were irksome, and his purposes a bore. Ariel's understanding and bitter experience convince him that his liberty depends upon obedience to the orders of the day, and the promise that liberty is near makes him more and more willing.

The first labor of Ariel was the raising of the storm and the dispersion of the shipwrecked mariners. His second labor was the bringing of Ferdinand to Miranda. His third labor was the rousing of Gonzalo in the third scene. In this as in the others he is executing the commands of Prospero. He says:

"My master through his art foresees the danger  
That you, his friend, are in; and sends me forth  
For else his project dies—to keep thee living."

He recognizes Gonzalo as the friend, and Antonio and Sebastian as the enemies of Prospero.

His song to the sleeping Gonzalo is again marked by indifference to death; he will preserve Gonzalo because Prospero has reasons for keeping him living.

"If of life you keep a care,  
Shake off slumber and beware!"

When the success of his mission is assured, and Gonzalo has been aroused to good purpose, Ariel soliloquizes:

"Prospero, my lord, shall know what I have done:  
So, king, go safely on to seek thy son."

The king goes safely, because Antonio and Sebastian have been checkmated by Gonzalo aroused by the spirit.

The sixth scene is that in which Stephano and Caliban discuss affairs of state, and the monster outlines the conspiracy against the life of Prospero. Ariel enters invisible. He speaks four times. His speeches are "Thou liest," "Thou liest, thou canst not," "Thou liest," and "This will I tell my master." There is no evidence in this scene that Ariel is on duty, and his interference, though opportune, appears frolicsome. However this may be, he, either through obedience to Prospero or through affection for him, reports the conspiracy against him. After causing poor Trinculo a beating, he plays the tune of Stephano's catch, and leads the monster and his friends by the music to the "filthy-mantled pool." This is the fourth labor of Ariel, and for it he is highly commended in Act IV by Prospero.

In the seventh scene Ariel, assisted by certain other spirits, over whom Prospero

gives him authority, presents a magic banquet before the nobles. Just as Alonso and his courtiers are about to "stand to and feed," being fatigued by their wanderings through the island in quest of Ferdinand, Ariel claps his wings upon the table, and the banquet vanishes. Ariel then addresses to Alonso, Sebastian, and Antonio a most solemn and effective speech. He declares them unfit to live.

Enraged by these charges, they endeavor to attack Ariel, who, however, gives new proof that power is at hand to disarm the "three men of sin." He declares even their valor to be wrong and suicidal. He declares spirits to be in league with the elemental fates, implying that through this league an appeal to natural force becomes useless against a spirit. Ariel vividly sets forth the foulness of the banishment of Prospero and Miranda, and concludes his searching lecture by the heaviest judgment, with only a slight hope of escape, dependent upon "heart-sorrow and a clear life ensuing." Ariel vanishes in thunder, and mocking shapes carry out the table.<sup>1</sup> None of Ariel's labors is more lauded by his master than this soul-piercing exhortation. Nothing is less in the true nature of Ariel than this Hebraic denunciation of sin, nothing less in the usual manner of Shakespeare; it is therefore to be observed with proportionate attention as significant and important. It is through this labor that the consciences of the egoists are touched, and, while two of them are scarcely softened, all three are defenseless and stand desperate, and openly condemned for selfishness and injustice.<sup>2</sup>

The masque of the fourth act follows hard upon this scene.

Prospero praises the spirits and calls upon Ariel for a sixth labor. He is to prepare the masque instantly, "With a twink." "Well, I conceive," he replies. As the spirits enter, silence is enjoined and soft music is heard. Ariel presents Ceres, but all the speeches of the masque are bright and spiritual, the sense-objects being chosen to suggest beauty as well as plenty. The question of Ceres concerning the presence of Venus is made the condition of the presence of the goddess of plenty

"Tell me, heavenly bow,  
If Venus or her son, as thou dost know,  
Do now attend the Queen? Twice they did plot  
The means that dusky Dis my daughter got,  
Her and her blind boy's scandal'd company  
I have foresworn."

Iris replies:

"Of her society  
Be not afraid; I met her deity  
Cutting the clouds towards Paphos and her son  
Dove-drawn with her."

Ceres, thus pacified, sings promises of plenty. After the masque, Prospero is deeply moved by certain thoughts, but he does not neglect to praise the spirits

<sup>1</sup> This miracle of providing food by magic was in Bacon taking on a scientific significance at this time.

<sup>2</sup> This is a Neo-Hellenic reading of sin as stupid, ugly, and subversive of freedom.

courteously, if somewhat briefly. He then makes the most profound of human reflections: "We are such stuff as dreams are made on": all that is of the senses fades away, and changes to something rich and strange, and we at the core are spirits such as produce and are our dreams. This reflection, in its disturbing reaction, recalls that incarnation of sense, the beast Caliban, who is as far as possible from his master's ideal. Hence, accordingly, Ariel's next service is the disciplining of the three valorous companions whom he had led to the "filthy-mantled pool."

Prospero commands Ariel to bring a load of glistening apparel<sup>1</sup> with which to keep the minds of the three companions turned away from their true purposes of destroying the books of Prospero, Prospero himself, and Miranda. This plan succeeds in spite of Caliban's superiority to the allurements that overcome fool and butler. Mountain, Silver, Fury, Tyrant are the symbolic names of the hounds by which these ignorant wretches are hunted.

In the fifth act Ariel performs two more services for Prospero. As the scene opens, he reminds his master of his promise of liberty. Prospero is not unmindful of what he has promised. In Ariel's reply to the wizard's question concerning the king and his followers, the description of Gonzalo is such that Ariel himself is almost touched by the contemplation of mortal woe; but Ariel is not human in the sense of mortal. When Prospero sees that Ariel himself has a feeling of their affliction, his austerity is moved, and he makes a speech at once tragic and magnanimous. Ariel is dispatched to free the king and his followers; the worst of whom are now weak and distracted, while the others mourn over them in a common fellowship of misery and "heart-sorrow." Ariel fetches them to the cell of Prospero, where they learn to know their real characters in the vivid words of the magician. After this event Ariel sings his song of freedom, with better reason than Caliban had had after forming his league with the butler and the fool. The simple playfulness of the song is superficially astonishing as the expression of the liberty of a being of such power, knowledge, and ubiquity. After the song, which is a cry of joy, Ariel receives a commission to bring the sailors to the cell of learning. While performing this service he incidentally sets the ship to rights. Ariel now ends his arduous tasks by fetching Caliban and his two companions to Prospero, who rates them soundly and gives them employment. Prospero's last words to Ariel are:

"My Ariel, chick,  
That is thy charge."

Alluding to the success of the voyage to Italy:

"then to the elements  
Be free, and fare thou well!"

It is clear that the play offers no dearth of facts about Ariel. These facts, too, have the similarities and significant relationships necessary for generalization. During the action Ariel appears as one who is much freer than he has been and much less free

<sup>1</sup> Cf. *Sartor Resartus*.

than he would be. If not strictly omnipotent, omniscient, and omnipresent, he yet has power to do all, knowledge to answer all, and ubiquity to be where his wise master desires, and Prospero's requirements surpass those of any ordinary mortal. Ariel is not a disembodied spirit, but his body is ethereal, changes its form, renders itself invisible, has attributes and powers not possessed by the ordinary "vesture of decay." Mentally the spirit displays powers of reasoning and remembering; his will is manifest in a persistent desire for freedom. Social opinion, affection, interest, purpose, he has none. He is not, like Caliban in scene ii, below social interests, and content in ignorant solitude; he is rather above social interests, more god than beast. If he cannot feel social interests as those who live among them, he nevertheless sees them and knows all their bearings and relations. What argument can be used with such a spirit to interest him in social affairs? A being who sees in death only a phase of progress, in sorrow only a purification of spirit, in life only the necessary experience of the soul, looks down with infinite calm upon moral affairs as one who had been through all and proved that all temporal affairs are nothing but a useful illusion.

There is only one argument that avails: It is the work of mortals that has set this spirit free; he must repay this debt; if not, an inexorable law enables his liberator to imprison him again. The gods dare not do wrong. And, in spite of his stubborn desire for freedom, Ariel's fine intelligence makes him an obedient, though at first moody, servant of the general weal of the little state.

As a spirit, Ariel is playful and devoted to pure beauty freed from any sense of utility, pure, and averse from the bondage of ignorance and the fatal senses that dominate Caliban. The strongest differentiating feature of Ariel is the note of calm super-mortal joy which seems to say: "I know all that, but everything is quite right; a mortal is a fool who does not understand." There are spirits and spirits, according to Prospero; some spirits being Ariel's "meaner fellows," the rabble, "over whom I give thee power;" all these have superhuman powers. But there is no evidence that Ariel is an absolute or perfectly developed spirit; he is a "chick." This immanent power upon whom Prospero has laid fetters, after freeing him by the exertion of his own learning and sympathy, is the power that Prospero can control: he is not absolute, infinite, final; but merely better than his meaner fellows. To Prospero he is known immediately; to others, rather through his works. His services are: (1) he wrecks the ship, disperses the fleet, conducts the nobles into the island; (2) he leads Ferdinand to Miranda and is the cause of their romantic meeting; (3) he rouses from lethargy that best prop of his state, the honest counselor Gonzalo; (4) he acts as detective and informer for Prospero; (5) he preaches to the "three men of sin" a most convincing sermon, full of power and terror, with just a spice of mercy at the conclusion; (6) he performs a masque illustrative of the blessings following upon a true love marriage; (7) he assists in punishing the citizens of the island who rebel against a just and wise ruler; (8) he conducts the king and his followers to

their reconciliation with Prospero; (9) he frees the common sailors and leads them to the cell of learning; (10) he frees Caliban, Stephano, and Trinculo, and brings them to the cell where they are treated as well as possible; (11) we may suppose that he gives the good ship which he has restored, and all the other good ships, a fair voyage to port. Such are the eleven labors of this delicate Hercules. But none of these acts as social, altruistic, or primitive, is an act of Ariel. They are manifestations of power and intelligence; their sole purpose is the love of liberty and fear of slavery. What, then, is Ariel? The creative imagination? The mysterious inner spirit of man evolved through culture? The spirit of some great departed poet? These and the multitude of similar question, or forms of the great question, that occur, must be thought at present to be idle, or irrelevant. Let us simply say with the Folio of 1623, or, as one may believe, with the creator of Ariel, Ariel is "an airy spirit" and know him and reckon him in the play, not by some phrase suggesting modern psychology or metaphysics, but by the qualities, language, services, relations, discoverable in the play of which he forms so important a part. He is clearly a contrast to Caliban, and as Caliban is the beast, so Ariel is the angel, though not yet the god. Ariel is the spirit attendant upon Prospero's scientific truth, and his acts are types of the movements of civilization that make for freedom. Dowden's idea that Ariel represents art, though true in a sense, is only a small fraction of the truth. Ariel stands, for all aspects of freedom, the human spirit freed by the truth.

#### CALIBAN: TYPE OF SENSUALISM

Caliban appears in five of the nine scenes: the second, fourth, sixth, eighth, and ninth. The first mention of him is made by Prospero, about fifty lines before Caliban's entrance. Reminding Ariel of the torment from which he had freed him, he recalls Caliban's mother, the foul witch Sycorax. Afterwards Prospero calls Caliban a "poisonous slave, got by the devil himself upon thy wicked dam." Near the end of the play all this is greatly emphasized by being repeated with precision:

"This mis-shapen knave,—  
 His mother was a witch; and one so strong  
 That could control the moon, make flows and ebbs,  
 And deal in her command without her power.  
 These three have robbed me; and this demi-devil—  
 For he's a bastard one—had plotted with them  
 To take my life."

Prospero tells Miranda that Caliban is necessary to their well-being on the island.<sup>1</sup> Caliban's first words imply his dislike for profitable labor—"There's wood enough within!" He enters uttering curses which are none the less vigorous for being uttered in language learned of Miranda; the diction alone is polite. Caliban's second speech is characterized by Prospero as elaborately false. His third speech

<sup>1</sup> Cf. Emerson's conception of the use of the lower classes.

admits the charge of brutal and cruel sensuality. Prospero's threats of physical torment reach his imagination and subdue him.

The general impression left by the facts of this scene is that Caliban is a beast. His plea for kind treatment is the cunning of an animal who could not have imagined kindness of himself. Prospero had treated him kindly long enough to find the folly of his policy, and Caliban had learned enough of kindness to reproach Prospero for his necessary harshness. Prospero speaks of Caliban as incapable of improvement; he may be made useful by supporting Prospero, but as Caliban he is a beast. Cursing, sloth, falsehood, sensuality, ingratitude, are strongly indicated. But he is vigorous. Every word speaks of a great primitive reservoir of social power ready to be used in the work of progress as soon as enforced labor and discipline are applied to utilize it.<sup>1</sup> In one short lifetime Caliban cannot be refined for the companionship of "good natures," yet it is admitted that he can learn, and to learn is to transfer some of the vast primitive energies to the brain. And Caliban's language evinces some powers of reasoning, and vivid powers of perceiving, which give a certain beauty to his rhythm and imagery.

In the fourth scene Caliban appears with a load of wood. His speech confirms one's admiration of his vivid perceptive powers, his energy, his great heartiness and interest. He shows equally the diabolical aggressiveness of his father and the shuddering superstition of the hag Sycorax—qualities that appear wholly bad in their brutal primitiveness.

Trinculo finds this beast similar to a fish. Caliban observes Trinculo and Stephano and says but little. At first he takes them for spirits sent by Prospero to torment him; afterwards he worships Stephano as a brave god who bears celestial liquor. Stephano attracts him more, as being more pretentious and self-assertive. Trinculo, a silly easy-going fellow, is mildly jealous of the honors paid to the butler, and there is threatened dissension in the newly formed state. But the bottle proves efficacious and the three depart, Caliban shouting his battle cry of freedom, and leading the way.

The facts offered here indicate unmistakably that Caliban is capable of social development. It is strange to see a fool and a drunken butler succeeding where Prospero had failed; yet it is clear that, while Caliban cannot ascend the ladder to Prospero at a step, he can mount the first rung by the help of a pair of knaves scarcely above him in knowledge, and inferior in power and integrity of instinct.<sup>2</sup> Caliban's education requires him to know him on his own level in order to know himself; to become worse in order to become better; and in this he suggests the general truth that without the division of the elemental forces there can be no refinement and no progress. Caliban's love of nature is genuine, but sensual. The "clustering filberts" please him because they are easy to gather and good to eat; this love of nature is

<sup>1</sup> This and other parts of the play irresistibly recall Plato, Dante, Spenser, and all the great philosophic poets. Cf. Homer's Thersites.

<sup>2</sup> Cf. the value of even the lowest political bosses in arousing some, though at first an evil, interest in politics among the lowest classes. Cf. also Salvation Army methods.

very far from the desire to live merrily "under the blossom that hangs on the bow;" where the pleasure of Ariel depends less even on the sense-harmony of this perfection of natural loveliness than upon its imaginative value as the illusion representing all harmony.

In the sixth scene Caliban is fairly launched as the citizen of a commonwealth less ideal than Gonzalo's. His knowledge of affairs proceeds apace under the instruction of the self-assertive Stephano and the foolish Trinculo, burlesque shadows of the selfishness and weakness of the great convention that produced them, as their ideal state is a bold burlesque of all states.

Caliban drinks freely and is servile to excess; he takes sides in politics, becomes a courtier, and has a suit at court. He succeeds in gaining a victory over Trinculo, who is beaten for a prank of Ariel's, who enters when Prospero's interests are threatened. Caliban's plot against Prospero shows some capacity and clear instinctive judgment, especially when he dwells upon the danger to ignorance to be feared from the books. There is a reckless humor about this conspiracy which makes it seem unreal and less horrible than that of Antonio and Sebastian against Alonso and Gonzalo. This arises from the stupidity of the conspirators, whose passions are, however, none the less capable of producing the worst results. The interruption of the conspiracy by Ariel's music draws from Caliban a speech which makes a new important fact in generalizing his character. In sleep he has visions in which the sensual appetites are dormant, and he dreams of heavenly riches; and the music of the island is a harmony capable of soothing and composing his passions. They go out this time together to follow the music which, like the lute of Orpheus, leads all that hear.<sup>1</sup>

The facts of this scene first confirm all our bad impressions of Caliban, and then complicate the character by indicating clearly that he has some susceptibility to influences not connected with the sensual appetites, but with the æsthetic sense; that, in a word, he has moods in which he vaguely feels that the faculty of æsthetic dreaming is more blessed than to eat and to drink.

After the masque in the eighth scene Prospero calls Ariel and says, "we must prepare to meet with Caliban." Ariel speaks of the power of music over the three drunkards, comparing them in this to colts. Caliban and his friends are both urged by their own evil purposes and the celestial liquor, and drawn by the music of the spirit on their course to the pond. The end of it is that they stand saturated in filth up to their chins. Prospero fears Caliban grows worse as he grows older.

Just as the three conspirators with bloody thought approach, they are caught by the sight of rich garments set by Prospero and Ariel "for stale to catch these thieves." While the butler and the fool are enjoying the playing with the rich garments, Caliban is disgusted and urges prompt action. But Prospero and Ariel now hunt them with spirits made visible as hounds who torment them.

In this scene Caliban appears to advantage as scorning the trumpery garments

<sup>1</sup> This love of beauty is the seed of conscience in Caliban, and is the most audacious stroke of insight in the play.

which prove too alluring for his friends. But he suffers with them for keeping bad company. In the last scene Prospero commands Ariel to set Caliban and his companions free. Caliban, upon seeing Prospero and the strange lords, admires them, and believes them spirits. He fears punishment.

Prospero describes Caliban's origin, but ends by saying: "This thing of darkness I acknowledge mine." Caliban fears greatly. Alonso, pointing to Caliban, says: "This is as strange a thing as e'er I looked on;" to which Prospero replies: "He is as disproportioned in his manners as in his shape," and orders Caliban to his cell to work. There is no possible salvation for Caliban but in work; and even in this ideal time of general joy, power, and forgiveness, Caliban must be made to work, which he would never do of his own free will.

But Caliban's last speech is one of the most extraordinary facts to be weighed in connection with this wonderful monster.

Prospero says:

"Go, sirrah, to my cell:  
Take with you your companions: as you look  
To have my pardon, trim it handsomely."

Caliban is very much afraid of punishment. But in earlier differences with his master no fear had checked his curses and vile wishes. Caliban has now seen the world for himself; by comparison and solid thinking, founded on his observations, he has discovered the superiority of Prospero. It is certain that the sullen momentum of Caliban will go far to carry him toward any purpose he forms. What he says is:

"Ay, that I will; and I'll be wise hereafter,  
And seek for grace. What a thrice-double ass  
Was I, to take this drunkard for a god,  
And worship this dull fool!"

Caliban is the beast; as Antonio is a fiend, and Gonzalo a saint, so Caliban is a beast. But, though animality, sensuality, and all beastliness riot in this great mass of muscles, bones, and blood; though his senses report facts in the most vivid and savage manner; though his powers of generalizing are low and stupid, he, like the toad, ugly and venomous, bears yet a precious jewel in his head. And we can form some conception of the means by which experience will bring some wisdom and grace, until the animal energy is further converted into thought.

#### PROSPERO: THE SCIENTIFIC TYPE

Prospero appears in the second, fifth, seventh, eighth, and ninth scenes. His first words in scene ii are:

"Be collected:  
No more amazement; tell your piteous heart  
There's no harm done."

Miranda's sympathy is deeply stirred by the vessel in the tempest, and she replies:

"O, woe the day!" "No harm," repeats Prospero, "I have done nothing but in care of thee." In this we see the motive of the tempest: Prospero has caused it solely in the interest of his daughter, who is the rightful heir of Milan. He throws aside the magic garment which is necessary to his control of the spirit, and proceeds to narrate in simple paternal manner the history of his life, so far as Miranda needs to know it, in order to understand why her father has been seemingly cruel.<sup>1</sup>

He calls upon Miranda to look searchingly into "the dark backward and abysm of time" in origin to bring back her origin. She has only the vaguest remembrance. Prospero presents the facts. Prospero had been duke of a state without a parallel for the liberal arts—meaning presumably, the arts of war and peace, science, philosophy, literature, sculpture, architecture, mathematics, and other branches of study. Prospero emphasizes the superiority of his signiory; it was the first, and Prospero the prime duke. This is important, inasmuch as it makes his downfall more striking. Here follows a long and exceedingly strong description of the ambition, treachery, and success of the usurping Antonio. Alonso is described as an inveterate enemy of the student Prospero. Antonio becomes a tributary of this king in order to procure his assistance in supplanting his brother. The story is told with intense vigor, every sentence full of indignation and of the emphasis of one who has brooded over his wrongs.<sup>2</sup>

"In few, they hurried us aboard a bark,  
Bore us some leagues to sea; where they prepared  
A rotten carcass of a boat, not rigged,  
Nor tackle, sail, nor mast; the very rats  
Instinctively have quit it."

The goodness of Gonzalo is spoken of as a manifestation of Providence divine. Food, fresh water, rich garments, linens, stuffs, and necessaries, and volumes from his own library, prized above his dukedom, were the means of his preservation, and of the after-progress of his finally successful researches.<sup>3</sup>

Prospero has spent his leisure in study; love of learning was the cause of his banishment, and, though he feels his brother's treachery, he has been happy with his books and the education of Miranda.

Prospero, about to speak of the present and to summon Ariel, resumes his magic robe.

Fortune, formerly his enemy, is now in league with him, and he seizes his opportunity to assert his rights and regain his dukedom, lost for twelve years.

He suggests sleep to Miranda, tells her it is a good dulness, and to give it way. Miranda, in spite of the exciting revelation she has listened to, falls asleep.

<sup>1</sup> This garment indicates his purely philosophical point of view: without it he plays a simple rôle among other mortals, and with like passions.

<sup>2</sup> A story as old as that of Cain and Abel.

<sup>3</sup> If there were any "allegory" or "enigma" in the play, this might suggest the renaissance of the Hellenic spirit in Shakespeare's age.

Prospero receives from Ariel the report of the shipwreck, and of his disposal of the voyagers. Finding Ariel moody, he speaks harshly to him, reminding him of his slavery to Sycorax, of his torture in the tree,<sup>1</sup> and of his own kindness in freeing him. He threatens him with worse torture, promises him his liberty, and succeeds in asserting his authority satisfactorily.

Ariel departs, Miranda awakes, or rather is roused by the magician. The father and daughter visit Caliban. Caliban is also rebellious and anxious to regain his liberty. Prospero treats him most harshly and successfully asserts his control.

When Ariel leads in Ferdinand, enchanted by his songs, Prospero meets them with Miranda, and takes the deepest satisfaction upon seeing that the meeting results in love at first sight. It is made clear that one of Prospero's chief purposes in causing the wreck was to bring about this result. From the romantic point of view, all is going satisfactorily. But romance must be guided by wisdom. Ferdinand is treated with a great show of harshness, for Prospero holds that too light winning makes the prize light, and takes care that the course of true love shall not run smooth. Ferdinand is made to feel the authority of Prospero, and is set at a heavy task of bearing logs.

This scene contains a large number of facts concerning the life and character of Prospero. First we learn that by right he is a powerful duke, but that through love of learning he has lost his practical interest in, and hold upon, affairs; that the vigilant ambition of his brother has seized the opportunity this offered to usurp his power; and that Prospero's studies having fully succeeded, and more than restored the power they had robbed him of, he will now, fortune being favorable, proceed to reassert his right to rule and depose the usurper; his plan extends not only to the reconquest of Milan, but, through an alliance with Ferdinand and the imprisonment of Alonso, to the inheritance of the larger world of Naples. Prospero's life falls into three parts: the past, in which he ruled successfully, just and beloved by his subjects; the present, in which he is banished and his rule is divided among selfish egoists, held in check by the mild Gonzalo; the future when Prospero shall rule again with justice, vigor, and the knowledge that is power.<sup>1</sup>

Prospero, through the knowledge derived from the books saved from his ancient library and derived from his own researches, raises a storm which brings the "three men of sin" within his power. But his motive is not revenge; he desires to secure the rights of his daughter, in whom all his hopes of the future are centered. Her learning and character are a guarantee that the state unparalleled for the liberal arts will continue to be great and renowned.

Prospero is one who has risked all in the pursuit of true knowledge, and, having lost all, is about to win back more than he had lost, after having acquired all the power that knowledge can give.<sup>2</sup>

<sup>1</sup> The Greek idea of the philosopher as king.

<sup>2</sup> Cf. Bacon's favorite theme of knowledge as control.

Prospero has had the most intimate and vital relations with the four characters already studied. Antonio, the selfish conspirator, is his brother, but his greatest enemy. Gonzalo has been his true preserver. Ariel is his powerful messenger, Caliban is his wicked but useful slave. *He holds a central position with reference to these four persons, who in their relations to each other are strongly contrasted pairs.*<sup>1</sup>

Prospero is not a magnetic character; his austerity and love of authority are not attractive. In this scene his whole relation to Ariel, Caliban, and Ferdinand is that of a harsh task-master; there is a certain crudeness about the monotony of his injunctions to work, and the work assigned the lover is the same as that assigned to Caliban, the carrying of logs. Prospero is wise, just, not more solicitous for himself than for the true interests of all the others; but outwardly at least he is too faultless, unsympathetic, regulated by high purposes, to be attractive through his personal qualities. Even his command of magic has something in it which appeals to none of the customary dramatic interests.

But there are glimpses of a different Prospero at times; and an occasional effusion of feeling for Miranda, Ariel, or Gonzalo reveals the tenderness and sensibility controlled by Prospero's wisdom, and suggests the Hamlet-like refinement and sweetness which had caused his downfall, and of which he had learned to make stronger use. He is a learned, just, and loving man of brooding thought, profound melancholy, and extreme sensibility, endowed with boundless power.

In the fifth scene Prospero appears behind Miranda in her stolen visit to the scene of Ferdinand's labors. He speaks three times. His words are:

[*Aside*] "Poor worm! thou art infected  
This visitation shows it."

"Fair encounter  
Of two most rare affections! Heavens rain grace  
On that which breeds between them!"

And in conclusion:

"So glad of this as they, I cannot be  
Who are surprised withal; but my rejoicing  
At nothing can be more. I'll to my book;  
For yet, ere supper time, must I perform  
Much business appertaining."

He is controlling human life. The absence of the romantic element in learning may blind criticism to the significance of this speech. It is the most emphatic speech of Shakespeare's wisest character. "My rejoicing at nothing can be more." The romantic interest is kept central and uppermost by this speech. The learning of the reader finds much to elaborate in *The Tempest*, but until the love story is loyally recognized as the true interest there can be no grasp of the play in its simple greatness. All proportion in this romantic drama depends upon the recognition of

<sup>1</sup> There is a chilling symmetry in the character-contrasts.

the love-story as the beginning, middle, and end of the whole action. Prospero's greatness must be seen by the wise and learned, not as less than they had supposed, but as being far inferior in importance to the love of Ferdinand and Miranda; Prospero, with all his magic and dignity, is merely the heroine's father, and a rather interfering old gentleman at that. One may peer through learned spectacles for the appearance of the scientific Prospero upon the stage, but the true "understander" must look more eagerly still for the lovers. This or nothing is the poetical philosophy. Hence Prospero says:

"So glad of this as they, I cannot be,  
Who are surprised withal; but my rejoicing  
At nothing can be more."

In this we see that Prospero is not merely a duke, magician, scholar, but a man—who carries all the interests of life in their full weight, but regards them all as subordinate to true love of the pure romantic type. It is this more than anything else that identifies Prospero's point of view with that of the mature Shakespeare. And it is this that should make one reflect when Prospero says:

"My rejoicing  
At nothing can be more."

All his hopes center in this alliance which will give Naples to Miranda and Miranda to Naples. Every incident narrated in the play is directly associated with this love-story. Learning, morality, philosophy, may interpret the incidents profoundly; but romance alone interprets without distortion or disproportion, and a pair of lovers cast contempt upon the pride of learning and magic. The quiet humor of Prospero in this scene is full of sympathy and pure affection.

Moralists have found a solemn warning for lovers in the fate of Romeo and Juliet. "Violent delights have violent ends," is the favorite text, chosen from the speech of the moralist of the tragedy, Friar Laurence. Prospero seems to tell us in this scene that Romeo and Juliet are perfectly ideal, but they need wisdom to guide them and watch over them, not the nurse and the Capulets. Shakespeare may quarrel with the environment, but never with love; the moralist blames the lovers, and quotes the good Friar Laurence.

In the seventh scene Prospero is present, but invisible to the king and his followers. In an aside he declares that some of the lords, meaning chiefly Antonio and Sebastian, presumably, are worse than devils. "Devil" is the term applicable to the father of Caliban, whence Caliban is called a "demi-devil." At the end of the banquet scene Prospero praises the spirits, declares his plans are progressing favorably, and returns to visit "Young Ferdinand" "and his and mine loved darling "

Prospero's relation to his enemies is not one of weak and effusive forgiveness, but of strong subjugation, judgment, and forgiveness equal to their capacity for appreciating forgiveness.

In scene viii Prospero begins to throw off his harshness because he is perfectly

assured that all will go as wisdom requires. Ferdinand's work and patience enable Prospero to show how kindly he has regarded him. The important thing about the masque is that it is bestowed upon the eyes of this young couple as a reward of their purity and devotion, and that even to tediousness Ferdinand is lectured on his abstemiousness up to the very moment when the preparations cease and the masque begins. The content of the masque echoes this introduction, all the blessings promised being conditional upon the temperance and goodness of the lovers, and the absence of Venus and her son.

The masque ends abruptly. Prospero starts suddenly at sight of the Reapers and Nymphs dancing; after which, to a strange, hollow, and confused noise, they heavily vanish. What has disturbed the magician while Ariel is executing the dream of an ideal republic sanctioned and ratified by Ceres and Juno, and brimming with beauty, plenty, hope, power, and purity? "I had forgot that foul conspiracy of the beast Caliban."

Thereupon follows the dismissal of the merry actors. Our revels now are ended. The actors were spirits and are melted into thin air. While the actors are mortal and sensual, the drama of life may be beautiful in part, but at the worst it ends in heaviness and confusion. The *summum pulchrum* rests in the spiritual state. All that is of sense must dissolve. What, then, remains is the real self. "We are such stuff as dreams are made on." The ideal commonwealth is not within "the most precious square of sense;" not in the world of Antonio, Caliban, and Gonzalo, but in the world of Ariel, of spirit-life. "Troubled I am." This is the manner of Theseus about to wage war against Creon. *Wisdom can find the way to the ideal world, but the mortal brain is troubled, and the scholar feels that the pageant of life must be renounced in its entirety; Milan, Naples, books and all, are transitory—an illusion; "I am sufficient to tell the world, 'tis but a gaudy shadow, that old Time, as he passes by, takes with him."* Prospero leaves the insubstantial pageant to return to the most disagreeable of his duties, the disciplining of "a devil, a born devil." The scene, which opened so brightly, ends with an air of sadness, if not of fatigue; but with the customary austerity of Prospero:

"Shortly shall all my labors end, and thou  
Shalt have the air at freedom: for a little,  
Follow, and do me service."

This is the absolute renunciation of mortality. In the spiritual state alone is immortality and liberty. Wisdom may bring beauty, purity, peace, and plenty, but not undisturbed by ignorance and the limitations of sense. A comparatively ideal commonwealth is possible even to mortals, but the *summum pulchrum* rests in dreamland.

The emotion of the latter part of Act IV is a profound indication of the truth that the absolute serenity that philosophy desires is beyond its reach. While it seems to mar the dignity of Prospero, it restores him to the social relations and makes it possible to sympathize with his austere and unattractive exterior. Perhaps it may be thought a culmination of tragic sublimity.

The fifth act is full of Prospero's words and influence. Hamlet once said: "The time is out of joint." Prospero is in strong hope: "My spirits obey, and time goes upright with his carriage." It is as if Hamlet had followed his impulse of returning to Wittenberg, and had through learning acquired the power to overcome his wrongs and seize his birthright, laying the tortured ghost by raising the spirits.

Ariel's report regarding the prisoners moves compassion in the justly indignant Prospero. "The rarer action is in virtue than in vengeance." He has Antonio completely at his mercy; it is because of his nobler reason that, though struck to the quick with the vile treatment he has undergone at his hands, he conceives it not worthy of himself to destroy him. Having decided upon a course of clemency, he dispatches Ariel for the prisoners. Prospero makes a speech concerning his magic art. The greater part of it consists of an apostrophe to the various spirits controlled by his art; he speaks in high praise of the potency of his knowledge—"graves at my command have waked their sleepers, op'd and let them forth." His powerful yet rough magic must give way to music. All the services of Ariel have been directed to the ends of justice, peace, harmony, and fraternity; now that these are about to prevail no services will be required of him; music will take the place of Prospero's potent but rougher art, and harmony will ensue. Staff and book will give way to heavenly harmony. Solemn music is called for to produce a healthy and reasonable rhythm in the brains of the king and his followers, now boiled within their skulls; the charm dissolves; the morning steals upon the night; their rising senses begin to chase the ignorant fumes that mantle their clearer reason; their understanding begins to swell, and the approaching tide will shortly fill the reasonable shores that now lie foul and muddy. Such is the magic method of this strange magician—so suggestive of modern ideas that it has tempted critics to read later-day science into it. He has brought them to a certain stage of reason by motives of fear, terror, sympathy, and other powerful tragic emotions, and now, finding them listless and confused he completes their cure by a musical charm mingled with suitable words of praise, invective, reproach, forgiveness—all delivered with great energy and conviction.

Prospero desires the common sailors fetched to the cell. Ariel departs, and Prospero reveals himself to the recovering lords in his true character as banished Duke of Milan. His manner to Alonso is more than human in its magnanimity and courtesy:

"I embrace thy body;  
And to thee and thy company I bid  
A hearty welcome."

There are degrees in forgiveness, and in this scene one finds a compendium of social truth; this estimate of the largest types of social character is central, human, just, absolute—from the poetic point of view.

The praise of patience as the great virtue of the just is an essential part of this

philosophy. Prospero begins to tell the story of himself and Miranda, but checks himself:

"No more yet of this,  
For 'tis a chronicle of day by day,  
Not a relation for a breakfast nor  
Befitting this first meeting."

Having said merely what is necessary to the introduction of the son whom the king has deplored so sincerely, and the daughter of Prospero whom the world had supposed certainly lost, he shows them the lover playing at chess within the cell. The happy scene that follows is simple almost to commonplaceness, and sublime through its typical breadth.

And is this the conclusion of the learning and magic of Prospero—to bring about a happy wedding like any ordinary comedy? Is there no deeper meaning, no worthier end, after all the complicated tragedy requiring the services of spirits and the most unheard-of learning and power to set things to rights? Such is the simplicity of the poetic point of view that from it there can be no deeper meaning and no more significant conclusion. Alonso echoes the commonplace judgment admirably:

"This is as strange a maze as e'er men trod;  
And there is in this business more than nature  
Was ever conduct of; some oracle  
Must rectify our knowledge."

Prospero is vigilant and practical to the end, showing himself friendly to the honest sailors and severe with the irresponsible delinquents, and yet as kind as true far-sighted kindness permits in the balanced interests of the whole society and of each member of it.

How may the facts concerning Prospero be generalized? Prospero is friendly to Gonzalo, whom he calls his true preserver. Yet Gonzalo is a weak character when compared with Prospero; he has Prospero's kind, gentle, forgiving nature, but not his aggressive strength in championing what he thinks right. Gonzalo is immensely and positively good, but his lack of power disables him to such a degree that he is able only to conciliate, placate, remedy evils already done, and quite unable to control powers and events; he renders justice possible, but cannot make it prevail. Prospero will do no wrong and take none.

Prospero tells Ariel that he loves him dearly. But Ariel is playful, purposeless in any social sense, far beyond and in advance of the order of the day. When all are just and ideal, Ariel will be in his element, but he is not of himself able to feel the needs of the little republic.

Prospero is hostile to Antonio. Even while forgiving him he expresses the bitterest contempt for his character. Prospero has all the brilliant reason and splendid energy of Antonio; but vitally fused with these powers in Prospero is the loving kind-

ness of Gonzalo. In Prospero selfishness is realized in the working for the common good; Antonio is selfish in the unsocial sense.

Prospero is hostile to Caliban. Caliban's morality is not of the cold selfish type; it is backward morality. He is a devil, a born devil, but he is full of possibilities. Prospero's regret is that the problem of inducing Caliban to seek for grace seems insoluble.

Prospero knows these types thoroughly and has them potentially in himself; he knows himself and them by reading, experience, and reflection, as well as by natural breadth, power, and sensibility. He knows life in its conventional sense from Milan, and he knows nature equally well. He is able to teach every character in turn to know himself deeply, truly, and feelingly. He controls, with equal authority Caliban, Ferdinand, and Ariel. He is adored and obeyed by Miranda. He eventually commands the respect of his bitterest enemies, and even Caliban comes to render him a rather hearty obedience. All these relations are made possible through his insight, knowledge, fair-minded bearing, and great feeling. It is easy to say that Prospero is wise, that he is a magician; but what is the nature of his magic wisdom?

That about which Prospero is wise and over which he exerts magical power is life. He is wise in his knowledge of the elements of social life. He is the complete master of the social forces, both as they occur in himself, in his complete, all-round, intensely human, individuality; and also, consequently, as they occur in the society around him, which he identifies with himself, treats as himself, reflects in himself. He is thus the embodiment of the balance of the social forces, an epitome of the selfish and unselfish, sensual and spiritual, shy and aggressive, conventional and natural, romantic and practical types of the race; and because of this, we may suppose, he is at heart under his grave exterior, exceedingly attached to the philosophy of the poet and the dreamer of dreams, expressing his beliefs, not in words, but in things, not in abstractions, but in lifelike illusions; writing, not with ink, but with men and women; and believing and knowing more than philosophy can seriously consider both of the world that is, and of the coming race. His is the science of *controlling* the forces of social life, and its focus is in controlling youth and marriage.



## TENDENCIES IN MODERN MUSICAL COMPOSITION

BY GEORGE M. CHADWICK

The relation of the past and present in music, the tendencies in modern music as they point toward the future of music, are subjects as difficult to understand and define as to foretell the future of poetry by tracing it back to the *Iliad* and then accepting Macaulay's view that "as civilization advances, poetry almost necessarily declines." It would be interesting to trace upon the chart of history those social and political conditions wherein poetry and music were the spontaneous expression of individual and national feeling. However different the medium of expression, there is this in common between poetry and music, that each not only reveals the mood of the age in which it is produced, it also reacts upon that mood; and hence, if we are rightly to judge the tendencies in modern music, we must understand the mood of the present, and ask and answer as best we can: Is this reactive force that of great genius or merely of exceptional talent? The question of the relative merits of genius can be discussed with perfect safety, because all have a right to an opinion and, according to some popular views on liberty, each one's opinion is as good as any other's. But the subject of the mood or conditions of the day must be approached with great caution, for there is so much that is out of tune with art in an age when great value is placed upon phenomena addressed to the physical eye, and the opinions of the majority are more respected than those of the wiser and sadder minority. Not materialism, but rather that mood which encourages and respects materialism, is the crushing force against which man's finer nature is powerless to contend. The creative genius will ever be both independent of and yet dependent on the mood of his time: Independent, in that he is isolated and in a sense unconscious of those demands which most men recognize; dependent, so far as he is dictated by the demands of the public, and in a yet more vital sense by the effect on him of those influences which either tend to encourage or else almost utterly to destroy his creative activity.

In a general way it can be determined whence and whither came and went this or that period in literature, but the different historical phases of art, especially music, are less easily identified with those larger social conditions to which literature owes so much. Not only this, but the so-called meaning of music is a subjective phenomenon quite independent of outward events.

Historically, it is almost impossible to criticise music except from the standpoint of the present, for at different times the same music has produced different effects. The subject of form can be somewhat definitely considered, but in its truest sense form is innate and not an outward application of rules. It is this latter view of form which ought to be discouraged, as it tends to substitute the study of the letter for the spirit of music. It is nobler to play a Bach fugue than to learnedly talk about it. The desire to analyze and reduce to facts, tends to produce insensitiveness in the realm of the imaginative, resulting in this, that the artistic nature is crushed and superficial learning is recognized in place of the finer artistic feeling which alone is able to create and interpret art. Art begins where definition ceases, and genius silently works unheeded of the theories and so-called learned opinions on the subject of what music has been, is and ought to be.

If we are to be just in this matter we must study the attitude of the composer toward his art and the public, and also thoughtfully view those present conditions which so strongly influence composers. Is that attitude serious, is it sincere? Granting that it is usually both serious and sincere, yet it may not always be right, owing to reasons for which the composer himself cannot be blamed. A less godlike genius than a Beethoven must be swept along by the current of his time. Neither diplomacy nor charlatanism can be forgiven in the world of creative art, but mistakes, the result of misdirected but earnest effort, can be in a measure overlooked. The modern composer has temptations that did not exist in the same sense in the classical period of the eighteenth and early part of the nineteenth century. The tendency of the classic was upward, while that of the romantic is toward the decadent, and hence the romantic can only be preserved by the force of exceptional creative genius. Such a genius was Schumann. "Attitude" is the word so little comprehended and yet so

vital. The attitude of a lesser composer of the classic period must necessarily have been right. If he failed it was no contradiction to the principles of his art; but the romanticist has the dangerous privilege of being looked upon as not understood, as having penetrated the mystery of life either beyond the power of his art to express, or else as having attained to a statement in his art beyond the power of the world at large to comprehend; and this constitutes a most powerful and at the same time most dangerous factor influencing modern composition.

Someone has said: "There are words that have been in love with each other from the beginning of language, and when they meet, that is poetry." Another has added to these lines: "There are notes in the realm of harmony which are seeking their complement; when found, that is music." Music from Bach to Schumann was in its inner nature lyric. It was the song of the heart, and true music will ever be the song of the heart whether as the simple folk song or as the outpouring of a world of musical feeling in the symphony. The final test, as in poetry, is that music be inevitable. The folk songs of the people have endured through the centuries: the compositions of many a profound theorist of the past, marvels of technical skill and learning, are now almost forgotten. Living as we do in the present age we cannot pass final judgment upon it; but is it not possible to say at least this, that much, very much of modern composition lacks the inevitable? Is it not too often the product of musical scholarship rather than the inspiration of genius? It is impossible to measure these vast tidal waves of art which have swept over the centuries. Their ebb and flow is all-powerful and can be neither hastened nor retarded. Kant confessed that he was overwhelmed with awe by two things: one, the star deep of space, without limit, and without end; and the other, right and wrong. And so he to whom the deeper meaning of art has been revealed, has learned that greatest of lessons—humility in the presence of the unknowable.

Let us now take a more definite view of the several forms as treated by modern composers. In modern songs we meet with much that is uninspired. A glance at the history of song reveals in Schubert that wonderful union of music and words, and if at times his heaven-born music lifts to a higher plane poems in themselves commonplace, it only proves that in

song it is the music and not the words that gives the stamp of greatness to the composition. With Schumann, Robert Franz, and Brahms, though we feel in the presence of less godlike genius, we also feel that a truer literary instinct guided the composer in a more careful selection of texts. Many a song-writer of today has been influenced for good by these composers; nevertheless a study of modern songs warrants this criticism, that too often the pure lyric note is lacking, and as a result there are composers whose songs suggest miniature symphonic poems with incidental words. There are certain laws which cannot be ignored, and one is that a song must, so to speak, sing itself, and for this reason no form of music takes more speedy revenge on the composer who refuses to recognize its demands.

While the piano and organ have suffered more or less at the hands of modern experimenters, the danger has been less, because those pianists and organists worthy of being called artists, are too well acquainted with the inexhaustible literature bequeathed by the masters for these instruments to be easily led astray.

To worthily speak of the modern opera, or music drama, would require a separate paper, involving us in a discussion of Wagner, his theories relative to the music of the future, and the effect of his composition and theories on the composers of today. On a gigantic scale his works illustrate the influence of the literary attitude toward music, and he has unquestionably come nearer to a true statement of the matter than any other modern composer, for he was consistent in his attitude and remained true to his high ideals, sweeping all obstacles aside by the tremendous force of his creative musical genius.

It is in purely instrumental music rather than in the lyric drama that the violation of the scientific principles of musical æsthetics is most dangerous to music. Realism in instrumental music—that is, the use of a text or “programme,” the attempt to describe literally a mood, a scene, or even an entire poem or the life of a hero—is often commendable, not only as a guide to the mood of the composer, but also as a means of assisting the imagination of the hearer. A privilege allowed a great composer, in lesser genius is too often a temptation leading to disastrous results. It would be interesting, did space allow, to cite instances of this realism in the works of

the older masters; but it is necessary to limit this observation to the relation of realism to modern composition, with a reference to its abuse. What may be termed the literary tendency encourages and at the same time disguises this abuse: the tendency to place pseudo-musical experiments in tone (mere results of study and ingenious device) above their actual musical value, not infrequently leads to an almost patronizing attitude toward the compositions of Mozart and Schubert; an attitude due to the failure to understand the immense distance between genius and mere talent and also an overestimation of the importance of mere technical achievement. Oliver Cromwell said: "A man never rises so high as when he knows not whither he is going." Genius works silently, guided by an intuitive force rather than by theories. The critical writings and theories of poets, painters, and composers are, after all, incidental to their creative energy. Hence, if art is really great, if art is the ultimate expression of the sensitized human consciousness as opposed to the insensitive, the coarse and brutal, then are we compelled to respect this intuitive power of genius as the truest, most real phenomenon, and question any attempt of science or theory to divert it from its natural course.

It is claimed in defense of modern originality that it was ever thus, genius having always struggled against precedent and pedantry. But what is true of the past is not necessarily true of the present, removed as it is to a sufficient distance rightly to behold those mountain peaks of genius—heights which could not be comprehended by the observer standing near them, whose vision might easily have been intercepted by mere foothills which are lost to view at this distance. It is impossible to anticipate judgments self-inflicted in the future. Though the contending opinions of modern conservatives and radicals in music cannot be reconciled on neutral ground, it is possible in a measure to understand the attitude of those widely differing in opinions. To conservatives (now alas, too few) educated as a rule amid the great Leipzig influences of Germany, the works of the classic period are a known truth in a sense possibly not understood by a younger generation molded under different influences. It is doubtless true that this is not because the former understand the modern spirit less than the younger enthusiasts who dream of "impossible destinies" in music, but that they (the conserva-

tives) alone truly understand the past. Nor is this opinion a mere theory: its truth is established by no less authority than the attitude of some of the greatest of modern composers. Wagner, that commanding force in the revolutionary spirit of modern music, worshiped Beethoven as a god, refusing to write a symphony because Beethoven had written the last great symphony. Only recently it is said of one of the greatest modern composers that after conducting Beethoven's Ninth Symphony, he turned with tears in his eyes to one standing near and exclaimed: "If I could only compose such music!"

While it is true that no one claims that the creative power of the present is as wonderful as that of the past, it is also true that an understanding of what constituted the real greatness of the past is far from being generally understood. The musical world today is intoxicated with technique—the technique of soloists, of orchestras and of composers. It is indeed truly wonderful to what heights virtuosity has reached, but alas, it is the universal history of art that the beginning of its ultimate decline is marked by the worship of technique. The gravest danger seems unquestionably to be that the virtuoso technique in orchestral composition is demanded of the modern composer. It is difficult to conceal poverty of musical ideas on the keyboard of the piano, but in the orchestra it is far different, and especially in the modern orchestra with its unlimited resources in tone—color and technical possibilities. The impressionist in music can give to the world impressions, moods stated in gorgeous masses of tone-color, and by "wandering through all the known and unknown keys," overwhelm a listening public, unable as it is to contradict such a composer's methods.

C. Hubert H. Parry, in his valuable work on *The Art of Music*, has most clearly stated this relation of the modern orchestral composer to the public in the following criticism on Berlioz, who so strongly influenced modern orchestration by his compositions and theories. "The kernel of the Gallic view of things is, moreover, persistently theatrical, and all the music in which they have been successful has had either direct or secondary connection with the stage. Berlioz was so typical a Frenchman in this respect that he could hardly see even the events of his own life as they actually were; but generally in the light of a sort of fevered frenzy, which

made everything—both ups and downs—look several times larger than the reality. . . . His enormous skill and mastery of resource, brilliant intelligence, and fiery energy were all concentrated in the endeavor to make people see in their minds the histrionic presentation of such fit histrionic subjects as dances of sylphs, processions of pilgrims, and orgies of brigands. Even the colossal dimensions of his orchestra, with its many square yards of drum surface, with its crowds of shining yellow brass instruments, is mainly the product of his insatiable theatrical thirst. It imposes upon the composer himself as much as it imposes upon his audience, by looking so very big and bristling to the imagination. But, though it makes a great noise, and works on the raw impressionable side of human creatures, and excites them to an abnormal degree, the effect it produces is not really so imposing as that of things which make much less show—for instance, the opening of Beethoven's B flat Symphony, which requires only seven different instruments to play it, and is all pianissimo. The means are in excess of the requirements; or rather, what should be means become requirements, because the effect is made by the actual sound of the instruments, and often not all by the music they are the means of expressing. And this aspect of Berlioz's work is even more noteworthy in relation to modern musical development than the fact that he uniformly adopted a programme for his instrumental works. He was a man of unusually excitable sensibility, and the tone of instruments, like color, appealed to him more than any other feature in music. He was also a man of literary tastes, and had no inconsiderable gifts in that line, and was more excited by the notion of what music might be brought to express than by the music itself."

The above is a most admirable statement of modern tendencies in orchestral composition, and it is no reflection on the few great living orchestral composers to say that it is now possible for a composer to claim as originality what is in reality the opposite, because the world today is looking for startling, heretofore undreamed of orchestral effects; and every composer who desires recognition must strive to rival his colleagues in the virtuoso style of orchestral composition, knowing that a beautiful musical thought simply stated would be looked upon either as stolen from the masters of the past or as a confession of an inability to write in a

worthy (?) manner for the modern orchestra. A calm unprejudiced observer may safely say that this is a transition period, or possibly a preparatory one for some future Beethoven. A Beethoven may never again appear, but if he does he will settle in his own way the problem either by denouncing the modern attitude toward orchestral technique, or else, which is more probable, by making that technique subservient to higher ends, he will prove that music must be judged by its thematic material and the harmonic and contrapuntal development of these themes. Of only one thing can we be certain, and that is that such an one will be no experimenter, that he will have a divine message in music not dependent on this wonderful medium of expression, but made more glorious by reason of it.

# A DEFINITION OF QUATERNIONS BY INDEPENDENT POSTULATES<sup>1</sup>

BY MISS RUBY L. CARSTENS

## § 1. QUATERNIONS WITH RESPECT TO A DOMAIN $D^2$

The usual theory relates to quaternions  $a_1 + a_2i + a_3j + a_4k$  in which the coefficients  $a_i$  range independently over all real numbers or else over all complex numbers, and the units have the following multiplication table:

	1	<i>i</i>	<i>j</i>	<i>k</i>	
1	1	<i>i</i>	<i>j</i>	<i>k</i>	
<i>i</i>	<i>i</i>	-1	<i>k</i>	- <i>j</i>	.
<i>j</i>	<i>j</i>	- <i>k</i>	-1	<i>i</i>	
<i>k</i>	<i>k</i>	<i>j</i>	- <i>i</i>	-1	

These give the real quaternion system and the octonian system.<sup>3</sup> As an obvious generalization, the coefficients may range independently over all the elements of any domain  $D$ .

## § 2. THE POSTULATES

A set of four ordered elements  $a = [a_1, a_2, a_3, a_4]$  of  $D$  will be called a quaternion  $a$ . The symbol  $a = [a_1, a_2, a_3, a_4]$  employed is purely positional, without functional connotation. Its definition implies that  $a = b$  if, and only if,  $a_1 = b_1, a_2 = b_2, a_3 = b_3, a_4 = b_4$ .

We make the following five postulates concerning quaternions in connection with the elements 0, +1, -1 ( $\gamma_{ijk}$ ) which are used 4<sup>3</sup> times as follows:

$$\begin{aligned} \gamma_{111} = \gamma_{122} = \gamma_{133} = \gamma_{144} = \gamma_{212} = \gamma_{234} = \gamma_{313} = \gamma_{342} = \gamma_{414} = \gamma_{428} = +1; \\ \gamma_{221} = \gamma_{243} = \gamma_{324} = \gamma_{331} = \gamma_{432} = \gamma_{441} = -1; \end{aligned}$$

the other forty-eight  $\gamma$ 's are zero.

<sup>1</sup> Read before the American Mathematical Society, February 24, 1906.

<sup>2</sup> DICKSON, "On Hypercomplex Number Systems," *Transactions of the American Mathematical Society*, Vol. VI, 1905.

<sup>3</sup> Octonians may be considered as quaternions with complex coefficients.

*Postulate I.*—If  $a$  and  $b$  are any two quaternions, then  $s=[a_1+b_1, a_2+b_2, a_3+b_3, a_4+b_4]$  is a quaternion.

*Definition.*—Addition of quaternions is defined by  $a \oplus b = s$ .

*Postulate II.*— $o=[o, o, o, o]$  is a quaternion.

*Postulate III.*—If  $o$  is a quaternion, then to any quaternion  $a$  corresponds a quaternion  $a'$  such that  $a \oplus a' = o$ .

*Theorem I.*—Quaternions form a commutative system under addition. For, by postulate I, quaternions form an additive group. Addition is commutative because

$$\begin{aligned} a \oplus b &= [a_1+b_1, a_2+b_2, a_3+b_3, a_4+b_4] \\ &= [b_1+a_1, b_2+a_2, b_3+a_3, b_4+a_4] \\ &= b \oplus a. \end{aligned}$$

*Postulate IV.*— $a$  and  $b$  being any two quaternions  $a \otimes b = p = [p_1, p_2, p_3, p_4]$  is a quaternion, where

$$\begin{aligned} p_1 &= a_1b_1 - a_2b_2 - a_3b_3 - a_4b_4, \\ p_2 &= a_1b_2 + a_2b_1 + a_3b_4 - a_4b_3, \\ p_3 &= a_1b_3 - a_2b_4 + a_3b_1 + a_4b_2, \\ p_4 &= a_1b_4 + a_2b_3 - a_3b_2 + a_4b_1, \end{aligned}$$

if the  $p_i$  are in  $D$ .

*Definition.*—The product of two quaternions is defined by  $a \otimes b = p$ .

*Theorem 2.*—Multiplication is not commutative. For, by postulate IV,  $a \otimes b =$

$$\begin{aligned} [a_1b_1 - a_2b_2 - a_3b_3 - a_4b_4, a_1b_2 + a_2b_1 + a_3b_4 - a_4b_3, \\ a_1b_3 - a_2b_4 + a_3b_1 + a_4b_2, a_1b_4 + a_2b_3 - a_3b_2 + a_4b_1] \end{aligned}$$

and

$$\begin{aligned} b \otimes a &= [a_1b_1 - a_2b_2 - a_3b_3 - a_4b_4, a_2b_1 + a_1b_2 + a_4b_3 - a_3b_4, \\ & a_3b_1 - a_4b_2 + a_1b_3 + a_2b_4, a_4b_1 + a_3b_2 - a_2b_3 + a_1b_4]. \\ & \therefore a \otimes b \neq b \otimes a. \end{aligned}$$

*Theorem 3.*—Multiplication is distributive.

For,

$$\begin{aligned} a \otimes (b+c) &= [a_1, a_2, a_3, a_4] \otimes [b_1+c_1, b_2+c_2, b_3+c_3, b_4+c_4] = \\ & [a_1(b_1+c_1) - a_2(b_2+c_2) - a_3(b_3+c_3) - a_4(b_4+c_4), \\ & a_1(b_2+c_2) + a_2(b_1+c_1) + a_3(b_4+c_4) - a_4(b_3+c_3), \\ & a_1(b_3+c_3) - a_2(b_4+c_4) + a_3(b_1+c_1) + a_4(b_2+c_2), \\ & a_1(b_4+c_4) + a_2(b_3+c_3) - a_3(b_2+c_2) + a_4(b_1+c_1)] \end{aligned}$$

$$\begin{aligned} &= [a_1b_1 - a_2b_2 - a_3b_3 - a_4b_4 + a_1c_1 - a_2c_2 - a_3c_3 - a_4c_4, \quad a_1b_2 + a_2b_1 + a_3b_4 - a_4b_3 \\ &\quad + a_1c_2 + a_2c_1 + a_3c_4 - a_4c_3, \quad a_1b_3 - a_2b_4 + a_3b_1 + a_4b_2 + a_1c_3 - a_2c_4 + a_3c_1 \\ &\quad + a_4c_2, \quad a_1b_4 + a_2b_3 - a_3b_2 + a_4b_1 + a_1c_4 + a_2c_3 - a_3c_2 + a_4c_1] \\ &= [a_1b_1 - a_2b_2 - a_3b_3 - a_4b_4, \quad a_1b_2 + a_2b_1 + a_3b_4 - a_4b_3, \quad a_1b_3 - a_2b_4 + a_3b_1 \\ &\quad + a_4b_2, \quad a_1b_4 + a_2b_3 - a_3b_2 + a_4b_1] \oplus [a_1c_1 - a_2c_2 - a_3c_3 - a_4c_4, \quad a_1c_2 + a_2c_1 \\ &\quad + a_3c_4 - a_4c_3, \quad a_1c_3 - a_2c_4 + a_3c_1 + a_4c_2, \quad a_1c_4 + a_2c_3 - a_3c_2 + a_4c_1] \\ &= (a \otimes b) \oplus (a \otimes c). \end{aligned}$$

*Theorem 4.*—Multiplication is associative.

$$\begin{aligned} a \otimes (b \otimes c) &= [a_1, a_2, a_3, a_4] \otimes [b_1c_1 - b_2c_2 - b_3c_3 - b_4c_4, \quad b_1c_2 + b_2c_1 + b_3c_4 - b_4c_3, \\ &\quad b_1c_3 - b_2c_4 + b_3c_1 + b_4c_2, \quad b_1c_4 + b_2c_3 - b_3c_2 + b_4c_1] \\ &= [a_1(b_1c_1 - b_2c_2 - b_3c_3 - b_4c_4) - a_2(b_1c_2 + b_2c_1 + b_3c_4 - b_4c_3) - a_3(b_1c_3 - b_2c_4 + b_3c_1 \\ &\quad + b_4c_2) - a_4(b_1c_4 + b_2c_3 - b_3c_2 + b_4c_1), \quad a_1(b_1c_2 + b_2c_1 + b_3c_4 - b_4c_3) + a_2(b_1c_1 \\ &\quad - b_2c_2 - b_3c_3 - b_4c_4) + a_3(b_1c_4 + b_2c_3 - b_3c_2 + b_4c_1) - a_4(b_1c_3 - b_2c_4 + b_3c_1 + b_4c_2), \\ &\quad a_1(b_1c_3 - b_2c_4 + b_3c_1 + b_4c_2) - a_2(b_1c_4 + b_2c_3 - b_3c_2 + b_4c_1) - a_3(b_1c_4 + b_2c_3 \\ &\quad - b_3c_2 + b_4c_1) + a_4(b_1c_1 - b_2c_2 - b_3c_3 - b_4c_4) + a_4(b_1c_2 + b_2c_1 + b_3c_4 - b_4c_3), \\ &\quad a_1(b_1c_4 + b_2c_3 - b_3c_2 + b_4c_1) + a_2(b_1c_3 - b_2c_4 + b_3c_1 + b_4c_2) - a_3(b_1c_2 + b_2c_1 + b_3c_4 \\ &\quad - b_4c_3) + a_4(b_1c_1 - b_2c_2 - b_3c_3 - b_4c_4)] \\ &= [(a_1b_1 - a_2b_2 - a_3b_3 - a_4b_4)c_1 - (a_1b_2 + a_2b_1 + a_3b_4 - a_4b_3)c_2 - (a_1b_3 - a_2b_4 + a_3b_1 \\ &\quad + a_4b_2)c_3 - (a_1b_4 + a_2b_3 - a_3b_2 + a_4b_1)c_4, \quad (a_1b_2 + a_2b_1 + a_3b_4 - a_4b_3)c_1 + (a_1b_1 \\ &\quad - a_2b_2 - a_3b_3 - a_4b_4)c_2 + (a_1b_4 + a_2b_3 - a_3b_2 + a_4b_1)c_3 - (a_1b_3 - a_2b_4 + a_3b_1 \\ &\quad + a_4b_2)c_4, \quad (a_1b_3 - a_2b_4 + a_3b_1 + a_4b_2)c_1 - (a_1b_4 + a_2b_3 - a_3b_2 + a_4b_1)c_2 + (a_1b_1 \\ &\quad - a_2b_2 - a_3b_3 - a_4b_4)c_3 + (a_1b_2 + a_2b_1 + a_3b_4 - a_4b_3)c_4, \quad (a_1b_4 + a_2b_3 - a_3b_2 \\ &\quad + a_4b_1)c_1 + (a_1b_3 - a_2b_4 + a_3b_1 + a_4b_2)c_2 - (a_1b_2 + a_2b_1 + a_3b_4 - a_4b_3)c_3 + (a_1b_1 \\ &\quad a_2b_2 - a_3b_3 - a_4b_4)c_4] \\ &= [a_1b_1 - a_2b_2 - a_3b_3 - a_4b_4, \quad a_1b_2 + a_2b_1 + a_3b_4 - a_4b_3, \quad a_1b_3 - a_2b_4 + a_3b_1 \\ &\quad + a_4b_2, \quad a_1b_4 + a_2b_3 - a_3b_2 + a_4b_1] \otimes [c_1, c_2, c_3, c_4] = (a \otimes b) \otimes c. \end{aligned}$$

To make quaternions four dimensional we add a fifth postulate.

*Postulate V.*—If  $\tau_1, \tau_2, \tau_3, \tau_4$  are elements of  $D$ , such that  $\tau_1 a_1 + \tau_2 a_2 + \tau_3 a_3 + \tau_4 a_4 = 0$  for every quaternion  $a$ , then  $\tau_1 = \tau_2 = \tau_3 = \tau_4 = 0$ .

*Theorem 5.*—There are four quaternions,  $\epsilon_i = [a_{i1}, a_{i2}, a_{i3}, a_{i4}]$  such that  $|a_{ij}| \neq 0$ .

By postulate V there is at least one quaternion different from zero. Let  $\epsilon_1 = [a_{11}, a_{12}, a_{13}, a_{14}] \neq 0$  be a quaternion where in particular  $a_{11} \neq 0$ . Consider  $\epsilon_1$  and also the quaternion  $\epsilon_2 = [a_{21}, a_{22}, a_{23}, a_{24}]$ .

There is at least one determinant of order two in the matrix

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \end{vmatrix}$$

which is not equal to zero. For if

$$\begin{vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{vmatrix} = 0,$$

then considering  $a_{22} = \tau_1$  and  $a_{21} = \tau_2$  the expansion  $\tau_1 a_{11} + \tau_2 a_{12} = 0$  gives by means of postulate V  $a_{21} = a_{22} = 0$ . But  $a_{22}$  may be assumed as any arbitrary non-zero element of  $D$ .

With  $\epsilon_1, \epsilon_2$  consider  $\epsilon_3 = [a_{31}, a_{32}, a_{33}, a_{34}]$  and assume  $a_{33} \neq 0$ . There is at least one non-zero determinant of order three in

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \end{vmatrix}.$$

For

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix} = 0$$

leads to the relation  $a_{33}A_{33} + a_{32}A_{32} + a_{31}A_{31} = 0$ , and by postulate V (since  $A_{33} \neq 0$ )  $a_{33} = 0$ .

Similarly it is seen that  $|a_{ij}| \neq 0$ .

### § 3. IDENTIFICATION WITH ORDINARY QUATERNIONS

The quaternion system as thus defined is holoedrally isomorphic with the quaternions of Hamilton, the coefficients belonging to the same domain  $D$ .

The quaternions  $e_1 = [1, 0, 0, 0]$ ,  $e_2 = [0, 1, 0, 0]$ ,  $e_3 = [0, 0, 1, 0]$ ,  $e_4 = [0, 0, 0, 1]$  form a four dimensional system since

$$\begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \neq 0.$$

By postulate IV and the definition of multiplication these quaternions  $e$  have the multiplication table

	$e_1$	$e_2$	$e_3$	$e_4$
$e_1$	$e_1$	$e_2$	$e_3$	$e_4$
$e_2$	$e_2$	$-e_1$	$e_4$	$-e_3$
$e_3$	$e_3$	$-e_4$	$-e_1$	$e_2$
$e_4$	$e_4$	$e_3$	$-e_2$	$-e_1$

which, apart from symbolism, is the same as the table of § 1.

§ 4. ON THE INDEPENDENCE OF THE POSTULATES

If  $D$  is a domain admitting addition and subtraction, postulates II and III are redundant.

Aside from this case postulates I-IV are independent, as shown by the following systems:

(I) Elements  $o, [\pm 1, o, o, o], [o, \pm 1, o, o], [o, o, \pm 1, o], [o, o, o, \pm 1]$ .  
 Postulate II holds, since  $o$  is an element.

Postulate III holds, since  $[+1, o, o, o] + [-1, o, o, o] = o$ ; and  $[o, +1, o, o] + [o, -1, o, o] = o$ ;  $[o, o, +1, o] + [o, o, -1, o] = o$ ;  $[o, o, o, +1] + [o, o, o, -1] = o$ .

Postulate IV holds, since the product of any two elements gives an element.

Postulate V holds, since no mention is made of the  $\tau$ 's.

Postulate I does not hold, since  $[1, o, o, o] + [o, 1, o, o]$  is not an element.

(II)  $D$  is the domain of positive integers.

Postulate I is true, since addition is possible.

Postulate III is dependent (conditionally) upon postulate II. Therefore it is not considered here.

Postulate IV holds for those values of  $a_i$  and  $b_i$  which make the  $p_i$  positive. The values which make the  $p_i$  negative are excluded by the statement of postulate IV and the definition of  $D$ .

No mention is made of the  $\tau$ 's. Therefore postulate V need not be considered.

Postulate II does not hold, since zero is not an element.

(III) Set (II) with zero added.

Postulates I, IV, V, hold for the same reasons as in (II).

Postulate II holds since 0 has been added to the domain.

Postulate III does not hold, since subtraction is not always permissible.

(IV)  $D$  is the domain of complex numbers, the  $a_i$  being pure imaginaries.

Postulates I, II, III hold, since addition and subtraction is always possible.

Postulate V need not be considered, as no mention is made of the  $\tau$ 's.

Postulate IV does not hold, since the product of any two elements is real.

(V)  $a_1$  arbitrary; other  $a$ 's zero.

Postulates I, II, III are true, since addition and subtraction are always possible.

Postulate IV is true, since multiplication is always possible.

Postulate V is not true, since, if  $a_1\tau_1 + a_2\tau_2 + a_3\tau_3 + a_4\tau_4 = 0$  where  $a_2 = a_3 = a_4 = 0$ ,  $\tau_2\tau_3\tau_4$  may have any values.

April, 1906.

# AREAL GEOLOGY OF LOWER CLEAR CREEK (COLORADO)<sup>1</sup>

BY JAMES UNDERHILL

## INTRODUCTION

The area under consideration, shown on the key map, Fig. 1, embraces the northern portion of what I have called the Evergreen Quadrangle, about 180 square miles, and the southern portion of the Black Hawk Quadrangle, about 60 square miles. I have also covered in great detail, as far as the dikes are concerned, the region embraced in the so-called Idaho Springs and Central City special maps, an area of about 18 square miles.

For the Black Hawk I had the excellent topographic map of the United States Geological Survey on a scale of 1-45,000, or about 1½ inches to the mile. For the special area I had the Idaho Springs and Central City specials on a scale of 1-12,000, or about 5 inches to the mile.

There being no topographical map of the Evergreen Quadrangle, one had to be made before geological mapping could be done, and this has been in part constructed as follows: Where the Georgetown and Black Hawk Quadrangles overlapped on the Evergreen Quadrangle, the topography of these maps has been used. On the south and east the topography of the Platte Cañon and Denver sheets respectively has been used. Surrounded as the Evergreen Quadrangle has thus been, it has been admirably checked on all sides. Several triangulation points of the U. S. Geological Survey on the Evergreen Quadrangle, with some other triangulation points on other quadrangles that may be seen from it, have been plotted. Other points have been more or less accurately determined with the pocket sextant. Then the township lines were laid on with checks by the topographic sheets above mentioned, and finally the sections and their topographic "guesses"—for they are little better—were sketched in. These topographic features have been found reasonably accurate at the intersections with the township lines, but as a rule

<sup>1</sup> Presented to the Graduate Faculty of the University of Colorado in a partial fulfilment of the requirements for the degree, doctor of philosophy.

absolutely unreliable in other places. These features, which consist usually only of the creeks, have been checked as well as may be by the pocket sextant, and also by pacing and courses taken with the Brunton Compass. The notes of the pipe-line for the City of Golden water-

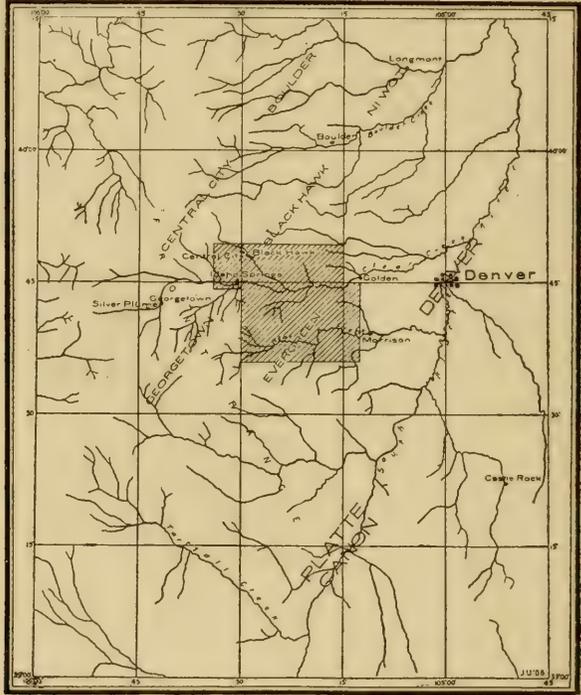


FIG. 1.

works kindly furnished by Mr. Carstarphen, the city engineer, have been of great service as a check on the northern portion of the Evergreen Quadrangle.

#### TOPOGRAPHY

The topography of the area in question may be divided into two divisions, the western and eastern sections. The topography of the western section is seen to be rugged, and, while not so much as the Georgetown and Central City Quadrangles to the west, its topography is more accen-

tuated than the topography of the eastern section. The topography of the eastern portion may be defined as subdued topography, except where it is deeply cut by Clear Creek and Bear Creek.

Unlike the Georgetown and Central City Quadrangles, there is little evidence of glaciation. On the flanks of Squaw Mountain, especially at the head of North Beaver Creek, the amphitheater-like topography gives one an impression of a glacial cirque, and the idea receives confirmation by an accumulation of detrital material just at the beginning of the V-shaped valley of North Beaver Creek. To a less extent South Beaver Creek exhibits the same phenomena, and both creeks continue their courses as V-valleys. The subdued topography of the eastern portion strongly reminds one of a peneplain, and there is good reason to consider that all the eastern portion was once base leveled, and

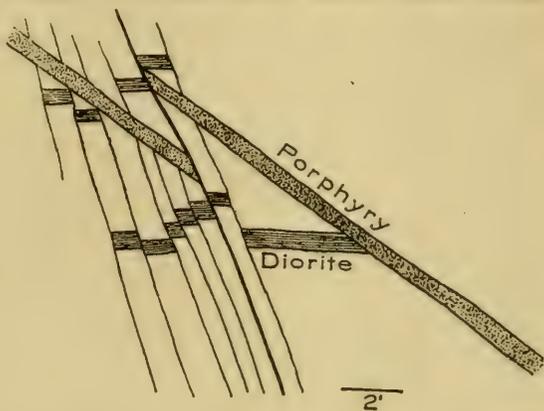


FIG. 2.

since has been deeply dissected on the north and south by Clear Creek and Bear Creek, and their respective tributaries.

This peneplain or base-level was elevated in common with the remainder of the Rocky Mountains in Tertiary times, and Clear Creek and Bear Creek cañons with the cañons of their tributaries have been entirely eroded since that period. In many cases the side streams have not yet cut deep cañons, and we have at their sources the gentle, well-rounded slopes of Tertiary time, in sharp contrast with the deep cañons of the lower portions of the same streams. This is true also of the upper waters of Clear Creek and Bear Creek outside of the area here considered. In fact, a very close approximation to Tertiary topography could probably be reached in a topographic map of the eastern portion of the area under consideration by simply neglecting the deep cañons and putting in their

place mature valleys with gentle slopes to represent the stream system of that time.

### GEOLOGY

In nearly all the accounts of this region and the associated areas of the front range, especially those written some years ago, the rocks have been

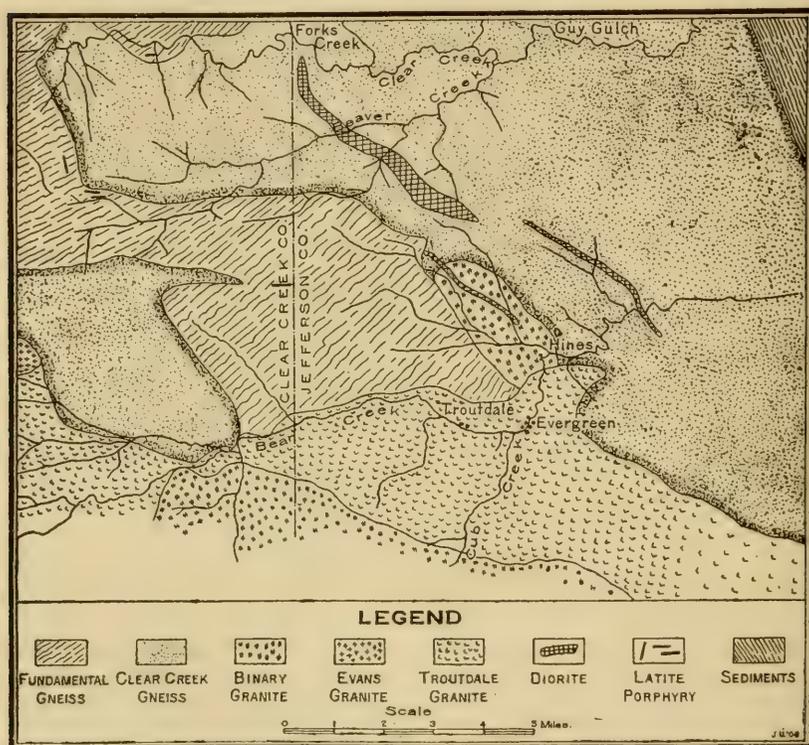


FIG. 3.—Portion of the Evergreen Quadrangle.

assumed to be of sedimentary origin, and so described. The banding has nearly always been regarded as the stratification, and thought to represent the dip of the original sedimentary rocks, from which the present complex was derived.

The geology of the lower Clear Creek area is a complex of presumably metamorphosed igneous rocks, usually designated as pre-Cambrian, but

only certainly pre-Jura-trias, and then only for the main masses. That certain portions are of late eruptive origin can be proved, and possibly all of the country will some day be shown, as in the case of the Green Mountain area in Massachusetts, to be as late as Devonian.

That this supposedly pre-Cambrian complex was originally igneous and since metamorphosed by great dynamic forces, regional metamorphism, and thus as a consequence has taken on a well-defined schistosity,

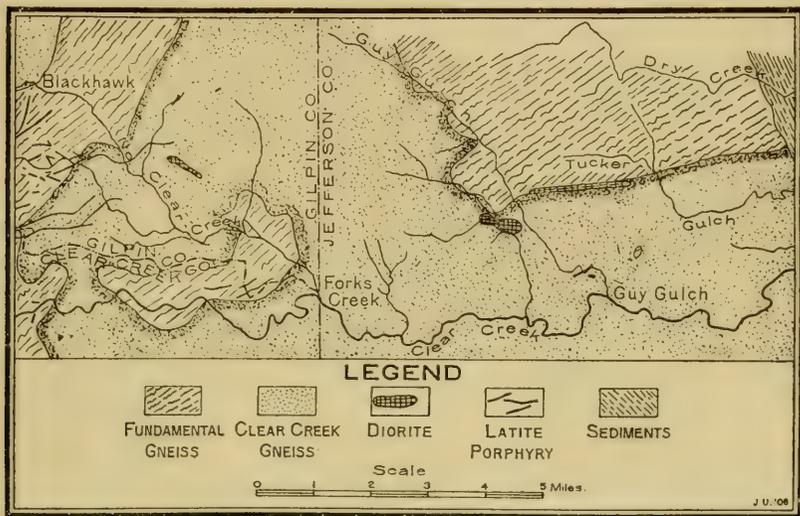


FIG. 4.—Portion of the Black Hawk Quadrangle.

is borne out by its comparative homogeneity over large areas in the field, and by the thin sections studied. It is difficult to believe that alternating strata and formation of sedimentary rocks could have been metamorphosed into such areas of homogeneous material as at present exist, and the appearance of the lithologic units as mapped up to the present strongly give the idea of an arrangement by igneous forces. While the complex of the lower Clear Creek area may be divided into a number of lithologic units with more or less certainty, in all probably about eleven or more, only ten can be recognized with certainty in the area in question. These formations beginning with the oldest, the Fundamental Gneiss, have been arranged as follows:

Fundamental Gneiss  
 Clear Creek Gneiss  
 Binary Granite  
 Central City Granite (Evans Granite)  
 Troutdale Granite  
 Diorite  
 Pegmatite and Aplite  
 Latite Porphyry  
 Pleistocene and recent

The Fundamental Gneiss and Clear Creek Gneiss, while tolerably distinct as areas, grade into each other at their boundaries, and the situation can be best described by a quotation from *Monograph XXVIII*, U. S. Geological Survey, on the Marquette Region, by W. S. Bayley. On p. 151 he says:

The foliated rocks occupy areas whose boundaries are not so well defined as is the case with the Marquette fragmentals. . . . Nevertheless, an attempt has been made to map these areas. In their interiors the different phases of schists, granites and syenites are well characterized, but on their peripheries there is always a complex mixture of the various schists with one another or with the granite rocks. The respective colors on the map are believed to cover the areas within which the corresponding rocks predominate largely over other rocks. The boundary lines separating the different areas are drawn at about the places the different varieties are found in approximately equal quantities.

And again from the Ashville Folio (Folio 116, p. 4):

In only a few cases do the boundaries shown on the map represent a single contact between two large masses; they usually indicate a narrow zone beyond which one rock or the other predominates. Sometimes an area shown as gneiss may contain many small beds of granite, or it may be substantially all gneiss. On the other hand, many of the areas represented as granite include also small bodies of gneiss. These may be continuous with one another or may be disconnected inclusions. Except where these bodies were the prevalent rock over considerable areas, they were disregarded in the mapping.

It might be added for the whole Clear Creek district that one outcrop may give examples of any or almost all of the lithologic units in question.

It is well known that pre-Cambrian areas have a close resemblance the world over. The lower Clear Creek area closely resembles other areas in the United States that have been most closely studied, as, for example,

the Lake Superior, Southern Appalachian, Southern Colorado, and Grand Encampment regions.

#### FUNDAMENTAL GNEISS

Wherever in the Clear Creek section the rocks have been studied, this biotite gneiss is found to be with the Clear Creek Gneiss, the prevailing lithologic unit recognized and

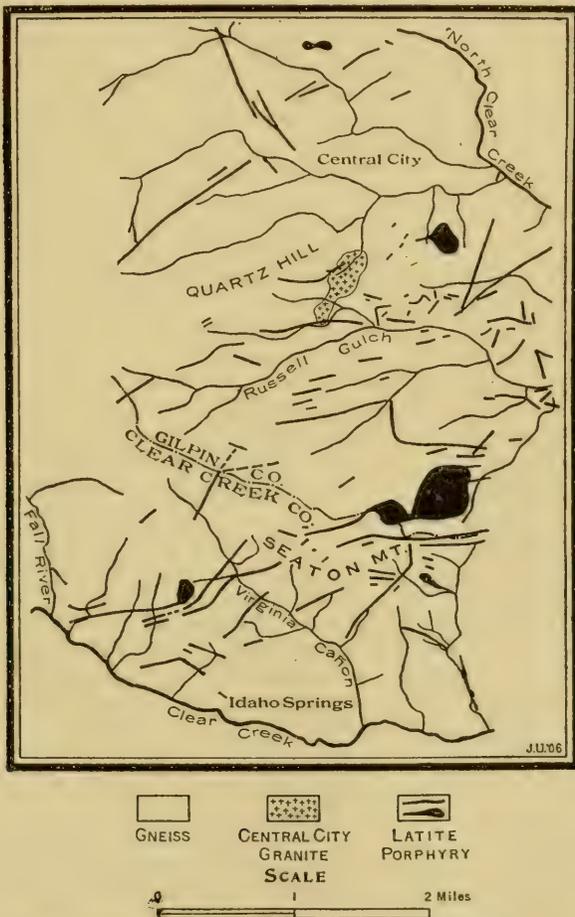


FIG. 5.—Idaho Springs and Central City Special Maps.

mapped. The Fundamental Gneiss as the prevailing rock is everywhere much plicated and crumbled, and shows signs of having been subjected to intense dynamic metamorphism. It is far more metamorphosed than any other rock of the country thus far studied,

and is older than any other petrographic unit. Except where it is in contact with the Evans Granite, its schistosity or banding has a prevailing dip to the north at every possible angle. Its strike is east and west. Where in contact with Evans Granite, it dips away from the granite with a strike parallel to the contact. In the intense metamorphism resulting from pressure, it takes on the most fantastic and varied plications and crumpings possible, and every variety of folding to be found in any mountain region can, as a rule, be found here within a restricted area. The folding is accompanied by faulting, but, wherever possible to be determined, the resulting movements are for short distances only.

The history of the rock would seem to be that of an igneous rock exposed to great compression in the zone of flowage, and recrystallization of its materials along bands or zones. A subsequent folding followed, and afterwards faulting and jointing. The development of garnet and fibrolite described in the specimens is not universal, and the fibrolite gneiss does not seem to be developed according to any particular law. The garnets, on the contrary, have been observed in greatest development on the borders of the granitoid gneiss, in the Evergreen Quadrangle on the east, south, and west of the mass, though not on the north. This leads to the suggestion that the intrusion of Clear Creek Gneiss has developed the garnets in the Fundamental Gneiss as contact minerals.

The rock in the hand specimen is seen to be a fine-grained mixture of quartz, biotite, feldspar, fibrolite, and garnet in a general banded arrangement.

*Microscopic.*—Under the microscope the rock is seen to consist of a banded arrangement of biotite, quartz, frequently showing pegmatitic intergrowths with the feldspar, and undulatory extinction, and both microcline and plagioclase feldspar. Apatite is abundant. In many specimens, especially those from the Evergreen Quadrangle, there is an abundant development of fibrolite. This occurs as highly polarizing fibrous masses in parallel bands with the other materials of the section, and even penetrating the biotite, following the cleavage. Usually associated with the fibrolite is developed characteristic iron garnet, often in great abundance. In addition, we frequently find magnetite, hematite, apparently formed from the magnetite, rubellane mica, and occasionally hornblende, closely interwoven with the biotite. The specimens have every indication of an eruptive rock, greatly compressed and recrystallized, hence the banded structure. It nowhere shows any signs of having been a sedimentary rock, and if it ever was, it has been entirely remelted to the complete destruction of all former texture.

#### CLEAR CREEK GNEISS

This formation occupies a large portion of the area under consideration, and while at some distance away from the Fundamental Gneiss it differs essentially from that unit, there is rarely any sharp contact between the two formations. The two nearest approaches to a sharp contact are to be seen in the eastern portion of the area studied. Here the contact transition zone probably occupies a space of about five hundred feet. On North Beaver Creek there is a space of about half a mile before either rock is prevailingly the unit mapped.

While the Clear Creek Gneiss shows the effects of having its banding or gneissic texture developed by great compressive forces, it has nowhere, except perhaps in the transition zone noted on North Beaver Creek, been so much plicated as the Fundamental Gneiss, neither has it suffered intrusion of pegmatite and diorite in so marked a degree as the

Fundamental Gneiss. Like the latter, its dip is prevailingly to the north. It is predominantly the home of the latite porphyry dikes.

*Microscopic.*—The hand specimen consists of an evenly banded arrangement of quartz, feldspar, and mica, but without the plications usual in the Fundamental Gneiss.

*Microscopic.*—Under the microscope the rock is seen to consist of quartz, orthoclase, plagioclase, microcline, biotite, muscovite, magnetite, apatite, epidote, titanite, calcite, zircon, fibrolite, and hematite. Sericite is occasionally developed.

The quartz is generally in excess and shows in every case undulatory extinction. The feldspars appear as in the Fundamental Gneiss series, but in most cases show marked undulatory extinction. The muscovite and biotite occur as independent aggregates, and also frequently intergrown. The rock in question is distinguished from the Fundamental Gneiss series by its greater resemblance to a normal granite and by the smaller quantity of biotite.

For the areas covered by the Idaho Springs and Central City special maps no attempt has been made to separate the Fundamental Gneiss from the Clear Creek Gneiss on the map. There are two reasons for this.

In the first place, the two units are very intricately combined in one vast complex, which has been subjected to repeated fissuring and faulting. The faulting is not important, so far as the distance of movement is concerned, but when one considers the area affected, it assumes considerable importance. Then, too, this special area has been almost universally injected with pegmatite, and intruded by recent eruptive dikes. In addition to all this, we have the metamorphism of the rock by the subsequent, or usually subsequent, vein-filling solutions. All this causes a complex exceedingly difficult to unravel, and still more difficult to represent on a small scale map such as must be used in a report of this kind. It may be stated, however, that detailed notes have been taken for this area, and material for a reasonably exact map is at hand.

To anyone interested in the study of these Gneisses the Newhouse Tunnel offers an admirable section of some three miles in length. The direction of the tunnel in round numbers is about N.  $15^{\circ}$  W. At a few hundred feet south of the Gem vein the tunnel leaves the Fundamental Gneiss and cuts the Clear Creek Gneiss. This contact is still further to the south on the surface; in other words, the contact dips to the north at an angle of something like  $45^{\circ}$ . While some porphyry dikes have been cut in the Fundamental Gneiss, a far greater number are to the north in the Clear Creek Gneiss. The Fundamental Gneiss has been greatly plicated and more disturbed, it is true, than the Clear Creek Gneiss to the north, but it is in this latter that we can see most clearly, though not on such a large scale, the effects of dynamic action. This is fortunate, for in the narrow section cut by the Newhouse Tunnel every possible example of faulting and folding is in evidence in the course of a few thousand feet. These evidences of movement are rendered clear by the frequent alternating bands of black diorite and white gneiss, and strongly reminds one of the diagrams illustrating works on geology. In most cases the faults are not composed of one simple fault-plane, but are a series of distributive faults or fault zone. Frequently the fault-planes are so numerous and close together that we have simply a zone of sheeting. One of the very interesting occurrences is that shown on the west side of the tunnel just beyond the Sun and Moon vein (Fig. 2).

## BINARY GRANITE

This granite occupies a small area just north of Hines' and a much larger area south of the Troutdale granite. No traverse yet made has reached the southern boundary of this mass. As this granite is easily weathered, it is almost impossible to find good outcrops, and it can be traced only by its residuals and by an occasional cutting. In this way we find the topography of the area occupied by the Binary Granite subdued, and relatively rolling with well-rounded slopes, especially in comparison with the Troutdale Granite area.

*Petrography.*—In the hand specimen this rock consists essentially of an intimate mixture of quartz and red feldspar.

Under the microscope the quartz is seen to have an undulatory extinction. The feldspar is, as a rule, microcline, with some acid plagioclase and occasional orthoclase. The accessory minerals are apatite and biotite occurring in small amount.

## CENTRAL CITY GRANITE

This rock, so far as known, occurs only on each side and a little to the south of the head of Spring Gulch just south of the Central City Railroad Station. It is very clearly a mass of granite intruded into the surrounding gneiss, with which it forms a sharp contact to the north on the road to Central City. With the exception of a small hill on its most southerly extension, this granite is easily disintegrated and forms characteristic well-rounded outcrops.

*Petrography.*—In the hand specimen this granite proves to be a hypidiomorphic arrangement of quartz, feldspar, and biotite. There is a suggestion of a banded arrangement, which is more evident in the larger masses.

Under the microscope the quartz shows the results of dynamic action by its undulatory extinction. The feldspar is found to be nearly all an acid plagioclase, with some few grains of orthoclase. There is an abundance of biotite, also a little hornblende. Apatite, titanite, magnetite, and zircon occur in the usual form of these minerals.

The rock is classed with the alkali granites or granitites.

## EVANS GRANITE

This granite occupies a small area on the western portion of the Evergreen Quadrangle. It strongly resembles the Central City Granite, and is very likely the same petrographic unit. No petrographic determination was made of this rock.

## TROUTDALE GRANITE

As can be seen from the map, this petrographic unit occupies a territory on either side of Bear Creek, from a point just east of the town of Evergreen to the western boundary of the Evergreen Quadrangle. It shows every evidence of being a true eruptive granite, and in many cases along Bear Creek, at best just west of Troutdale, are seen apophyses of granite in the Fundamental Gneiss. This has been called the Troutdale Granite on account of its picturesque development at the resort of that name. It is probably, judging from the comparison of hand specimens, the same granite that occurs at Georgetown, Colo., though, so far as known, there is no direct connection. While not found cutting the Binary Granite, there is good reason for thinking it is younger, especially as it seems to divide the Binary Granite into two masses. The topography of the area occupied by

the Troutdale Granite is rough and accentuated, forming in many cases deep cañons with steep walls and picturesque towers of rock. This area is in marked contrast with the subdued areas to the north and south.

*Macroscopic.*—In the hand specimen this granite appears as a hypidiomorphic mixture of quartz, red or pink feldspar, and biotite.

*Microscopic.*—Under the microscope we find that the quartz has a slight undulatory extinction at times; the feldspar is chiefly an acid plagioclase with some orthoclase and microcline. The microcline frequently shows Carlsbad twinning in addition to the characteristic cross-hatching. Sometimes the feldspar is seen in pegmatitic intergrowths with the quartz. The feldspar is frequently found altered to sericite. In addition to these minerals, we have muscovite, apatite, titanite, magnetite, and zircon.

This is also an alkali granite. It differs from the Central City granite in the less amount of femic or ferro-magnesian minerals, and in the presence of muscovite, wanting in the Central City Granite.

#### DIORITE

The next lithologic unit of importance is represented by the numerous diorites, of which one large mass east of Creswell is particularly interesting. This mass, extending nearly to Clear Creek Canon, turns toward the southeast to a point north of Bear Creek. Except in several local instances, this rock is a massive diorite, and shows little or no evidence of dynamic metamorphism, though there is good reason to believe, from the study of the specimens collected and examined, that chemical metamorphism has been active.

Besides this large mass of diorite, there are everywhere present in the Fundamental Gneiss, and to some extent in the Clear Creek Gneiss, small dikes of diorite, for the most part parallel to the schistosity or banding, and, while almost without exception greatly sheared and squeezed by dynamic forces, are but rarely plicated. These, while not so extensively metamorphosed as the inclosing rock, are still greatly affected by the same or similar forces. The greater metamorphism of the smaller dikes seems to imply either a greater age for these intrusions, as a rule, than for the larger mass of diorite, or else a less ability to withstand the forces of metamorphism than was possessed by the larger mass of diorite. No attempt has been made to map these smaller dikes, only the most important receiving attention.

*Macroscopic.*—The rock consists of an even grained holo-crystalline mixture of hornblende and plagioclase feldspar. In many specimens and in the larger masses of rock, as a rule, there is no striking evidence of banded texture, but some specimens have a banded appearance which at times becomes schistose. In some of the dikes there is a marked coarse-grained texture, strongly suggestive of a typical gabbro, and here the component minerals occur in large crystals with abundant development of garnet.

*Microscopic.*—Under the microscope the rock is seen to consist essentially of a holo-crystalline mixture of green hornblende and plagioclase, with some biotite, augite, quartz, apatite, magnetite, titanite, epidote, garnet, and secondary calcite and actinolite; the whole, as a rule, taking on a banded arrangement.

The hornblende is of the common green variety, showing basal sections predominating, with the usual two prismatic cleavages. It is, as a rule, distinctly pleochroic, but in some specimens shows only the faintest pleochroism. In the strongly pleochroic

varieties we have  $a$ =yellowish green,  $h$ =dark green,  $r$ =yellowish green. Absorption showing  $r=h > a$ . The feldspars are all striated, showing polysynthetic twinning according to both the albite and pericline laws. As no examples of Carlsbad twinning were observed, it was found impossible to determine the plagioclases according to the method of Michel-Lévy, but, as the extinction angles average about  $15^\circ$  and one as high as  $40^\circ$  was observed, the composition is probably about oligoclase-andesine. Nearly all the feldspars show undulatory extinction, showing that they have been exposed to great pressure, but at the same time not so much as would be expected from the appearance of many of the hand specimens. This would seem to imply that considerable recrystallization had taken place.

In the very coarse-grained varieties an iron garnet is very abundant. Inclosed in the garnet have been noticed quartz, plagioclase, and hornblende. The other minerals mentioned above present the usual aspects.

#### PEGMATITE AND APLITE

Every rock noticed in this district has been intruded by pegmatite and aplite, usually acid in nature, but more rarely, as in the case of the diorite pegmatite described for Guy Gulch, and also another occurrence near the Gem power plant on Clear Creek, basic in composition. These pegmatites, intruded in every imaginable way into older rocks, have the most fantastic and varied cross-section. They frequently carry great quantities of magnetite, which afterwards supplies in great part the black sands and pebbles in the placers. Locally, graphic granite is often developed, probably at its best near Roscoe on Clear Creek. The pegmatite rarely shows evidences of having been subjected to great dynamic forces. It has a common development near bodies of sheared diorite.

It has been found impossible to map satisfactorily the pegmatite injections, and for this area no attempt has been made in this direction. Some petrographic descriptions of these rocks are, however, added.

#### PEGMATITE (*Graphic Granite*). Roscoe, by C. & S. tracks

*Macroscopic*.—The rock consists of bands or pencils of quartz and feldspar showing on cross-section the common graphic texture.

*Microscopic*.—Under the microscope the rock is seen to consist of alternating bands of quartz and microcline, the former showing undulatory extinction, giving in one place the appearance of twinning. The microcline has the usual cleavage texture, but with one cleavage developed parallel to the quartz, the other at right angles. This would seem to indicate a continued pressure in one, or perhaps two, definite directions.

#### APLITE. N. W. Corner of Evergreen Quadrangle

*Macroscopic*.—The rock is a pegmatitic rock consisting of quartz, feldspar, and some pyrite. The specimen is traversed by a small vein of oxidized material.

*Microscopic*.—The rock under the microscope is seen to consist of a medium fine-grained holocrystalline mixture of quartz, microcline, and some orthoclase, with small amounts of pyrite, magnetite, and muscovite. The quartz shows undulatory extinction, and the whole rock shows signs of compression, and effect of dynamic forces, as is suggested by the microcline twinning. The specimen is seen to be traversed by a small vein consisting of oxidized material, and here the feldspars have been impregnated and somewhat altered.

## DIORITE PEGMATITE. Guy Gulch, by C. &amp; S. tracks

*Macroscopic.*—The hand specimen is a rather pegmatitic-looking mass composed entirely of hornblende, feldspar in most cases striated, and black mica.

*Microscopic.*—Under the microscope the rock is seen to consist of a coarse-grained aggregate of green hornblende, biotite, plagioclase, orthoclase, the former predominating, together with a little quartz, apatite, epidote, calcite, titanite, and magnetite, all exhibiting the ordinary characteristics of these minerals. The quartz and feldspar show frequent pegmatitic or granophyric intergrowths. The plagioclase appears to have a low extinction angle, and to be near the albite end of the series, probably oligoclase.

## LATITE PORPHYRY

In certain portions of the district in question, notably the areas covered by the special maps, and also in the western portion of the Black Hawk Quadrangle, the country is extensively traversed by porphyry dikes. While these dikes run in every direction, the majority of them have a course N. E. by S. W., or the same as the prevailing vein system. It is interesting to note that, while there are no veins of importance outside of the area traversed by the dikes, the area of the dikes at the same time extends beyond the area traversed by the important veins. These dikes vary in size from a few inches to hundreds of feet in width, and from a few feet to many miles in length. As a rule, however, they die out in a few hundred feet. In the field they all have the same general characteristics, and vary in color from brown and red to gray. They are reasonably straight, but dip at all angles, though, like the veins, in the majority of cases the dip is rather steep.

At various points all over the area studied, and especially near veins, the dikes have been brecciated, and in some cases the fragments in every way resemble water-worn pebbles. These occurrences have been explained as true conglomerates of as early as Algonkian time, notwithstanding the fact that there is good reason to consider the porphyry composing the pebbles as Tertiary. The phenomena have also been explained as resulting from the fall of water-worn pebbles into open crevices. The true explanation of the phenomena probably is the extensive brecciation and complete shattering of the dike. Subsequent kneading movement, possibly aided by solution, reduced the angularity of the fragments, and in some instances gave them the appearance of water-worn pebbles. The best places to study these phenomena are Banta Hill and the so-called "Queen's Chair."

The dikes, as a rule, are closely "frozen" to the inclosing walls, and, though carefully sought for, in but one case was any sign of contact metamorphism observed. That there has been shrinking in cooling is evident by the lines of fracture when the rock is broken.

It is difficult to obtain fresh specimens on the surface, and when near veins they are also greatly decomposed, as a rule. The best specimens are to be procured in cross-cut tunnels outside of the vein area and in newly made roads. The dikes usually have a fine-grained appearance when fresh, and the porphyritic appearance and the display of phenocrysts, as a rule, are the result of weathering or underground decomposition. In the hand specimen the rock varies through all the stages from what might be called a felsite, which is all ground-mass with no phenocrysts, to a granite porphyry which has little ground-mass, and which might be said to be all phenocrysts. This latter phase is often taken for a granite and not regarded as a porphyry at all. Those rocks locally known as porphyry

have been described by every name from andesite to phonolite in different reports. They do vary from the composition of andesite to that of trachyte, but in the area specially studied they are of intermediate composition, and may be called Latite Porphyry.

It is very possible that they are the necks of surface flows which furnished the andesite pebbles for the beds of the Denver Formation.

*Microscopic.*—Under the microscope the porphyries vary from a rock composed of a holocrystalline ground-mass of quartz and feldspar with no phenocrysts, to a rock with little ground-mass and resembling the true granite. As a rule, the ground-mass is a fine-grained granitic mosaic, and might be called a micro-granite. In many specimens, especially those that are highly iron-stained and rich in magnetite and hematite, the feldspars are lath-shaped, and the quartz is allotriomorphic to the feldspar and arranged in the spaces left over after the consolidation of the feldspar. Here in many cases the feldspars are iron-stained all through; in other cases the stain has not penetrated to the center. The lath-shaped feldspars have here usually taken on a rough flow structure. In the case of vein breccias and the more andesitic varieties the ground-mass may resemble a felted paste. The highest powers of the microscope fail to resolve this paste into its component minerals.

In the ground-mass, of whatever character, as a rule are larger crystals of phenocrysts of one or more generation. The larger crystals are generally plagioclase, with some orthoclase. These nearly always show evidences of zonal development, and are of intratelluric formation. The feldspars frequently show evidence of rebuilding. The crystals of a second growth are the same as those of the first growth, but, as a rule, rather more acid, with quartz, biotite, and hornblende. In no case in this area has the quartz been seen in large crystals, though one dike on Mill Creek studied outside of the area shows good quartz phenocrysts, with perfect crystalline outlines. All these larger crystals have suffered more or less from corrosion by the magma before the consolidation of the ground-mass. This is especially true of the biotite and hornblende crystals, of which in many cases only the skeletons remain for identification. In one case portions of the ground-mass were noticed entirely inclosed in a phenocryst of feldspar. Among the earliest consolidations are apatite and titanite, frequently in relatively large and well-formed crystals. In the ground-mass, and in addition to the quartz and feldspar previously noticed, are found pyrite, magnetite, biotite, hornblende, augite, hematite, zircon, and in one case fluorite. Sericite, epidote, zoisite, calcite are present as alteration products, with frequent secondary quartz.

#### PLEISTOCENE AND RECENT

At several places noted previously under glaciation, and also at various points in Clear Creek Cañon, gravel deposits have accumulated. On the northwest portion of the Evergreen Quadrangle by the Silver Age Mill on the north side of Clear Creek, and also nearly opposite Sawmill Gulch, on the north side of Clear Creek, the remains of an old stream terrace can be seen about one hundred feet above the present stream-bed. These correspond to the old terraces which are more prominently developed on the Georgetown Quadrangle around Idaho Springs. Some of these are more or less completely consolidated into conglomerates.

#### SEDIMENTS

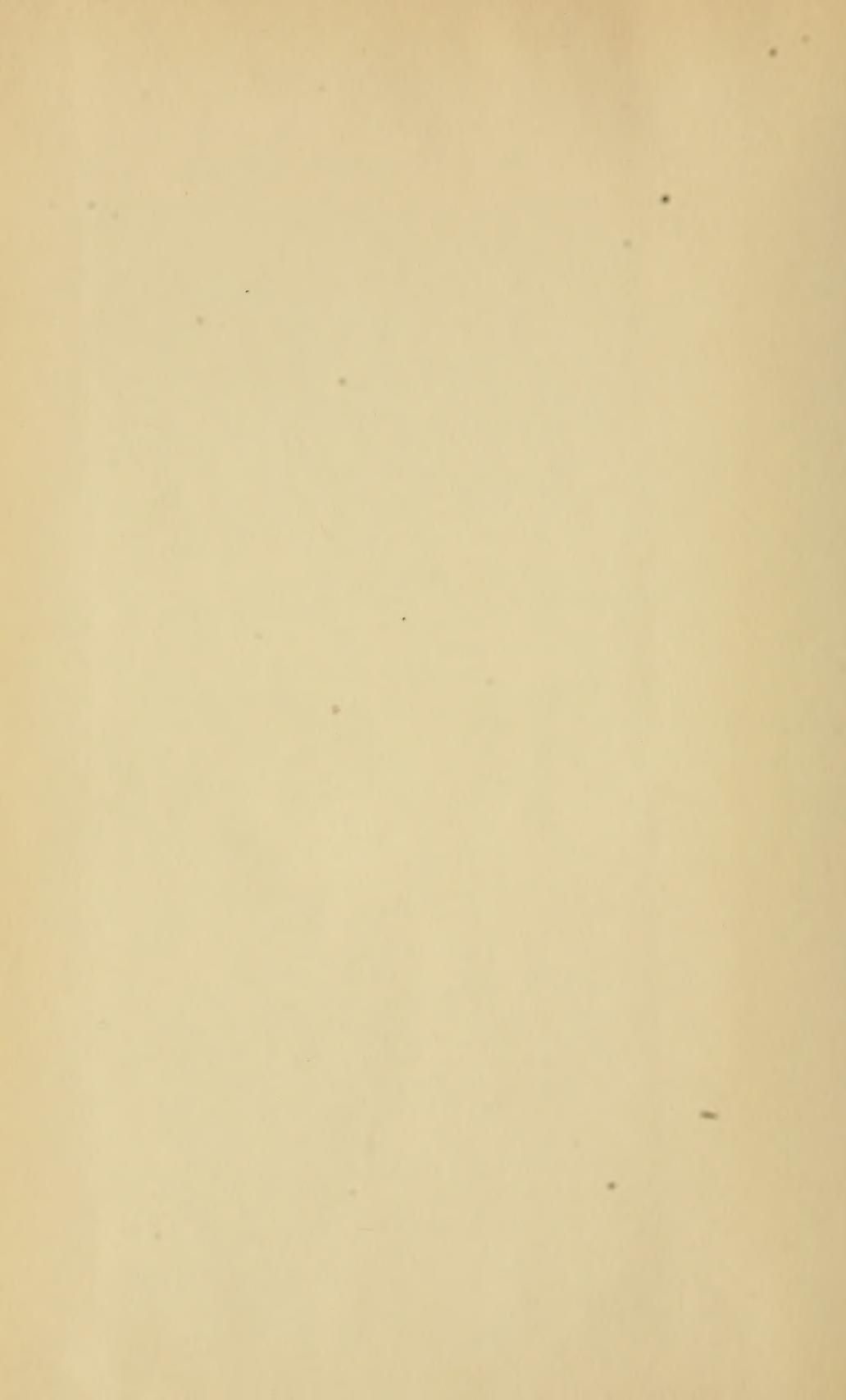
No attempt has been made to map the sediments which have been described in the Denver Monograph.

276











SMITHSONIAN INSTITUTION LIBRARIES



3 9088 00895 7110 \*